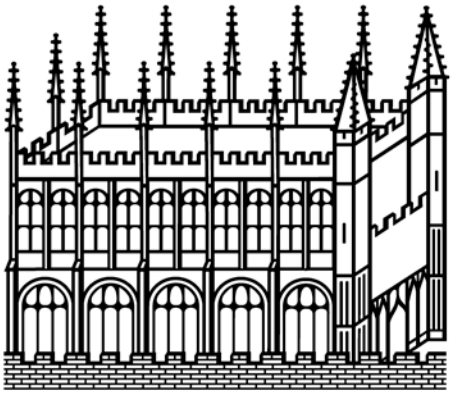

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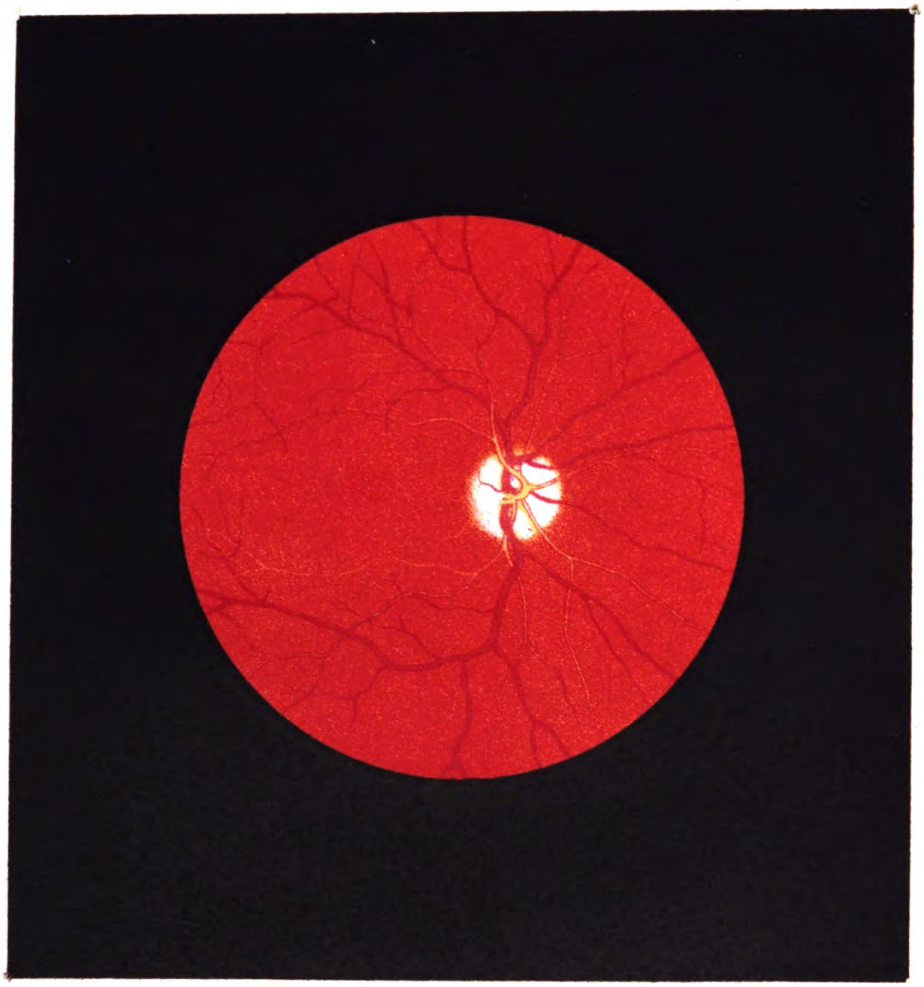
OPHTHALMOSCOPY.

HENRY WILSON.

PLATE I.



Morison, Lith. Dublin.

DUBLIN:
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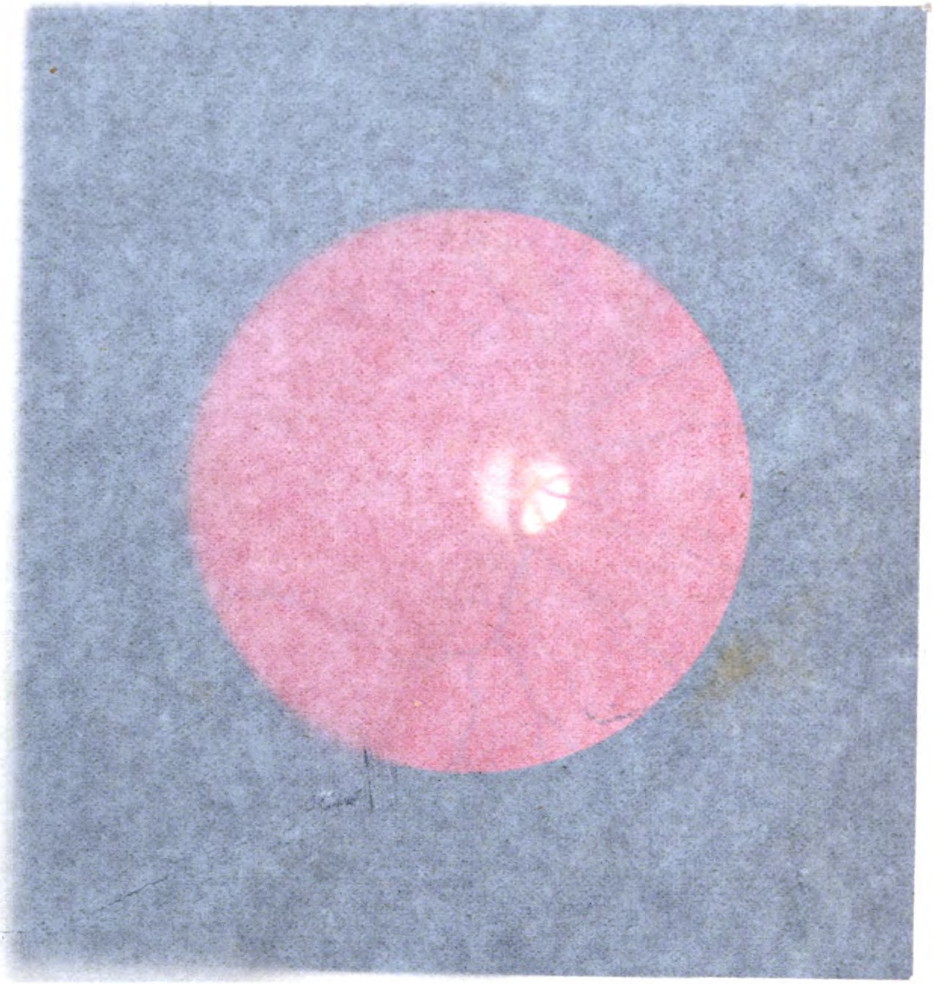
1868



LECTURES

ON THE

THEORY AND PRACTICE

OF THE

OPHTHALMOSCOPE.

BY

HENRY WILSON, F.R.C.S.; M.R.I.A.;

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ETC., ETC., ETC.

DUBLIN:

FANNIN & CO., 41, GRAFTON-STREET.

LONDON: LONGMAN & CO.

1868.

160. h. 16.

Dedicated

TO

SIR WILLIAM R. WILDE, M.D., F.R.C.S.;

VICE-PRESIDENT OF THE ROYAL IRISH ACADEMY;
SURGEON OCULIST IN IRELAND TO HER MAJESTY;
SURGEON TO ST. MARK'S OPHTHALMIC HOSPITAL; ETC., ETC., ETC.;

IN RECOGNITION OF
HIS GREAT AND VARIED SERVICES TO IRISH LITERATURE,
AND TO THE IRISH SCHOOL OF MEDICINE;

AND IN GRATEFUL REMEMBRANCE AND ACKNOWLEDGEMENT OF
THE PRACTICAL INSTRUCTION AND INFORMATION
DERIVED FROM HIM FOR MANY YEARS
BY
HIS AFFECTIONATE PUPIL,

THE AUTHOR.

PREFACE.

THE following Lectures have been delivered from time to time in St. Mark's Ophthalmic Hospital and in the Richmond Hospital in the shape of stated lectures or as clinical instruction by the patient's side; some of them have already appeared in *The Dublin Quarterly Journal of Medical Science*, from which they have been reprinted. It may perhaps be asked what necessity there was for their publication, seeing that several works, probably of a superior character, are already in existence, which either embrace the same subject or treat of it specially. To this not unreasonable question I have to answer that several of these works being expensive or in a foreign language are inaccessible to the general student. I am constantly asked by my pupils what work they should read on the ophthalmoscope, and on my recommending the best and standard one—that of Zander, translated by Mr. Carter—more than one have confessed to me that they have been deterred from the study of that work by its eminently scientific character, by its very learnedness. It is a well-known fact that students and others will read the work of one who is personally known to them in preference to that of a stranger, and that they will study the former when they will not, unless obliged to do so, open the latter at all. The present compilation, which I intend to be simply an *introductory* guide to the study of the diseases within the eyeball, is specially addressed to the students of the Dublin

School of Medicine, to some of whom the Lectures were originally delivered, by one who is personally known to them and who was but recently one of their own body; by one who can and does enter into their difficulties and whom they have no hesitation in questioning and referring to in their doubts and perplexities. So far as my experience goes intra-ocular diseases and the employment of the ophthalmoscope have not hitherto received that attention in this country which they undoubtedly deserve; the use of the ophthalmoscope in ocular and cerebral affections is assuredly as imperatively necessary as the use of the stethoscope in pulmonary and cardiac affections. For these and other reasons I have ventured to make these Lectures public. If I shall thereby have succeeded in diffusing any little additional knowledge, or have assisted my professional brethren in their difficulties, or rendered even the slightest service to the unfortunately very large class of sufferers from diseases of the eyes in my own country, my labour will not have been in vain.

DUBLIN, 29, LOWER BAGGOT-STREET,
26th February, 1868.

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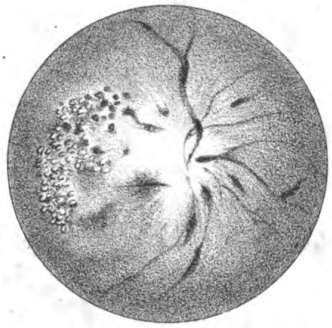
„ Fig. 6.—Long-existing chronic glaucomatic excavation.

PLATE II.

1



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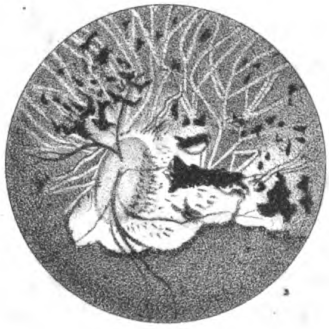

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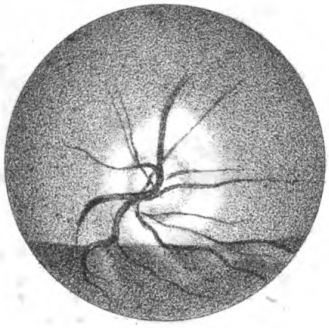

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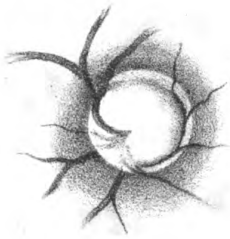

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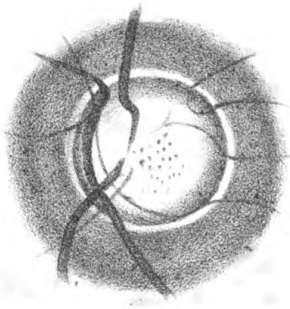

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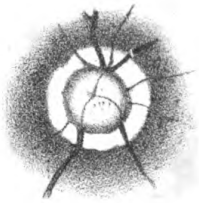

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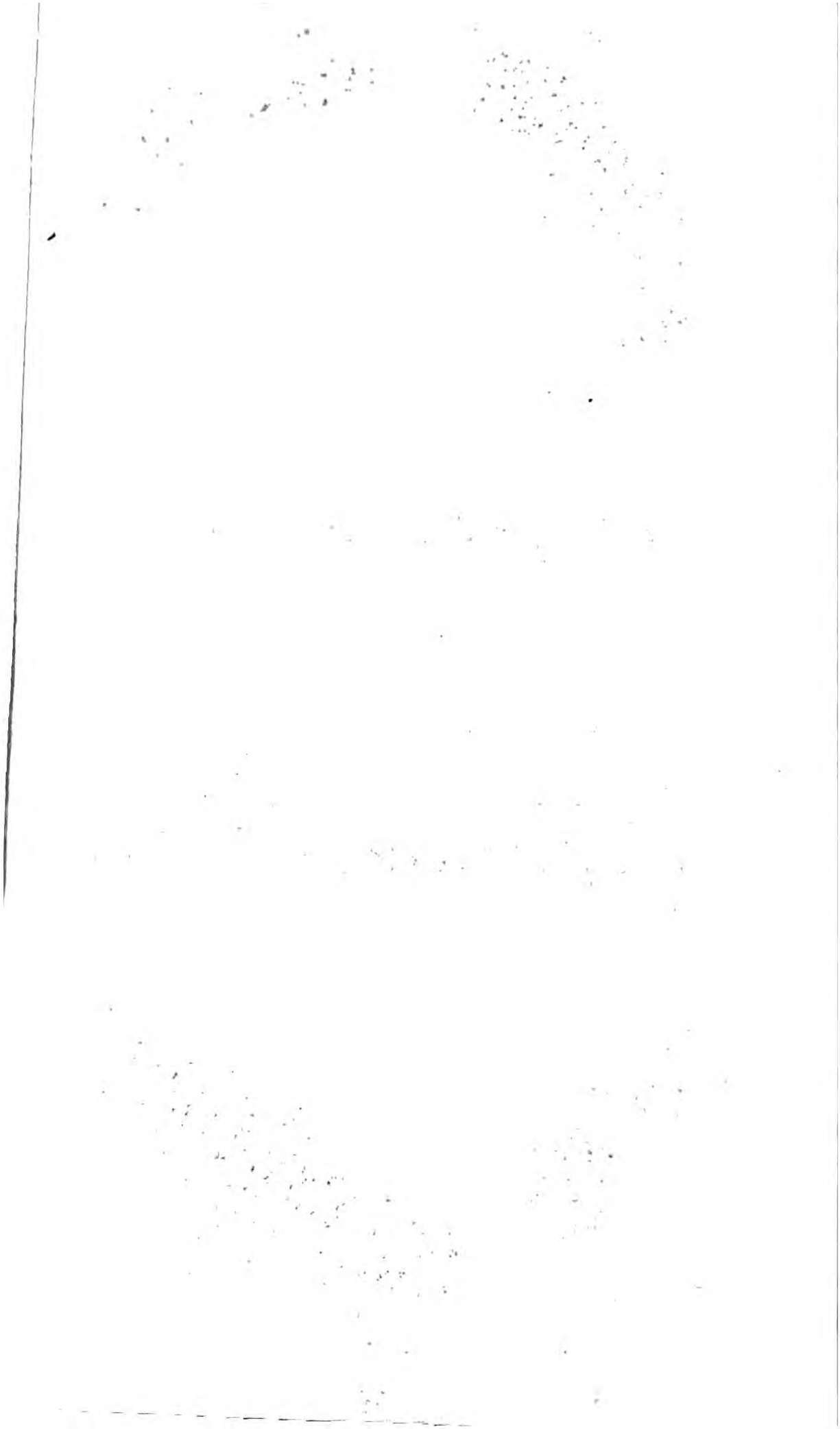


LECTURE I.

ON THE

THEORY AND PRINCIPLES

OF THE

OPHTHALMOSCOPE.

In proportion as our knowledge of the laws of nature increases and as science advances, do the art and means of discovering the seat and nature of disease become more and more developed. The application of the exact sciences in the domain of medicine has resulted in the discovery, or the utilization, of chemical tests and mechanical contrivances whereby the practitioner is enabled to pronounce definitely on disordered conditions, the existence or nature of which he could only have guessed at, without the employment of those means. Morbid changes in the tissues and fluids, such as amyloid degeneration (which has been elucidated by Dr. Robert M'Donnell's able researches), leucæmia, &c., with which we were previously unacquainted, have been revealed by the microscope, by chemistry, &c.; diseased conditions of the vocal and respiratory apparatus hitherto unknown, except, perhaps, as *post mortem* appearances, have been not only recognized during life by means of the laryngoscope, but also successfully treated; quite recently the endoscope has been so perfected by my friend Dr. Cruise, as to bring into view the interior of the urethra, bladder,

&c.; and the ophthalmoscope has opened quite a new field of investigation. Immediate exploration by instrumental aid, wherever practicable, is gradually superseding, in a great measure, all other methods of investigation, and the practitioner is becoming less and less dependent upon the statements of patients or their friends, which, owing to various causes, are in many instances so very unreliable; thus the art of diagnosis is becoming facilitated and perfected, and in direct ratio to the accuracy of diagnosis will the practice of medicine be less and less empirical.

Since Lænnec's great discovery of auscultation and the stethoscope, no instrument has rendered such vast services as the ophthalmoscope, not merely in the interpretation of purely ocular affections, but also in the elucidation of disease in other organs. It renders visible in the living eye the various phenomena of healthy and diseased circulation, and many disordered conditions which illustrate and explain physiological and pathological processes elsewhere; by means of it morbid actions and structural changes may be watched from day to day, or hour to hour, and its employment not unfrequently leads to the detection of disease in other organs, such as the brain, kidneys, and circulating apparatus.

With the discovery of the ophthalmoscope a new era dawned in ophthalmic literature—discoveries followed each other in rapid succession—optical defects, the nature of which had been hitherto unknown, or misunderstood, have been explained and remedied, and the laws and mechanism of refraction and of accommodation have been but lately satisfactorily explained. In no branch of the profession, indeed, has there been such great progress of late years, as in ophthalmology, and, thanks to the indefatigable and zealous labours of earnest and scientific men, ophthalmic medicine is becoming more closely allied to the exact sciences; it is worthy of note, indeed, that some of the most distinguished oculists of the present day are eminent also as mathematicians.

The importance of the ophthalmoscope as a means of diagnosis can scarcely be overrated. I need only adduce in proof thereof the former definition of *amaurosis*, "that condition in which the patient sees nothing, and the physician likewise nothing;" this definition is now quite untenable, for the instrument renders either positive evidence, and the physician is able to see the cause of the blindness (which is the case in the large majority of amaurotic persons), or else it affords negative evidence, that is of the eye itself being healthy, and the physician is in a position to pronounce the cause

of blindness (amaurosis) extra-ocular, and he may thereby be led to ascertain the nature and seat of the lesion or disturbance (generally intra-cranial) which has given origin to the blindness.

The term amaurosis is becoming less and less frequent, and will, I hope, eventually come to be used only in its true significance, and simply denote a symptom, and not as is but too generally the case at present, a disease.

And if by its means we are enabled to make a correct diagnosis, the ophthalmoscope must, of necessity, be useful also in the treatment of disease; while in one instance we are able to pronounce our patient incurable, and spare him the sufferings, mental as well as physical, of futile treatment—in another we are able to declare him curable, and subject him to appropriate treatment. No doubt long experience and accurate observation, will, in a great number of cases, enable the practitioner to arrive, empirically, at the same conclusions, without the aid of the instrument, but how much more satisfactory to ourselves, and beneficial to the public, when even the youngest practitioner can at once give a prognosis as reliable, if not more so, than that which it has taken a lifetime, perhaps, to be enabled to pronounce.

The ophthalmoscope is especially important and useful in cases of suspected deception in the selection of recruits, for the various public services, or in the examination of those already in such services. Thus, defects can be detected in the eyes of recruits which would unfit them for various duties, and soldiers and others who are really labouring under disease of the internal structures of the globe, the eye presenting, externally, no sign whatever of disease, are now free from the odium which may have formerly attached to them as schemers, while real malingerers are liable to detection and punishment. The Army Medical Department has taken up the subject of the ophthalmoscope very warmly, and there is a special course of study thereon, at Netley, under the able guidance of its distinguished Professor of Military Surgery, Deputy Inspector-General Longmore. This increased attention to the vision of recruits, soldiers, &c., must result in a considerable pecuniary saving to the country at large. The following extract from Dr. Longmore's *Ophthalmic Manual*, published for the guidance of army surgeons, is, I think, equally applicable to civil as to military practice:—

"A soldier who is really the subject of serious disease may, by chance, be regarded as a malingerer, because all the superficial ocular apparatus are free from disease, and all that can be seen by ordinary

observation of the deeper structures of the eye are observed to act precisely as they do in eyes that are known to be healthy. We have, unfortunately, conclusive proofs that such errors as these formerly occurred very frequently; and that they led to soldiers being sent on foreign service, often to tropical climates, where their diseases became rapidly aggravated, so that they had shortly to be invalided home again, as well as to the retention for considerable periods at home stations of others who were useless, and who had at last to be discharged from the service, after much expense being incurred by their prolonged maintenance. If a defect of vision really exists the medical officer should be able to report to his professional superiors, the exact cause of the disability, for on this also may hinge many points of importance to the public service, to the soldier, and to the State. If the defective vision be the result of some natural abnormality of the refractive media, or special form of the globe, the service has suffered from the admission into its ranks of an ineligible recruit. If the defect be the result of disease, such as too often follows service under the glare of a tropical sun, then the soldier has suffered from his employment by the State, and is entitled to compensation according to the degree of his disability. There is only one way in which a diagnosis, in these cases, can be truly arrived at, and that is by means of the ophthalmoscope." [a] These, and other considerations, point to the very great practical utility of the instrument, the cost of which is trifling, and the manipulation not difficult; I would, therefore, claim for it a larger share of the attention of the Irish profession than has been, I think, hitherto accorded to it.[b]

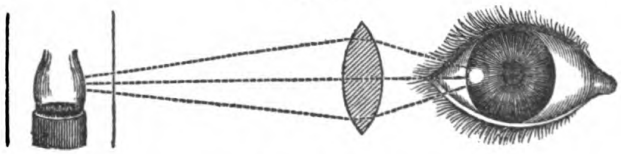
Before, however, entering upon the subject of the ophthalmoscope, I would direct attention to other methods of illumining and examining the eye. In the ophthalmoscopic examination we illumine the bottom of the eye, as shall be presently explained, by light *transmitted* through the transparent media; hence, any opacities in

[a] One of the most able and exhaustive reports on ophthalmic surgery which has appeared of late years is that contained in the Army Medical Reports for 1860, written by Assistant-surgeon Dr. Frank, the merits of whose writings and teachings are universally acknowledged. Dr. Frank has withdrawn from the army, and it is much to be regretted that the State has thereby lost the services of so accomplished and efficient a medical officer. The greater part of his report is devoted to the examination of the deep-seated diseases of the eye, which can be recognized and studied only by means of the ophthalmoscope.

[b] The various forms of ophthalmoscopes, as well as lenses and other optical appliances, can be had at Mr. Yeates', 2, Grafton-street.

the latter will intercept some of the light, and appear simply opaque, as happens also in microscopic examinations; to determine the colour and character of these opacities, therefore, *incident* light must be employed, and this is effected by means of *focal* or *oblique illumination.* Focal or lateral illumination consists in concentrating, on any given spot of the eye, by means of a convex lens, the light from a lamp placed at the patient's side. I am in the habit of using for this purpose a two-inch convex lens. The apartment should be darkened, and a lamp placed about one foot and a half from the patient's side and towards the front, so that the flame and eye shall be nearly on a level, and the globe to be examined illumined, while the opposite eye remains in darkness; the convex lens is then held between the thumb and index finger, two inches from the eye, as indicated in the woodcut, in such a manner that the rays from the

Fig. 1.



flame shall pass through it and be brought to a focus on the cornea. If it be desired to examine the iris, capsule, or lens, the convex lens must be held nearer to the eye so as to focus the rays on these parts. This mode of examination can also be practised by intercepting and concentrating on the eye, by the same lens, direct beams of sunlight; but the eye is, as a rule, not very tolerant of such illumination, and sunbeams are not always at command; ordinary diffused daylight does not suffice for the purpose. Another method of effecting *oblique illumination* consists in reflecting on or into the eye, by means of a mirror, the rays from a lamp, while the observer places his eye nearly in the line of these rays. This is best accomplished by holding a small circular plane mirror, or, better still, the ordinary ophthalmoscope mirror itself, just over or in front of the eyebrow, so that the rays from a lamp, placed at the side or above and behind the head of the patient shall be reflected into the observed eye. The distance between observer and patient is then diminished or increased, and slight rotatory movements of the mirror on its own axis executed until a satisfactory illumination is obtained of the part to be examined. Although it is only of recent years that these methods have received that attention which they undoubtedly deserve, similar modes of examination have long been known, and

occasionally employed. Mackenzie mentions, at p. 508 of his *Practical Treatise on the Diseases of the Eye*, published in 1840, the circumstance of his having seen what he considered the effects of hyaloiditis, "in directing the light of a gas jet through the pupil with a lens;" and at p. 639 he speaks of concentrating the light on a cataractous opacity by means of a double convex lens. Himly in his *Krankheiten und Missbildungen des menschlichen Auges*, 1843, likewise recommends the ordinary daylight to be concentrated on the eye by means of a convex lens; he also advises illumination by means of reflected light from a mirror, but says it should be used only with completely blind eyes. He noticed a greyish or greenish appearance of the pupil when the interior of the eye was illumined, and states that the blackness of the interior always ceases when strong illumination is used. It is worthy of note how very near to the discovery of the ophthalmoscope this author had arrived. By focal or oblique illumination each portion of the *cornea* may be brought successively into view. Opacities and irregularities in or on this structure are exhibited with surprising distinctness; the effusions in *iritis*, covered with red vessels; the sequences of inflammation, such as adhesions, patches of pigment on the capsule of the lens, &c., are brought very clearly into view; their colour, extent, and consistency, are incomparably better ascertained by focal than by any other mode of illumination, and we are thus enabled to estimate the length of time which may have elapsed since the occurrence of the active inflammation. Partial or total loss of vision may occasionally form the subject of a medico-legal inquiry, and any iritic complication which might exist would afford valuable information. But it is principally in examinations of the *crystalline lens* and its capsule that I would advocate these methods; for the determination of the condition of these parts I rely altogether on focal illumination. The anterior capsule affords, as a rule, in health, a very faint reflection, but in young persons there should be no reflection from the interior of the lens, which should hence be invisible. The lens itself is composed of such various elements—tubes, fibres, &c., &c.—and is of such complicated arrangement, that it can be perfectly transparent only when all its component parts exhibit their proper refractive index. About the middle period of life (thirty), the individual parts begin to undergo an alteration in their refractive condition, and reflect a certain portion of the incident light, and consequently become visible. This fact should be always remembered, lest the natural reflection peculiar to advanced age be

mistaken for cataract. If, when this reflection is strongly marked, the lens is examined by transmitted light, by means of the ophthalmoscope mirror, it will often be found perfectly transparent.

The seat, extent, and consistence of lenticular opacities may be accurately determined; and this is, in practice, an object of the greatest moment, for a knowledge of these circumstances will, as a rule, enable us to decide whether the opacity is a stationary or progressive one, or what length of time may elapse before the lens becomes completely opaque, and will also guide us in the selection of an operation. Opaque capsules, and exudation membranes, resulting from cataract operations, are best seen by focal illumination; I have been thus enabled, in some instances, to observe accurately false membranes which I was not able to perceive otherwise, although I possess very acute vision. These cobweb-like glistening membranes are of a greyish colour, with whitish bands or specks scattered through them, or they appear as a cellular network of fine tendinous bands in one or two layers, stretching across the pupillary area, about midway, sometimes between the iris and vitreous, or simply in the pupillary opening of the iris. The impairment of vision caused by these membranes is often very great, and the improvement resulting from their removal is truly astonishing. Partially or completely luxated transparent lenses are also easily recognized by this illumination; the periphery or equator appears, as also in daylight illumination, as a brilliant amber or golden-coloured semicircle, varying in its position as the eye or light vary in their relative positions. This appearance is said to have been observed in the normally placed lens, in albinos, through the iris, which is scarcely at all pigmented; the periphery of the lens can be seen also where the iris is partially or wholly absent. Focal illumination allows us even to examine the anterior part of the *vitreous humour*, and affords the best means of seeing tumours protruding into the chamber of vitreous humour.

The luminous appearance presented by the eyes of certain animals, such as the dog, cat, &c., occupied the attention of philosophers from a very early period. At the commencement of the last century Méry made some investigations on the subject, and while examining a living cat's eye, under water, saw the retinal vessels. This was subsequently confirmed by Lattère, who accounted for it by supposing that the eye under water adapted itself to the new medium, and that the rays, leaving the eye, were divergent, and therefore brought to a focus on the observer's retina, a theory we

now know to be fallacious. Based, however, on the fact of the interior of the eye being visible under water, is Czermak's *orthoscope*, which is a box-like apparatus with glass sides, open at one side so as to fit over the eye, and at the top for the reception of water; when fitted on to the integuments, over the orbital margin, it forms a water-tight chamber, projecting into which is the eyeball. The water in front of the cornea acts as a lens, and the natural focus of the eye is displaced forwards, and hence the retinal vessels become visible.

At the beginning of this century Prévost established the fact that the luminosity of animals eyes was not perceptible in a *perfectly* dark apartment, but that some light must be present; he concluded, therefore, that the luminosity was attributable to a *reflection* from the bottom of the eye, of light which had penetrated from without. He also found that this luminosity could be seen only in certain positions, and not in others. In the dog and cat, and indeed in the majority of the carnivora, in the ruminantia, in the horse, in the cetacea, and in the cartilaginous fish, there exists at the outside of the optic nerve entrance a patch of peculiarly constituted choroid, which is devoid of pigment, and of a beautiful metallic lustre. This is the *tapetum lucidum;* it varies in colour—blue and green being the predominant ones—and has a smooth polished surface, which acts as a concave mirror. The luminosity in these animals is attributable then, not as was anciently supposed, to spontaneous generation of light, but to a reflection of light incident on this tapetum.

The blackness of the human pupil was referred to the complete absorption of light by the choroid membrane which possesses no tapetum. Complete absorption of light is, however, very rare; were the choroid even as dark as chorcoal (one of the substances most capable of absorbing light), a portion of the rays would still be reflected, for in their passage from one medium to another rays of light are never so completely and altogether absorbed but that some of them are reflected. Moreover, certain portions of the healthy retina, such as its vessels, as also the intraocular end of the optic nerve, should reflect a large portion of light. The blackness of the pupil cannot, therefore, be owing to absorption of light. Furthermore, we know from practical experience that although the pupil is, under ordinary circumstances, black, yet, it has occasionally been observed to be luminous; thus, I have seen the human eye as brilliant as any animals eye, on the occasion of a laryngoscopic demonstration, where all the circumstances of Cumming's experiments, to be mentioned presently, were accidentally fulfilled; similar

occurrences have been noticed by other observers. The interior of the human eye was long ago noticed to be luminous in albinos, in partial or complete deficiency of the iris, in certain diseased conditions, such as fungus hematodes, various tumours, separation of the retina, &c.; the "cat's-eye amaurosis," first described by Beer, at page 495 of his *Augenkrankheiten*, in which there existed in the bottom of the eye a "concave pale grey or yellowish-white, or reddish opacity," was, I believe, in the majority of instances due to separation of the retina. A consideration of these theories and facts leads to the conclusion that a portion of the light which enters the eye is again reflected from it, but that we are, under ordinary circumstances, unable to perceive it.

One of the first to investigate this subject, and to arrive at some satisfactory conclusions, was Mr. Cumming, formerly house surgeon to the London Hospital; it may be said, indeed, that on his experiments and writings is based the discovery of the ophthalmoscope. In 1846 he published, in the twenty-ninth volume of the *Medico-Chirurgical Transactions*, his essay[a] "on a luminous appearance of the human eye," the object of which was "to show that the healthy human eye is equally, or nearly equally, luminous as the eye of the cat, dog, &c., when observed under favourable circumstances; and the application of the abnormal appearance, or want of this luminosity to the detection of changes in the retina and posterior part of the eye." The circumstances necessary for observing this luminosity are, he remarks:—"*a.* That the eye must be at some distance from the source of light, the distance being greater in proportion to the intensity. *b.* That the rays of light diffused around the patient (and sometimes around the eye itself), should be excluded. *c.* That the observer should occupy a position as near as possible to the direct line, between the source of light and the eye examined; hence, it is sometimes necessary for the observer to stand obliquely, that his eye may approach nearer to the direct line." "Let the person under examination sit or stand eight or ten feet from a gas-light, looking a little to the side; standing nearer the gaslight we have only to approach as near as possible to the direct line, between it and the eye to be viewed, at once to see the reflection." It having thus been established that the human eye is, under certain circumstances, equally luminous as that of animals, the enquiry arises what these circumstances are, and how we may

[a] See Sir Wm. Wilde's notice thereof in the Dublin Quarterly Journal of Medical Science, for February, 1847, p. 257.

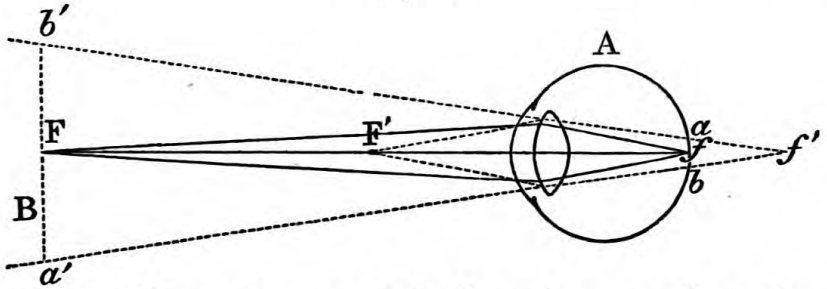
at all times, and most effectually for practical purposes, illumine the interior of the eye.

The human eye possesses a dioptric apparatus, and is endowed, in addition to the ordinary refractive powers of its system of lenses, with the vital function of adjustment—altering its focus, and thus accommodating itself for various distances and various sized objects. By means of this *accommodation* we are able to see an object distinctly whether it be one foot or six feet distant. Various have been the explanations of the mechanism whereby this is effected; some imagined it to take place by alteration in the shape of the globe by means of the extrinsic muscles of the eyeball. Kepler, the celebrated mathematician of the 16-17th century, who first described the humours of the eye as refractive media, and the consequent formation of images on the retina, was also the first to ascribe this accommodation to the ciliary ligament, the contraction of which produced, according to him, elongation of the globe, in which movement the retina was carried to a greater distance from the lens when objects were near. Porterfield, a learned physician and mathematician, whose *Treatise on the Eye—the Manner and Phenomena of Vision*, 1759, is still one of the best works we possess, regarded the ciliary ligament as muscular, and attributed to it the function of changing the position of the lens, of increasing or diminishing the distance between it and the retina, according to the different distances of objects to be seen, so that the retina should be "always at a due focal distance behind the crystalline." According to a still older theory, the ciliary ligament or muscle effected an alteration in the curvature of the lens, and hence in its focus; and this theory has been, in recent times, amply confirmed by the experiments of Helmholtz, Knapp, and others.

A normal eye is so constructed that when at rest parallel rays striking the cornea are brought to a focus on the bacillary layer of the retina (Jacob's membrane). Strictly speaking, there is in nature no such thing as parallel rays, for all rays emanating from a luminous point are divergent and must continue so; the divergence of rays coming from an infinite distance is, however, so very slight, and the surface of our eye, on which they impinge so very small, that practically we may look upon them as parallel. If an eye be accommodated for a luminous object—say a flame—rays from it on entering the eye will undergo a certain definite refraction or change of direction whereby they are brought to a focus on the retina; a portion of these rays will be absorbed by the choroid, while the

remainder will be reflected; this reflected portion must, however, return from the bottom of the eye in exactly the same line as it entered; it will therefore again undergo a refraction similar in nature, but opposite in direction, to that it underwent on entering; and emerging from the eye these rays will return to the flame from which they originated, and there form their focus. Let A (Fig. 2) be an eye accommodated for F, a flame; rays from the latter impinge on the cornea slightly divergently, and entering the eye will be rendered convergent by the refractive media and brought to a focus at *f*, at which place there will therefore be an image of F; from this luminous image rays will be reflected outwards in the same line as they entered; they strike the posterior surface of the crystalline

Fig. 2.

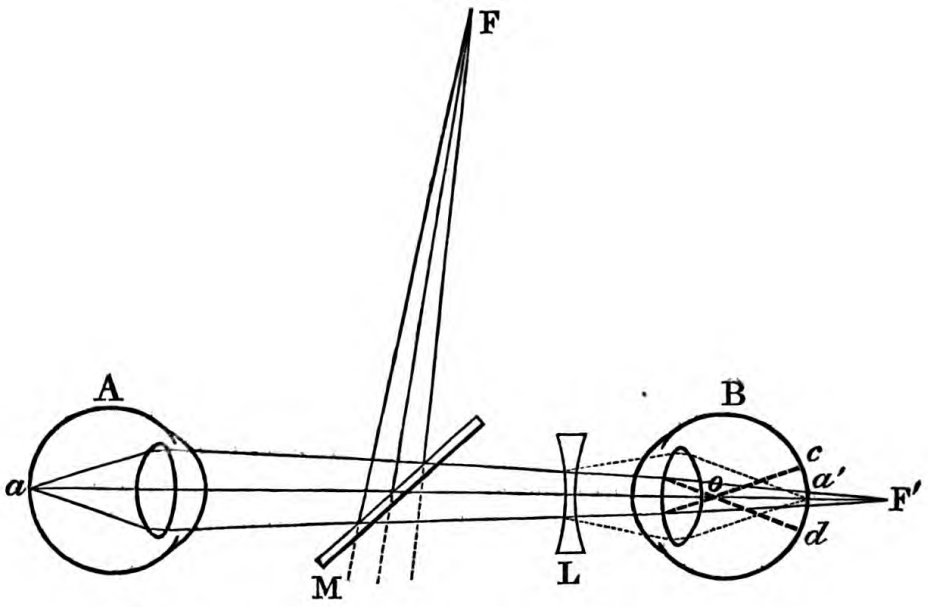


lens divergently, are converged by it, and emerge from the eye convergently, and are united into a focus at F; hence, F, the luminous object and, *f*, its retinal image will act reciprocally as *conjugate foci*, each being alternately object or image—whichever be the radiant point the other will be the focal point. In like manner, when we regard another individual's pupil, it will be merely a representation of our own; and as our own pupil appears black, and sends no light into the observed eye, the pupil of the latter will consequently appear black also. The eye of the albino would appear, at first sight, to offer a contradiction to the above, as the pupil in such cases presents, even in ordinary daylight, a reddish or brilliant appearance, but this luminosity is due to rays entering the eye through the very scantily pigmented iris and choroid, parts which ordinarily possess such an abundant pigmentation as to render them very opaque. This may be proved to be the case by holding a blackened card or screen with a central aperture corresponding to the pupil in such a manner before the eye that all rays except those entering through the pupil shall be excluded; the red reflection will then disappear, and the pupil appear black like that of an ordinarily pigmented eye.

In order then for an observer to perceive the returning rays his eye must be in the line of their emergence, *i.e.*, between F and A, or at F, for at any other place (such as at B) A's pupil will appear black. If we interpose between F and A the illuminating rays would be necessarily cut off; and it is impracticable to place our eye at F. We may, however, bring our eye very close to F, and by looking through the margin of the flame we approach very nearly to the direct line of the emergent rays, and in this position we obtain a bright reflection from behind A's pupil, as in Cumming's experiments.

Professor Helmholtz, now of the University of Heidelberg, constructed an apparatus by means of which the observer could readily place his eye in the direct line of the emergent rays; and in 1851 he published an account thereof. The chief features in this invention are the employment of *reflected* light, and the utilization of the laws of refraction. Let A, in Fig. 3, represent the observed

Fig. 3.



eye, and F a flame on the same level, five inches to the side, and a little towards the front of the patient; M, a piece of well polished plane glass, with parallel surfaces, placed one inch in front of A, at such angle that rays falling on it from F shall be reflected into the eye, as if they came from F′, which is a point as far behind M as the flame is in front of it. The observed eye will apparently see the flame at F′, for which distance (five inches) it then accommo-

dates. The plate M acts as a speculum, but being transparent some of the rays from F pass through it, and are lost; others, however, are reflected into A, and are brought to a focus on its retina—at *a*—where there will be consequently an image of F. As already explained rays emerge from this image, some of which are reflected back to F by M, while the remainder traverse M to form their focus at F′, the point for which the eye is accommodated, and where there will therefore be an image of *a*. The observer, therefore, can now, by placing his eye, B, behind M, between it and F′, readily intercept these rays, but yet he does not receive on his retina an image of *a*, but merely perceives a brilliant red reflection from A. The cause of this lies in the fact of the rays *a* M F′ being convergent, and being still further converged by the dioptric apparatus of B (a normal eye) they unite into their focus between the lens and retina at *o* (indicated in Fig. 3 by the interrupted lines), where they become divergent and form a circle of dispersion, *c d*, on B's retina—hence there is no distinct image of *a*. By interposing a concave lens, L, however, between M and B these convergent rays are rendered divergent (indicated by the dotted lines), and entering B are again converged by the refractive media, so as to be focussed on B's retina at *a′*. The observer, B, will therefore now obtain a clear and well-defined image of the illumined spot *a*. No matter where B placed his eye so long as the rays from A were convergent he could only obtain a confused and indistinct image. This simple contrivance was improved by the addition of other plates of glass, which, together with suitable lens, were fitted into an appropriate tubular case, and was styled by its inventor *speculum oculi* or *ophthalmoscope*, and is no doubt the first ophthalmoscope, properly so called, by means of which the retina of the living eye could be seen. The subject was, I believe, first brought before the English profession by Dr. Sanders, in the *Monthly Journal of Medical Science* for July, 1852. Professor Wharton Jones announced in the *British and Foreign Medico-Chirurgical Review* for October, 1854, that Mr. Babbage had, seven years previously, showed him the model of an ophthalmoscope which "consisted of a bit of plain mirror, with the silvering scraped off at two or three small spots in the middle, fixed within a tube at such an angle that the rays of light, falling on it through an opening in the side of the tube, were reflected into the eye to be observed, and to which the one end of the tube was directed. The observer looked through the clear spots of the mirror from the other end."

It is much to be regretted, for the sake of British ophthalmic surgery, that this discovery was not made public, or even utilized by the learned professor of ophthalmic medicine and surgery in University College Hospital, London, at an earlier period.

By means of Helmholtz's ophthalmoscope, just described, the image of the flame could be projected *successively* on different portions of the bottom of the eye, and thus gradually an examination of the whole fundus[a] might be obtained. Although the instrument was subsequently much improved by Epkens, by its deviser, and others, it was always difficult to manipulate, and the field of illumination being so very small, it was of but little practical value.

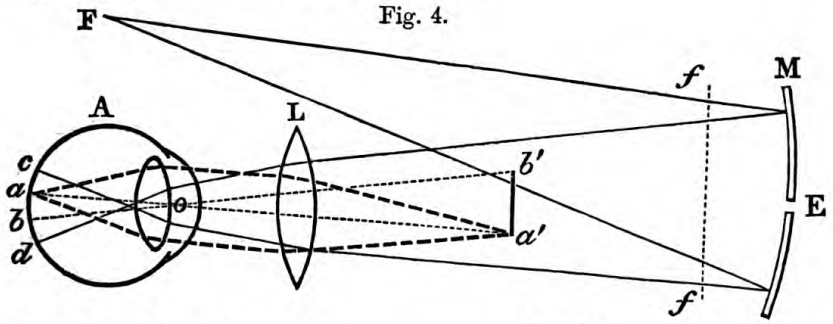
As I have endeavoured to explain, the illumination consisted in bringing to a focus exactly on the retina the image of a flame. Another method, conceived by Professor Brücke, consists in illumining the fundus by means of a *circle of dispersed light.* In 1847, Brücke published an account of his experiment, whereby the illumination of the interior of the eye could be easily and satisfactorily demonstrated. This experiment, which is based on a knowledge of the laws of refraction and accommodation, already briefly alluded to, consists in adjusting the vision for a shorter or longer distance than that occupied by a flame placed in front of the eye, so that instead of an image of the flame there shall be merely dispersed light on the fundus. While the observed eye A (Fig. 2) remains adjusted or accommodated for the distance A F, move the flame nearer to the eye—to F′; its image would now fall at *f′*, but that the retina is interposed; therefore a part of the fundus *a b* will be illumined by diffused light. From this circle of dispersion *a b*, rays are reflected outwards which must return, and form their focus, not in the flame from which they originated, but at the distance for which the eye is accommodated—F, at which place there will consequently be an image *b′ a′* formed of *a b*. If the observer's eye now occupy a position anywhere between *b′* and *a′* (behind and to the side of F), the returning rays are readily perceived, the luminosity of A's pupil becomes very apparent, and even the details of the fundus are occasionally seen. This image *b′ a′* is formed at a considerable distance from the observed eye, is inverted, large, faint, and indistinct, and the details, as a rule, not recognizable; hence, though perfect as a means of rendering the

[a] By the term *fundus* is meant all that part of the eye lying behind the lens and vitreous humour, viz., optic nerve entrance, retina, choroid, sclerotic, and blood-vessels.

illumination visible, it is, as a means of seeing the individual parts, practically useless.

To the acute and reasoning mind of Helmholtz, however, this experiment suggested a practical idea, and in his hands assumed a new and great importance, for from it he deduced and perfected a method of obtaining easily a well-defined image of the fundus. This method consisted in projecting on the fundus a large circle of dispersion, and converging the reflected rays to a focus at a short and convenient distance, by means of a double convex lens of short focus held before the eye. Rays of light falling on this convex lens are refracted, and enter the eye convergently; they are still further converged by the crystalline lens of the eye and brought to a focus somewhere between this and the retina; from this focus they diverge, and fall on the fundus in the shape of dispersed light; from this circle of dispersion rays are reflected from the fundus, and emerge parallel if the eye be accommodated for parallel rays (as a rule, however, they emerge slightly converging). Meeting the convex lens in front of the eye, they are converged and united within the plane of the principal focus of the lens, at which place an image of the fundus is formed. The flame of a candle or lamp placed before the eye was used for the illumination, and a screen was fixed behind the flame, so that the observer was enabled to bring his eye close to the source of illumination, and thus be as nearly as possible in the direct line of the emergent rays. To obviate the inconveniences and difficulties attendant on this mode of illumination Professor Ruete had recourse to *mirrors*. Concave mirrors possess the property of rendering rays falling on their surface from a certain distance convergent; therefore in them we possess a means of producing a circle of dispersion in the retina. Fig. 4 illustrates the passage of rays to and from the fundus.

Fig. 4.

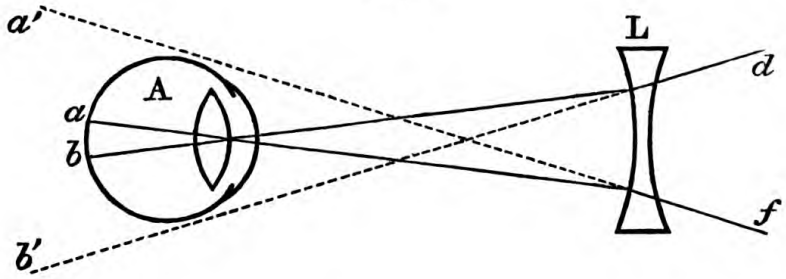


Let A be the observed eye, accommodated for distance, *i.e.*, for

parallel rays, *o* its optical centre, and F the flame placed behind or to the side of A, so that the cornea and pupil may be in darkness. A concave mirror, M, of suitable focus is now held in front of A, so that rays falling on it divergently or parallel from F are reflected into the eye convergently, and illumine the fundus as dispersed light; from this circle of dispersion rays are reflected outwards to form at *f*, *f*, as already mentioned, a large inverted and indistinct image of the fundus; if we now interpose between A and M, at its focal distance from A, a double convex lens L, of short focus—two inches—the rays from M will be rendered more convergent by L, and still further so by the dioptric apparatus of A, so that they will unite behind the lens of the latter and form on the fundus a circle of dispersion *c d;* from any points of this circle, such as from *a b*, pencils of rays will be reflected and emerge from the eye parallel to the lines (dotted) through the optical centre; they are, however, converged by L, and brought to their foci at *b′ a′*, at which place, then, there will be an inverted, magnified, and distinct image of *a b* (the interrupted lines indicate the course of rays from *a*, and similar ones may be traced from *b*). By making an opening in the mirror at E, and placing our eye there, and accommodating our vision for the distance E *b′ a′*, we readily become cognizant of the image. As is evident, this is an *aërial image situate between the observer and the convex* lens; it is also actually *inverted* and enlarged. If it be desired to obtain an enlargement of this image, it may be effected by placing behind the mirror another convex lens, but of a longer focal distance than L; or we may primarily produce a large image of *a b* by having L of a long focal distance, such as four inches, for such a lens will be of a lower converging capacity than one of two inches; and hence the image will be larger. By the above process we illumine the greater part of the fundus, and by using a convex lens of very short focus we obtain a very large field, *i.e.*, a view of nearly the whole illuminated portion, but the details are very small; by using a lens of longer focûs the field of vision is curtailed, but the parts much magnified: thus, for instance, if we employ a lens of two-inch focus we obtain an image of the entire fundus, whereas if we use one of four we merely obtain an image of the optic nerve entrance. This mode of examining has been termed the *indirect*, or the examination of the reversed aërial image, to distinguish it from another, styled the *direct*—in which a *virtual erect* image of the fundus is seen.

In the production of the *erect* image we employ the ophthalmoscope mirror alone, and make use of the refracting media of the eye itself as a lens; in this examination the observed as well as the observer's eye must be accommodated for distance, and be very close to each other—about two inches; the emergent rays being parallel, will be united on the examiner's retina, and form there an inverted image of the observed fundus; this image, which is magnified by the dioptric apparatus of the observed eye itself, and apparently situate behind the eye, will, however, be mentally perceived as upright. Another mode of producing the erect image consists in the employment of a concave lens, as shown in the accompanying illustration. If *a b*, Fig. 5, be two points in the illumined fundus of A, pencils of rays will emerge parallel to the axial lines *a* L, *b* L to form at the anterior focal distance of A an image of *a b*. The concave lens L, however, being now interposed, these rays are diverged to *d* and *f*, and they appear to proceed from the prolongations of these lines—from *a'* *b'*, at which place an enlarged *upright image* of *a b* will apparently be

Fig. 5.



situated. The direct examination is principally of value in cases where it is desirable to obtain a more accurate observation of the minute details, such as individual vessels or nerve fibres, or in the determination of anomalies of refraction, such as myopia or hypermetropia. It is, however, attended with more difficulties than the indirect method of examination; it necessitates, also, a very close approximation of patient and examiner, which may, for various reasons, be undesirable or objectionable; the enlargement is very considerable, and therefore only a small portion of the fundus can be seen at a time; moreover, the concave mirrors of the ordinary ophthalmoscope do not suffice for this examination. I would, therefore, recom-

mend beginners first to employ the indirect method of examination; and as soon as they may have become familiar with this method, and the reversed image, they may proceed to the direct examination.

LECTURE II.

ON THE

CONSTRUCTION AND VARIETIES

OF THE

OPHTHALMOSCOPE.

As might naturally be expected, there is a great variety in the form and construction of ophthalmoscopes; but no matter how they may apparently differ in outward shape and appearance, they are, one and all calculated to fulfil the same purpose—to illumine the background of the eye by dispersed light, and to allow of the parts so illumined being clearly seen at a convenient position and of a suitable size. The essential part of the ophthalmoscope is the perforated mirror; this may be either of glass, backed with a layer of amalgam, or of metal; the metal specula are preferable to the glass ones, inasmuch as they are less liable to injury, but chiefly on account of the central aperture through which the observer looks; in the glass mirrors this orifice is more or less in the shape of a tube or canal, from the internal surface and edges of which there is very likely to be most disturbing and annoying

reflection of light, which would obviously interfere with the reflected light from the fundus; in the metal mirrors, on the contrary, the walls of the central perforation are extremely thin and the margins sharp, and there can be, therefore, very little, if any, reflection from this part. The illumination afforded by glass mirrors is, moreover, in my opinion, too intense (provided the examiner's eye be normal); the details can be discerned more satisfactorily by a somewhat subdued illumination; hence I am in the habit, when using a glass mirror, of breathing on its surface, or otherwise damping its reflection. When I was in Berlin, some years ago, Liebreich, who has since then removed to Paris, employed a metallic mirror which he had dulled by means of sand-paper. All mirrors have necessarily an opening, and are usually attached to a suitable handle or frame.

Ophthalmoscopes may be divided into two great classes—in one the mirror is concave, and its focus calculated from its surface definite and fixed; such instruments are termed *homocentric*. In the other class the mirror is either plane or convex, and in combination with a double convex lens; in these the focus may be altered, is negative, and situate behind the surface of the mirror; such instruments are denominated *heterocentric*.

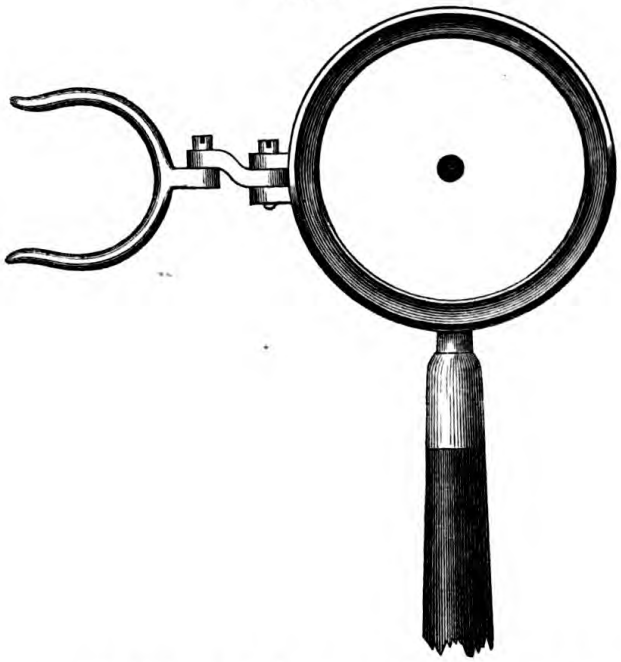
An enumeration and explanation of the several individual instruments constructed would be of little practical value. I will, therefore, merely adduce a few of the more important ones, commencing with the *homocentric*.

The simplest, most convenient, and, at the same time, most practical of all instruments is Liebreich's small or hand ophthalmoscope, and is the one I usually employ. It consists, as shown (the actual size) in Fig. 6, of a concave metallic mirror $1\frac{1}{4}''$ in diameter, and of 8″ focal length,[a] which is fixed into a metallic frame, to which the handle is attached. The central aperture is a shallow, funnel-shaped opening, the base $\frac{3}{8}''$ wide in the metallic frame, the apex nearly $\frac{1}{8}''$ wide in the mirror itself; the sight-hole thus enlarging gradually from before backwards, and the parts adjoining it, and indeed the whole back and sides of the instrument being thoroughly and effectually blackened there can be no reflection from these parts and no interference with the rays coming to the observer's eye. The handle, about $3\frac{1}{2}''$ long, is screwed into the

[a] The inch is, for brevity, expressed by (″), the foot by (′), and the line by (‴).

frame, to which is also attached a clip with a jointed movable arm; the clip serves to hold a small convex or concave ocular lens, which can thus be brought immediately behind the opening in the mirror,

Fig. 6.



and consequently in front of the examiner's eye. The instrument is fitted into a case $5\frac{1}{4}''$ by $2\frac{1}{4}''$, and little more than $\frac{1}{2}''$ thick; two large double convex object lenses, generally of $1\frac{1}{2}$ and $2''$ focus; four small concave ocular lenses, of 6, 8, 10, and 12 inch focus, and one small convex ocular lens of $10''$ focus are likewise fitted into the case. In my own case I have substituted for the $2''$ convex lens one of $3\frac{1}{2}''$, as I find in the general run of cases the enlargement produced by the latter much more satisfactory. One of the uses of the small ocular lenses is to neutralize any error of refraction or accommodation which may exist in the examiner; another use is to effect the examination in the erect image; the convex ocular may also be employed to magnify the reversed image. The large lens, whether convex or concave, which is held before the examined eye in order to produce the image, is styled the *object lens*, to distinguish it from the small one placed in the clip behind the mirror, which is called the *ocular lens*, and the reflecting surface of the ophthalmoscope is regarded as the front of the instrument. Dr. N. C. Macnamara,

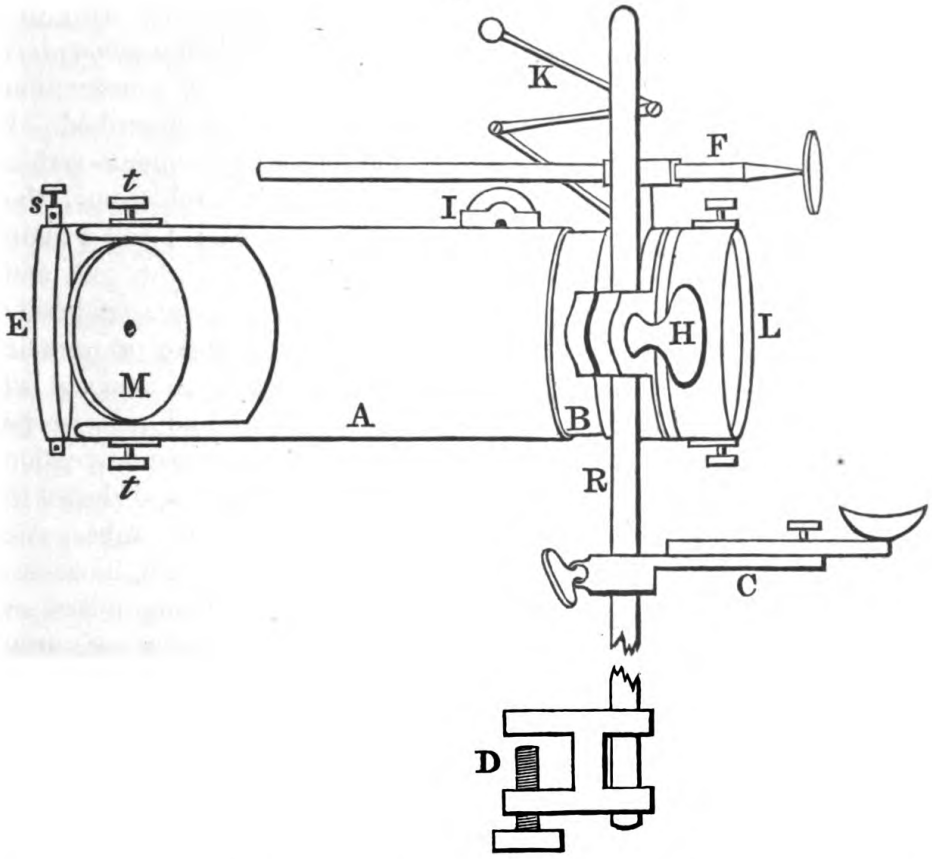
professor of ophthalmic medicine and surgery in Calcutta, has lately published a most admirable and trustworthy work on ophthalmoscopy under the title *Lectures on Diseases of the Eye;* but in his description of Liebreich's instrument he states that "attached to the mirror is a clamp by which one of the *object-glasses*, to be found in the instrument case, may be fixed *in front* of the sight hole." This sentence, which to a beginner would be so confusing, shows the necessity for a strict adherence to a uniform nomenclature.

Messrs. Weiss manufacture an ophthalmoscope consisting simply of a concave mirror set in a circular frame, the principal recommendation of which is its portability, as it may, together with a convex lens, be carried in the waistcoat pocket or in a pocket instrument case.

The best of the *fixed ophthalmoscopes* belong to this division; such instruments are so constructed that when adjusted they and the patient's eye shall retain a definite, fixed, relative position, so that once the image is projected a number of persons may in succession, examine it without any trouble or difficulty on their part. Here, likewise, Liebreich's ophthalmoscope is undoubtedly the best. The accompanying diagram, Fig. 7, (about one-third the actual size), shows its construction. A and B are two tubes moving one within the other by means of a rack and pinion, I, and having their interior well blackened. At the end of the tube A a concave perforated mirror, M, is swung on trunnions, *t t*—and a portion of the walls of the tube cut away so as to allow the rays from a laterally placed lamp to fall on the mirror; the tube B carries the convex object lens L, of 2″ focus, swung, like the mirror, on trunnions: this tube is provided with a stout encircling collar, having at one side a projecting clamp, capable of being widened or narrowed by means of the screw H; an upright rod, R, is affixed to the corner of a table by means of a strong clamp, D, and the instrument is then affixed to this rod by means of the perforated projection, and slides up and down on the rod, and may be fixed at any wished-for height by the screw H; on this rod slides also a stout horizontal jointed arm, C, having at its extremity an oval padded cup, which acts as chin-rest; this, of course, is put on the supporting rod beneath the ophthalmoscope. A horizontal bar, F, slides in a box projecting from the upper part of the collar: at the extremity of this bar is a padded disk, which serves as a head-rest; a small jointed

movable arm, K, carries a polished metal ball, for directing the patient's eye to any given position, and a shade, projecting laterally from each extremity of the instrument, at *s* and B, screens the observed and observer's eye from the lamp; there is also a clip behind

Fig. 7.

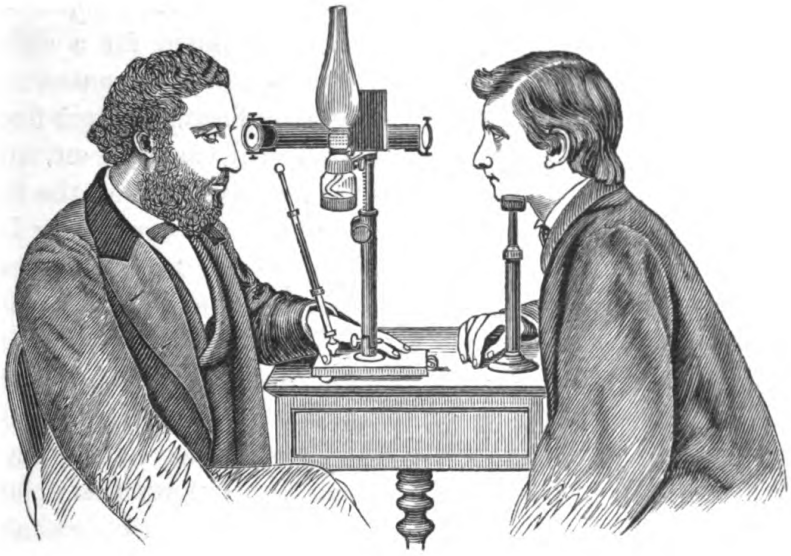


the mirror, M, for holding a convex lens, three of which are contained in the case. When in use the patient's chin rests in the cup, C, and his forehead against the pad, F; the instrument should usually be about two inches from the eye—the focal distance of the lens L, and a lamp placed towards the side, from which rays may fall on M, and so directed then through L into the eye; it will be seen that the anterior extremity remains stationary, while the tube A, carrying the mirror, is movable. The formation and position of the image is the same as that already described and illustrated by Fig. 4. When obtained, the image of the fundus is very clear

and beautiful, and may be readily seen by any number of persons in succession. A camera lucida for drawing purposes may be attached, and also a microscope; its inventor has also constructed an ingenious addition to the instrument, by means of which the fundus of the living eye may be photographed. Professor Follin, whose learned and well-written *Leçons sur l'Exploration de l'Œil* I can confidently recommend to those who are familiar with the French language, has also constructed a fixed ophthalmoscope; but in its optical arrangement, and even in its mechanical construction it appears to differ but slightly from the one just described. I have found the manipulation of Liebreich's instrument rather difficult, and its adjustment often tedious and troublesome, the light being one of the principal sources of trouble; I had a lamp made some years ago which I attached to the upright rod, and which I found to answer much better than the lamp placed beside the instrument; the instrument, too, is liable to shake or tremble from the nature of its support. These and other circumstances led Messrs. Smith and Beck, the eminent opticians and microscope manufacturers, of 31, Cornhill, London, to construct a modification of Liebreich's large ophthalmoscope. This instrument is shown in use in Fig. 8. It consists, like its prototype, of two tubes, one carrying the lens, the other the mirror. These tubes are, however, fixed permanently on an upright stem capable of being raised or lowered by a rack and pinion; to this stem is attached a horizontal arm which carries the lamp. No matter how the instrument may be moved, up or down or from side to side, the flame of the lamp and the mirror will always be on the same level, and always retain their relative positions; the instrument is mounted on a broad board, having three small rollers fixed in its inferior surface, so that it can be freely moved about on a table or any smooth surface; by means of a half-rule joint, secured by a pin close to the base, the board is capable of being turned up against the stem, and the lamp, being brought round to the mirror end, the instrument may be fitted into a small space. As seen in the engraving, a chin-rest supports and steadies the patient's head at any convenient height; a small shade screens the light from the patient's eye, and a small ivory ball at the end of a sliding tube, with a ball and socket joint at its base, serves for fixing the patient's eye at any wished-for position. I now employ this in preference to Liebreich's original ophthalmoscope, as it is much more easily and quickly adjusted, and affords

an equally good image; even an inexperienced person may, by its aid, see the fundus of an ordinary eye without any difficulty. I

Fig. 8.



have been able also on several occasions to demonstrate satisfactorily the fundus of my own eye to others by means of this instrument.

Another useful tubular ophthalmoscope, although not nearly so efficient or practical as the two just described, is that constructed by my friend Dr. Galezowski of Paris. This instrument is not exactly a fixed one, but holds an intermediate place; the ocular end of the tube projects beyond the object lens, and is so shaped and padded as to fit over the margin of the patient's orbit, and so to exclude all light except that transmitted by the ophthalmoscope mirror; the instrument can be shortened or lengthened in the same manner as a telescope.

The principal advantage of fixed instruments is, that by their means the fundus can be satisfactorily demonstrated in a short time to a large number of observers. Fixed ophthalmoscopes are, however, at all times cumbrous and do not afford a satisfactory view of the peripheral portions of the fundus; hence they are, and probably will always remain, merely ancillary to the hand ophthalmoscopes.

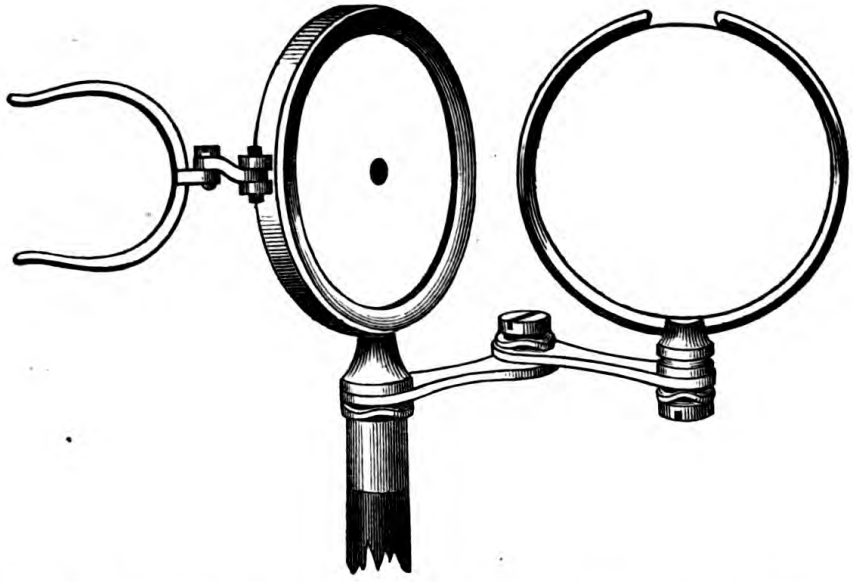
Ophthalmoscopes in which the mirror is either plane or convex

and in combination with a double convex lens, are termed *heterocentric*, and were first devised by Coccius.

The convex lens, which must be of shorter focal length than the negative focus of the convex mirror, is interposed between the flame and the mirror. These ophthalmoscopes are based on the principle of Brücke's experiment, already alluded to (Fig. 2)—*i.e.*, of the eye under observation being accommodated for a different distance than that from which the light actually emanates. Coccius' ophthalmoscope consists of a plane perforated mirror fixed to a handle, attached to which is a jointed arm carrying an upright clip with a convex lens in it: there is a smaller clip on the mirror frame for an ocular lens. Figure 9 may be supposed to be an illustration of this instrument. The rays of light passing through the convex lens fall on the mirror convergently and are reflected by the latter converging into the eye, and form on its fundus a circle of dispersed light. The eye regards the bright surface of the mirror, but in consequence of the action of the convex lens the image of the flame seen in the mirror does not correspond with an actual flame in the position of the reflector, but with one placed a certain distance behind the mirror.

Zehender's ophthalmoscope, shown, the actual size, in Fig. 9,

Fig. 9.



differs from Coccius' only in the mirror, which is convex; in appearance, therefore, these two ophthalmoscopes are at first sight identical.

The lens is $1\frac{1}{2}''$ focus, and the convex mirror has a curvature of $6''$ radius. This is a most valuable instrument, and preferable to Coccius'; it affords a larger and better field of illumination than any other ophthalmoscope, and is especially of use in the direct examination. Its manipulation is, however, not very simple, and hence partly it is not such a favourite as Liebreich's hand ophthalmoscope. The light must be at the patient's side, and the lens inclined at such an angle that the rays shall traverse it, and fall on the mirror, from which they are reflected into the eye.

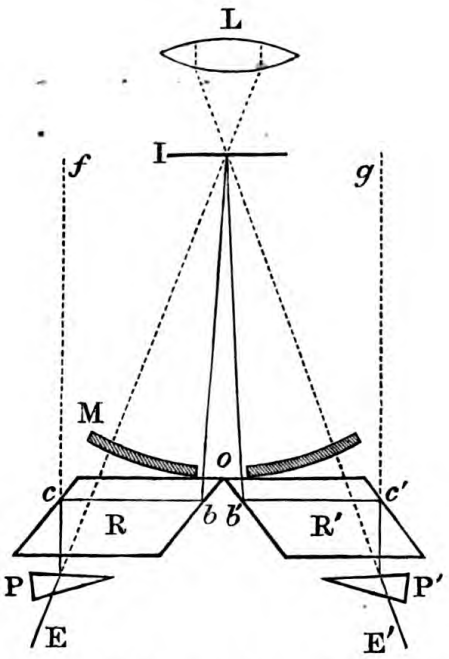
Two other forms of heterocentric ophthalmoscopes deserve mention, but more for their ingenuity than for their practical utility. Ulrich employed two prisms presenting in section the forms of right-angled triangles, with equal containing sides, and fixed them together in such a manner that the hypothenuse of one should be at right angles with that of the other; rays of light falling on the first prism reach its hypothenuse, and are there totally reflected and thus projected into the eye, the fundus of which they illumine; emerging from the eye they strike the hypothenuse of the second prism, and are reflected by it at right angles into the observer's eye.

Another form of ophthalmoscope is that of Hasner, and consists of a convex or concave lens, having one surface silvered, with the exception of a small space in the centre, which acts as a sight-hole. The chief object aimed at in these is the combination in *one* of the reflector and the lens; a biconvex silvered lens acts as a concave mirror—a biconcave silvered lens as a spherical mirror.

The construction of the instruments I have mentioned, and the large variety of kindred ophthalmoscopes, is such that the observer perceives the image with *one* of his eyes only; hence the errors and deceptions which arise from monocular vision are at all times likely to occur. To rectify this defect Dr. Giraud-Teulon constructed an ophthalmoscope, by means of which binocular vision was secured, and an image of the fundus obtained, in which the parts are seen as they actually exist—in relief, or depressed, or plane. This *binocular ophthalmoscope* is constructed on the principle previously applied in microscopes by Mr. Wenham, and by Nachet, the optician, of Paris—that of employing prisms or rhombs for the purpose of deflecting the rays in part or in whole. Giraud-Teulon employed a glass concave mirror, with a large oval opening in its silvering, and placed behind it two rhombs of crown glass, each representing a double prism of 45°, and capable of effecting total reflection from their inclined surfaces; these rhombs were

placed horizontally behind the mirror, with their apices meeting behind the orifice. The accompanying diagram will serve to explain the nature and principles of this instrument. M represents the concave mirror and L the convex lens, by means of which the reversed aërial image I is formed as with the ordinary ophthalmoscopes; if we take any point in this image we find rays proceeding from it divergently; thus, a pencil of rays is represented in Fig. 10 passing through the orifice *o* in the mirror. Here it meets the

Fig. 10.

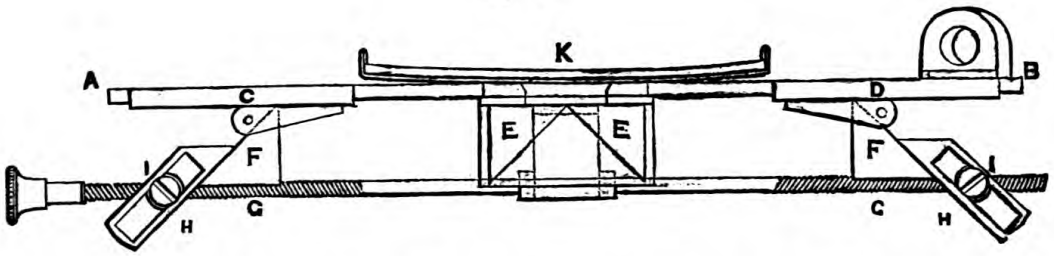


rhombs R and R′, and divides right and left; the ray on the left side is reflected at *b* to *c*, where it is again reflected to P, and emerges from the rhomb; in the same manner the ray on the right side undergoes total double reflection. If an observer now place his eyes in the line of emergence of these rays at E and E′, he will see two images, *f* and *g*; by placing two prisms, P, P′, however, with their bases turned outwards behind the rhombs, the emergent rays are deflected outwards and receive the direction E I, E′ I; the two images are fused into one, and thus both eyes participate in the visual act. As is evident, the width between these emergent rays must correspond to the distance between the examiner's eyes, for otherwise one eye would be excluded from seeing the image, and the instrument would be simply a monocular one. Nachet subsequently

remedied this defect by dividing the right-hand rhomb into two, and making the outer half of it movable, so that the instrument as now made can be adapted to the distance between the eyes of various observers. The rhombs are enclosed in a metal case, in which are spaces for the prisms, four of which are supplied, of various angles; there is an aperture at one side of the frame, into which a handle may be screwed; I frequently use the instrument, however, without the handle, holding it between finger and thumb. The mirror is attached by a universal joint, so that the instrument can be used with the flame either above or to the side of the patient.

My friend Mr. Zachariah Laurence, ophthalmic surgeon to St. Bartholomew's Hospital, Chatham, and the Ophthalmic Hospital, Southwark, has devised a very ingenious modification of this ophthalmoscope; it consists of two reflecting prisms, E, E, placed

Fig. 11.



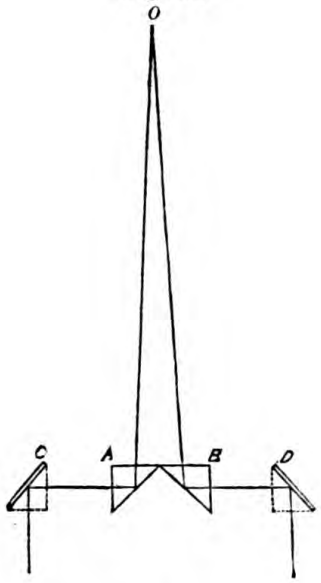
behind the opening in the mirror, K, and two others, F, F, termed oculars, at some distance to the outside; these latter "shift upon an horizontal metallic plate, A B, and can be adjusted to any required inclination by means of a screw G G, carrying the nuts I I, which work in the slots, H H."

"The optical action of the instrument is represented in Fig. 12. O A and O B are the extreme outer rays of a pencil, proceeding from a point (*O*) of the inverted image formed by the ordinary object lens; the ray O B is reflected by the prism B to the prism D, and hence to the observer's right eye placed behind D. Similarly, the ray O A is reflected to the observer's left eye. He then sees *two* images of the fundus oculi. By inclining the ocular prisms (D and C) inwards by the mechanism described above, the two images are fused into *one*."[a] I am indebted to Mr. Laurence for the loan of these two cuts.

[a] Laurence and Moon's Handy-Book of Ophthalmic Surgery.

The framework and adjusting mechanism is, however, fragile and delicate, and easily injured by careless handling; it is said, however, to prevent the squinting which may occur in the examination

Fig. 12.



with the French instrument, and to produce a clearer image; and its weight is only half that of the other. I cannot speak with confidence on the relative merits of the two, as my experience of Laurence's has been somewhat limited. I have, however, found its manipulation and adjustment difficult, and prefer Nachet's improvement of Giraud-Teulon's ophthalmoscope as a more practical instrument for every-day use; many, however, prefer Mr. Laurence's to Giraud-Teulon's binocular instrument. The manipulation of the French instrument is so easy, and the image afforded by it so beautiful, that I am now beginning to employ this binocular ophthalmoscope in preference even to Liebreich's hand ophthalmoscope. These ophthalmoscopes are most useful in the examination of cases in which an inequality of surface may be suspected; thus, in glaucoma they afford a beautiful and clear image of the cup-like depression of the optic nerve and of the vessels on the sides and in the bottom of the depression.

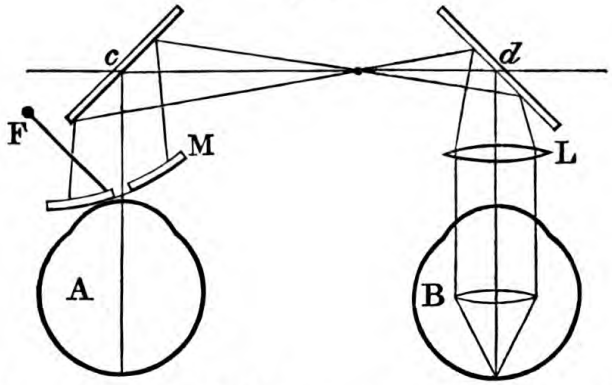
As is evident, the image of the fundus can be examined only by one individual at a time. Mr. Z. Laurence, has here also brought his great knowledge of the science to bear on the subject, and in 1863 proposed a method whereby the original aërial image may, while

being regarded by the observer, be reflected so as to become visible to a *second* person at the same time; he interposed at right angles between the ordinary reversed image and the ophthalmoscope mirror a plate of glass, with plane parallel surfaces like that used in Helmholtz's first ophthalmoscope; by means of this plate a duplicate image is formed, which may be seen by a second person placed in a certain given position. Giraud-Teulon has suggested an addition whereby even a *third* person may participate in the examination; this is the employment of a plane perforated mirror to reflect the light on to the ophthalmoscope mirror; a lamp is placed near the ophthalmoscope, and is furnished with a chimney, blackened on three-fourths of its circumference; through the remaining clear portion the light proceeds, and falls on the plane perforated mirror, and is reflected by it on to the concave ophthalmoscope mirror, from whence it proceeds to illumine the fundus; the original observer sees the image in the usual way through the ophthalmoscope mirror opening; the second observer sees the reflected image by means of Laurence's plate of glass; and the third places his eye behind the opening in the plane reflecting mirror, and obtains an image from the concave mirror; this third observer is, in fact, almost in the position of a conjugate focus.

Shortly after the establishment of the science and art of ophthalmoscopy Coccius proposed and eventually carried into practice a plan of examination whereby the eye can inspect its own fundus. This consisted in placing close in front of the eye a perforated plane mirror, with its reflecting surface towards the eye, and behind this a flame; the rays passing through the aperture are focussed on the retina; and after emerging from the eye again are made to strike on the mirror close to the perforation, where an image of the illumined portion can be seen; by this means the optic nerve entrance may be seen by the macula lutea of the same eye. Various ingenious *autophthalmoscopes* were subsequently devised; one of the best, though large and complicated, was that of Dr. Heymann, of Dresden. Dr. Giraud-Teulon also constructed one, the principles of which may be learned from the accompanying diagram, copied from the more elaborate figure in his *Précis de la Réfraction et de l'Accommodation de l'Œil*, &c., contained in the supplement to the admirable French translation and annotation of Mackenzie. In this figure the eye A is examining its fellow B; F is the flame, and M a concave perforated mirror, held obliquely before the eye, so that rays from F shall be reflected on to *c*, a plane mirror which is inclined

at such an angle that the rays falling on it are reflected towards *d*, a second plane mirror, which will reflect them into the eye B; a double convex lens of short focus, L, is interposed between

Fig. 13.



B and *d*, by means of which the usual inverted aërial image is formed, which will be seen by A apparently situate beyond the mirror *c*, although absolutely situate between the two mirrors, near *d*; the erect image may be produced by dispensing with the lens L and approximating the eyes to the mirrors. By this instrument the whole fundus of one eye may be examined by the other eye. I should mention that it is necessary to dilate the pupil for all these various experiments and examinations.

From the foregoing brief and imperfect sketch it will be seen that the ophthalmoscope is not the result of accident or some happy thought, nor the creation of some one inventive genius, but that it owes its origin to deep research and laborious study, to years of observation, reasoning, induction, and calculation on the part of many, pre-eminent amongst whom will always stand Helmholtz, the founder of ophthalmoscopy. The instrument may possibly be still in its infancy as a means of physical diagnosis, and further modifications and improvements may yet be carried out which will render the ophthalmoscope even more perfect and efficient than it at present undoubtedly is.

LECTURE III.

ON THE

ANATOMY OF THE PARTS

SEEN BY THE

OPHTHALMOSCOPE.

An acquaintance with the *anatomy* of the parts concerned in ophthalmoscopy being essential, it may not be out of place to recapitulate briefly a few of the leading features regarding the relations and structure of those parts.

The eyeball is nearly spherical, and composed of various membranes enclosing the refracting media and sensitive apparatus. The case or outer wall of the globe is a fibrous structure, of which the chief portion is dense and opaque, and termed sclerotica; the anterior middle portion, the cornea, is transparent, forming, as it were, a window. Internal to the sclerotic there is a vascular and pigment membrane, the choroid, which terminates in the ciliary body and iris; and internal to the choroid is the nervous expansion, termed retina. The refracting media, of which the cornea itself forms a portion, are the crystalline lens and the aqueous and vitreous humours; the aqueous humour lies between the cornea and the front of the lens, the vitreous between the back of the lens and the

retina; the lens itself is biconvex, more convex posteriorly than anteriorly, suspended in a delicate transparent capsule behind the iris.

The parts with which we are more immediately concerned, however, are those lying posterior to the crystalline lens, which, as seen by the ophthalmoscope, are the vitreous humour, optic nerve, and retina, choroid and sclerotic.

The *vitreous humour* is a perfectly transparent, jelly-like body, filling up about three-fourths of the cavity of the globe, lying between the lens and the retina; it consists principally of water, together with a small amount of chloride of sodium, and a minute quantity of albumen; it is composed of a delicate structureless cellular membrane, in the meshes of which the fluid is contained. This structure is surrounded by the hyaloid membrane which assists in forming the suspensory ligament of the lens and the canal of Petit. Anteriorly there is a saucer-like depression in the vitreous humour for the reception of the lens; its posterior surface is throughout in connexion with the retina, but separated from it by a very delicate layer of clear transparent cells. On its anterior surface, around the margin of the lens, is the radiated appearance known as the zone of Zinn; this is formed by the pigment of the ciliary processes remaining on the hyaloid membrane, which is there thrown into folds. Traversing the centre of the humour, from the optic nerve to the posterior pole of the lens, is a canal for the transmission of an artery during fœtal existence; during intra-uterine life, this branch is large and passes forward from the central artery of the retina through the vitreous to the posterior capsule of the lens; after birth, however, this branch disappears altogether; a few cases have been recorded where it remained permanent, but closed, and I, myself, have seen an instance of this atrophied thread-like remains of the artery. Being transparent in its healthy condition, the vitreous humour is, of course, ophthalmoscopically unrecognizable.

The *optic nerve* after leaving the commissure runs forwards and a little outwards to the optic foramen, through which it passes and then through the orbit to the back of the eyeball, where it pierces the sclerotic and choroid, somewhat to the inside of the optic axis. As soon as the nerve has entered the globe, it, as well as its individual nerve-fibre bundles, lose their sheaths, and the denuded nerve fibres pass forwards as far as the inner plane of the retina, where they bend outwards on all sides, more or less at right angles, and expanding on the convex surface of the vitreous, form, together with new nervous

and other elements, the retina. These optic nerve-fibres form the most internal of the retinal layers, and project consequently beyond the plane of the external layers before expanding into the retina. As they bend outwards on all sides there must remain more or less of a depression in their centre; this depression is usually filled up by the vessels, and, in the majority of eyes, is scarcely appreciable; in many instances, however, it is considerable, its depth and size depending principally on the character of the external layers of the retina; if these be very thick or reach close up to the nerve entrance, the optic nerve fibres are necessitated to take a more perpendicular course and to bend sharply round at right angles, leaving a hollow in their centre; this is termed *physiological excavation*, and is ophthalmoscopically recognizable. At the sclerotic opening the sheath of the optic nerve merges into the sclerotic coat, and the tubular sheaths of the individual nerve-fibres cease, or rather bend horizontally outwards to unite with the margins of the sclerotic opening, and assist in the formation of the *lamina cribrosa*. This perforated or sieve-like plate is formed by delicate bands of fibrous tissue from the sclerotic itself, which pass across the opening; by the sheaths of the nerve-fibres just alluded to, and also by some delicate processes from the elastic lamina of the choroid, its use would appear to be to support this weak spot of the outer wall of the globe, and resist pressure from within the eyeball. Internal to the lamina cribrosa the termination of the optic nerve is transparent, and the lamina is consequently ophthalmoscopically visible to a certain degree. Before its entrance into the globe, the optic nerve is pierced by the *arteria* centralis retina, which, together with its corresponding vein, runs in its centre, and branches out in all directions, but principally towards the temporal side in the substance of the retina; the artery may be traced as far forwards as the ora serrata, where it terminates in a delicate capillary network.

The *retina* is a fine transparent membrane composed of cellular and nervous tissue, the latter arranged in superimposed layers; it extends from the optic nerve entrance to the ora serrata at the cillary processes, and presents a uniform concavity in apposition with the convex surface of the vitreous humour, between which and the choroid it is expanded; its proper nerve structure is separated from the hyaloid membrane by the *membrana limitans interna*, which is composed of a variety of cellular tissue denominated neuroglia by Virchow, and which sends processes into the retina as far as the bacillary layer. These processes are named Müller's radial fibres,

after their discoverer, and serve in all likelihood the same purposes as connective tissue elsewhere; the *membrana limitans externa* formed of the same structure lies between the bacillary layer and the outer granules, and is much finer and more delicate than the internal one. The retina may be divided into the following seven layers from within outwards:—1. non-nucleated optic nerve fibres; being the expansion of the optic nerve already alluded to; it is principally in this layer that we find the vessels, but they are not exclusively confined to it as their minute ramifications enter the granular layers; 2. ganglionic nerve cells (similar to the cerebral); 3. granular layer: grey nerve fibres; 4. internal granular layer: small oval nucleated cells; 5. inter or middle granular layer, consisting of fibres passing to the former layer; 6. outer or external granular layer: partially nucleated; and, 7. the bacillary layer called also rods and bulbs, or Jacob's membrane, composed of minute cylindrical rod-like bodies, arranged side by side in a regular close packed layer perpendicular to the surface of the retina, and of equally minute bulbous or conical bodies scattered regularly through the rods. This structure is *sui generis*, and is not found elsewhere. It will then be seen that the optic nerve forms only a very small portion of the retina, and that the description so generally made use of, to the effect that the retina is the expansion of the optic nerve, is not quite accurate. Situate at the optic axis, and to the outside of the optic nerve entrance is what is known as the *yellow spot* or foramen of Sœmmering, or fovea centralis; this is said to be of a yellowish tinge; there are no capillaries at this spot, and the larger branches of vessels course round it, but do not pass over it; the optic nerve fibres also course round it, and are nearly totally absent in it; the ganglionic nerve cells form a very thick layer which is in apposition with the membrana limitans. This latter does not send any processes into it; the rods are absent, but the bulbs of the bacillary layer exist; the granular layers are exceedingly thin. This spot is said to be peculiar to the human eye; it is found, however, in some monkeys, and recently Mr. Hulke has demonstrated it in the eye of the chameleon.

The optic nerve-fibres, themselves, are said to be insensible to the stimulus of light; the bacillary layer is the perceptive one, and the optic nerve-fibres conduct the impression to the brain; the intervening granular layers are supposed to transmit the impressions from the bacillary to the fibrous layer, but how this is accomplished has not as yet been satisfactorily demonstrated. The most acute vision

resides in the yellow spot, and the fact of the existence of the bulbs at this place, and the absence of the rods would seem to indicate that the bulbs are the most essential part, and that in them resides the most acute perception. As to the function of each of these parts, M. Wecker, in his excellent work, *Maladies des Yeux*, states he has arrived at the following conclusions:—"The elements of the bacillary layer convey the perception of the fainter luminous impressions; this impression becomes converted into a nervous irritation in the granules; the cellules of the layer of granules reunite a certain number of Müller's fibres, and preside over the tone of colours; the ganglionic cells finally collect all the impressions which several rods convey to each of them, and then transmit them to the nerve fibres which convey the entire impression to the brain. It is, however, still absolutely impossible to determine whether the ganglionic cells possess a central vital power, or whether they are endowed simply with reflex activity."

External to the retina, between it and the sclerotic, lies the *choroid*; this dark brown-coloured membrane is loosely attached throughout to the sclerotic by the perforating ciliary vessels and nerves, and by connective tissue; posteriorly, where it possesses an opening for the entrance of the optic nerve, it is firmly attached to the sclerotic by means of fibrous tissue; anteriorly it is intimately connected to the sclerotic and ciliary body, and terminates in the iris. The choroid is composed principally of blood-vessels and pigment; its arteries, derived from the posterior short ciliary arteries, take a straight course; some are transformed direct into veins, while others go to form the capillary network; the veins, called vasa vorticosa are curved and unite into four or five principal stems, which assist in forming the ophthalmic vein. The stroma or basis of the choroid is composed of cellular and elastic tissue, and has some muscular fibres and also nerve elements scattered throughout; the pigment is contained externally in large cells in the meshes of the stroma and between the vessels; internally in hexagonal cells. Anatomists have divided the choroid into several layers, which may be summarized from within outwards, as, 1. pigment epithelium; 2. elastic lamina; 3. tunica vasculosa. The epithelial layer is composed of hexagonal flattened cells containing pigment granules; it is next the retina, and is probably intimately related to and in connexion with the bacillary layer; the quantity and the colour of the pigment in this choroidal epithelium varies considerably, sometimes, as in albinos, it is

altogether absent, so that this layer is transparent; sometimes it is very dark and abundant; generally it suffices to conceal or render indistinct the other parts of the choroid lying beneath it. The elastic lamina, or membrana limitans uveae, is a delicate, extremely thin transparent membrane lining the interior surface of the vascular choroid, and extending forwards on the ciliary processes and the posterior surface of the iris; this structure assists in the formation of the lamina cribrosa posteriorly, and is connected with the membrana limitans of the retina anteriorly at the ora serrata. The tunica vasculosa may be divided from within outwards into the chorio-capillaris, the proper tunica vasculosa and the lamina fusca. The chorio-capillaris, known as the membrana Ruyschiana, is a fine dense network of capillaries, devoid of pigment; the peculiar red colour seen by the ophthalmoscope is due principally to this layer; it is this structure, too, which becomes most frequently the seat of disease, and from which occur effusions into the retina, or into the vitreous chamber. External to this are the arteries, veins, and pigment, and next the sclerotic a deep brown layer, the lamina fusca, in which are embedded the ciliary nerves and the long ciliary arteries.

The principal object of these very numerous blood-vessels would appear to be that of supplying and depositing pigment, and this pigment seems to be essential to the perfect act of vision; it excludes unnecessary or disturbing light, and absorbs to a very great extent the rays of light which have been utilized; the pigment of the choroid seems to be as essential to the function of the retina as is the metallic amalgam in the mirror—indeed the retina and subjacent choroid may be roughly likened to the glass and quicksilver in the mirror.

The *sclerotic* forms a protecting case for the contents of the eye-ball; anteriorly it is continuous with the transparent cornea; posteriorly with the sheath of the optic nerve. As already stated, this structure contributes principally to the formation of the *lamina cribrosa* through the openings in which the fibres of the optic nerve, freed from their sheaths, pass into the retina; the membrane is also pierced by the vessels and nerves going to the choroid; it is supplied scantily with blood-vessels from the posterior short ciliary, the anterior ciliary arteries and muscular branches; twigs of the ciliary nerves are also traceable in its structure. It is composed of white fibrous tissue, with a small admixture of yellow elastic tissue; the fibres interlace in a very

irregular manner. Its external surface is rough and has attached to it the ocular muscles; its internal surface is glistening and stained of a brownish colour from contact with the lamina fusca. It is but very seldom attacked by primary disease, but becomes not unfrequently involved in diseased conditions of the choroid; it is not visible ophthalmoscopically, excepting a very minute portion around the entrance of the optic nerve; in consequence of disease of the choroid, however, it becomes frequently visible to a greater or less extent. This membrane varies considerably in the animal kingdom both in structure and in thickness, being cartilaginous in some, bony in others, and fibro-cartilaginous in others; while in man it is half a line thick posteriorly; it measures one and a-half inch in the same place in the whale.

LECTURE IV.

ON THE

EXAMINATION OF THE EYE

WITH THE

OPHTHALMOSCOPE.

In order to examine the interior of the eye with the ophthalmoscope, it is necessary to have a suitable illumination in a darkened apartment; any ordinary oil lamp with its globe removed will answer the purpose; all that is required is a steady broad flame; it need not be very large or very brilliant; on the contrary, I should rather recommend a subdued light as being more grateful to the patient and more suitable for the recognition of the finer details. We may be occasionally compelled to employ a candle, but it affords too small a body of light, and its flame is too unsteady and too narrow for a satisfactory illumination, or for general use. When I am called on to examine patients at their own homes, I generally bring with me the little lamp of Smith and Beck's fixed ophthalmoscope; a conveniently small and portable lamp for ophthalmoscopic purposes is much to be desired. The lamp I habitually employ, both in my own house and in the Richmond Hospital, is a German reading lamp, with its shade removed; as may be seen in Fig. 1, that part of the lamp which carries the flame is movable on an upright stem, so that the light may be fixed at any convenient height, or any desired position. Gas affords an excellent source of illumination; but the flickering and unsteadiness common to gas jets should be prevented; the steadiest ordinary gas jets are those supplied by dry meters. The best form of gas bracket I am acquainted with

is that which I had put up in St. Mark's Ophthalmic Hospital in 1859, similar to the one used in the Royal London Ophthalmic Hospital. It has an argand burner closed beneath with fine wire gauze, which equalizes the supply of air and causes a uniform draught and a steady flame. The bracket possesses universal motion, and the flame always remains vertical in consequence of a parallel rod attached to one of the arms. This lamp affords likewise one of the best sources of artificial illumination for laryngoscopic or aural examinations, and may be supplied with metal chimneys, perforated in any desired manner. For ophthalmoscopic purposes it is well to have the glass chimneys faintly tinged with blue, so as to modify the light. The flame should occupy a position behind the examined eye, so that its rays shall not directly impinge on the eye. I prefer, as a rule, having the light in one given position—a little above and behind the middle of the patient's head; others, however, prefer the light behind and to the side of the patient's right ear; and this position is probably the best where the examiner uses his right eye only. All direct sunbeams or other light which might interfere with the rays going to or from the examined eye, must be avoided. It is, however, not necessary that daylight should be completely excluded; a small amount of diffused and modified daylight may be present, and will be found very convenient. Sunlight is also employed in ophthalmoscopy, but principally in warm climates, and where the facilities we possess in our cities cannot be had. It is admitted through a circular orifice in the window-shutter, or door, or reflected by a plain mirror into the darkened chamber through the open door or window.

The eye should always be first examined without dilating the pupil artificially, as there are various objections to the latter proceeding. When the patient sits with his back to the light for a few minutes in the darkened chamber, and regards some distant object, the pupil will generally be found sufficiently dilated naturally for an experienced examiner to see the fundus, and to ascertain, in a large number of instances, the cause of the impaired vision. If, however, the pupil remain too small, or it be desirable or necessary to obtain a view of the whole of the lens or of the fundus, it can be readily dilated at any time; for the purposes of teaching, demonstrating, or learning also, it is well to have the pupil dilated; the substance used for the purpose is belladonna or its alkaloid atropia, the latter being preferable on account both of its activity and its cleanliness; one grain of sulphate of atropia

to the ounce of distilled water will suffice to dilate the pupil in healthy eyes in about half an hour (the strength of the solution I generally employ in diseased conditions of the cornea, iris, or lens, is one grain to the drachm).

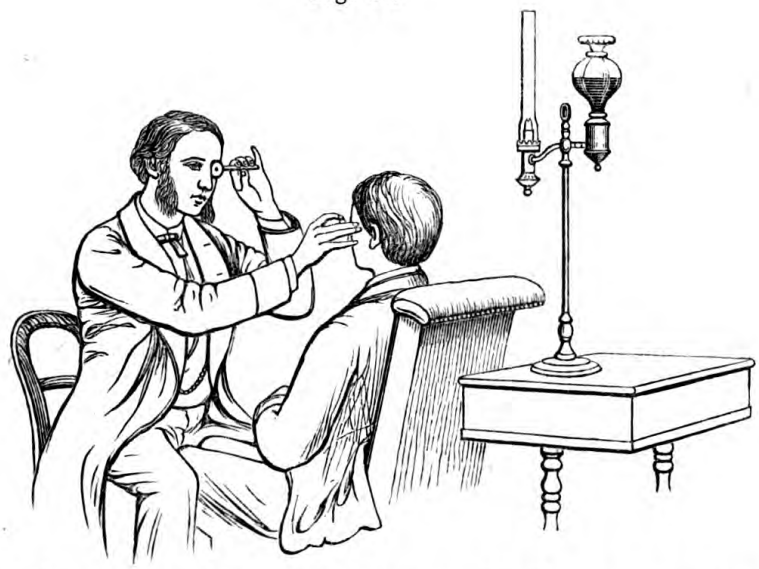
Prior to studying on the human eye it is advisable to practice ophthalmoscopic illumination of other objects. The beginner should take the plate representing the arteria centralis retina in Gray's Anatomy, or the accompanying chromo-lithograph, place it upright in front of a lamp or candle, so that it shall be in the shade, and then practice illuminating it from various positions, with and without the interposition of the lens, and with each eye alternately. Rabbit's eyes afford an easy and a beautiful object for study; the fundus in these animals differs, however, from that of the human eye; the eyes of persons, who are completely and incurably blind from cerebral disease, may be selected by the beginner, with advantage to himself, and without inconvenience to the patient; highly myopic eyes should also be selected, as the fundus becomes very readily visible.

The following observations refer, in particular, to the examination of the reversed or aërial image with Liebreich's small ophthalmoscope. The patient should be comfortably seated beside or with his back to a table, on which the light is placed; he should hold his head fully erect in one fixed position, and not move it about from side to side. The examiner should occupy a seat a little higher than that of the patient, and have his eyes on a somewhat higher level than those of the patient; he should also fairly front the observed. The distance between the two faces must depend on the refractive condition and the power of accommodation of both eyes. When these are normal it will be about eighteen inches—a short and convenient distance. I myself prefer standing in front of the patient for short examinations, and having the patient's head slightly inclined backwards, with the light vertically above and a little behind it. When dexterity and facility in examining have been acquired, this method affords many advantages; it allows of greater control over the patient; the examiner can move more readily in all directions, practice oblique illumination, and examine a number of cases in succession more expeditiously.

All preliminaries being now arranged, and the left eye the one to be examined, the transparent media are to be observed by oblique illumination; and when it has been ascertained that these are transparent, the mirror is to be applied into the angle formed

by the eyebrow and nose on the left side somewhat in the same manner as an eyeglass; the central aperture in the mirror should then be opposite the observer's pupil; the handle of the instrument is to be held horizontal, its extremity being grasped somewhat in the same manner as a flute between the thumb below and the three first fingers above; the little finger should be free, project beyond the handle, and be held erect, as shown in Fig. 14. The upper arm may be retained at the side, or, as in the cut, project from and be at right angles with the body. While being kept close pressed into the angle between the nose and eyebrow, the mirror should be moved vertically by rolling the handle between the fingers and thumb, and horizontally by movements of the handle backwards and forwards until the light is made to fall on the eye under examination. It is most important to recollect that the patient and examiner must retain their original facing position.

Fig. 14.



The right or non-examining eye may be kept open so as to control the patient's movements and the proper position of the reflected light; it should, however, be occasionally closed, so as to make sure that the left or examining eye is looking through the ophthalmoscope opening. When the patient is unsteady it is advisable, in the beginning of the examination, to place the open right hand on his head, so as to keep it in the erect position, and prevent its moving. The examination having proceeded thus far, and the eye being now fairly and steadily illumined, the observer

should perceive a brilliant red glow behind the pupil, which will be fixed or transitory according as the illumination or position is properly maintained or not. When this luminosity has been clearly obtained, the examiner should move to and from the eye, so as to inspect the refractive condition, for in some abnormal states of refraction he will be able to perceive the details of the fundus at certain positions more or less distinctly. The examined eye should also be made to move up and down, and laterally, rapidly and slowly, so that floating bodies in the vitreous humour or opacities at the periphery of the lens may come into view. The patient is next desired to regard (without moving his head) the point of the observer's erect little finger, and when he has done so the red brilliancy will assume a somewhat white character, which indicates that the optic nerve entrance is then in the exact visual line. While the patient keeps steadily regarding the point of the little finger the examiner takes one of the large convex lenses—two inch focus—between the finger and thumb of his right hand, and holds it about two inches in front of the eye in such a manner that the rays from the mirror shall traverse it before entering the examined eye; the hand carrying the lens may be steadied by resting the little finger on the malar bone or brow of the patient. The iris should not enter into the formation of the visual field; the lens must be moved to and fro until the image of that membrane and its pupillary margin disappear altogether, and nothing remains but the circular bright red field. These directions being followed, and the patient's and examiner's eyes being normal, the latter should perceive the image of the fundus, as shown in Plate I. In regarding this image, its position between the lens and the observer should not be forgotten, and the latter should, therefore, not endeavour to look through the lens, but should accommodate or adjust his vision for a near distance, and suppress the vision of his right eye. The lens must be moved from or approximated to the observed eye, or moved on its axis until the greatest degree of distinctness in the image is obtained; it must also be held quite vertically (to the axis of the eye), as otherwise inaccuracies, deceptions, or distortions may arise, which would lead to erroneous conclusions.

The entrance of the optic nerve into the eye is not exactly in the optic axis, but a little below and to its inside, having the yellow spot external to and on a level a little above it; the patient's eye must, therefore, be turned inwards and a little upwards, in order to bring the optic disc into the visual line, and the point of the erect

little finger affords the most convenient and generally the best object for fixation. When it is wished to observe the position of the yellow spot or its vicinity, the little finger is closed, and the index finger is raised close to the mirror for the patient to regard; in this manner each finger may be raised successively, and a prolonged and steady examination made of the most important portions of the fundus. The little finger may be armed with a bright polished metallic thimble, which will readily attract the attention of amblyopic[a] persons.

In the examination of the right eye the proceeding should be similar to that just mentioned, except that the ophthalmoscope is to be held in the right hand and to the right eye, and the lens in the left hand. We should in all instances make a comparative examination of both eyes.

I would particularly recommend this mode of examination to all who have equal vision in both eyes; it affords great facilities; the optic papilla comes into view the moment the patient regards the point of the extended little finger, and the hand carrying the lens is never in the way. When from imperfect vision in one eye, or other cause, the examiner can only use one of his eyes, he should have the light placed beside and a little behind the patient on the side of the examining eye, and direct the patient to look inwards and a little upwards towards the examiner's ear; thus, if the right eye be the examining one, the light is to be placed on the patient's left side, no matter which eye is to be observed; and if the left be the examining eye the light should be on the patient's right side; the ophthalmoscope is to be held by the hand on the same side as the observing eye, and the lens in the opposite hand; by this means the illuminating rays are not intercepted. Where the patient is quite blind, or from other cause cannot fix his vision on the little finger, or in children, the examination is more difficult; in the case of adults the individual's hand may be placed in the wished-for position, and the person desired to look towards it; in the case of children the parent or attendant should occupy the position the child is to regard, and attract its attention by speaking to it, or holding up a watch or other bright object. If we fail by these means to obtain a view of the optic disc, we must alter our

[a] The term *amblyopia* is used to denote *impaired vision*, attributable to any cause other than anomalies of refraction. *Amaurosis* is now almost exclusively used to denote *total blindness*, without even perception of light (dependent generally upon cerebral disease).

position. While the patient retains his head erect, and looks straight in front, the observer moves to the temporal side of the eye under examination, and getting about a three-quarter view of the patient's face, illumines the fundus in that position, when he will, as a rule, be able, with some little difficulty, to obtain the desired view. Where the eyelids are not opened sufficiently wide, the upper lid may generally be raised by the two middle fingers of the hand carrying the lens, these being disengaged while the thumb and index finger hold the lens, and the little finger rests on the malar bone. It should be our object, first, to obtain as extensive and general a view of the fundus as possible, so that any isolated irregularity or lesion will present itself at once as contrasting with the surrounding parts; and we should endeavour to have the optic nerve forming the centre of the picture. A slightly concave, or even a plane mirror, and a convex lens of $1\frac{1}{2}''$ focus will give the desired results. Subsequently the individual portions may be magnified by low-powered object lenses, such as those of 3″ or 4″ focus, or by magnifying the aërial image by a convex ocular lens inserted into the clip behind the mirror.

The beginner must guard against being led into error by the *reflections* which are caused by the cornea and the convex lens; these reflections are at all times more or less present, and are sometimes very embarrassing. One of these reflections is a small but exact image of the ophthalmoscope mirror, and is liable to be mistaken for the optic disc. It may, however, be distinguished from this by the dark spot in the centre, answering to the orifice in the mirror, by the absence of vessels and by its position; these reflections may generally be obviated by slight movements of the lens on its axis, and to and fro. Occasionally a thread or film of mucus adheres to the cornea, and simulates, at first sight, an opacity in the transparent media; when such occurs it must be removed by gently rubbing the upper lid over the globe.

The student must not be discouraged by getting mere momentary and passing glimpses of the optic disc. It requires considerable practice before we are able to obtain a steady and prolonged view of the parts. When the disc comes into view, and then suddenly disappears, it is attributable to some movement or unsteadiness on the part of either examiner or patient—most frequently, I think, of the former. When in searching for the optic papilla, a vessel comes into view, it should be steadily regarded and traced backwards in the direction of its increasing thickness,

until finally the papilla is found where the vessel appears to terminate.

As I have already explained, the convex object lens produces the inverted image; and in reference to this image Mr. Carter, in his excellent translation of Zander's *Augenspiegel*, or rather his new, improved, and annotated edition of that work, says:—"In order to understand clearly the effect of the inversion, it is well to take a piece of thin writing-paper, and to draw upon it a circle to represent the fundus of the left eye of a person placed opposite to the spectator. The circle may be surrounded by the letters Na Su Te In, so arranged as to indicate the superior, inferior, temporal, and nasal boundaries of the figure. To the nasal side of the centre a small circle may be drawn for the optic disc, with lines radiating chiefly towards the temporal side to represent the blood-vessels. The sketch, as it stands, will give an idea of the erect image, with its temporal side to the right of the spectator and the vessels passing to the right. If the piece of paper be turned bottom upwards, with the written side still towards the spectator, the ordinary conditions of the inverted image will be fulfilled, and the inversion of all parts will be complete."

Plate I., copied partly from Jaeger's *Beiträge zur Pathologie des Auges*, gives an idea of what the student is to look for; it represents the inverted image of the fundus of a healthy left eye, of a dark-complexioned adult. Although emanating from a concave surface, the image, as seen by the monocular ophthalmoscope, presents a flat appearance; at its centre is the optic papilla, contrasting markedly by its whitish colour with the surrounding parts, which are of a brilliant uniform red colour, traversed by fine dark-coloured lines, representing the retinal vessels. The red colour varies according to the individual; it may be a very pale or very dark red, or may contain a yellow or orange, or even a greyish tint. The fundus, as already stated, consists of the optic nerve, the retina, choroid, sclerotic, and vessels and nerves belonging to these structures.

The intra-ocular end of the nerve, termed *optic papilla*, or *optic disc*, is circular or nearly so, and, as contrasting with the surrounding surface, appears of a white colour; it is, however, of a soft cream colour or pinkish grey, and not unfrequently conveys the idea of relief; it forms the most prominent and important feature

in the image; it may be either sharply demarcated from the surrounding fundus, or may be partially or completely surrounded by one or two circles indicating the sclerotic and choroidal openings—the former white, the latter dark coloured. When the choroid is abundantly pigmented close up to the optic nerve, there is no appearance of the white or sclerotic ring round the disc, but when it is not we look down upon the sclerotic opening, which appears as a whitish ring round the nerve. Occasionally we find at one side—generally the outside—of the disc a very dark or black semicircular line; this is simply an accumulation of pigment in the choroid at this situation, and is seen in perfectly healthy eyes. Starting from the centre of the disc we find the branches of the centralis retinæ artery and vein, the former are the smaller of the two sets, and light red in colour. As a rule the artery, after emerging from the porus opticus, divides into two main stems, one above and the other below; these subdivide and branch out into numerous small stems, which take a direction towards the temporal side, coursing somewhat circularly round the yellow spot towards the periphery of the retina. The course of the veins is similar, both sets of vessels avoiding the yellow spot; the veins are larger in calibre, darker in colour, and a little tortuous; in addition to these larger branches several minute ones may be seen ramifying on the disc. The vessels do not usually subdivide until after leaving the disc; they do not always pass through the nerve in one and the same opening, and one vessel is often seen to cross the other—sometimes the artery beneath, sometimes the vein. In the drawing the artery is seen to cross the vein above, and to pass beneath the vein on the lower part of the disc. Occasionally the disc presents a slightly mottled appearance, attributable to a number of small oval, dark, or bluish spots; this appearance is due to the anatomical arrangement; the intraocular portion of the nerve being almost transparent, we can see completely through it as far as the *lamina cribrosa*, which reflects the light very strongly; occasionally some of the nerve tubules continue transparent for some distance on the cranial side of the perforated plate, and we are thus enabled to look down into them beyond the cribriform plate; hence they appear as dark spots, while the lamina cribrosa itself appears as a glistening white surface. It is not uncommon to find in the centre of the disc a depression; this may be of greater or less magnitude and simulate the cupped optic nerve seen in glaucoma. This *physiological excavation*, as it is termed, is due to the circumstance of the

nerve fibres bending round suddenly at right angles into the retina, leaving a space at the centre between them; it is seen as a bright white spot, generally at the outside (real) of the papilla, or it may appear as an extensive cup-like depression of the nerve. In this normal excavation, however, the margin of the depression never corresponds with the margin of the nerve disc, which it usually does in glaucomatic excavation. Another remarkable physiological phenomenon consists in the visible pulsation of the veins of the disc, which is not a very uncommon appearance during health; it is confined to the veins, and does not occur outside the optic disc. This *venous pulsation* is attributed to the temporarily increased intraocular pressure caused by the influx of blood brought to the eye by the arteries at each systole of the heart; an increase in volume occurs in the coats of the globe and compresses the vitreous humour, which on its part reacts and presses on the veins, they being the most yielding parts; a complete or partial momentary stoppage of the column of blood in the vein is thus produced, and as soon as the transient pressure is removed the vein expands and the arrested column passes rapidly on. Immediately after the pulsation at the wrist the vein may be seen to fill from its peripheral end, and then, after a moment, to empty. This venous and normal pulse must not be confounded with an *arterial pulsation*, which only occurs during disease, when the pressure of the vitreous is continuous and greater than the lateral pressure exerted in the artery itself. This pulse cannot be easily mistaken, as it occurs synchronously with the systole of the heart; it appears as a rhythmical movement of the red column of blood, and as the vessel appears empty during the diastole of the heart. Both these pulses may be produced by pressing on the outside of the globe with one of the disengaged fingers of the hand carrying the lens. Slight pressure will, as a rule, suffice to produce the venous pulse; if the pressure be kept up steadily and firmly the venous pulse ceases, the optic papilla pales, the veins empty, and the arteries pulsate, and dimness of vision ensues. When on slight pressure being made the arterial pulse becomes apparent, it shows that the intraocular pressure is already abnormally great. The physiological explanation of the arterial pulse was first given by von Gräfe, who likewise drew attention to its great practical importance and significance in the diagnosis of glaucoma.

In shape the optic papilla is, as a rule, circular. Sometimes, however, it is oval from above downwards, and very rarely

horizontally oval. Whenever it is seen to vary from the circular shape, we should be on our guard and satisfy ourselves that it is actually anatomically oval, for by a false position of the lens its shape may be distorted. In case the papilla appears oval in the reversed image, we should examine it by the direct method, and *vice versa*, as a comparison of the results of both methods may lead to the recognition of a rare anomaly of refraction—astigmatism. Minute spots of pigment have, on rare occasions, been observed as congenital peculiarities on the optic papilla of normal eyes.

The *retina* cannot, as a rule, be distinctly seen during health; it is, if not perfectly transparent, at all events highly translucent, and we look through it on to the choroid. When the choroid is deeply coloured with abundant dark pigment, the retina may be indistinctly visible as a slightly greyish cobweb-like membrane; occasionally delicate, isolated lines, representing the nerve fibres, may be detected radiating towards the periphery. The presence of the retina may, however, always be recognized by means of the branches of the arteria and venacentralis retina, which, after passing the disc, course towards the periphery in the nerve-fibre layer of the retina. These vessels are, as I have stated, distinguished by their size and colour. The arteries are small, and filled with bright red blood, while the veins are larger, somewhat more tortuous, and of a darker colour. The arteries appear sometimes as if transparent along the centre of the vessel, or, which is the same, as if the lateral walls were opaque; this is, however, solely owing to the reflection of light, in the direction of its incidence, from the most prominent part of the vessel (that towards the observer). The retinal vessels appear almost to stand out in relief, and are easily visible. When one of these comes into view, while the observer is looking for the optic disc, he should trace it backwards in the direction of its increasing thickness, or in the contrary direction to that in which its vessels are given off.

The *macula lutea*, or yellow spot of Sœmmering, is situated to the outside of the optic disc in the retina. Its position in the inverted image is indicated by the dark shading in Plate I. to the inside or left-hand side of the disc. This so-called yellow spot can be only exceptionally distinctly recognized; its position may, however, be at all times easily seen. The patient should regard the image of the flame in the mirror, or the point of the erect index finger of the hand carrying the ophthalmoscope, the finger being close beside the mirror. The position of the yellow spot is characterized

ophthalmoscopically by the absence of retinal vessels of any size, and by the dark colouration which is due to a more abundant pigmentation of the choroid at this than at other places. The fovea centralis is said to appear as a small, bright spot about the middle of this dark-coloured portion. Those wishing to study this part more particularly should employ a plane mirror, with a concave lens behind it, and get the observed to regard steadily the flame of the image in the mirror; there will then be formed an image of the flame, or part of it, on the fovea centralis.

The *choroid* membrane lies beneath the retina, and forms one of the most important features in the ophthalmoscopic image, as to it is due the peculiar red colour of the fundus; in the examination we are, in fact, regarding not the retina but the choroid. The colour of the fundus depends on the illumination and on the pigmentation of the choroid and its epithelial layer; it is a bright blood-red, with an admixture of yellowish brown due to the blood in the tunica vasculosa and the chorio capillaris; and to the pigment in the stroma and in the epithelial layer; in blonde persons the amount of pigment in the cells is small, and the fundus appears of a light yellow red, whereas in dark-complexioned individuals, with brown or black irides, the pigment is abundant, and the fundus appears of a brown red. Dark, brown, or black spots, with irregular outlines, are of not uncommon occurrence in the fundus of healthy eyes; they are simply accumulations of pigment corpuscles, and are most frequently seen at the outside of the optic nerve entrance. As a rule, the fundus presents a uniform colour, and a faintly granular or stippled appearance, in front of which the retinal vessels stand out in relief; or the retina itself may be recognizable as a delicate bluish grey film in front of the dark choroid. Occasionally the internal (epithelial) layer of pigment is so scanty and diaphanous that we are able to see the large choroidal vessels through it; these are always of a lighter colour, and are likewise broader than the retinal vessels; they are likened to flattened ribands, of a yellowish or orange tinge; they are not sharply defined, take a winding course, anastomose, and divide frequently, and may be distinctly seen lying beneath the retina; by fixing a large dark retinal vein, we can satisfy ourselves of the existence of a space between it and the choroidal vessel, and by means of the binocular ophthalmoscope this relation becomes very manifest. Occasionally the pigment is so abundant and dark in the meshes of the stroma between the vessels, and so scanty in the epithelial layer, that the

choroid appears as if mapped out into irregular, angular, dark, island-like spaces, bounded by yellowish lines, the latter representing the large choroidal vessels. In healthy eyes the fundus should be perfectly clear and brilliant, without any haziness or indistinctness of its parts. At the entrance of the optic nerve into the globe the choroid appears sometimes as a dark circle or half circle around the nerve.

The *sclerotic*, although entering into the formation of the fundus, is but rarely visible during health, being concealed by the choroid; it contributes, probably, in a slight degree, to the colouration of the ophthalmoscopic image. Occasionally a small circle of this membrane is exposed around the optic disc at the nerve entrance, and appears of a brilliant white, or tendinous aspect. As a result of pathological alterations, this membrane frequently becomes visible.

LECTURE V.

ON THE

ANOMALIES OF REFRACTION.

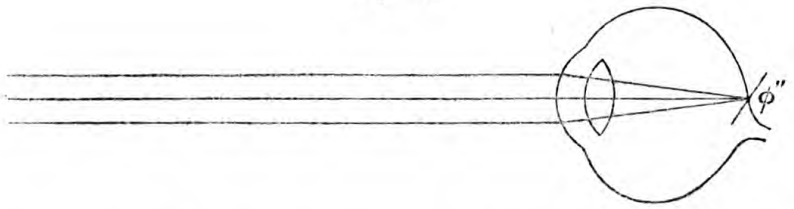
As the subject of refraction is so interwoven with the ophthalmoscopic investigation, and as one of the first objects of the examination should be to determine the state of the dioptic apparatus, some allusion to the subject is necessary; it is not, however, my present intention to do more than very briefly allude to it. To those who may be desirous of obtaining full information on such matters, I would recommend Donders' great work, *On the Anomalies of Accommodation and Refraction of the Eye*, translated by Dr. William D. Moore, of this city. Mr. J. Z. Laurence's *Optical Defects of the Eye*, is, in my opinion, the best short treatise I can recommend to the student; and those already engaged in practice will find Soelberg Wells' *Long, Short, and Weak Sight*, a most valuable work.

I have already referred to refraction and accommodation, but as these two distinct conditions are liable to be confounded with one another, I would again direct attention to them, and would impress on the student the necessity of distinguishing one from the other. *Refraction* is a power inherent in certain bodies or media of altering the direction of rays of light which strike on their surfaces; in the human eye it is dependent on the anatomical

structure and configuration of the transparent media, and is entirely a passive condition totally independent of volition or muscular action. *Accommodation* is an active condition, and, to a certain degree, a voluntary act, accomplished by muscular force; it may be said to govern refraction; thus, in a perfectly constructed healthy eye in repose, parallel rays from an object at infinite distance are brought to a focus on the bacillary layer of the retina and distinct vision ensues; when the object is moved nearer to the eye the physiological act of accommodation comes into play, and so alters the refraction that the object is still clearly seen.

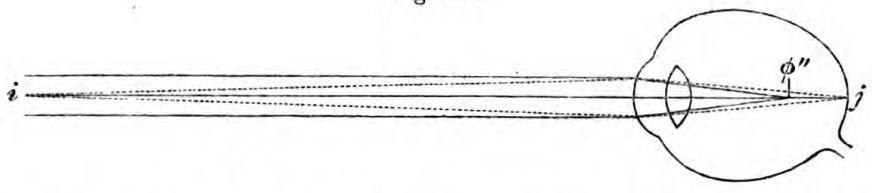
Eyes are now divided into three great groups, according to their state of refraction. In the first of these the refractive state is perfect, *i.e.*, parallel rays are focussed on the outer layer of the retina (at φ'', Fig. 15) when the eye is in a state of repose, and therefore uninfluenced by accommodation; this condition has been termed *emmetropia* (from ἔμμετρος, having an accurate size, or being of just proportions, and ὤψ eye), and is shown in Fig. 15, copied, together with the next five diagrams, from Donders' work referred

Fig. 15.



to above. In the other two groups the principal focus of the rays lies either in front of or behind the retina; and *ametropia* is said to exist (from ἄμετρος, abnormal measurement, and ὤψ, eye.) When the focus of parallel rays falls *in front* of the retina, as seen at φ'', in Fig. 16, the eye is *myopic*, or short-sighted. Such an

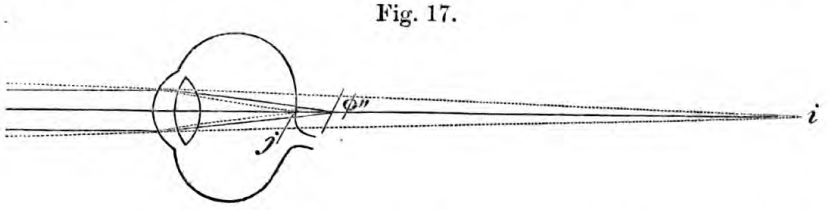
Fig. 16.



eye can only focus on its retina divergent rays (dotted in figure); rays which are easily obtained by holding the object close to the eye. The opposite of this condition is where the principal focus of

the parallel rays falls *behind* the retina, as exemplified in Fig. 17. In this condition, which is denominated *hypermetropia*, only convergent rays can be united in the retina—such rays do not exist at all

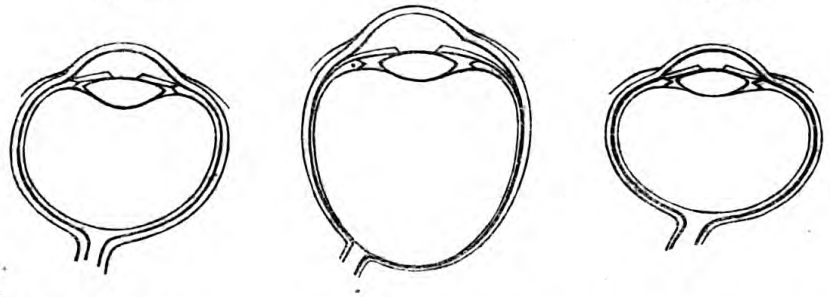
Fig. 17.



in nature, and can only be produced artificially. Donders, to whom we owe the discovery and elucidation of this anomaly, says that in myopia "in the condition of rest, objects are accurately seen which are situated at a definite, finite distance (Fig. 16 *i*);" in hypermetropia "they are at no distance accurately seen, for the rays in falling upon the cornea must, in order to unite in the retina, already converge towards a point situated behind the eye (Fig. 17 *i*). In the first case the farthest limit lies *within* the normal measure; the measure is too short, and the condition might therefore be called *brachymetropia*. In the second case the boundary lies *beyond* the measure, and I have, therefore, called this state *hypermetropia*."

These anomalies may be attributable to defects in the refracting media, or to abnormal configuration of the globe; thus, absence of the crystalline lens, whether congenital or acquired, will produce hypermetropia, or the lens may be abnormally situated or abnormally curved. In general, however, these anomalies are found to be due to abnormal configuration of the eyeball.

Fig. 18. Fig. 19. Fig. 20.



While Fig. 18 represents the typical or emmetropic eye, the other two diagrams represent the ametropic globe. In the myopic eye (Fig. 19) it will be seen that the antero-posterior diameter is too long, and that therefore the rays must come to a focus before

they reach the retina; hence only rays of dispersion fall on the sensitive apparatus, and indistinct vision ensues. In the hypermetropic eye, Fig. 20, the antero-posterior diameter is too short, and the focus of parallel rays would fall behind the retina; in this case, likewise, only diffused rays (before their union) strike on the retina, and therefore indistinct vision exists. As a rule, myopic eyes are large, full, and prominent, while hypermetropic ones appear small and flattened.

Up to recent times myopia was attributed to abnormal convexity of the cornea; Donders has proved, however, by actual measurement, that the cornea is, as a rule, less convex in myopes than in emmetropes; and has found "that in the most highly myopic persons the cornea is the flattest."

The majority of eyes affected with convergent strabismus are hypermetropic, as are also a large number of the cases denominated asthenopia. Many individuals affected with hypermetropia acquire such a wonderful power of accommodation as to overcome temporarily their defect of refraction; in such persons the anomaly can only be fully established by paralysing the muscle of accommodation by means of atropia solution.

If it be borne in mind that the myopic eye can focus on its retina only such rays as impinge divergently on its cornea, and that the hypermetropic eye can only focus convergent rays, the principle of selecting for the myopic eye concave lenses, which render parallel rays divergent; and for the hypermetropic eye convex lenses, which render parallel rays convergent, will be readily understood.

In consequence of senile changes, certain alterations take place in the eye, and one of the most frequent results of these is an impairment of vision denominated *presbyopia*, far-sightedness or old-sightedness. This defect of vision has been, and even still is, not uncommonly confounded with hypermetropia, principally, I believe, because convex glasses are found to remedy both. While, however, hypermetropia is purely an anomaly of refraction, presbyopia is chiefly due to defective accommodation; strictly speaking, presbyopia is not an anomaly, but merely a natural consequence of advanced life. In childhood and early life the crystalline lens is soft, rather globular in shape, and easily acted upon by the muscle of accommodation; with advancing age the lens becomes firmer, and flattened, and, in consequence of its increased solidity, it is no longer easily altered in its curvature. Presbyopia commences,

according to Donders, about the tenth year, but does not cause any disturbance of vision until about the fortieth year of age. When the eye is at rest and its accommodation in repose, distant objects are seen, and the farthest point of critically distinct vision is obtained; this *far point* is briefly designated R (*punctum* R*emotum*). As soon as the accommodation acts, near objects are seen, and when the accommodation has reached its maximum, the nearest point of critically distinct vision is obtained; this *near point*, denominated P (*punctum* P*roximum*), is the nearest point to the eye at which accurate vision exists. Young persons can usually accommodate for a distance of about four inches, at which proximity to the eye they can read ordinary type; their eye in its passive condition unites parallel rays from distant objects on its retina; in its active condition its adjusting apparatus so increases the curvature or convexity of its lens that even divergent rays from very near objects are united on its retina, which, but for this power of accommodation, could only be united at some point behind the retina. In myopia and hypermetropia the far point is abnormal, *i.e.*, at a certain definite distance, in the healthy as well as in the presbyopic eye the far point is at the normal or infinite distance; the near point, however, becomes in presbyopia abnormally far off, and the individual is unable to see near objects distinctly, although distant objects may still be seen with great accuracy. When the near point has receded to eight or ten inches from the eye, presbyopia may be said to exist.

It is evident, then, that the lenticular system may be correct—that its focus may fall on the retina, and that yet presbyopia may be present—from defective accommodation; it will also be seen that presbyopia is not the opposite condition to myopia. Presbyopia may exist in the normal eye, and it may co-exist with myopia or hypermetropia. It is a well-known fact that myopic persons frequently improve in their vision with advancing years; and this is due to the accession of presbyopia; owing to the same cause also, many persons retain good vision up to a very advanced period of life; such individuals were myopic, but to such a slight extent that they themselves were unaware of the circumstance.

Besides the two anomalies of refraction alluded to, there is a third, termed *astigmatism* (from α, privative, and στίγμα, focus,) in which the eye possesses different powers of refraction in its several meridians, or even in one and the same meridian. It may be myopic or hypermetropic to a very slight extent in one meridian, while in another it may be so to a very great extent, or it may be myopic in

one and hypermetropic in another meridian; or emmetropic in one or more, and ametropic in other meridians.

If the eye be regarded as a globe, and the centre of the cornea as one pole, and the corresponding point at the back of the eye as a second pole, then circles drawn through these poles will represent meridians.

The defect of vision under consideration was first described by Dr. Thomas Young in the *Philosophical Transactions* for 1801; then by Professor Airy, Astronomer Royal; by Dr. Goode of Cambridge, and by Dr. Fischer of Berlin, all of whom were themselves the subject of the anomaly, to which the Rev. Dr. Whewell, of Cambridge, gave the name of astigmatism, and for which Sir William Wilde proposed the designation "*cylindrical cornea.*"[a]

It has now been established that very few eyes are totally exempt from astigmatism; if vertical and horizontal lines are drawn on a sheet of paper few eyes can discern both sets simultaneously with the same degree of accuracy, or two threads which cross in a plane, the one being vertical the other horizontal are not seen with equal sharpness. Donders when speaking of regular astigmatism in the normal eye says that "the points of the refracting meridians are not symmetrically arranged around one axis. The asymmetry is of such a nature that the focal distance is shorter in the vertical meridian than in the horizontal. In order, namely, to see a vertical stripe acutely the rays, which in a horizontal plane diverge from each point of the line, must be brought to a focus on the retina: it is not necessary that these diverging in a vertical plane should also previously converge into one point, as the diffusion-images still existing in a vertical direction cover one another on the vertical stripe. On the other hand, in order to see a horizontal stripe acutely, it is necessary only that the rays of light diverging in a vertical plane should unite in one point upon the retina. Now horizontal stripes are acutely seen, as I have remarked, at a shorter distance than vertical ones: consequently rays situated in a vertical plane, which are refracted in the vertical meridian of the eye, are more speedily brought to a focus than those of equal divergence situated in a horizontal plane; and the vertical meridian therefore has a shorter focal distance than the horizontal." This focal difference in the two principal meridians is termed regular

[a] Dublin Quarterly Journal of Medical Science, September, 1845, and Malformations and Congenital Diseases of the Eye, p. 66.

astigmatism and may be present to a certain extent without interfering with ordinary vision; where however it exists in its higher degrees it materially affects vision, and various distortions and inaccuracies of sight ensue, such as seeing only certain parts of letters; as for example while the vertical lines of the letter L appear distinct the horizontal ones may not appear at all or indistinctly; or a square may seem an oblong, a luminous point may appear as a line either upright or horizontal. A homely example of the nature and effects of astigmatism is afforded in the badly blown and irregularly curved glass so frequently found in old windows; the distortions and displacements of objects seen through such glass is familiar to all. The cause of regular astigmatism resides principally in the cornea, and partly in the lens; the curvature of the cornea may be abnormal congenitally, or in consequence of disease. Normal irregular astigmatism causes very indistinct vision and polyopia uniocularis and is due to irregularities in the crystalline lens; abnormal irregular astigmatism is due to irregularities in the cornea, such as nebulous spots transparent ulcers, conical conea. Abnormal or regular astigmatism may be relieved by the use of proper cylindrical lenses; irregular astigmatism is as a rule incurable.

Hypermetropia and myopia are pretty easily recognized by means of the ophthalmoscope. Whenever the retinal vessels or optic disc are visible, no matter how imperfectly, without the interposition of the object lens the eye is either hypermetropic or myopic; myopia being the more frequent of the two. In the emmetropic eye the emergent rays return in the same direction as they entered and form a large very indistinct image at a considerable distance from the eye as shewn in figure 4, and we are unable to perceive its details without the interposition of the convex lens. In myopia the emergent rays are convergent, unite into their focus early or close to the eye, and form an actual inverted image; in hypermetropia the emergent rays are divergent and form an erect image. In the examination of the myopic eye without the object lens the details of the fundus are clearly seen at a distance of 18″ or two feet; in the hypermetropic eye the fundus is seen close to the eye; in myopia the nearer we approach the eye more ill defined and the farther we recede the more distinct will the image become, whereas in hypermetropia the nearer we approach within certain limits the more distinct will be the image, and the farther we recede the more indistinct will it be. In myopia the image is inverted; if an

individual portion of the fundus be regarded and the observer move his head in any given direction the observed part appears to move in the opposite direction; thus if the examiner hold up one of the fingers of his disengaged hand for the patient to look at, and then while steadily regarding the optic disc or a vessel move his head to the right side the optic disc or vessel will move to the left; in hypermetropia the image is erect; if an individual portion of the fundus be fixed it will be found to move in the same direction as the examiner's head. In hypermetropia the reversed image is large but appears dim and slightly obscure, whereas in myopia it is small but bright and clear. The lens employed for the production of the reversed image in hypermetropia must be of short focus, in myopia one of much longer focus may be used. Some examiners who have acquired an accurate knowledge of and command over their own accommodation can even determine the degree of ametropia existing in the eye under observation. In addition to these refractive diagnostics there is a pathological condition visible by means of the ophthalmoscope which is pathognomonic of myopia; I refer to the myopic crescent or staphyloma posticum, which shall be further alluded to in another lecture. The beginner will do well in all cases of supposed ametropia to supplement his ophthalmoscopic observation by actual test with the proper lenses.[a]

The ophthalmoscopic diagnosis of astigmatism is not so easy as that of the two anomalies just alluded to. In the emmetropic eye the disc appears as a rule circular, every part of it is readily perceived at one glance and all the branches of vessels are equally distinctly seen; in the astigmatic eye on the contrary while some of the vessels are clearly and distinctly seen, others which have a different direction are but indistinctly seen, unless by an effort of accommodation on the part of the examiner. Dr. Schweigger in his *Vorlesungen uber den Gebrauch des Augenspiegels* has pointed out that the optic nerve appears of different shapes in the reversed and erect images when astigmatism is present; thus if the disc appear

[a] Paetz and Flohr of Berlin have arranged a case of trial lenses which may be had of Mr. Yeates, 2 Grafton-street. This case contains about 25 pairs of convex and concave lenses, a set of prisms, colored glasses, and a spectacle frame. The lenses are defined in Prussian inches which are almost identical with the English measurement and numbered from 2 to 80. The number denotes the focus—whether positive or negative of the lens, so that the arbitrary numbering of English opticians is avoided;—thus + 2 means a double convex lens of 2 inch focus while − 2 denotes a double concave lens of 2 inches negative focus. These lenses and Snellen's test types have now become the standard ones all over the world.

vertically oval in the erect image and horizontally oval in the reversed image regular astigmatism must be present, for the same nerve cannot anatomically have both shapes; the comparative employment of the two methods should therefore be always had recourse to when the shape of the nerve deviates from the normal. The most frequent anatomical deviation from the circular shape is when the disc is elongated in the vertical direction, it is occasionally though rarely horizontally oval. Opacities or pronounced abnormal curvatures of the cornea will also produce corresponding irregularities in the ophthalmoscopic image. In displacement or dislocation of the transparent lens we sometimes obtain two images of the fundus; an instance of this irregular astigmatism was described by me in the *Dublin Quarterly Journal* for August, 1865.

LECTURE VI.

ON THE

VITREOUS HUMOR.

In examining the vitreous humor we should always make use of oblique and focal illumination, so as to ascertain as far as possible the real position, colour and consistency of bodies in that structure; the direct method of examination, without the interposition of the lens, should also be always employed in exploring the vitreous. The disengaged hand is to be placed on the patient's head so as to prevent its moving, the patient is then desired to look up, down, in and out, while we regard the illuminated bright field through the ophthalmoscope, held in the usual manner in the angle between nose and eyebrow; any free particle or membrane which may exist in the humor or any swelling protruding into it, is almost certain to come into view during some of these motions; the reversed image may be used, but then the object lens should be held further from the eye than its focal length, or than the distance requisite for the fundus; so as to obtain very nearly the reversed image of the pupillary margin of the iris.

As might naturally be expected from its position the vitreous humor becomes very frequently diseased in consequence of morbid processes in its surrounding membranes generally and of the choroid more particularly.

As already mentioned the *hyaloid artery* which runs during intra-uterine life from the central artery of the retina forwards to

the posterior capsule of the lens, for the nutrition of which it is destined, remains exceptionally as is always the case in oxen, persistent though closed; in the calf it is still patent and carrying blood. It is seen in certain positions as an opaque spot at the back of the lens or between that and the optic disc, and when viewed obliquely it appears as a fine opaque thread extending from the lens to the optic nerve entrance. In the one instance which I saw of this it did not interfere materially with vision.

Hyalitis.—Inflammation of the vitreous body occurs, though very rarely, without any disease of the neighbouring structures; as a rule it is consequent on disease of the surrounding membranes. The circumstance of inflammation existing in a non-vascular structure, like the vitreous, and without vascularity is a phenomenon well worthy the student's attention; pathological processes are found going forwards in the vitreous humor which, their non-vascularity excepted, are identical with those of inflammation, of which vascularity is said to be an essential and necessary feature. The nuclei of the hyaloid membrane undergo various metamorphoses and we find in the vitreous, exudation corpuscles, blood cells, fibres and connective tissue in its various stages of development or even fully formed; and even newly established blood vessels. Blood-carrying vessels have been described as stretching from the retina into the vitreous humor.

Opacities of the vitreous-humor.—The abnormal appearances most frequently met with in the vitreous are the so-called *muscae volitantes;* these appear to the affected individual of the most diverse shapes and varied sizes; small, circular black dots, plain or with a nebulous halo round them or light in the centre; or tailed black objects like a comma (,); these spots may be single or numerous and may have a certain determinate motion up and down or may revolve round each other, the muscae may also be in the shape of a gauze-like film or mist, plain or spotted; of elongated lines or streaks, or beaded threads; or a dark irregular mass of greater or less magnitude; they may have a fixed position, but usually they move about, either in a certain definite traject or irregularly; as a rule they are only seen when the lids are open, and when looking at a white surface, at the sky or at light; sometimes they can only be seen in certain positions of the eye and when sought for; in other instances they occur in all positions and movements of the eye. A very common complaint is that of a small black spot floating in the peripheral portions of the

field of vision; the affected individual, thinking on the first appearance of the spot, that it is a particle of dust floating in the air, or a fly (hence the name *myodesopsia* from μυῖα a fly and ὄψις vision; visus muscarum) puts up his hand to brush it away, but finding it still persistent after various such attempts, becomes often not a little alarmed. When we are consulted about these phenomena we should always dilate the pupil fully and make a very careful examination of the lens and the interior of the eye before pronouncing an opinion respecting them. When the parts in front of the vitreous are transparent we are able in a great number of cases to see these muscae; the ophthalmoscope mirror being used alone and the affected eye made to move quickly in different directions the dark object is seen to float into the bright illumined field, and then to disappear slowly or rapidly; it may even remain stationary for a time, and then sink down. These floating bodies generally arise from the sides or bottom of the vitreous chamber in the movements of the eye, and appear by their direct examination with transmitted light as more or less dark opaque objects very often corresponding to the patient's description of them; by incident light with oblique illumination they appear often of their natural greyish color. Sometimes extensive masses of membraneous opacities float about in the humor almost constantly, which would mechanically interfere considerably with vision, were there even no disease in the other structures; indeed I have seen persons who during the temporary and occasional subsidence of such floating bodies could see pretty distinctly, and who would become almost blind the next minute from these objects ascending and intercepting the rays, and causing symptoms not unlike those of detached retina. The fundus may be normal and wholly visible or these bodies may prevent its being distinctly or entirely seen; or it may be, as is frequently the case, diseased. These floating bodies consist of broken-down hyaloid membrane, or proliferation membranes, or fibrinous remains of blood clots, or effusion products from the choroid and ciliary tract. Simple floating spots are a very common precursor of cataract, or accompaniment of that disease in its early stage; when the cataract has fully formed they disappear because they are invisible against the dark opaque lens, when the lens is removed and light once more admitted they frequently again become visible; they also arise from congestion, from overwork or straining of the eye. I have known them arise in persons, possibly predisposed to them, who worked much at the microscope, the

ophthalmoscope, or the telescope; the large floating masses are often exudation membranes, due to choroiditis; they have frequently a thick black border, and diminish gradually into a thin semi-transparent cobweb-like membrane. Muscae volitantes are often attributable to gastric derangements, but they are merely temporary and passing and are not due to any defect in the vitreous humor, we should be slow in attributing muscae to disorders of the stomach, as is so frequently done; we are too prone indeed to ignorantly father on the stomach, symptoms, which owe their origin to morbid processes in some other organ. Muscae occur at all periods of life, and may often remain unaltered, without any further complication, or without any impairment of vision beyond the temporary and mechanical one. To nervous and timid persons they are a source of great annoyance and mental anxiety; the defect is always present not only to their mind's eye but literally to their bodily eye, they are constantly thinking of it, and incessantly looking for it and regarding it. I have known such persons go from one practitioner to another seeking for a cure and finally fall into the hands of nostrum-mongers and quacks.

Effusions of blood occur into the vitreous humor in consequence of injuries, or of spontaneous rupture of vessels in the adjoining structures; this hæmorrhage takes place most frequently from the anterior part of the choroid into the front of the vitreous humor; and the rupture is invisible; when the lesion occurs at the equatorial or posterior parts of the choroid the lesion is often apparent. I have seen several examples of effusion of blood extending completely across the vitreous chamber and then destroying vision. One of the most remarkable cases I saw was due to an injury during the performance of a strabismus operation. The entire space across the front of the vitreous, behind the lens, was occupied by a reddish mass of effused blood, across which extended several dark-brown lines as if the blood were separating into fibrine; the lens was quite transparent and vision confined to the perception of light. I witnessed a similar appearance in a boy whose eye had been injured by a piece of crockery, six months prior to my seeing him. A mass of blood of such a size, extent and position cannot I think be absorbed, and if there be evidence of the greater part of the fundus being healthy and the effusion being merely a layer of blood, it might be advisable to remove the lens and subsequently the sanguineous opacity.

The vitreous humor becomes sometimes completely muddy from

effusion of serum or lymph, and the fundus is either entirely obscured or else is very dimly visible, in consequence of choroiditis. I have known this effusion to occur in a night, and have seen it extending even into the chamber of aqueous humor. Pus is also occasionally seen in the vitreous humor in greater or smaller quantities; in some forms and stages of glaucoma the vitreous becomes turbid, green or opaque and the fundus invisible.

Synchisis. *Fluidity* of the vitreous humor ensues frequently on direct injuries, and also on certain peculiar forms of disease accompanied by increased secretion of liquid, such as glaucoma, as well as on atrophy of individual structures of the globe or entire eyeball, posterior and general staphyloma, &c. Fluidity cannot at all times be recognized, but when we see membranes or specks floating about in the vitreous, we know that the humor must be fluid, at least to the extent of the traject of the floating body; if the body is seen to move indifferently through every part of the humor we may pronounce upon the fluidity of the whole vitreous. Beyond this, I know of no certain ophthalmoscopic diagnostic sign of fluidity of the humor.

Synchisis scintillans is a very remarkable form of fluid vitreous, in which the vitreous chamber is seen filled with bright glistening metallic-like little bodies, which dance up and down, like gold leaf in fluid during the motions of the eye; these bodies were analysed by Dr. Aldridge in 1848 at the instance of Sir Wm. Wilde and proved to be crystals of cholesterine, which reflect the light very strongly. There was a patient lately in the Richmond Hospital with a cataractous lens, apparently entirely transformed into cholesterine and which looked like a piece of bright roughened silver. These crystals of cholesterine may be readily perceived with the unassisted eye in bright daylight direct illumination. Eyes affected with this peculiarity are always radically diseased and should not be meddled with. Another cause of fluidity of the vitreous humor; and frequently cholesterine formation, is the depression or couching of a cataract; a most reprehensible and as a rule an unjustifiable operation.

Foreign bodies, such as grains of shot, pieces of glass or of metal, fragments of guncaps, occasionally pierce the globe and become visible in the vitreous humor; a depressed cataract is a dangerous foreign body. The foreign body if small is suspended in the humor and surrounded sometimes with blood or lymph; after some time the humor liquifies and the object falls to the bottom where it

occasionally becomes encysted and may remain without doing much more mischief; frequently however, it gives rise to violent inflammation, which destroys vision or the entire globe, and even extends by sympathy to the second eye. These foreign bodies are generally recognizable by means of the ophthalmoscope if the media be clear. Mr. Dixon recorded, some years ago, a most interesting and instructive case in which he recognized a piece of metal in the vitreous chamber and extracted it with the most satisfactory results.

Entozoa may be mentioned as amongst the foreign bodies met with in the vitreous humor. I have seen the *cysticercus cellulosa* in the chamber of aqueous humor, but have never as yet observed it in the vitreous chamber; several instances are on record where the entozoon was recognized by the ophthalmoscope, and demonstrated after the removal of the entozoon alone or of the entire globe; it has been seen free and encysted; wholly in the vitreous humor, or partly in the vitreous and partly in the membranes of the fundus, its head and neck extending into the vitreous. It is developed in the membranes, probably the choroid, and then bursts through the retina. It is seen as an opaque bluish-white vesicle from which the head and neck may or may not be protruded in the shape of an elongation of the vesicle; occasionally the neck may be seen to contract or project, the head to move; if the whole mass is seen to shift its position there can be but little doubt as to its nature. Generally there are also a number of opacities in the vitreous, and considerable impairment or even loss of vision. The *filaria oculi humani*, a species hitherto found in the crystalline lens, has been observed in the vitreous humor of a woman aged 30 by Quadri of Naples. The cysticercus has been removed from the vitreous with preservation of the globe and partial vision.

Tumors of various kinds may encroach upon or obliterate altogether the vitreous humor. Benign or malignant intra-ocular tumors originate generally in the choroid, and extend into the vitreous humor; so far as I have seen, these tumors commence at the anterior or middle portions of the choroid, and are pretty easily seen; it is not so easy however to pronounce upon their nature; focal and oblique illumination, as well as direct ophthalmoscopic examination should be employed; these tumors appear usually of a yellowish colour, and the surrounding fundus hazy, or the entire fundus may be obscure; the vascularity observable on the visible surface of these growths is said to afford a means of recognizing their nature; when the retinal structure is apparent, the vessels

straight, few, indistinct and recognizable as the retinal vessels the probability is, the growth is benign; if the vessels are numerous, large, gorged and apparently coming from many points and running in all directions the disease is likely to be malignant.

The vitreous humor may disappear altogether, or degenerate into an atrophic cellular substance which in its shrivelled and greatly diminished size lies up against the back of the lens having the retina detached from the choroid, in close apposition on its outside; both the remains of the vitreous and the retina forming a funnel-shaped expansion from the back of the lens to the optic nerve. Tubercular deposit may also compress the vitreous and retina forwards in the same manner, and cause eventually destruction of the cornea and expulsion of the lens. In these cases however the pupil is usually closed at an early stage of the malady and we are unable to observe the alteration in the vitreous chamber. An instance of this occurred in the Richmond Hospital about 18 months ago, in which the globe was removed; scarcely a trace of original vitreous humor remained, but the retina and a small dense cellulo-fibrous mass formed a funnel-shaped prolongation from the optic nerve forwards; the cornea had almost completely perished and the lens had escaped; the vitreous chamber was filled with a yellowish scrofulous deposit. The patient made a good recovery and left the hospital apparently well. In about nine months subsequently he was admitted to the Hardwicke Hospital where he died and considerable scrofulous disease was found existing within the cranium.

LECTURE VII.

ON THE

OPTIC NERVE.

THE optic nerve is rarely the seat of primary and independent disease. It is, as a rule, secondarily affected in consequence of disease in the adjoining ocular structures, or of the brain, and is most frequently seen co-existing with disease of the retina. In the present lecture I purpose confining my remarks to the optic nerve alone.

A number of *congenital peculiarities* of the optic nerve have been recorded before the invention of the ophthalmoscope, such as fusion of the two nerves into one in cyclopia; in a case of complete absence of the right globe the left optic nerve was bifurcated, one branch normal, the other going to and terminating in the dura mater; in absence of the globe the optic nerve may be altogether absent, or only deficient from the optic commissure outwards; the optic commissure has been found wanting in microcephalus and hemicephalus, and also in otherwise normal heads and brains. The intracranial ends of the optic nerve have been found free and unattached to the brain, lying in the sella turcica; variations in the length and the diameter of the nerve have been recorded; in hydrocephalus the optic, as well as other cerebral nerves, has been found deficient of its nervous elements, and consisting simply of neurilemma; one of the most curious observations is that recorded by Magendie of the existence of a retina, without an optic nerve, in a dog with cyclopia. Congenital atrophy of the nerve is frequently mentioned. The congenital anomalies of the optic nerve recorded, as seen by means of the ophthalmoscope, are: atrophy, abnormal insertion in one eye, absence of, or misplacement of its vessels, coloboma of the nerve or of its sheath. Dr. Newman of London has recorded, in the fourth volume of the *Ophthalmic Hospital Reports*, the notes of two cases (sisters) of congenital blindness in which he observed the complete absence of the optic discs and retinal vessels. Abnormal insertion

of the nerve into the globe is classified by Desmarres as amongst "the principal maladies of the optic papilla;" it gives rise, he says, when the second eye is sound, to amblyopia with strabismus, which may be cured by suitable treatment. This anomaly must be very rare, and further observations beyond Desmarres' statement, and one somewhat doubtful instance recorded by v. Graefe, are, I think, necessary to establish its occurrence. I look upon the cases of recorded absence of the central vessels as ones of complete atrophy. The vessels, instead of appearing at or close to the centre of the disc, may project near its periphery, and there may be, instead of one principal arterial and one venous trunk, several, as the vessels may break up into branches within the nerve instead of on its intra-ocular surface. Part of the disc may be occupied by a white patch which extends into the retina; this is due to the fact of the nerve fibres retaining their opaque sheaths; or there may be spots of black pigment on the disc; the outline of the disc may be irregular and angular, and may vary from the usual circular shape. With coloboma of the iris is sometimes also coloboma of the choroid, retina, and optic nerve, or its sheath; this coloboma is easily recognized as a white, irregularly oval or pear-shaped figure, extending from the pheriphery to the optic papilla, part of which it may include. Dr. Mauthner, in his *Lehrbuch der Ophthalmoscopie*, mentions a case in which the nerve fibres, instead of spreading out on all sides, were collected chiefly into two bundles, one above, the other below; the vessels coursed in these bundles upwards and downwards, the inner and outer intervening parts of the retina being non-vascular.

As the exterior of the eye is scarcely alike in any two individuals, so does the appearance of the optic papilla also vary in almost every individual; and I find it a difficult matter even still sometimes to decide, from inspection alone, whether the nerve under observation presents a normal appearance or not. When any doubt exists as to the condition of one or both nerves, a careful comparative examination of the second eye should be instituted, and the acuteness of vision tested with Snellen's type, and the field of vision accurately noted before pronouncing an opinion. Patients' statements as to their vision should be received with a great deal of caution, for they not unfrequently give a false report either intentionally or unintentionally; patients are frequently themselves in ignorance of their exact amount of sight, or even of the visual defect in one eye. Thus I have occasionally demonstrated to persons that they were partially or wholly blind of an eye, when they asserted or believed the

contrary. It is well in all cases to keep a written record of the visible appearance and the amount of vision, as well for scientific as for practical purposes. Such accurate tests, and the notes thereof, from day to day, are not only of practical and scientific importance, but may guard against and prevent misunderstandings with our patient or the patient's friends.

The *acuteness of vision*, which is briefly expressed by S (*Sehschärfe*) or V (*Visus acies*) is to be ascertained by means of Snellen's test types. These are so constructed and numbered that the healthy emmetropic eye can see them distinctly at the distance in feet, which corresponds to the number attached to each type. Thus No. 20 should be read at 20′ or 200 at 200′. If the acuteness of vision be so diminished that No. 20 can only be seen at 10′, then it has decreased to $\frac{10}{20}=\frac{1}{2}$; or if to read No. 15 the person must approach to within 5′, then S is only $\frac{1}{3}$rd. Snellen's test types include a series of figures, squares, circles, and lines, seen under the same visual angle of five minutes, as the letters, and numbered from 20 to 200; these figures correspond in size and angle to the letters, and are of use if the examined individual be illiterate, for he can readily describe their appearance. The largest letter in Snellen's test types is an A, which measures about $3\frac{3}{4}''$ high and nearly $4\frac{1}{2}''$ broad; if the patient is unable to see this at any distance he should be directed to count the examiner's fingers held up before him, or asked to distinguish light from darkness, &c. While one eye is being tested the second one should be closed.

The *field of vision* should also be examined in each eye separately. The affected person is desired to regard steadily the nose or mouth of the observer, who then moves one of his hands up and down successively on all sides of the eye, commencing some distance from the eye, and gradually approaching it until the patient discerns the moving hand; in this rough manner we may obtain an estimate of the functional activity of the various portions of the fundus. For accurate tests or for the purpose of sketching the field of vision, the patient is placed sitting 18 inches in front of a black board, or white sheet of paper, in the centre of which a cross is made, on which the person is desired to keep his eye steadily fixed. The examiner, provided with a piece of white chalk, attached to a long handle, moves it up and down in a line from the circumference towards the cross, until the patient becomes aware of its motions, a small cross is then made at that spot, and the chalk continued to be moved inwards until it becomes plainly perceptible and recognizable; at this place another cross is made. The same manœuvre

should be carried out on all sides, until two circles or lines of crosses are obtained—always taking care that the observed keep his eye fixed on the central cross; the crosses are then connected to one another by a line passing through each, and two circular or irregular and contorted figures are obtained representing the field of vision—the outer one the indistinct, the inner one the distinct visual field.

Anœmia.—The intra-ocular end of the optic nerve, denominated optic papilla or optic disc, is found sometimes anæmic, of a very pale, blanched, or white colour, but quite transparent, and its large vessels perfect; this condition depends on a general anæmic condition of the body. *Embolism* of the central artery may also produce this condition. I lately saw a gentleman in whom, I believe, this obstruction of the central artery had occurred, producing total blindness in a few minutes, the second eye having been lost and collapsed from injury many years previously; the optic disc was of a very pale, bluish tint, the arteries had altogether disappeared, and there remained only two or three fine thread-like veins, which seemed to vary in calibre every now and then; the surrounding fundus was pale but otherwise healthy, with the exception of a couple of scarcely visible white specks about the position of the yellow spot.

Hyperœmia, or congestion of the papilla, is of much more frequent occurrence than anæmia; it is often temporary, sometimes enduring; the optic disc is partially or wholly of a pink or reddish colour, and a stippled appearance, with the centre of the papilla bright and normal; if the parts be highly magnified with a 4″ convex, the pink stippling will be seen to consist of capillaries; the white central spot is either a physiological excavation or the ordinary healthy nerve; the central vessels in hyperæmia are rather enlarged; the nerve may also be somewhat hazy, and its outline dimmed, or the entire papilla may be even slightly swollen. The appearance of the optic papilla, with healthy and perfect nervous function, corresponds often with that of hyperæmia. We should therefore, in all such cases, be careful to examine into the subjective phenomena; congestion of the papilla may be confounded with asthenopia, hypermetropia, or astigmatism; a careful examination of the refractive condition should therefore also be instituted. I frequently find redness of the papilla to ensue after the application of atropine, and this is another reason why I make it a rule first to examine the fundus before dilating the pupil.

Neuritis.—Inflammation of the optic nerve is not often seen in

its earliest stage, as the affected person neglects applying for advice until the disease has made considerable progress, and its symptoms become inconveniently established. Congestion of the papilla gradually merges into inflammation, and to distinguish one from the other and pronounce where one ceases and the other begins is no easy matter. In practice we find an acute, subacute, and chronic form. Acute neuritis is so well marked and its appearances so decided, that it cannot be well overlooked or mistaken, and when once seen is not easily forgotten. The papilla loses its transparency; is of a general red colour, which varies in intensity from a slight red to a deep dark red, contrasting by its dulness with the bright red of the normal fundus; it is swollen, œdematous, and projecting beyond the plane of the retina, as may be seen with the binocular ophthalmoscope, or by the curved course of the vessels in their descent from the elevated papilla into the lower lying level of the retina; it is dull, hazy, or opaque, from vascularity and serous infiltration; its outline is irregular, ill-defined, hazy, or altogether obliterated, and it becomes impossible to determine where the nerve ends and the retina commences: its position can only be determined by the relations of the large vessels, and its being the point of their convergence; its size appears sometimes abnormally large. The central vessels are partially or wholly obscured by the infiltration; generally the arteries are very thin, or even obliterated, while the veins are large, gorged, tortuous, and concealed here and there by the exudation. The nerve in neuro-retinitis from Bright's disease (Fig. 1, Plate II.), presents generally a striated appearance, greyish or white-coloured streaks radiating irregularly outwards through the red surface towards the retina, with here and there small spots or lines of hemorrhage free in the disc, or along the course of its vessels; the nerve outline wholly disappeared, and the disc appearing abnormally large, and the retina involved in the morbid process. The papilla may be uniformly dark red, swollen, and its vessels indistinct or interrupted, and the retina quite free from disease; we see this state in cerebral disease. Dr. Lyons lately showed me a patient under his care with undoubted cerebral disease, where both optic nerves were uniformly and intensely red, enormously swollen, and infiltrated; the lower part of each papilla appeared more prominent than the upper part, and the vessels underwent a considerable bend in their passage from the projecting papilla into the retina; the demarcation between the swollen and opaque papilla and the retina was very well defined and manifest in this case, as the

patient was blonde, and the choroidal pigment scanty; and the light, yellowish colour of the choroidal vessels and stroma contrasted markedly with the overhanging dark red papilla. Occasionally one side of one or of both optic papillæ is hazy, with indistinct margin, and presenting all the appearances of slight inflammation. A variety of neuritis is described by some authors as *perineuritis*, in which the swelling, infiltration, and redness are confined to the peripheral parts of the nerve, while the central portions remain comparatively normal. There is a subacute form of neuritis constantly met with during the progress of cerebral disease; the papilla is of a reddish grey, slightly swollen, and having what Dr. Hughlings Jackson describes as a "woolly" or fuzzy appearance.

Neuritis may occur acutely and rapidly without any warning, and may cause blindness in a very few days, or there may be premonitory symptoms; generally it arises slowly, is chronic and insidious, and the impairment of vision is so slight and so gradual that we are not consulted till long after the establishment of the disease and considerable alterations have taken place; neuritis may also be periodic, each attack resulting in a further diminution of vision. Neuritis may exist and cause even blindness without any direct symptom or ophthalmoscopic evidence, when the inflammation and changes are confined to the extra-ocular portion of the nerve; sooner or later, however, such an inflammation will either extend to and manifest itself in the intra-ocular end or cause its atrophy; neuritis may also exist, but be invisible in consequence of opaque media. One eye is generally first affected, and the second one becomes attacked a short time afterwards; there is often a very slight difference in the amount of vision of the two eyes. When both eyes are simultaneously affected the cause is nearly invariably cerebral.

There is no one symptom or group of symptoms characteristic of neuritis in particular. I know of no constant symptom in this malady beyond the loss of vision, and this, as well as other symptoms, are common to many and variable disorders. It should be remembered, however, that decided and well-marked neuritis may exist, and yet vision be almost perfect; it is very difficult to comprehend this apparent contradiction, but the fact has been noticed by more than one observer. The loss of vision may be rapid, or slow and progressive; there is often a gradual narrowing of the field of vision from the periphery inwards, until finally total blindness ensues; pain, intolerance of light,

coloured and luminous spectra may be present or absent; there may be dark arborescent figures, flashes of light, balls of fire, or hideous objects, and all these present themselves to the patient by day or night, frequently the latter, whether the eyes be open or shut. I attended one person affected with chronic neuritis, which terminated in complete blindness, who described to me how tormented he was with flashes of light, showers of snow, globes of fire, and at other times with dark, black objects, or even human faces, before him. The only reliable evidences of the existence of neuritis are those yielded by the ophthalmoscope. Neuritis of the optic nerve being so constantly a mere extension of inflammatory processes within the cranium, symptoms of cerebral lesion are also constantly present; there is pain in the head, diffused or localized, more or less violent, persistent or temporary, and periodic; sickness of stomach and vomiting, giddiness or even loss of consciousness, buzzing in the ears, incapacity for mental exertion, loss of memory, difficulty or loss of speech, strabismus on one or both sides, double vision, owing to paralysis of third or sixth nerves, and want of co-ordination, dilatation of pupils, or hemiplegia. Some writers have sought, from the ophthalmoscopic appearance of the nerve and fundus, to pronounce upon the exact seat and the nature of the cerebral disturbance; and notably Professor Bouchut, of Paris, who has written a very elaborate work on the subject: *Du Diagnostic des Maladies du Système Nerveux par l'Ophthalmoscope*, appended to which is an atlas containing twenty-four bad and unreal chromolithographs, representing the fundus in "tubercular meningitis, rheumatic meningitis, hydrocephalus, partial chronic encephalitis, idiotcy, cerebral hæmorrhage," &c., &c. It is, I believe, impossible, in our present state of knowledge, to fix or localize the cerebral lesion from the appearance of the fundus; it is impossible, in many instances of cerebral disease, to determine its seat and nature, even taking every symptom, objective and subjective, into account; neuritis or atrophy of the nerve with blindness, co-existing with other symptoms of cerebral disease, will render us certainly very valuable assistance as a link in the chain of evidence, and the ophthalmoscope should be employed in all cases of suspected or confirmed intra-cranial disturbance. Disease of the optic nerve and amaurosis may result from disease of any part of the brain; it does not follow, however, that disease of the brain must cause amaurosis. Extensive disease of the brain may exist in one individual without causing any serious disturbance for a considerable

period, which, in another person, may cause amaurosis and other symptoms; the tolerance of the brain in some individuals to extensive disease was well exemplified by a case of disease of the temporal bone and the brain, brought forward by Dr. Eustace at the Pathological Society in 1866-67. Amaurosis due to cerebral disease may exist without any ophthalmoscopic evidence. I saw a young patient two years ago who was perfectly blind of one eye, and in whom various paralyses became established some six months subsequently; partial loss of motor power, loss of smell, and of sensation in one side. This person recovered eventually from this attack, and regained perfect vision. At no time during the illness was there any deviation from the normal in the optic papilla. After six months apparent perfect health this patient's second eye has now become perfectly blind, and the same train of symptoms are being established on the opposite side of the body as existed previously on the other side; there is slight haziness of one side of the papilla. Double amaurosis occurs as a rule in consequence of disease of the central nervous system; optic neuritis has been found by Dr. Hughlings Jackson more frequently with hemiplegia of the left than of the right side. Dr. Jackson remarks in his philosophical and practical "Observations on Defects of Sight in Disease of the Nervous System," published in the *Ophthalmic Hospital Reports*:—"In all cases of neuritis in which I have made a *post-mortem* examination, there always have been found notable organic disease of the head. But, as I have repeatedly said, from this symptom, with or without headache and vomiting, we cannot, during life, predict where the intra-cranial disease is, nor what it is. If, however, there is hemiplegia besides, or, as I think, unilateral epileptiform convulsions, we have strong evidence that the amaurosis depends on disease of the hemisphere. The hemiplegia may precede or follow the amaurosis; it may be passing or permanent, but in all the cases in which it had been in any way present during life, I have found disease of the hemisphere *post-mortem*." In a note he adds, he has seen a tumour pressing on the crus cerebelli, causing paralysis on the same side as the lesion, and amaurosis, but that in such cases paralysis of one or more of the cranial nerves arises, which shows the disease to be at the base of the brain. Anything which gives rise to congestion or inflammation of the brain or of its coverings may also cause neuritic congestion or inflammation. Typhus fever, the exanthemata, mental emotions, injuries of the head, intra-cranial tumours, disease of the meninges or of the brain

itself, or of the spinal chord, suppression of the catamenia, cardiac or aneurismal diseases, local apoplexy, Bright's disease, tumours of the orbit pressing on the nerve, or causing exophthalmus, intra-ocular tumours, cellulitis of the orbit, pyemia, disease of the retina and choroid, or panophthalmitis, may all cause neuritis. Towards the end of last winter I saw a young girl with considerable redness and vascularity of the optic papilla, the inside of the discs being infiltrated, very hazy and indefinable; the veins were large and gorged, and the vessels presented an interrupted appearance. I attributed this state of affairs to intra-cranial causes, and the physician under whose care she was informed me subsequently that she had had very many falls on the ice during the severe weather, and that her head frequently came in violent contact with the ice. Vision in the left eye was confined to the perception of large objects. With this eye, which presented the greatest amount of disease, Snellen's largest type could not be read, and with the right eye No. 40 only at 14 feet. I have been lately informed that this girl recovered perfectly, at which I am much astonished, for the usual termination of so much disease is at least partial atrophy and partial amblyopia. Another cause of impaired vision and chronic neuritis consists in the immoderate use of alcohol or tobacco; there is a recognized form of blindness known as "tobacco amaurosis," which Mackenzie was chiefly instrumental in establishing and bringing under the notice of the profession; and to which Mr. Wordsworth of London has devoted considerable attention. When occasionally visiting the eye infirmary in Glasgow, some years ago, I was very much surprised at the frequency of this term and the large number of cases denominated tobacco blindness at the clinique of that institution. I have no doubt of the occurrence of this blindness, but I have doubts as to its great frequency; it is singular that amongst the thousands, or I may say millions, of smokers, blindness can be so comparatively seldom attributed to the poisonous influence of tobacco. Patients labouring under this malady are scarcely ever seen until the disease has passed through various stages; in a very few instances, which I believed to have been the early stage of tobacco amaurosis, the nerve presented a very slightly swollen pink appearance and partial whitish opacity. I not unfrequently see alcoholic amaurosis in which there is decided congestion and even infiltration of the papilla; it presents a dimmed soft swollen appearance, the vessels large but not as distinct as they should be, the outline of the disc not sharply defined, and the whole fundus congested. This is

sometimes, I think, primarily due to choroiditis. The affected person complains of dimness of vision as if a mist or veil was before the eyes. They see best in strong light, but at no distance can they see well. Such persons may recover their sight under suitable treatment and total abstinence. I have occasionally seen neuritis and amaurosis in children co-existent with or subsequent to cerebral lesion.

Neuritis when engaging the whole nerve is nearly always fatal to vision, and partial or complete blindness results; it may sometimes remain stationary for a time, and then progress, or vision may even improve slightly temporarily, but it will get worse again or disappear. In rare instances it ends favourably, and vision is restored. As a rule, however, the tumefaction subsides, the redness disappears, and the nerve undergoes disorganization and becomes atrophied.

Atrophy of the Optic Nerve presents itself to us under different aspects, according to its origin and degree. In well marked examples of this malady, the optic papilla presents a white glistening, tendinous appearance, which cannot easily be overlooked or mistaken, for it contrasts so vividly, by its dense whiteness, with the surrounding bright red field, that it forms a very prominent and conspicuous feature in the image; it appears as a flat white disc set in a red field. The capillaries and small vessels have totally disappeared, and the central vessels are very few and attenuated thread-like lines, the arteries may be visible, but empty, or may have completely vanished, and the veins be very thin, or, in rare cases, also have disappeared. The lamina cribrosa becomes frequently invisible from opacity of the nerve surface. The boundaries of the optic papilla may be very sharply defined, and its shape perfectly circular, or it may be oval according to whatever anatomical shape which may have existed prior to the invasion of the disease; the disc is seen sometimes surrounded by a large circular white zone, which is due to the sclerotic, the choroid being atrophied all round; this is, however, only a coincident feature; the outline of the disc is frequently irregular and the diameter of the papilla diminished. The colour of the nerve varies; in cerebral amaurosis it is generally of a dense white and sometimes even of a metallic lustre; in other cases the nerve is of a bluish grey or a greenish blue tint. In the commencement or in slight degrees of atrophy it may be easily overlooked; the disc is pale, wanting in transparency, its vessels diminished in calibre, one portion of the nerve may present an atrophied condition, while another may be of

a natural delicate pink colour, or be congested and vascular. The papilla, when atrophied, is frequently also excavated, but this excavation differs materially from, and presents quite different characters to those seen in glaucomatic excavation; the depression due to atrophy does not extend beyond the plane of the choroid, and the lamina cribrosa is not displaced; the depression is very superficial, and does not present the steep walls and sharp rectangular margins of the glaucomatic excavation, nor the temporary disappearance of the vessels as they descend into the cup; neither is there pulsation, either spontaneous or arising on slight pressure, as in glaucoma.

Atrophy of the optic nerve is frequently a chronic progressive disease, advancing slowly, and causing gradual loss of vision, without any pain or other appreciable symptom; and the patient does not seek special advice until an advanced period of the disease. It is sometimes very difficult to decide whether the appearances of the nerves are those of atrophy in its early or mild stage, or whether the nerve is really normal; in such a case we must make a careful examination of the entire fundus, of the state of refraction, and of the second eye, if it be unaffected; and thus by elimination and differential diagnosis we may arrive at a just conclusion; where congestion or inflammation of the nerve has been seen to precede the supposed alteration of the nerve, and the impairment of vision, there can be little doubt as to the existence of the atrophy, but in such cases the disease manifests itself very plainly to our view.

The symptoms of atrophy of the optic nerve are of the most variable and diverse, and include the majority of those usually mentioned in works under the heading "Amaurosis;" the invariable and constant one is impaired vision, diminution of the field of vision, and of the acuteness of vision.

The best diagnostic symptom of disease of the optic nerve is impairment of the central acuteness of vision and gradual concentric narrowing or limitation of the field of vision. The anterior or peripheral portion of the retina is normally the least functionally active part of the sensitive apparatus, which is readily comprehended, if we bear in mind that the retina, at its periphery, has become thinned, and that its nervous elements have become scanty or have altogether disappeared at the ora serrata, where the retina consists simply of cellular tissue. Any interference with the optic nerve acts at once also on the least highly endowed portion of the retina, and renders it functionless; hence the peripheral portions of the visual field suffer first and become obscured; as the optic nerve disease advances the more highly endowed and sensitive parts of the retina also become

deprived of their nervous energy, and corresponding obscurations advance in the visual field, until it is finally reduced to a small limited space, or obliterated; the remaining small field may be circular, and correspond to that part of the retina in which is normally situated the seat of distinct vision, or the field may be slit-like, and correspond to the expansion of the optic nerve fibres, between the nerve and the yellow spot; the obscuration may not be concentric, but may be irregular, or the field of vision may be obscured in spots. At the same time that this concentric obscuration occurs the central acuteness of vision also becomes impaired, and the patient is unable to read anything but the largest type, and even that indistinctly.

Atrophy of the optic papilla may result from all the causes mentioned above, as causes of congestion or actual inflammation of the optic nerve; it may also occur without any inflammation of the nerve. Tobacco causes frequently disturbances in the circulating system, brought about by nervous agency; I believe the tobacco acts poisonously on the sympathetic nerve and brain, and even causes functional paralysis, and the optic nerves suffer secondarily or participate primarily in the process, and become afterwards atrophic; the papilla is not extensively atrophied, nor does it present the dense white of cerebral amaurosis, and vision never entirely disappears. One of the chief arguments in favour of the existence of tobacco amaurosis is the fact, that vision improves on the discontinuance of the use of tobacco. The immoderate use of tobacco and intemperance are very frequently found in the same individual; impaired vision is more generally attributable to alcoholism; I often see it in persons who do not make use of tobacco at all; but where the two go hand in hand, and are used in poisonous excess, it is difficult to draw the line of distinction between them. In the alcoholic atrophy I think the nerve is of an indistinct bluish grey colour, and somewhat opaque; the outlines of the disc are indistinct; the arteries appear sometimes perfectly empty and transparent along their centres, or as whitish reflecting lines with dark outlines; the veins are large and tortuous, and they also may appear partially empty; the affected person complains of a mist before him, his visual field is limited, and he cannot see distinctly at any distance. Atrophy of the corresponding sides, or of different sides of the optic nerve, as well as similar paralysis of the sides of the retina, have been observed in hemiopia; atrophy of the nerves has also been found in ataxie locomotrice. I was consulted two years ago by a young man, about his sight; he presented very partial and ill-defined atrophy of both optic nerves, and complained of various disturbances

of vision, such as occasional double or confused vision, or disappearance of objects; some months subsequently this man had pretty well marked ataxie, and I had him under observation and treatment for some months, but lost sight of him until a few weeks ago, when I observed him in the street, walking with a peculiar shuffling running gait. A frequent cause of atrophy of the optic nerve is said to be atheromatous degeneration of the vessels at the base of the brain, and of the brain itself; it is, according to Galezowski, who has written an excellent essay on *Les Altérations du nerf optique et les maladies cérébrales d'ont elles dependent*, the most frequent cause; choroidal disease, and the frequently concomitant staphyloma posticum, retinitis, neuro-retinitis, hæmorrhages, glaucoma, cysts, and tumors in the nerve, and obscure changes in the nerve, such as fatty degeneration, all cause atrophy of the optic papilla.

The principal pathological alterations which occur in the atrophied optic nerve, consist in destruction of the nervous elements, and the formation of cellular tissue. The papilla is flattened, and its transparent nervous portion replaced by dense cellular tissue. The whole nerve is found flattened; its sheath dilated, or sacculated, and but loosely attached to the nerve, owing to shrivelling of the nerve itself; the interspace between the sheath and the remains of the nerve is filled with serous exudation, and a loose reticulated network of delicate connective tissue; the bundles of nerve fibres become shrivelled, of a dirty yellowish tinge, and widely separated in consequence of the increased thickness of their enclosing neurilemma; the newly formed cellular structure, or the hypertrophied remains of the original tissue may undergo degeneration, and contain fat globules and cholesterine. The small vessels and capillaries completely disappear, and the central vessels may also disappear, or be converted into dense tendinous strings, with atheromatous or pigmental degeneration of their walls; occasionally the vessels are represented by lines of chalk-like substance; sometimes they are permeable, or they may be closed and filled with disorganized blood, or with a hyaline, granular substance. One of the most beautiful works on microscopical pathology with which I am acquainted, Professor Wedl's *Atlas der pathologischen Histologie des Auges*, published with the co-operation of Stellwag von Carion, contains several figures illustrative of atrophy of the optic nerve. In one instance the sheath of the optic nerve was found adherent to the neurilemma of the nerve fibres, and the latter displaced; in another, the interspace was filled with a trabeculated structure, the interstices

of which were occupied by a thin gelatinous mass—embryonic cellular tissue. On rare occasions the nerve has been found ossified.

Apoplexy of the disc itself, will lead to atrophic degeneration. I have seen a case where the upper half of the optic disc was occupied by a recent hæmorrhage, of a dark-red colour and irregular outline, the lower part of the disc was pretty normal, and part of the retina was clouded. The patient could see the upper part of objects before him, but not the middle or lower portions.

Tumors of a benign or malignant character originate occasionally in the optic nerve, but unless situated in the visible portion of the nerve they cannot be ophthalmoscopically diagnosed. Some cases are on record of tumors springing from the intra-ocular end of the optic nerve; and, in a very few instances, tumors in this situation have been recognized by means of the ophthalmoscope. In a case recorded and figured by Jacobson, in the *Archiv für Ophthalmologie*, the papilla was very irregular in its outline, and projected unequally into the vitreous humor, with white reflecting striæ on its surface; one portion of the papilla presented a yellowish brown atrophic condition, another part was slightly swollen and vascular, and a third projected more than the others beyond the plane of the retina, was of an intense light blue colour, and devoid of vessels; the vessels were partly attenuated, or presented here and there bright white outlines, and disappeared suddenly; part of the disc was surrounded by a dense mass of pigment; on enucleating the eye the diagnosis was confirmed and a tumor found occupying the optic papilla; several similar ones were removed from the orbit; they were all composed of a mixed form of tissue, the cellular structure sclerosed, and at the part of the ocular tumor, which appeared brown coloured, there was a bony plate in connexion with the choroid; the tumor was denominated myxosarcoma. Fungus hæmatodes originates, I believe, frequently in the optic nerve, and presents to the unassisted eye a strange bright yellowish metallic lustre in the bottom of the eye. I have known four children of the same family to die of this disease, and in a fifth I found a scrofulous tumor at the base of the brain. Melanosis, generally of a cancerous nature, also commences sometimes in the optic nerve.

Aneurism of the central artery of the retina occurs within the optic nerve very exceptionally, but it is doubtful whether it can be diagnosed. Sir William Wilde possesses, in his very extensive and magnificent collection of illustrations of ophthalmic diseases, the drawing of a case in which aneurism of the central artery existed.

LECTURE VIII.

ON

THE RETINA.

Congenital Peculiarities.—The retina is sometimes found congenitally atrophied or detached from the choroid and lying in the vitreous humor, of a pyriform shape, the base at the back of the lens, the stalk extending backwards to the optic nerve; other extensive pathological alterations co-exist usually with this condition. Congenital coloboma of the retina is found associated with coloboma of the iris and choroid. It is said that the retina is completely deficient at the position of the coloboma, but that some portion of it at least remains may be concluded from the fact of the retinal vessels being traceable across the deficiency and into the retina on the opposite side; it is probable that a membraneous remnant of the retina, without any nervous elements, exists at the coloboma. I have seen two instances of this malformation; one well-marked case many years ago, when I did not fully understand its nature; the other more recently, but in which there was so much pathological disturbances that the exact condition of the retina could not be ascertained. While this coloboma would seem to be due to an arrest of development during fœtal existence, another congenital anomaly occurs equally rarely, which would appear to be attributable to a hyperdevelopment. This peculiarity consists in the presence of one or more irregularly-shaped opaque dead-white patches in the immediate vicinity of, or even encroaching upon, the disc; they are more or less dentated at the circumference, where they present a white striated appearance;

highly magnified, the periphery seems composed of fine white lines of irregular length radiating outwards in the transparent retina; the dense white opacity terminates gradually in these radiating lines. The central vessels appear to dip into the opacity, and become wholly or partially concealed and invisible; the retina adjoining, and in the interspaces of the striæ is perfectly normal; part of the choroid is concealed by the opacity, and vision may be quite perfect. That the opacity is in the retina, and of a physiological character, is known from dissections, comparative anatomy, and from the visible symptoms; the obscuration of the vessels and of the choroid, the radiated appearance, the otherwise healthy condition of the fundus, and also from the fact of perfect vision existing. As already mentioned in the brief remarks on the anatomy of the retina and optic nerve, the sheaths of the nerve fibres cease at, and become incorporated with, the lamina cribrosa, and the denuded nerve fibres pass on into the retina as transparent axis cylinders; in the congenital peculiarity under consideration the nerve fibres regain, in a limited portion of the retina, their opaque sheaths, or these latter may be continued direct from the nerve into the retina. Such nerve fibres, with double or opaque contours, as they are denominated, exist normally in the rabbit and some other animals. Liebriech figures this anomaly in Plate XII. of his *Atlas*, and Jäeger, in Plate XIII. of his *Beiträge zur Pathologie des Auges*, although at the time ignorant of its real nature. Pigmental degeneration, or, as it is called, retinitis pigmentosa, is also found as a congenital disease.

Anæmia of the retina may exist in general anæmia, but owing to the few vessels and small amount of blood in the retina and the transparency of the membrane, it can be but ill defined; the vessels are thin, pale, and almost empty.

Hyperæmia, or congestion of the retina, is not at all of uncommon occurrence, either alone or in combination with other disturbances. The disc is of a reddish, stippled appearance, its outline indistinct; the retina has lost its transparency to a slight degree, appears œdematous from serous infiltration, and of a pale yellowish tinge; there may be localized or general slight reddish haziness of the membrane, damping the choroidal reflection; the arteries may be increased in number, the veins large, full, and hazy along their course, and there may be pulsation of the central vessels. As already remarked of the optic disc, so it is also here sometimes almost impossible to decide whether the redness be physiological or

pathological; and it requires considerable care and some experience to pronounce a decided opinion. Hyperæmia is so allied to inflammation, and it is sometimes so very difficult to distinguish one from the other, that their symptoms, causes, and pathology may be considered at the same time.

Retinitis Dictyitis. — Inflammation of the retina is nearly invariably accompanied by inflammation of the optic papilla; it presents ophthalmoscopically various appearances, according to its degree, extent, cause, and individual peculiarities. It is always characterized by loss of transparency and a clouded condition of the retina; the optic disc is red and its margin hazy, so that the choroidal or sclerotic rings are invisible, or it may be of the same colour as the surrounding fundus, from which it is only distinguished by its being the point of convergence of the vessels; it may also be swollen uniformly or irregularly. The entire fundus may be infiltrated with serous exudation, and may be of a dull, dark red, greyish-red, or yellowish-grey colour, swollen, and obscuring the choroid to a greater or less extent. The most obvious alteration from health and most striking objective symptom is that afforded by the vessels; the veins are large, dark-coloured, do not taper towards the periphery, but are throughout of the same large size, distended and full, tortuous, and here and there partially or nearly completely obscured, so that they present an interrupted appearance in their course; this latter is the most constant and certain symptom of retinitis; the vein seems to end abruptly, disappears, and then again becomes visible, full and gorged at some little distance further on; the arteries are generally few, their calibre much diminished, or they may have become altogether invisible. Sometimes there are but two or three large, cord-like, dark gorged veins standing at intervals prominently forwards in the hazy field; the retina is nearly always more nebulous along the course of the veins than elsewhere. In addition to these appearances there are frequently red sanguineous effusions in the retina, single or numerous, of a greater or less extent, in the shape of punctiform specks, or circular, oval, and most frequently linear spots, or they may be large irregular blotches; very often these sanguineous effusions are along the course of the vessels, and give the fundus a radiated or striated appearance; these effusions are mostly in the nerve fibre layer, and often conceal the vessels. There may also be grey or yellowish-grey elongated patches radiating towards the periphery. The optic disc and the retina round it are the parts

most frequently affected; the yellow spot and its immediate vicinity may be altogether free from disease, while the surrounding retina is hazy, grey, or grey-red; the retina at the yellow spot being very thin and transparent, and the choroidal colouration naturally very dark, the normal dark red, or almost brown may contrast so strongly with the surrounding grey haziness, that it may be mistaken for a sanguineous effusion.

That these alterations have their seat in the retina and not in the choroid may be inferred from the circumstances of the retinal vessels being themselves implicated in the manner described, from the alterations in the disc and the obscurations of the choroid and of the choroidal and sclerotic rings which encircle the optic nerve entrance. By focal alterations, lateral displacements, and by means of the binocular ophthalmoscope, we are able sometimes to perceive that the patches of effusion are in the surface of the retina, between us and the vessels. The sanguineous effusions are distinguished from choroidal pigment effusions by their bright red or dark red colour. Plastic effusions occur occasionally, and produce a general yellowish-grey opacity of the retina, most marked at the disc and its vicinity. Plates XI. and XII. of Jäger's *Beiträge*, are excellent and life-like representations of neuro-retinitis.

The *subjective symptoms* of retinitis present considerable variations, and sometimes apparent discrepancies; amblyopia is, as might be expected, always present, but its degree cannot always be stated from the ophthalmoscopic appearance alone; thus, while in one individual, with but a small amount of retinitis apparent, vision may be reduced to mere perception of light; in another, with a large amount of disease manifest, there may be but comparatively slight impairment of vision; great or total loss of vision may be caused by a small extent of disease at the yellow spot; non-visible intra-cranial disturbances co-exist not unfrequently with slight retinal disease, and may cause considerable or total loss of vision. The comparatively small loss of vision which sometimes exists with a large amount of disease, is difficult to understand. I recently attended a patient who presented well-marked neuro-retinitis, whose principal complaint was that he could not distinguish people across the street, and who thought I might perhaps suit him with a different glass to the one he had been in the habit of wearing; and this person was himself a medical man, who, one might naturally suppose, would be more alive to any visual defect than a lay person. One of the most constant complaints is that of a grey or

dark mist or veil in front of the eye. As the disease progresses this mist becomes darker and darker, like a thick cloud of black smoke, until finally either total or almost complete blindness ensues. The acuity of vision is diminished, and the field of vision contracted or mutilated; central acuity may remain but slightly impaired for some time, so that the patient is able to read small type held close to the eye, although quite unable to decipher large letters at some little distance. Convex glasses, by magnifying the object and increasing the amount of light, sometimes renders vision for close objects better, but not for distant ones. As in optic neuritis, so also in retinitis and neuro-retinitis, the obscuration of the visual field occurs sometimes in a regular concentric manner; more generally, however, it is irregular, one portion of the retina or one entire side may be functionally inactive, while the rest is still active, or there may be separate, distinct, and limited obscurations in the shape of black spots, which are to be distinguished from the ordinary muscae by their retaining the same relative position to one another and to the optic axis in all movements of the eye. If a sheet of white paper be held in front of the patient so affected he will observe one or more black spaces on the paper. Luminous appearances and coloured vision are only occasional symptoms; objects appear sometimes crooked, distorted, enlarged, or diminished; pain and intolerance of light are also occasionally present, but absent in the majority of cases. I have seen intense pain and intolerance of light in one case of retinitis, in which there was, however, also choroiditis and glaucomatic symptoms. I have also known pain complained of in the region around the eye, which I attributed to periostitis—generally of a syphilitic origin. Externally the globe presents, as a rule, a perfectly normal appearance; occasionally there is slight pink sclerotic injection around the cornea, or there may be slight conjunctival vascularity; the pupil is ordinarily quite natural, dilates and contracts naturally; in the advanced stages it may be partially dilated and sluggish. It will be seen that the symptoms I have alluded to differ materially from those mentioned by the older authors; the description of acute retinitis, given, for example, in the earlier editions of Mackenzie's great work, corresponds more to acute choroiditis with effusion than to retinitis. I do not make this remark with any disparaging intention; I entertain too high an opinion of our early authors to do so, and I believe they are too little read in the present day; it will be ever difficult to match or

excel such works as those of Porterfield, Wardrop, Ware, Saunders, Tyrrell, Lawrence, or Mackenzie, in our own language.

The structures adjoining the inflamed retina suffer generally more or less; on rare occasions the sanguineous effusions burst into the vitreous humor; more frequently they penetrate outwards towards the choroid, on account, as Schweigger remarks in his excellent Lectures, of the strength and resistance of the inner layers and the internal membrana limitans. Floating bodies also arise in the vitreous; minute interlacing thread-like filaments are occasionally met with at the periphery of the humor, adjoining the most diseased portion of the retina: and these are said to be peculiar to retinitis, occurring during Bright's disease; small punctiform opacities are seen in the same position in syphilitic retinitis, and occur to such an extent sometimes as to form a punctiform nebulous veil in front of the retina; this latter form of opacity has, however, also been observed with retinitis in Bright's disease. The choroid is frequently implicated; its epithelium may lose its pigment, and the whole membrane may undergo considerable alterations.

Causes.—Retinitis and neuro-retinitis occurs sometimes idiopathically without any assignable cause; sometimes it may be traced to direct injuries, intra-ocular growths, the presence of a foreign body, such as a cysticercus or a dislocated lens, or to disease of the adjoining structures; the retina may be infiltrated and turbid from effusion during choroiditis. The most frequent causes of retinitis are intra-cranial lesions, disease of the kidneys with cardiac complications, and constitutional syphilis. Retinitis from these latter causes attacks, as a rule, both eyes. Exposure to intense bright light, or sudden and oft-repeated alternating exposure to even moderate degrees of light, are also adduced as causes of retinitis, but I think on insufficient grounds. So far as I am aware, retinitis is not found commonly amongst those who are constantly exposed to intense light, such as persons whose business it is to attend to furnaces, or other occupations where high degrees of light are always present; I have never yet seen a case of retinitis which I could attribute to such causes. Dr. Macnamara, of Calcutta, who must have very considerable experience, seems inclined to attribute retinal congestion to intense light. At page 47 of his practical work, already alluded to, he says:—"It is not an uncommon thing to meet with people in this country [India] suffering from headaches induced by over-exposure to the sun. The papilla will often be found intensely congested under these

circumstances, the capillaries of the retina being somewhat hyperæmic also. The glare of the tropical sun appears to over-stimulate the retina, and it becomes congested and swollen; if the exciting cause continues in operation, the irritation is propagated to the brain, and headache and irritative fever ensue. There can be little doubt as to the necessity of protecting one's head from the rays of the sun, but it is almost as important to shade the eyes from its glare. Nature appears to have made a provision of the kind for the natives, the colouring matter contained in the pigment cells of the iris, choroid, and cells of the elastic lamina, absorbing the excess of light which would otherwise impinge on the retina, and acting much in the same way as blue or neutral-tinted glasses do in the case of Europeans. But, even among the natives, the glare of the sun in the long run causes irritation, and often, I believe, chronic congestion of the choroid, which in its turn induces opacity of the lens." The colour of the native Indian fundus is a brownish-grey, owing to the deep brown or black choroidal pigment. Constant over-exertion of the eye by strong light, or even moderate degrees of light, may cause hyperæmia and inflammation; this occurs, I think, in eyes naturally weak, or in ametropic eyes, where no correcting lens or an improper one is made use of. Lightning is also said to produce retinitis, but I am inclined to think it causes direct paralysis of the retina and optic nerve. Alcoholism causes general hyperæmia of both eyes. I have seen drunkards almost totally blind with the symptoms of neuro-retinitis, the retina of a pale yellowish colour and œdematous, the veins large, gorged, and tortuous, but not interrupted. Any cause which interferes with the return circulation, such as obstruction of the veins at the back of the orbit, in the cavernous sinus, or obstruction of the internal jugular vein, may also cause, mechanically, hyperæmia of the retina and eventually inflammation. Neuro-retinitis may also be due to direct transplantation of inflammatory processes from the brain or its meninges; tumours and exudations within the cranium and the orbit, may also give rise to retinal inflammation. Masturbation may possibly also give rise to neuro-retinitis; during the past year I had a case of well-marked neuro-retinitis on both sides, under my care, in the person of a young man who suffered greatly from spermatorrhœa. Liebreich figures, in his magnificent *Atlas der Ophthalmoscopie*, a very remarkable variety of retinitis, which he attributes to leucæmia. Inflammatory processes elsewhere may be transferred to the retina by metastasis.

Retinitis has been classed into acute and chronic, simple and complicated, syphilitic, nephritic, leucæmic, pigmental, &c. A very peculiar form of neuro-retinitis, with generally well-marked and distinct characteristics, arises not unfrequently in persons suffering from Bright's disease of the kidneys, with hypertrophy of the left ventricle of the heart. In this *nephritic retinitis—retinitis albumenurica*—the optic disc is more or less hazy or grey, and indistinct, sometimes only recognizable by the convergence of the vessels. The whole fundus is turbid or opaque, and presents a striated appearance; grey, or yellowish-grey linear opacities in the dull red ground, radiating outwards towards the periphery of the retina; isolated small bright white reflecting bodies are seen in the retina, chiefly at the position of the yellow spot, where they frequently form nests, or run into patches of greater or less extent, or they are sometimes arranged in a circular or semi-circular manner at or around the yellow spot. The vessels present the interrupted appearances characteristic of all forms of retinitis, or they may, in advanced stages, appear to have white lines along their course; they appear sometimes superficial to and occasionally beneath the white spots. Linear ecchymoses are seen along the vessels, and red hæmorrhagic effusions are of almost constant occurrence, either in the form of irregular patches, or as linear radiating striæ. I have endeavoured to represent this condition in Fig. 1, Plate II., which is copied from a pencil sketch of the reversed image of the left fundus of a female aged thirty, whose urine was loaded with albumen and of low specific gravity, and who died with all the symptoms of Bright's disease, exceedingly well pronounced, about a year after I made the sketch. The disc was very indistinct and unrecognizable from the fundus, the underlying choroidal ring and the choroid throughout quite invisible; the disc and retina in and around the yellow spot was of a grey white colour; the whole fundus was nebulous and presented a faintly striated appearance, which was best marked around the papilla; small elongated spots of hæmorrhage were seen here and there radiating outwards; two such are represented in the drawing on the right hand side (inside) of the papilla, and another along the course of a small vessel at the inferior side of the image; the characteristic bright white spots existed in considerable masses at the yellow spot. The veins presented the usual interrupted appearance. This patient had been under medical treatment for some time previous to my seeing her, but Bright's disease had not been suspected until the ophthalmo-

scopic examination led to its diagnosis, which diagnosis was fully confirmed by subsequent investigations and the character of the fatal termination.

Syphilitic retinitis presents nearly always a uniform haziness or opacity of the retina, but the white specks alluded to in Bright's disease are scarcely ever present; there may be whitish or grey radiating striæ, and ecchymoses and blood effusion. There is always, or nearly always, extensive choroidal disease associated.

Retinitis is usually a slow and chronic affection; occasionally the inflammation subsides, the serous exudation and sanguineous effusions are absorbed; the retina becomes transparent, and its function restored. This is, however, a very rare termination of inflammation with effusions; more generally it terminates in atrophy, and more or less degeneration and alteration of structure, and corresponding functional impairment, extending even to complete blindness; the retina may also be separated from the choroid; suppuration of the retina and destruction of the globe are also said to occur exceptionally from retinitis.

Apoplexy of the retina, termed sometimes *retinitis apoplectica*, when a number of apoplectic spots exist. Sanguineous effusions occur constantly during the progress of retinitis, in the shape of linear or punctiform spots, or as large irregular patches. Retinal apoplexy arises not unfrequently without any other apparent disease in the fundus; it occurs suddenly, and produces various disturbances of vision from partial impairment to complete blindness. If the hæmorrhage occurs at the yellow spot vision may be altogether obliterated; if, at the periphery, vision may be but slightly impaired, the affected persons complain of a dark cloud before them, or a dark body coming suddenly between them and the object they are looking at. Sometimes the obscuration is gradual; partial vision is sometimes restored in a short time after the attack, and again replaced by blindness, and alternations of partial and total loss of vision occur, perhaps, for some days. There is generally no outward change in the eye; sometimes a feeling of distension or of fulness in the eye is experienced; if partial vision exist one portion only of objects will be seen; distorted vision also occurs, and blank, black spaces in the visual field. On ophthalmoscopic examination the hæmorrhage appears as a bright red spot with irregular outline, or circular, oval, or eliptical, occupying not unfrequently the vicinity of the yellow spot; or there may be numerous elongated, radiating effusions, as occurs in nephritic

retinitis. The rest of the fundus may present a natural condition; the retina may be slightly hazy from serous exudation, or it may be absolutely red from the sanguineous effusion; the papilla is often slightly red and indistinct, and the large vessels may be normal; the apoplexy is sometimes seen in the course of a vessel, and occasionally the branch from which it occurred may be ascertained. These blood-effusions, as a rule, cover and conceal the choroid; when slight and occupying only the nerve-fibre layer I have been able to look beside and behind them, and perceive the choroid beneath; this has, however, occurred only exceptionally; they are generally dense and opaque, and implicate the choroid. The blood-clot perforates not unfrequently outwards, and lies between the retina and choroid, causing separation of those membranes; sometimes it bursts through the membrana limitans interna into the vitreous humor, where the blood may become partially absorbed and broken up into particles and filaments, and float about the fluid humor; or blood may be poured out in greater quantity and remain unabsorbed. No matter where the effusion takes place the fluid will gravitate downwards, so that when we come to examine an apoplectic spot in the retina its lowest part will present a more dense and a darker red appearance than the upper part. Sometimes one or more other spots of hæmorrhage are seen in the fundus, in different stages and periods of existence, recent or ancient; when of some standing apoplectic spots in the retina become of a white colour, with occasional black specks or lines on them; this is attributable to fatty degeneration of the retina and metamorphosis of the blood-corpuscles and pigmental degeneration. Fig. 21, from a pen and ink sketch, represents the inverted image of a recent

Fig. 21.

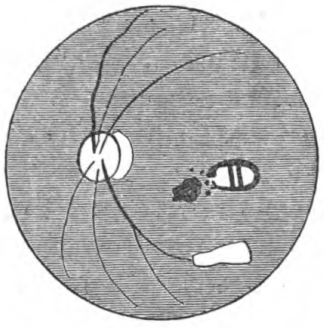
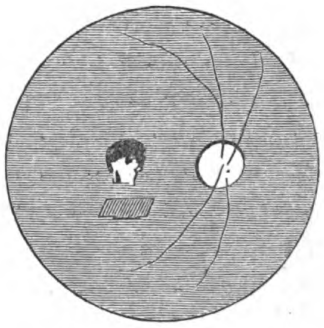


Fig. 22.



blood-clot, at the yellow spot; internal to it is an oval white reflecting spot, with a couple of bands across it, and below is another

white patch, all in the same plane as the retina; the eye was myopic; the white crescent at the side of the papilla is the posterior staphlyloma. Fig. 22 represents another apoplexy, also at the yellow spot, in which the clot was undergoing absorption at the time I made the sketch, seven weeks after its occurrence. These isolated circumscribed apoplexies take place, as a rule, from the large vessels; they may be small and limited, or may be very extensive, and occupy a large portion of the fundus.

The causes of retinal apoplexy are the same as those of cerebral apoplexy, such as cardiac disease or degeneration of the coats of the vessels; direct injuries may cause the rupture of a vessel; sanguineous effusions are of constaut occurrence in certain forms of retinitis. Apoplexies in the fundus are frequently from the choroid; and it is difficult sometimes to say positively whether the hæmorrhage is from the retina or from the choroid.

Apoplexy terminates occasionally favourably, and vision is almost perfectly restored; more generally vision is permanently damaged, either altogether extinguished or only partially lost; recurrent attacks of hæmorrhage are not at all uncommon, just as one blood-clot is nearly absorbed a second apoplexy often supervenes, and eventually these recurrent attacks disorganize the greater part of the retina. The prognosis in these cases of sanguineous effusions in the retina should be very guarded, not merely in respect of vision, but also as regards the patient's life. After repeated attacks of intra-ocular hæmorrhage the iris becomes generally discolored, and the eyeball often assumes a different position from that of its healthy fellow.

LECTURE IX.

ON

THE RETINA.

(Continued.)

THE *pathological alterations* found during and after retinitis are serous, sanguineous, and occasionally plastic, purulent, or tuberculous infiltration, all of which cause swelling and opacity of the retina. The striated radiating appearance is due to infiltration between the nerve fibres, or to sclerotic hypertrophy of the nerve fibres themselves. The partial obscurations and interrupted appearance of the vessels are accounted for by the fact of the vessel dipping down here and there deep into the retina, and then again rising up towards the most internal part of the retina, where it becomes quite superficial. When the retina is infiltrated and opaque the deep portion of the vessel will naturally be less distinct than the superficial part. The papilla is found œdematous and prominent from infiltration, owing sometimes to constriction at the lamina cribrosa. The cellular tissue of the retina undergoes very extensive modifications; it becomes hypertrophied and undergoes fatty degeneration, and a peculiar alteration termed sclerosis, a species of hypertrophy, in which the hypertrophied structure is of a hyaline appearance and highly reflecting. The cellular tissue in the coats of the vessels is hypertrophied; the coats undergo also occasionally amyloid degeneration, and appear as dead-white, chalk-like threads. The coats of the capillaries undergo fatty degeneration and sclerosis, all of which render the vessels very liable to rupture.

Müller's radial fibres are found actively engaged in proliferation and hypertrophy; they have been described as even giving rise to polypous excrescences on the membrana limitans interna, from which the vessels I alluded to in a former lecture are sent into the vitreous humour. The nervous elements of the retina may be compressed and atrophied, or may disappear altogether, so that the retina is found composed altogether of cellular tissue; they also undergo fatty degeneration and sclerosis; the nerve fibres are found irregularly thickened, and presenting here and there bulbous swellings and a beaded condition. The clusters of white shining spots delineated in Figure 1 are sclerosed nerve fibres. Cholesterine crystals have also been found in retinitis from Bright's disease; fatty degeneration is the principal alteration in nephritic retinitis. Sometimes the pathological alterations are confined almost altogether to the coats of the vessels. In tuberculous or purulent infiltrations the media are usually opaque and prevent an ophthalmoscopic examination. The vitreous is often fluid, and contains blood-effusions or other opacities already alluded to; the choroid suffers generally a loss of its pigment epithelium, which is sometimes found engaged in proliferation; the choroidal capillaries undergo sclerosis, and the coats of the large vessels may become hypertrophied.

Atrophy of the retina may be partial or complete, may engage the inner or the outer layers chiefly, or may exist in certain portions of the membrane, while other portions are either healthy or engaged in active inflammatory processes, or the entire retina may be atrophic; the fundus appears of a greyish-yellow or bluish-grey colour, frequently with quantities of black pigment scattered through the retina, or the retina may be quite transparent and invisible, but its vessels reduced to extreme thinness, and very few in number. I have seen them represented by one or two thin, delicate, thread-like lines; the optic disc is white and atrophied, or not to be distinguished from the rest of the fundus, and the choroid is nearly always atrophied. In this state the retina may be devoid of nervous elements, and consist of cellular tissue, or the cellular tissue may be scanty and the membrane represented by an opaque, delicate, molecular, striated structure.

Retinitis Pigmentosa.—Pigmentary degeneration of the retina, styled by the French *rétinite tigrée*, and originally named *morbus Arianus*, after a nobleman in whom the disease was remarkably well developed, was first described in the living eye by v. Graefe

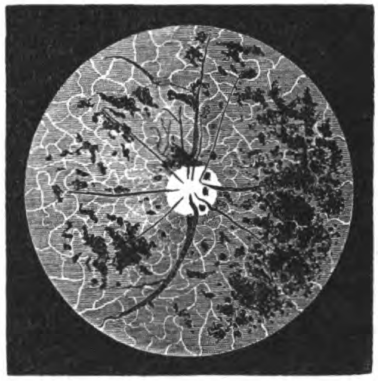
some years ago. The name retinitis is, I think, open to objection, as that term implies and conveys the idea of an active primary inflammatory disease of the retina, whereas the affection is usually the result of choroidal disease, and the retina is merely secondarily engaged. Independent development of pigment may and does undoubtedly occur in the retina without any other structure being implicated; but this appears to me to be the exception.

Eyes affected with this malady present externally but little peculiarity, except in the very advanced stage of the disease, when the pupil becomes very small, and responds but slightly to the stimulus of light; when it is congenital nystagmus occurs—an oscillating or to-and-fro movement, common to all congenital or early acquired ocular defects. One of the earliest symptoms generally complained of, as well as the most constant one, is night blindness, at first partial, and in the advanced stage complete. Vision then begins to fail by day, and in such a manner that the field of vision is narrowed. There is, also, loss of the power of fixation; the ability of at once and promptly discerning any given object is diminished, and the patient sees best in strong light. There is no pain, nor is there—externally at least—any trace of inflammatory action. The disease is an exceedingly slow and insidious one, and terminates, as a rule, in blindness. It is essentially progressive, but continues sometimes as long as twenty years before terminating in complete blindness. It occurs congenitally, is hereditary, and is sometimes complicated with opacities of the lens and in the vitreous humour. The ophthalmoscopic examination reveals a very marked contrast to the normal state; the fundus of the eye, instead of being of a uniform brilliant or dull red (according to the pigmentation of the choroid) presents patches or spots of a jet black colour, varying in shape and size, scattered irregularly over it; these spots are generally stellate; they occur as small isolated black specks, irregular in outline, having more or less numerous projecting processes, resembling in their appearance bone corpuscles; or they occur as jagged irregularly shaped striæ; or grouped and massed together, forming a black irregular network. The black deposit is nearly always in greatest quantity at the place of division of the retinal vessels. These latter are, as a rule, extensively implicated in the disease, and present here and there streaks of pigment along their course, while at other places they are wholly or partially obliterated, or appear as very fine thin threads, which condition is usually best

seen on the optic papilla. The optic nerve is generally atrophied, and has occasionally some isolated specks of pigment on its disc. Pigmentation of the retina commences usually at the peripheral and equatorial parts of the retina; the pigment is always most abundant at the periphery, and may exist almost exclusively at the anterior portions of retina, where it should always be searched for.

The black deposit cannot well be confounded with accumulations of pigment which are sometimes seen in the choroid; that it is situate in the retina is ophthalmoscopically recognizable, from the circumstance of its being either in the same plane as the retinal vessels, or even anterior to these, so that they are concealed by it, as well as from the fact of the choroid being generally distinctly visible behind it. In the large majority of cases the choroid itself is extensively diseased, and its pigment epithelium so highly atrophied that the large choroidal vessels are clearly visible. In these cases the black specks, and masses of pigment in the retina, form a very marked contrast to the bright yellowish or red colour of the underlying choroidal vessels, and the dark red of the choroidal intervascular spaces. This condition can be very inadequately represented in anything but a coloured plate. I have, however, attempted to delineate it, Fig. 2, Plate II., and also in the accompanying woodcut, taken from a drawing I made of the left

Fig 23.



fundus of the eye of a man aged fifty-five, who stated that he had enjoyed excellent vision up to the year 1862, when he noticed that he could not see as clearly as usual in the twilight. His vision had gradually decreased since then, both quantitatively and qualitatively, so that when I saw him three years subse-

quently he could only read, and with very great difficulty, "canon" type (No. 18 Jæger). His field of vision was small, and it took him a considerable time to make out the exact outline of an object. He saw best in a bright light; the head was held erect, and the eyes appeared as if seeking the light—just the reverse of the condition seen in persons affected with uncomplicated cataract. About the time he noticed his vision becoming impaired he had suffered great domestic affliction and much anxiety. At this time, too, he had a feeling of great heat and tightness in the head, and would sometimes stagger in the streets like a drunken person—symptoms probably referable to intra-cranial disturbance. The pupils were normally dilated, but sluggish; the lenses slightly muddy, the left having a few striæ at its circumference; the vitreous was clear and free from muscæ.

The background of the image was formed by an unequally coloured structure, composed of bright yellow and red tortuosities, which varied in size, and possessed well-defined outlines, with dark coloured, island-like interspaces, indicated in the cut by the white lines and shaded interspaces, which give but a faint idea of the beautiful yellow plexuses formed by the choroidal vessels, which had become visible in consequence of complete and extensive atrophy of the layer of choroidal epithelium. The colour was much lighter at the position of the yellow spot—to the left of the central disc in the cut—where the atrophy had not only destroyed the pigment epithelium, but had engaged the stroma of the choroid. In front of this background, that is nearer to the observer, a quantity of jet black patches and specks were scattered irregularly over the fundus, aggregated here and there into large masses, especially on the outer or temporal side; one large triangular-shaped piece is seen encroaching on the upper border of the optic papilla, and three smaller ones are seen on its surface, towards the temporal side. The retina appeared very slightly hazy on the inner side, and around the papilla; the papilla itself was atrophied, of a white colour, its outline slightly indistinct, irregular, and indented here and there. The condition of the retinal vessels was very peculiar; above and below a large dark-coloured gorged vessel arrived at the optic disc, after entering which it became much smaller, assumed apparently a different direction from that which it previously possessed, and tapered gradually to a point—an appearance somewhat similar to the condition known as excavation of the optic nerve. Besides these there were several small arteries,

some of which were so minute and attenuated that they could only be seen by using a high magnifying power; some were altogether obliterated or had disappeared in the network of pigment. Pigment existed along the coats of some of the vessels, and was in the same plane or in front of the retinal vessels, and the denuded large choroidal vessels were distinctly visible behind it.

Opinions are still divided as to the origin of this very peculiar disease. Donders, who was the first to institute a careful microscopical examination of the structures engaged in it, considers it to be a special and independent affection, combined with, or due to, a chronic inflammatory process in the retina; his view as to the idiopathic development of pigment in the retina has been confirmed by a case in which Schweigger found on dissection the choroid perfectly healthy and normal in its entire extent, while the pigment occupied a zone of the retina lying between the equator and the ora serrata, and was confined to the vessels. Other investigators have arrived at the conclusion that the pigment is derived from extra retinal sources; thus Schweigger, one of the best authorities on the pathology of ocular diseases, maintains that in the majority of cases pigmentation of the retina is attributable to choroiditis, with effusion and secondary infiltration of the retina. A very strong argument in favour of this view is afforded by the observations made independently by Schweigger and H. Müller, that at these places where the retina was unaffected and perfectly healthy, the subjacent choroid was likewise perfectly normal and unaltered, while at these spots where the retina was implicated in the disease, the choroid was correspondingly altered and was devoid of its pigment cells. Some ophthalmologists still regard pigmentation of the retina as a mere accidental circumstance, which may ensue on any form of retinitis.

Our knowledge of the causes and mode of origin of pigment as a pathological product is, I think, still a limited one. Melanotic formations occur in various tissues and secretions, as in pleural adhesions and in sputa; the small cerebral arteries are also occasionally found to have undergone pigmental degeneration. Paget states, with reference to this subject, that the general tendency of inflammatory products is to imitate the properties of the natural products of the part inflamed; and so far as disease of the lungs, choroid, and iris are concerned, this explanation is verified, but whether it will be found satisfactory in all cases of pigmental degeneration is doubtful.

The pigment is found, on microscopical examination, to be principally in the layer of grey nervous matter, and on the vessels. It occurs, however, in the various layers of the retina. It is found as pigment granules, or as pigmentated cells, which are flattened, polygonal, discoid, or elongated, the large polygonal ones having a bright nucleus. One or more of the retinal laminæ is, as a rule, atrophied; from its proximity to the choroid, the bacillary (Jacob's) layer is the most frequent to suffer, and is generally highly atrophic. The walls of the vessels are found to have undergone sclerosis, and the tube is narrowed or even obliterated.

A remarkable feature in this disease is its hereditary nature, and its occurrence in the children of consanguineous parents. While revising this very page, a man, aged twenty-seven, was led into my study, who presented one of the best-marked cases of retinitis pigmentosa I had ever seen. His vision, congenitally impaired, gradually failed until it was totally lost. His parents were cousins. In thirty-five cases, which Liebreich noted more particularly, he was able to prove descent from blood relations in nearly half. Thus, another example has been added to the list of ocular and other defects dependent on consanguinity, to which Sir William Wilde has drawn attention in his writings, more especially in his essays on Deaf Dumbness and on Congenital Malformations of the Eye.

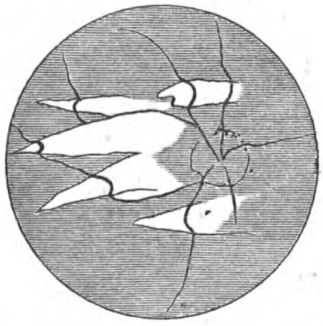
Detachment of the Retina.—The retina is pretty frequently separated from its attachment to the choroid, and when detached to any extent may be easily recognized by ordinary daylight illumination as a greyish-white membrane floating in the vitreous chamber; the patient should be seated close to a window, the unaffected eye covered, and the light allowed to fall directly and fully into the eye; the examiner, standing a little in front and to one side of the patient, looks somewhat obliquely into the eye, and will readily perceive the moving membrane during the movements of the eye. The retina may be detached to a greater or less extent; small isolated portions may be separated, or one-half of the membrane, or it may be altogether disconnected from the choroid infundibulum-like, and remain attached to the optic nerve behind and at the ora serrata in front; although lying in apposition with the choroid its connexion with that membrane may have become dissevered throughout its entire extent. Detachment of the retina is most frequently seen at the inferior part of the fundus; any part of the membrane may be detached in the first instance, but owing to

the laws of gravity the inferior portion will be the part most likely to suffer and remain permanently separated; in exceptional instances the upper part has been found detached.

Direct examination and focal or oblique illumination afford the best means of detecting detachment of the retina; when the ophthalmoscope mirror is used alone in the commencement of the ordinary examination, and the patient directed to look in various directions, that part of the fundus on which the retina is unseparated presents the usual red brilliancy, while the part from which the retina is detached appears of a dull dark grey, greenish, or bluish colour, and at this place a moving object, with a wave-like motion, attracts attention, which, on closer examination or by focal illumination, may be readily recognized as the retina. The affection is also easily diagnosed by the examination in the reversed image, but we must remember that the separated retina is usually bulged forwards, bladder-like, and is in a plane nearer to us than the rest of the fundus, and that we must, therefore, alter the focus of the object lens; the position of the lens which is best adapted for the undetached portion of the retina will not answer for the detached portion; lateral movements of the object lens produce considerable distantial displacements of the adjoining separated and unseparated portions. When an entire segment of the membrane has become separated, as shown in Fig. 3, Plate II., there is usually an undulating line across the fundus, which represents the point of separation; from this line to the periphery the colour of the fundus is different to that of the remainder; the colour of the detachment will be different, according to the different character of the cause of separation; if there be clear transparent fluid beneath the retina, projecting it forwards, the colour of the detachment will resemble very much the remainder of the fundus; if the effusion be dark or opaque, the detachment will be dark also. The circulation in the vessels on the detached retina is frequently uninterrupted, and the vessels are usually well seen; indeed, sometimes they contrast markedly by their dark red color with the grey color of the surrounding detachment. The course of the vessels on the detached portion of retina present some peculiar features characteristic of the affection; if a vessel be traced from the papilla to the detachment it appears sometimes to terminate abruptly at the line of separation, and to become again visible on the summit of the detachment close to its apparent termination, or the vessel is seen to bend laterally to its original direction and become curved; the

reason of these conditions is that the vessel has either to ascend perpendicularly from the ordinary level of the retina to the summit of the elevation, or to rise up more gradually on a gentle incline; the vessels on the detachment itself present a broken, interrupted, or curved appearance; a vessel, which at one moment may be distinctly visible, becomes in the next invisible or very faint, the cause of this phenomenon is to be sought in the circumstance of the separated retina being thrown into folds; the part of the membrane which at one moment forms the top of a fold is the next moment the bottom of a sulcus between two folds, and the vessels must naturally follow all the alternating sinuosities, curves, and folds in the loose and ever-varying membrane. These folds and the wave-like motion are peculiarly characteristic of detachment; it is possible for the inexperienced to confound them with or mistake them for moving membranes in the vitreous humor, but the vessels being generally visible on the detached retina, the employment of focal and oblique illumination and the subjective symptoms will guard against this error. The retina itself loses usually its perfect transparency, becomes somewhat greyish, and reflects a considerable quantity of the incident light. Small, limited, circular, oval, or elongated portions of the retina may be detached: sometimes we see one fold stretching across the field, either vertically or horizontally, from the periphery to the optic papilla; it is seen often as a bright line, shading off towards the sides, and the vessels crossing it are seen to pass over an eminence; two or more such folds may exist in different parts of the fundus. Fig. 24, copied from a rough pen and ink sketch, represents a curious case of detachment of the left retina in a boy seven years of age, who

Fig. 24.



had been weak-sighted from infancy, and who discovered that his left eye was blind shortly before the time I saw him. The optic

papilla could scarcely be distinguished from the surrounding fundus; the greater part of the fundus was of a greenish tint, the yellow spot and the vicinity was occupied by a dull white patch, from which prolongations were sent outwards; two other white patches were observed—one above and one below the papilla; the curved manner in which the vessels crossed these white patches is well represented in the cut. By lateral movements of the object lens, the distantial displacement of the vessel on the white patch was greater than that of the same vessel in the level of the rest of the retina. This was a case of old effusion under the retina—probably congenital; that it was not one of choroidal atrophy is seen from the course of the vessels. The undetached portions of retina may present a normal appearance, or the fundus may be otherwise disorganized. In the rough sketch in Plate I. the fundus is dim and dull, and the papilla is seen as through a hazy watery mist; there was also posterior staphyloma, indicated by the irregular white zone round the nerve. Occasionally eyes affected with extensive separation of the retina reflect, on direct opthalmoscopic illumination, little or no light, and the vitreous chamber appears dark and obscure; in these cases oblique or focal illumination will generally afford evidence of the retina being pushed considerably forwards.

The subjective symptom nearly invariably met with is partial or complete obscuration of a portion of the visual field; the patient complains of a cloud or screen between him and part of the object looked at; the detachment being usually at the lower part of the retina, the upper part of the object is the one usually obscured; this interruption in the upper part of the field of vision occurs suddenly, and may be regarded almost as pathognomonic of detachment; the dark cloud with irregular outline is particularly well marked and distressing when the patient looks at a white object or the sky. At the margin of the cloud the object regarded appears curved, crooked, and distorted; thus, if the patient looks at a person's face, the upper portion of his retina being still functionally active, the upper part of the person's head and his forehead will be quite invisible, the eyes will be faintly visible, but not on a line with each other—one perhaps higher than the other, or with streaks across them; the nose will be bent and distorted, and finally the mouth may be plainly and naturally visible. If the upper part of the retina be detached and the lower part healthy, the lower portion of the field of vision will be obscured. The

original obscuration may remain permanently fixed and limited, or it may increase and even become total or decrease slightly, and in a few exceptional instances it has been known to pass away, the detached retina having again become apparently connected to the choroid. In some cases the globe adapts its position to the still sensitive portion of retina, and the patient, when looking at an object, directs the axis of the eye elsewhere; thus, in regarding an object straight before him, the eyeball will be turned upwards.

The *causes* of detachment of the retina are: choroiditis, retinitis, hyalitis, hæmorrhages, injuries. In sclerotico-choroiditis posterior there occurs a gradual staphylomatous bulging of the sclerotic and choroid outwards; the retina, not being capable of the same distension as the outer tunics, becomes occasionally detached, when these have become expanded beyond a certain degree. The same disease acts also on the vitreous humor, which is deprived of nutrition and becomes fluid; in consequence of choroiditis fluid is poured forth between the two membranes and pushes the retina forwards, thus separating it from the choroid; in like manner fluid is sometimes poured out in consequence of retinitis or sudden obstruction of the return venous circulation from the globe; penetrating wounds of the sclerotic result sometimes in detachment of the retina; this occurs during or after the cicatrization of the sclerotic wound. The vitreous humor is sometimes the seat of exudations and membraneous growths, composed chiefly of cellular tissue, which are frequently attached to the retina; these neoplasms, in contracting, pull with them the retina, to which they are affixed, and the connexion between the retina and the choroid being normally only slight, the retina becomes separated; this is called detachment by traction or attraction. The void between the two membranes is generally filled up by fluid. Tumors growing from the choroid or a cysticercus will also effect separation of the retina. I have seen detachment of the retina not unfrequently in elderly persons, who had been operated on in early life for cataract by needle operations. The characters of the subretinal exudation will vary according to its origin; the retina is sometimes pushed up against the back of the lens by strumous and purulent products, but when this is the case the ophthalmoscope is of little or no use, for the transparent media are invariably opaque, or have even perished. In those cases in which the media are transparent and the globe externally normal the fluid between the detached retina and the choroid resembles serum; it is to a great extent coagulable,

and contains sometimes pus globules, metamorphosed blood particles, or cholesterine.

The upper segment of the fundus is the part frequently affected at first; the fluid between retina and choroid then gravitates downwards, and may remain in this depending position, pushing forwards the retina; if, on watching the case and noting the subjective and objective signs from time to time, we observe that the inferior part of the visual field is unobscured, and that it remains so, and that the line of separation of the retina remains stationary, we may conclude that the upper half of the retina is again in connexion with the choroid, and it is just possible that matters may remain in this condition. Detachments of the retina are, however, progressive, and their tendency is to increase and spread; the eye sometimes softens and even collapses. Owing to the same causes which produced the detachment, other disturbances may ensue; thus the pupil may be closed, the lens often becomes cataractous, and occasionally calcareous or cretaceous. The retina is sometimes torn or burst by underlying effusions and inflammatory products; these occur generally towards the periphery. Cases are on record in which the detached retina was ruptured at the optic nerve; thus Mr. Hulke has described and figured in the *Ophthalmic Hospital Reports* for 1861 a case in which the retina was detached in consequence of acute choroiditis with effusion, and completely torn away from the optic nerve entrance. The retina and choroid together are said to become separated from the sclerotic, but this, if it does occur at all, must be a great rarity. The iris becomes frequently of a greenish-yellow hue in cases of detached retina due to choroidal effusion.

Tumors, both benign and malignant, occur rarely in the retina; when small they are readily mistaken for a detachment of the retina, from which it is very difficult to distinguish them; it is almost quite impossible occasionally to decide on their benign or malignant character; even after extirpation and microscopical examination it is sometimes very difficult to determine the exact nature of some of these retinal tumors. Medullary cancer originates sometimes in the retina or optic nerve, causes detachment of the retina, increases in size, and finally bursts through the outer coats of the eyeball, symptoms of violent inflammation, intra-ocular pressure, hardness of the globe, ciliary neurosis, &c., being generally present. If the pupil be not occluded we are often enabled to see the tumor as an irregular mass with a yellowish reflecting surface. Although

extremely interesting in a pathological view, it is practically not of great importance to diagnose beforehand the exact nature of such tumors, for whenever intra-ocular growths are recognized the globe should, as a rule, be enucleated out of its capsule, by the method described by Mr. O'Ferrall in the *Dublin Journal of Medical Science* for July, 1841.

I have already alluded to the *cysticercus cellulosa* as occurring beneath the retina, causing its detachment, or bursting through the membrane into the vitreous humor; some of the patients had been previously affected with tæniæ.

The retina is said to become ossified occasionally, but this I believe to be an erroneous opinion; the calcareous and osseous plates found within old diseased eyes are due to the choroid, and are products of choroiditis.

Blows and concussions of the eye may cause detachment, or even laceration of the retina, without any external lesion; both the retina and the choroid have been torn from a sudden violence. Mr. White Cooper, in his *Wounds and Injuries of the Eye*, v. Graefe, and other authors, report such cases; those lacerations are seen as dead-white cicatrices, with pigmented borders, stretching across the fundus. The prognosis in these cases is not necessarily unfavorable, a large amount of vision may be recovered and retained. Blindness may ensue in injuries without any visible lesion, either externally or internally; this may be due to irritation of the vaso-motor nervous system, the retina may be paralysed, and its functions destroyed by concussions.

LECTURE X.

ON

THE CHOROID.

Congenital Peculiarities.—The pigment is occasionally partly deficient, or altogether absent in both the choroid and the iris, and the pupil presents the well-known reddish reflection seen in albinos; although the pigment may be absent, yet the epithelial cells themselves may still exist. In consequence of the non-pigmentation of the iris and choroid, light enters the eye on all sides, through the iris, sclerotic and choroid, and instead of being absorbed to a great extent as usual, is reflected backwards and forwards within the eye, from the reflecting white surface of the sclerotic; bearing this in mind, it can be readily understood how this reflected and diffused light must interfere with the proper formation of an image on the retina, and why the albino is amblyopic. The myopia which so generally accompanies albinism may be accounted for by the fact of the person habitually seeking a dim or very modified light, in order to shut out this disturbing light; in this dim light he is obliged to bring the object close to the eye, and he gets the habit of accommodating for his near point. Otto records, in his anatomical description of 600 monsters, published at Breslau in 1842, an instance of cyclopia, in which the choroid and the sclerotic were of a gelatinous consistency; in this same malformation two choroids are found. Total absence of the choroid has been found together with numerous other anomalies of the globe; and v. Ammon alludes to partial deficiency of the membrane with spots of union scattered through it. The most interesting congenital anomaly is one easily seen by

the ophthalmoscope—*Coloboma of the Choroid*, first described by v. Ammon, as a continuation of coloboma of the iris. Coloboma of the choroid is seen as an oval or pear-shaped white figure in the fundus, extending from the anterior termination of the choroid to the optic nerve; it may embrace the optic papilla, or extend, as is generally the case, close up to it, and be separated from it by a narrow band of choroid; it is sometimes continuous with the fissure in the iris, sometimes separated from it by rudimentary ciliary processes; coloboma of the iris is not necessarily accompanied by coloboma of the choroid, but it is so in a large number of cases. More or less complete absence of the choroid allows the sclerotic to shine through at the colobomatous spot, which accounts for the white glistening appearance. The optic papilla may be distinguished from the coloboma by its pink, or reddish-grey color, as well as by its vessels; it has been observed by Liebreich, to be horizontally elliptical; the retina is rudimentary or absent, the crystalline lens has been found ovoid, or notched at its margin, corresponding to the coloboma; the ciliary muscle is usually defective, and hence the power of accommodation is either lost or defective; the sclerotic which forms the bottom or background of the white figure, is generally staphylomatous, and presents here and there pouch-like depressions; the branches of the retinal arteries and veins course along the margins of the coloboma, sink into it here and there, or course over it, dipping down into the staphylomatous spots in the sclerotic; the margins of the coloboma are frequently deeply pigmented. There is always myopia and amblyopia; a defect occurs in the field of vision corresponding to the deficiency of the internal structures. The anomaly is due to an arrest of development at an early period of embryonic existence. Full information on the development of the eye, and its arrested growth, will be found in Sir William Wilde's valuable and unique work on *Malformations and Congenital Diseases of the Organs of Sight*, to which I refer my reader.

In examining the choroid we should never lose sight of its anatomical arrangement, and must always take into account the coloration of the hair and the general complexion of the patient, already alluded to at p. 51.

Hyperæmia.—Congestion of the choroid must exist frequently, owing to its great richness in vessels, but it is doubtful whether it can be seen in an otherwise healthy and normally pigmented eye, the pigment of the choroid epithelium preventing as a rule the parts lying beyond it being seen. Excessive employment of the

eyes on small objects results frequently I think in congestion of the choroid, which produces temporary indistinctness of vision and is followed by one or more muscæ. I have known persons become unable to go about or do anything for an entire day after a few hours spent on very small writing.

Inflammation may attack any one portion of the choroid primarily, but it is almost certain to implicate eventually, not only the remaining portions of the membrane but also the retina and the vitreous humor; the sclerotic and the crystalline lens become also affected secondarily; it may be taken as a rule that every choroiditis is followed or accompanied by alterations in the vitreous humor; any impediment to the circulation and the nutrition of the choroid acts also on the vitality of the vitreous and the lens; in the former are found various neoplastic formations and floating particles, and the latter becomes opaque—very often on its posterior surface; whenever an opacity is seen at the posterior pole of the lens some deeper-seated mischief may be suspected.

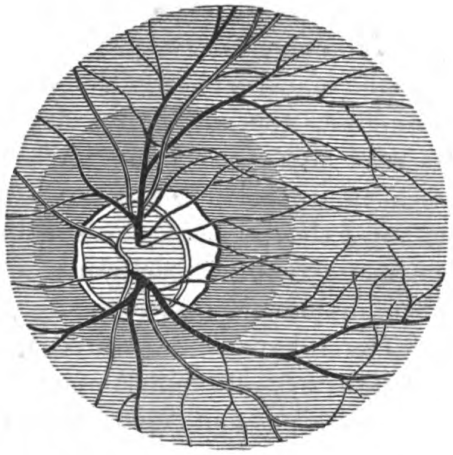
Inflammations of the choroid are of the most varied character, result in the most diverse products, and assume the most different appearances. Inflammation is often very limited and confined to a small extent of the choroidal thickness or of its superficies—sometimes serum is poured out, sometimes lymph or pus or blood.

The choroid is occasionally so infiltrated and swollen as to press upon the optic nerve at its entrance into the globe and to cause considerable pathological changes in it; serous fluid is also poured out sometimes, in consequence of choroiditis, and permeates the retina and optic nerve so as to render these quite indistinct; this condition is not uncommon in iritis, or rather irido-choroiditis, for iritis rarely if ever exists without more or less choroiditis, as was pointed out long ago by Dr. Jacob. Several varieties of choroiditis may exist at the same time in the same eye, one merging into the other. Almost every and any disturbance in the choroid reacts on the epithelium and its pigment, and this part of the choroid very readily becomes atrophic, and implicates the retina; the rods of the bacillary layer of the retina being implanted on the hexagonal cells, any alteration in the latter must also necessarily affect the former. The nomenclature and descriptions in the following pages are principally from Stellwag v. Carion's *Lehrbuch der praktischen Augenheilkunde*, and Wecker's *Etudes Ophthalmologiques*, the two standard text-books of the present day.

Staphyloma posticum, called also *Sclerectasia posterior*, *Sclerotico-*

Choroiditis posterior, Consecutive Atrophy, Myopia, &c.—This affection was known so long ago as the time of Scarpa, who found it during dissections, and gave to it the name *Staphyloma sclerotic*æ *posticum ;* its discovery during life is due to the ophthalmoscope, without which instrument we must still have remained ignorant of this, as well as other interesting conditions during life. Myopic eyes, or those affected with posterior staphyloma, are the best suited for the beginner in the use of the ophthalmoscope; the fundus is much more easily and clearly seen than in the normal eye; I have known pupils exclaim in glad surprise and admiration on first seeing the fundus of such an eye, and more than one have confessed to me that they could never previously have really seen the fundus oculi, although they thought they had. The ophthalmoscopic and characteristic symptom of posterior staphyloma consists in a crescentic white patch, the *myopic crescent* at the side of the optic nerve, the concavity of the crescent embracing the outside of the optic disc,

Fig. 25.



as seen in Fig. 25, which represents the reversed image of the fundus of a myopic eye, copied from Donders' *Anomalies of Refraction and Accommodation ;* in this figure the crescent embraces the whole disc; the veins are represented large and dark, the arteries thin and light colored. Another characteristic sign of this malady is the visibility of the fundus without any object lens in the reversed image as already explained. The white crescent may be very small and narrow, or it may be extensive, and project considerably into the fundus; it may be limited to the outside of the nerve, its horns may extend around the upper and lower side of the disc, or

it may even embrace the entire papilla; it occurs usually on the outside of the papilla, but it may occupy any side, it is very exceptionally seen above. When small, it may be mistaken for part of the papilla; it contrasts however always by its white color with the pink optic disc; the adjoining choroid is also generally altered, being more or less atrophied and denuded of its pigment; the crescent is also frequently bounded externally by a dark margin of pigment; it is to be distinguished from retinal exudations by the normal character of the retinal vessels, and by the transparency of the retina. Indeed the retinal vessels appear more numerous and are better seen on the white crescent than in the normal fundus, owing to the great amount of light reflected from the denuded sclerotic, the small vessels which are scarcely visible against the normal choroid become visible here and stand out in relief, they appear also to be stretched across the white space; the myopic crescent cannot be easily confounded with the ring seen in glaucoma, as the white space in the latter is of a uniform breadth all round the disc, as shown in the three figures on Plate II. In glaucoma there is visible pulsation of the vessels and progressive presbyopia, whereas in posterior staphyloma there is no pulsation and there is progressive myopia. Sometimes one or more large yellowish choroidal vessel may be seen in the white space and sometimes spots of pigment. The optic papilla is frequently oval, as seen in Fig. 2, Plate II., and flattened on the side next the crescent, and the long diameter of the disc is at right angles to the direction of the greatest extent of the staphyloma; this is due to the nerve being dragged backwards and to one side by the bulging of the staphylomatous sclerotic.

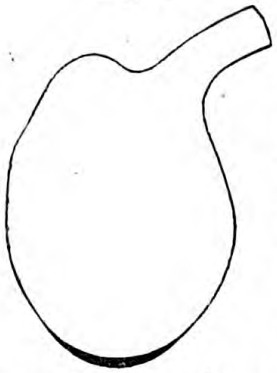
In Fig. 2, Plate II., I have endeavoured to represent the reversed image of the right eye of a female aged forty-three, affected with extensive staphyloma posticum and other pathological conditions. The optic disc is oval downwards and outwards; the choroid is completely atrophic to the right and below, and allows the sclerotic to shine through; in the upper part of the figure the white lines give a faint idea of the larger choroidal vessels laid bare by the disappearance of the epithelium pigment and the chorio-capillaris. Scattered over the fundus and mostly in the retina is a quantity of black pigment, one very large mass is seen to the right hand side; the part of the fundus in the under part of the figure was pretty healthy. The eye was highly myopic and its vision confined to the perception of large objects; the woman could not distinguish Snellen's 200, and does not remember ever to have seen well with

it. Her left eye for which she consulted me was also myopic and affected with slight posterior staphyloma and atrophy of the choroid, without however any pigmental deposit or retinal or neural atrophy.

The symptom invariably complained of is myopia, indeed the terms posterior staphyloma and myopia have now become synonymous, there may be amblyopia and muscæ, but no pain, redness, or any inflammatory sign whatever.

The *pathological alterations* found in posterior staphyloma are atrophy of the entire thickness of the choroid immediately adjoining the outside of the optic papilla, and more or less diffused atrophy of the adjacent choroid; the globe is lengthened in its antero-posterior diameter, either an entire segment of the sclerotic is staphylomatous or only a small limited portion to the outside of the nerve-entrance, as shown in Figure 26, copied from Briggs' translation of Scarpa's *Practical Observations on the Principal Diseases of the Eyes*, 1806. The sclerotic is also thinned; the retina may be quite unaltered, or its bacillary layer may be disintegrated or atrophied, it may also be detached owing to its being incapable of the same amount of stretching across the staphyloma as is the choroid; the iris and the lens are sometimes drawn backwards and the ciliary muscle is sometimes atrophied. Next to the complete atrophy and discoloration of the choroid near the optic disc, and the staphylomatous condition of the sclerotic, the most remarkable pathological alteration described is one in the sheath of the optic nerve; this sheath consists normally of an external and internal layer of fibrous tissue, enclosing between them a delicate layer of connective tissue; the external layer bends outwards when it reaches the globe, and merges into the external surface of the sclerotic; the internal layer accompanies the nerve as far as the choroid, joins the latter and assists in the formation of the lamina cribrosa; part of it turns outward into the inner surface of the sclerotic. In posterior staphyloma the cellular tissue between these two layers is found enormously enlarged and distended, pushing asunder the fibrous layers and stretching and thinning them. How or why this arises is unknown, but it is plain that if the sclerotic be thinned posteriorly it cannot resist the constant pressure from within, and is unable to sustain the choroid; this

Fig. 26.



latter losing thus its support and being put on the stretch, its capillary circulation becomes obstructed, which is probably the first step in the atrophy that ensues. The choroid is found as a perfectly structureless tissue, even the elastic lamina being frequently lost. Posterior staphyloma is sometimes complicated with choroiditis disseminata, and cataract not unfrequently supervenes, serous choroiditis and glaucoma is not of uncommon occurrence in such eyes.

Posterior staphyloma with atrophy may occur elsewhere than around the nerve. I have seen one well-marked instance of it at the yellow spot, and Mr. Streatfeild has given a very beautiful and truly artistic representation—painted by himself—of such an exceptional case, in the fifth volume of the *Ophthalmic Hospital Reports.* In the same volume are two other excellent pictures of posterior staphyloma by the same gentleman. In his essay on the subject, Mr. Streatfeild remarks that although posterior staphyloma exists yet the eye may not be myopic, and alludes to some very rare instances in which it was observed even in hypermetropic eyes. I should also mention that myopia may exist without the crescent.

Posterior staphyloma with myopia is congenital and acquired; it is also hereditary, it has been observed in early infancy when specially sought for. As to its original predisposing cause it is difficult to pronounce upon, some regard it as an arrest of development and suppose it to be in connexion with the protuberantia scleralis, described by v. Ammon, as the last stage of the closure of the sclerotic fissure in the very early stages of fœtal existence. Constant application of the eyes on minute objects may bring about posterior staphyloma with atrophy of the choroid and myopia. Mr. Hutchinson alludes in Vol. v. of the *Ophthalmic Hospital Reports* to a case of acquired myopia in the person of a reader for the press who was constantly employed at his occupation from 5 o'clock a.m., to 11 o'clock p.m. The disease is generally progressive; it may remain stationary for a time and then increase for awhile to become again stationary. Where the crescent is well defined and the adjoining choroid quite healthy the affection is usually stationary; in some instances of periodic progressive disease, we find indications of two or three crescents one without the other, showing the portions of choroid successively attacked. With advancing years and alteration in the curvature of the lens the near point moves away from the eye and vision often improves for distant objects.

Atrophy of the Choroidal Epithelium.—Atrophy may ensue in any part of the choroid and may exist with or without myopia; the

choroidal epithelium is frequently found completely atrophied over the entire fundus; the epithelium pigment disappears without any inflammatory symptoms, either in patches or throughout its entire extent, and the fundus appears mapped out into dark island-like spaces by the light colored choroidal vessels and the dark colored intervascular spaces. This is a very common appearance and is compatible with pretty good vision. There may be here and there considerable maceration of the pigment, large irregular masses of dark pigment may be seen lying beneath the retina, with orange or yellow choroidal vessels. The pigment very often disappears in advanced life, in some persons earlier than in others, and it is a common thing to find in elderly persons that the pigment has disappeared or is accumulated here and there into irregular masses.

Choroiditis disseminata, exudativa or *plastica* is characterized ophthalmoscopically by the presence of irregularly-shaped whitish spots or patches in or on the choroid; these spots vary from the size of a pin's head to that of about twice the diameter of the optic disc; they consist of exudation probably of lymph, and in the recent state are of a reddish or yellowish white or brownish color. As a rule however the patient does not come under our notice until considerable advance and alterations have occurred and the spots are then dull white, they are circumscribed often by pigment or have dark pigment scattered over their surface. The choroid adjoining such spots is quite healthy generally. Disseminated choroiditis is very easily mistaken for and often cannot be distinguished from atrophy of the choroid; in the latter affection the choroid adjoining the atrophic portion is usually slightly atrophied—the atrophy gradually merging off into the sound structure, whereas in disseminated choroiditis the spots are sharply defined and the choroid next them unaltered; the spots are generally more numerous in disseminate than in atrophic choroiditis; in atrophy the spot is glistening bluish white, while in disseminated choroiditis the spots are dull white. The choroidal tissue may however and often does become atrophic and translucent in disseminated choroiditis, allowing the sclerotic to shine through. Whitish patches in the retina also resemble these spots, but are easily distinguished by the surrounding haziness and striated appearance of the retina as well as by the tortuous and obscured conditions of the vessels. In simple disseminated choroiditis the exudation spots are mostly at the equatorial parts of the fundus, while in syphilitic disseminated choroiditis the spots are in the immediate vicinity of the optic disc. Slight diffused haziness

occurs in the vitreous humor, or there may even be very extensive opacity of the humor; the retina and optic nerve may become atrophied, particularly in the syphilitic form, and iritis is not an unfrequent complication; other forms of choroiditis may also be associated with the disseminated variety.

There is I believe no subjective symptom by which we can recognize this affection; the ophthalmoscope alone yields evidence of its existence. The patients complain of more or less general impairment of vision, of fixed or floating bodies before the eye, and sometimes of a feeling of tension. Externally the globe may present a perfectly natural appearance.

The causes of disseminated choroiditis are rather obscure: it is supposed to depend often in females upon uterine conditions, as it is frequently observed about the period when menstruation ceases, it has been observed after severe fevers and after hæmorrhages, it has also been attributed to excessive use of the eyes and to exposure to intense light; syphilis is often an undoubted cause.

The disease is a very insidious and chronic one, and advice is not sought for frequently until irreparable mischief has taken place, when of syphilitic origin and early seen and treated it may terminate favourably, the turbidity in the vitreous may disappear and the infiltration in the choroid be absorbed and vision restored completely. Frequently more or less atrophy of the retina and optic nerve ensues, and consequent impairment of vision.

The pathological alterations which take place are very similar to what occur in retinitis; dissection of recent cases has been very exceptional, but in old and long standing cases the retina and choroid have been found intimately united at the exudation spot, atrophied and transformed into cellular tissue with some pigmental remains; the stroma atrophies, the chorio-capillaris disappears, the vessels of the tunica vasculosa are obliterated, the elastic lamina is found hypertrophied with some degenerated epithelial cells on it, and lying on it are the atrophied remains of the retina; retinitis pigmentosa may result occasionally from this variety of choroiditis.

In a very instructive paper in the third volume of the *Ophthalmic Hospital Reports* on the Epithelium of the Choroid, Mr. Hulke states that in disseminated choroiditis the pigment cells of the stroma are rarely totally absent. "Towards the border of the spot the pigment particles are more numerous and the clusters more abundant. Most of these seem to be mere aggregations of particles, and although often deceptively like cells, yet a distinct bounding

membrane is often not demonstrable. At the extreme border of the spot these cell-like clusters are mingled with indubitable cells, the membrane of which is distinctly visible." Some of these cells are small while others are colossal and are termed *macroscopic.*

Hereditary Syphilitic Choroiditis is a disseminated choroiditis around the optic papilla; characterized ophthalmoscopically by small circular or oval white patches, separate and distinct from each other, circumscribed often by pigmented margins, slightly elevated above the surface of the choroid, and accompanied by opacities in the vitreous; they are often masked and concealed from our view by opacity of the cornea resulting from keratitis. Mr. Hutchinson, to whom we are indebted for the diagnosis of inherited syphilis has described this choroidal affection in the *Ophthalmic Hospital Reports*, the *Medical Times and Gazette*, and also in his book on *Syphilitic Diseases of the Eye and Ear.* The subjects of inherited venereal present in after-life a very remarkable dental formation; the central upper incisors of the permanent set of teeth have a broad vertical notch in their edges, and are short and narrow, the teeth are wedge-shaped and the lower ones frequently peg-shaped; there are pits and scars about the mouth and face the result of ulceration in infancy; the bridge of the nose is broad and expanded, often sunken; the forehead is protuberant, and the head often presents a hydrocephalic appearance, and interstitial keratitis is of very common occurrence. Mr. Hutchinson divides the choroidal disease in these cases into three stages. " The first of these is characterized by much dimness of vision, and by the presence of diffused patches of lymph in the choroid, the retina being hazy, and now and then the vitreous also. After a while the sight improves and the patches become more defined, and in the third stage, that of cure, the latter are seen abruptly circumscribed, and unattended by any deposit in the adjacent tissues." The choroiditis and plastic effusion leads to atrophy of the entire thickness of the choroid and sometimes of the retina at the spots affected, and the white scars and cicatrices seen in the fundus result. In one of these cases reported by Mr. Hutchinson an extensive layer of lymph was smoothly plastered over the entire fundus similar to what takes place in choroiditis hyperplastica. Keratitis often co-exists with heredito-syphilitic choroiditis and iritis occasionally, and cataract sometimes supervenes. More or less blindness always follow this inflammation unless actively and early treated, many such eyes become altogether blind.

LECTURE XI.

ON

THE CHOROID.

(*Continued.*)

Choroiditis Hyperplastica (Stellwag), *Parenchymatosa* (of Wecker), is characterized according to these authors by a growth from the choroid which projects more or less into the vitreous chamber, and presents a yellowish or reddish metallic lustre, often perceptible to the unassisted eye; if the media be transparent the growth is ophthalmoscopically seen as a rounded prominence with the greyish retina over it, spots of pigment, and sometimes choroidal vessels are visible on it; exceptionally the tumor increases rapidly in size, advances into the vitreous humor, comes to lie up against the back of the lens and pushes this and the iris forwards against the back of the cornea; the cornea may finally ulcerate and burst allowing the lens to escape; this benign tumor of the choroid sometimes even protrudes through the opening in the cornea, or the sclerotic may become thinned and burst and allow of the tumor projecting through. When this variety of choroiditis is rapid in its development the vitreous becomes quickly opaque, but when of slow origin the humor may retain sufficient transparency to allow of the parts behind it being seen. The diagnosis of this malady is always very difficult; as a rule serous fluid is poured out in large quantity between the choroid and the retina, so that the disease may readily be mistaken at the commencement for simple detachment of the retina. Besides the blindness which invariably attends parenchymatous

choroiditis there is frequently pink zonular sclerotic vascularity; this vascularity is rarely absent in the advanced stages of the disease, or it may be confined to that portion of the sclerotic situate at the seat of the growth; the globe is often harder than normal, showing increased intra-ocular pressure, it is also projected forwards so as to present a slight exophthalmos; the iris is often not inflamed, but becomes atrophied and altered in color; the pupil is generally immobile and does not react even to atropine; it often becomes adherent to the capsule of the lens.

The symptoms of this malady vary considerably, a constant one however is the great and rapid loss of vision—often the first and only one which attracts attention, when the growth from the choroid is considerable there is often excruciating and intolerable pain, there may however be but slight pain or none at all; flashes of light and colored spectra may also be present, owing to stretching and tearing of the retinal nervous elements, intolerance of light, lachrymation, iritis and closure of the pupil may likewise exist.

The disease is a very insidious one arising sometimes without any warning; occasionally it would appear to be periodic; it is always slower in its course in adults than in children, in the commencement it is impossible almost to distinguish it from simple detachment of the retina, or even from cancer of the eye; it resembles fungus hæmatodes very closely, but is I think of a duller color; the diagnosis is frequently so perplexing that it is quite impossible to decide on any opinion, and time alone can clear up the difficulty.

There is a form of choroiditis peculiar I think to childhood, which corresponds in many respects to this choroiditis hyperplastica of Stellwag, but in it there is no absolute tumor; the entire fundus appears to be become plastered over as it were with a layer of lymph or new cell-growth, and presents even to the unassisted eye a yellowish-red, or greyish-yellow reflection very similar to, but duller than the appearance seen in fungus hæmatodes. There is little or no external indication of the internal mischief, and the peculiar reflection or the blindness may perhaps be the first and only symptom to attract attention to the eye. The iris soon becomes slightly discolored, its pupil immobile and the eye acquires a blind look, an appearance not easy to describe in words, but soon practically recognized by the observant student. I have seen this choroiditis most frequently after severe scarlatina and measles, and have observed its occurrence during the recent epidemic of cerebro-

spinal meningitis.[a] There is sometimes lachrymation, conjunctivitis and slight pink zonular vascularity, but there is often an absence of any symptom which would point to the existence of so very grave a disorder. In one of these cerebro-spinal cases which I saw at an early stage there was no reflection from the fundus on ophthalmoscopic examination, the pupil was however immobile though not closed or even contracted, vision was extinct and the peculiar yellowish reflection subsequently made its appearance, and finally the globe became soft and phthisical. Such eyes frequently collapse; sometimes however they do not even get small, but their further growth and development is completely arrested, and if the individual grows up to adult age the eye appears preternaturally small, the lens frequently becomes opaque or calcareous, and the iris of a greenish-yellow or orange tint. This choroiditis occurs in delicate strumous children during and after severe fevers in which there appears to be blood-poisoning. I have endeavoured to ascertain the exact condition of the fundus, but have never yet obtained any very satisfactory results; beyond a straw-coloured or yellowish-red uniform surface there is very little to be seen; neither optic disc nor retinal vessels are visible. Atropine has little or no effect on the pupil, and the unsteadiness of the child and the incessant motion of the eye render it frequently very difficult to examine such cases. As a rule this disease attacks but one eye, and the right eye has been the one most frequently lost in the Dublin epidemic cerebro-spinal meningitis; coincident with the loss of vision from this cause I have seen complete and incurable deafness without any visible alterations, owing probably to plastic or purulent exudations around the auditory nerves or at their origin.

In these cases of choroiditis the fundus is I think somewhat approximated to the lens by the existence of the new growth, and therefore partly is seen by the unassisted eye. In a valuable practical Essay on *Periostitis of the Orbit* in the *Dublin Journal of Medical Science* for 1836, Mr. John Hamilton alludes to a case of a syphilitic node in the orbit which had protruded the eyeball; in this eye he remarked a bright metallic spot, which resembled fungus hæmatodes, but which was caused he believes, by the node pushing forwards the fundus and approximating it to the lens. Vision was impaired but became restored as the periosteal growth subsided under

[a] See a paper on *Diseases of the Eye in Cerebro-spinal Meningitis* in the *Dublin Quarterly Journal of Medical Science* for May, 1867.

appropriate treatment; it is however possible that this bright spot was caused by plastic effusion, which eventually became absorbed under treatment.

The termination of the disease is always fatal to vision and nearly always to the shape and appearance of the eyeball. As a rule phthisis of the eye ensues; the globe becomes soft, squared by the recti muscles, and diminishes in size. In such collapsed globes the cornea is comparatively small but transparent, the anterior chamber is obliterated, the iris is atrophied and discolored, the pupil is adherent to the capsule of the lens which latter is opaque and often calcareous; the vitreous is wholly or partially obliterated, the retina has either disappeared or is lying up against the back of the lens. The choroidal growth may burst through the walls of the globe, and appear as a button-shaped or mushroom-like soft greyish colored mass, irregular on the surface, and exuding a purulent secretion; the suppuration is sometimes very great, and may prostrate the patient. The essential peculiarity of this form of inflammation of the choroid appears to consist in a very extensive and abundant proliferation of cells, there is a large formation of new cells and considerable serous exudation. The new growth appears composed of a more or less dense and vascular reticulated cellular tissue, and an amorphous structure which contains cells and free nuclei in different stages of development, pigment granules, fat globules, cholesterine crystals; this neoplasm may become *calcareous* or even *bony*, and that sometimes without any previous formation of cartilage; the choroid has been found in atrophied eyes represented by a thin plate of bone, having a canal in it corresponding to the nerve entrance, or having openings in it for the transmission of vessels.

The causes of parenchymatous choroiditis are chemical and mechanical injuries, and foreign bodies; it arises however without any apparent cause, and is most frequently seen in children after scarlatina, measles, &c. Syphilis is said to cause it; I believe scrofula also causes it. The most marked case of it I have seen occurred in a man of about 25 years of age, who was labouring under choridoiritis when I first saw him; there was considerable pain in the eye, and about the eyebrow, there was pink zonular sclerotic vascularity, slight discoloration of the iris, partial adhesion of the pupil and complete obscuration of the vitreous, the globe was hard and rather sensitive to the touch, and slightly projected forward. There was no evidence of syphilis. The ordinary antiphlogistic

treatment had not the slightest effect upon the disease; he was cupped, leeched and blistered, mercury was administered and large quantities of iodide of potassium, but all without making any appreciable impression on the disease. The pupil became smaller and more firmly adherent, notwithstanding the application of atropine several times daily, the anterior chamber was diminished and the iris came to lie nearly up against the back of the lens. Eventually the eye became apparently quiescent and the man left the hospital. After leaving the eye became painful, the cornea ulcerated and burst, the lens and remains of the humors escaped and a fungus-like mass protruded through the opening and gave rise to a considerable purulent discharge. When readmitted to the hospital the patient was greatly reduced in health and he was very depressed and desponding. The globe was excised; some portions of the retina were found still extant but loose and grey, the site of the choroid was occupied by a greyish soft thick mass, which nearly filled up the ocular cavity. The man made a good recovery, but died some months subsequently from scrofulous disease at the base of the brain. I have at present another man under observation, whose right eye has been lost under somewhat similar circumstances but with the addition of chemosis and considerable exophthalmos; this patient has several large osseous growths on the right side of the head which have arisen and increased while under my care; he also lost the feeling on the right side of the face, and the right side of the tongue became paralysed and apparently atrophied, loss of taste and smell were also noted on this side, and the power of mastication was impaired on this side: after about a month the apparent atrophy of the tongue disappeared, but the loss of taste and the anæsthesia remain. When last I saw him some few weeks ago the tumors had increased considerably, the left eye previously sound had become totally blind with dilated pupil and some congestion of the optic disc, his walk was very unsteady and staggering, the hearing on the right side was completely gone, and that on the left slightly impaired—all evincing intracranial disease, most likely of a scrofulous nature; several members of his family have died of scrofulous disease, either of the lungs or brain. It appears to me highly probable that the Casserian ganglion in this case became the seat of disease, or was at all events involved in disease, and that as a consequence thereof the eye became affected and perished.

Choroiditis suppurativa—Panophthalmitis, differs but little from

the last described form of choroiditis; instead of the neoplastic cellular structure being formed pus is secreted from the choroid. There is great zonular vascularity followed by intense chemosis of the conjunctiva, swelling and discoloration of the lids, projection forward and hardness of the globe, intense pain, febrile disturbances, even delirium; the aqueous humor becomes turbid and even containing pus, the anterior chamber diminished, the iris greatly inflamed, covered with lymph or pus and adherent to the capsule of lens; the cornea becomes hazy, infiltrated with pus, ulcerates and bursts, sometimes the sclerotic bursts; there is no conjunctival discharge, and the chemosis is dry and devoid of moisture. The disease is very rapid and violent in its progress, vision is early and totally destroyed, and eventually the globe is destroyed by the suppuration and collapses. Suppuration of the eyeball may occur with much less severe symptoms, and the pain, œdema of lids and the chemosis may be very mild.

The causes of panophthalmitis are chiefly injuries; penetrating foreign bodies, the presence of a cysticercus, injuries of the cornea may also produce it; even a dislocated lens will give rise to it; it is unfortunately not of very uncommon occurrence after operations on the eye such as extraction, I have seen it a couple of times after abscision of a staphyloma; it also occurs by metastasis, and I have seen it in puerperal fever co-existing with purulent depots elsewhere in the body; it occurs also after epidemic cerebro-spinal meningitis, scarlatina, measles and typhus fever. The youngest individual in whom I have seen this disease was a twin child aged three months; the right cornea was yellowish-grey, softened and infiltrated with pus or lymph and had burst when I first saw the infant, the anterior chamber was evidently filled with the same kind of effusion. The left cornea was dull and hazy, about one quarter of the anterior chamber was filled with lymph or pus which presented a vertical margin from above downwards and a convex margin at the corneo-iritic junction; this peculiar figure was owing no doubt to the position of the child's head previously; the effusion increased, the cornea became duller, finally ulcerated at the lower part and burst. There was zonular vascularity, palpebral conjunctivitis, considerable muco-purulent discharge, and some swelling of the lids. The child was puny and delicate, but beyond this no cause could be assigned for this terrible disease. The second infant presented also conjunctivitis, and the cornea of one eye became slightly hazy, the color of the iris dulled, and the anterior chamber somewhat

diminished. This passed off and the eye became quite normal under treatment, with the exception of a very trivial circular deposit of pigment which was seen by ophthalmoscopic examination on the capsule of the lens after dilitation of the pupil.

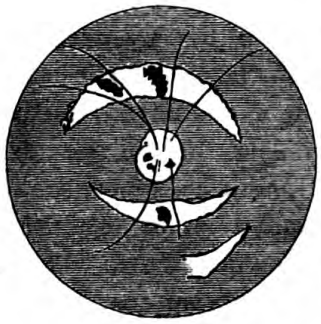
The transparent media become opaque very quickly and the ophthalmoscope lends us no assistance in this malady.

The suppuration probably commences on the walls of the vessels of the choroidal stroma; Schweigger has found pus cells and active proliferation in the cellular tissue along these vessels; the pus increasing in quantity enters the retina, destroys it and pours into the vitreous humor, already probably liquified or engaged in active cell formation; the chorio-capillaris may probably also give rise in the first instance to the suppurative process; the only structure which does not appear to become altered or destroyed during the process is the capsule of the lens, neither it nor its epithelial cells seem to undergo any pathological alteration. For a full account of the pathology of panophthalmitis I must refer my readers to Mr. Power's excellent work, *Illustrations of some of the Principal Diseases of the Eye*, quoted in the *Dublin Quarterly Journal* for February of this year. Pus globules may possibly be taken up by the circulation and pyæmia result from suppurative choroiditis, meningitis with fatal termination is also said by Stellwag to have exceptionally resulted from this malady.

Choroiditis serosa is characterized by increased intra-ocular pressure, hardness of the globe, diminution of the anterior chamber, diseased conditions of the iris, dilated pupil, &c.; it includes all those affections termed generallically *glaucomatic*, and will be found fully described in the lecture on Glaucoma.

Rupture of the choroid takes place occasionally in consequence of blows and injuries, and, as a rule from side to side, and is seen as a white cicatrix. The man from whom the accompanying sketch was taken received a blow some months previous to my seeing him; that the retina is still present at the places of lesion is known by the presence of its vessels over the white cicatrices; some patches of pigment are also present. In this instance there was probably rupture of the choroid and hæmorrhage followed by atrophy; the choroid may be lacerated and torn by penetrating wounds; I have seen such after

Fig. 27.



gun-shot injuries; the retina may at the same time be ruptured or lacerated or remain uninjured.

Apoplexy.—Hæmorrhage occurs from the choroidal vessels and the blood is effused either between the choroid and the sclerotic, in the choroid itself, into the retina or into the vitreous humor; if the epithelium pigment be present and abundant, and the apoplexy occur in or behind the choroid it will not be possible to see it; the blood frequently bursts through the elastic lamina and epithelium and is seen as irregular roundish effusions of a red color, beneath the retina. It is often impossible however to decide whether the apoplexy be choroidal or retinal; sanguineous effusions in retinitis are striated, following the radiated expansion of the nerve fibres, and may be easily distinguished as retinal, but where apoplexy occurs in large masses and there is no retinitis it is impossible to determine its exact origin unless when seen to occur in the course of a retinal vessel.

These hæmorrhages result from direct violence and from diseased conditions of the circulation; they also occur during glaucoma and occasionally after iridectomy performed for the relief of glaucoma.

As in the case of retinal apoplexy choroidal hæmorrhages may become absorbed, they frequently terminate in atrophy and fatty degeneration of the part affected which appears then as a white spot with pigmented borders. The retina is occasionally detached and the vitreous becomes fluid, or this latter may contain blood.

Tumors, both benign and malignant, have their origin frequently in the choroid; they cause detachment of the retina generally, and also give rise to opacity of the media so that an ophthalmoscopic inspection is often impossible. A quantity of serous fluid is poured out between the retina and the tumor, masking the latter and giving the impression of simple detachment; the wavy motion of the retina is however absent; occasionally we are able to see the tumor beneath the retina and observe it traversed by large vessels. When numerous large vessels are seen ramifying on a tumor, or suddenly disappearing intoit and differing from the arborescent retinal vessels the probability is that the tumor is of a malignant nature. I have on one or two occasions seen a nodulated tumor springing from the anterior portion of the choroid and projecting into the vitreous humor close up to the posterior surface of the lens, and could distinctly perceive by oblique illumination the grey retina stretched over the yellowish irregular surface of the tumor, but could not satisfy myself as to its nature; in one of these cases the

optic disc and greater part of the fundus were but little altered from health and vision was good, except at that part of the field corresponding to the tumor.

Amongst the benign tumors of the choroid may be mentioned the neoplasm resulting from parenchymatous choroiditis, scrofulous deposits and the so-called colloid degeneration. True *miliary tubercle* has been found on dissection scattered through the choroid in the shape of small nodules, projecting from its inner surface; when this has been the case extensive tubercular deposits have been found in almost all the other organs of the body. This deposit of tubercle in the choroid occurs primarily and is quite distinct from and independent of scrofulous degeneration of the products of choroiditis. *Colloid disease* is situated in or on the elastic lamina under the hexagonal cells; in it small globular bodies, transparent and highly refracting are visible by the microscope; these bodies are sometimes coated with calcareous matter which effervesces on the application of acid, but the bodies themselves remain unacted upon by any reagents, and appear to be a material sui generis; the same material is found sometimes in the thyroid cavity. The disease is found in elderly people, but is I believe not ophthalmoscopically recognizable. Mr. Hulke has given a good description of this condition in the early parts of the *Ophthalmic Hospital Reports.* The cysticercus may also arise in the choroid and present the appearance of a tumor.

Cancerous tumors of the globe take their origin frequently in the choroid; they arise often from the outer side of the choroid or from its outer layers, so that it is impossible to see them. The most common form is melanosis which differs from medullary cancer, only by its containing between its cells black or brown pigment. Cancer of the eyeball arises and increases generally with very violent inflammatory symptoms; there is great and continuous pain, febrile disturbances, chemosis of the conjunctiva, œdema of the lids, the media become opaque, the pupil dilates, the iris and lens are pushed up against the cornea, this latter or the sclerotic bursts and allows the cancerous fungus exit, and bleeding occurs frequently from the surface of the tumor; black spots are sometimes seen in the sclerotic. I have seen melanosis of the choroid arise however on several occasions with but exceedingly slight inflammation of the globe, and have examined some cases where it took its origin from the vicinity of the ciliary processes and had perforated the sclerotic without any marked change in the fundus; in one instance I remember the

fundus was quite normal. This disease is very apt to occur in old diseased eyes; in one case in which I assisted Sir William Wilde to remove the globe the melanosis had appeared in an atrophic globe over which an artificial eye had been worn. Melanosis is very liable to return in other parts of the body, and often makes its appearance in the shape of black or purple tumors in the skin; in one patient whose eye had been removed in St. Mark's Ophthalmic Hospital I counted two years subsequently ten such tumors on various parts of the body, about the size of small oranges, some fully two inches above the surface, they were extremely painful and itching, one in the leg bled occasionally. Melanosis is also likely to recur in the internal organs. Mr. Maurice Collis has written some valuable papers on this subject in the *Dublin Hospital Gazette* for 1858, and in the *Dublin Quarterly Journal* for 1863.

The choroid undergoes sometimes pathological alterations during *Bright's Disease*, the coats of the vessels become sclerosed, causing diminution, or even occlusion of the vessel, the tubes of the vessels are found sometimes closed by plugs consisting in part of colorless blood corpuscles, and in part of the epithelium of the walls of the vessel; other fatty degenerations are found throughout the membrane, as well as in the retina.

Sympathetic or *Reflex Ophthalmia.*—Strictly speaking, this subject should be considered under the heading of *iritis* and does not come within the scope of these lectures which I had intended to limit to the conditions of the parts lying behind the crystalline lens; the disease is however of such great practical importance that I cannot refrain from alluding to it. Sympathetic inflammation of one eye results nearly invariably from injuries which have produced disorganization of the other eye; it may however result from other causes such as irido-choroiditis, dislocation of the lens; reclination of the cataract is occasionally followed by this form of disease; that operation cannot be too strongly condemned, and is now I am happy to say scarcely ever witnessed or heard of in this country; the wearing of an artifical eye over a collapsed globe has been known to cause it: it may ensue on any inflammation of the uveal tract to which is superadded cyclitis. *Cyclitis* is a disease which was first described by Sir William Wilde in the *Medical Times and Gazette* for 1854, and denominated by him *inflammation of the corpus ciliare;* excellent representations of it will be found in Dalrymple's magnificent and truly artistic plates—*Pathology of the Human Eye*—from drawings furnished by Sir William;

the disease is most insidious, and readily mistaken for certain forms of pustular ophthalmia in which the disease is developed at the sclero-corneal junction; sooner or later, even after years, the second eye is attacked, and if unrecognized, imperfectly treated or not at all, partial opacity of the cornea, closed pupil, opaque capsule of lens, and blindness result. The ætiology of sympathetic ophthalmia is still rather obscure, but in all probability the disease consists primarily of cyclitis, together with choroiditis, and serous or plastic effusion; the disease ensues most frequently on direct injury of the ciliary region; foreign bodies lodged in the globe may not only cause its destruction, but may, and do frequently cause loss of vision in the second eye, by sympathy. As to the channel of propagation of the disease from one eye to the other, we can only speculate—nothing certain has been as yet established; some suppose the inflammatory disposition to be carried to the second eye by means of the blood vessels which communicate with each other within the cranium, the ciliary nerves of the injured eye may also convey the irritation through the third and fifth pair of nerves to the central nervous system, from whence reflex irritation may be transmitted by the same nerves on the opposite side to the unaffected eye; the irritation may also be conveyed through the sympathetic system; the optic nerve may also be the channel of conveyance. Mackenzie, who was probably the first to draw particular attention to sympathetic inflammation, and in whose great work a very admirable treatise on the subject may be found, considers it highly probable that the retina of the diseased eye is in a state of inflammation, that this inflammation is propagated along the optic nerve as far as the chiasma, and that the inflammatory irritation is conveyed from thence to the retina of the second eye, by means of its optic nerve; sympathetic inflammation commences, he says, in the retina, and gradually invades the other structures. In this latter view, however, I cannot coincide, notwithstanding my great reluctance to differ from so great and universally recognized an authority. I believe on the contrary that the retina is *generally* only secondarily affected, and that the parts primarily affected are the anterior choroid including the ciliary body and the iris. I do not remember ever seeing neuritis or neuro-retinitis in this disease; but on the contrary have seen the nerve and retina wherever the media were transparent, free from independent disease. Mooren, in his practical work, *Ophthalmiatrische Beobachtungen*, records a curious case to show that the optic nerve itself may give rise to sympathetic inflammation; he

alludes to a laceration of the cornea and sclerotic and complete smashing of the eye, the wound being still fresh when he saw the patient; two days after the injury he removed the globe, and in cutting across the optic nerve the blades of the scissors being probably badly adjusted got locked, and caused some squeezing of the nerve trunk. The man made a good recovery, but returned after some weeks complaining of amblyopia, pain, and intolerance of light in the remaining eye; and eventually, notwithstanding every possible treatment his vision became very much impaired, and finally the optic disc was seen to pale and become somewhat atrophied. The disease was, the author remarks, not attributable to the original injury for which the globe was excised two days afterwards, but to the injury of the optic nerve during the operation.

The period of the invasion of the disease in the second eye varies considerably, from a few days to a few years, the usual time appears to be about six weeks after the injury. Old diseased eyes, previously quiescent, may suddenly take on inflammatory action, idiopathically, or from injury, and are likely to give rise to sympathetic inflammation; the knowledge of this fact should make us very careful in our advice respecting such eyes, and put us on our guard respecting the second eye. I have seen some very lamentable instances in all ranks of life, where from want of this knowledge, or from neglect, either on the part of the patient or of the medical attendant, the sufferer has become permanently and incurably blind. The disease occurs more frequently in the young than in the middle-aged or old, and runs its destructive course much more rapidly in the former than in the latter.

The symptoms of sympathetic inflammation are, loss of vision, at first very slight, but gradually increasing, photophobia and lachrymation; the impairment of the power of accommodation seems to be one of the first symptoms, the patient cannot continue to read or employ his sight for any length of time without feelings of fatigue, and often lachrymation, which soon oblige him to desist from whatever occupation he is engaged at; intolerance of light supervenes, a nebulous veil appears before the eye, vision gradually diminishes, so that small objects can no longer be perceived, and eventually vision may be altogether extinguished. Pain is usually very violent in the originally diseased eye, and all around the eye-brow and temple; the sympathetically inflamed eye is generally not affected with pain at all in the beginning of the disease; at a later period, however, pain is generally experienced on the slightest

pressure over the ciliary region, and when this symptom exists together with any disturbance of vision or impairment of accommodation the existence of the disease is undoubted. Amongst the objective symptoms there is frequently pink zonular vascularity, augmented on exposure of the eye to strong light or on using the eye, turbidity of the aqueous humor, sometimes punctated opacities on the back of the cornea, irregularity and contraction of the pupil, evidences of slow chronic iritis, with adhesion of the pupil and opacity of the capsule of the lens, and occasionally increased tension of the eyeball; later on greenish discoloration of the iris, indentation of the globe at the lower rectus muscle, softening and collapse of the globe ensue. If the media be clear, and we have an opportunity of examining the eye with the ophthalmoscope, we obtain generally but negative evidence, and the fundus may be quite normal, occasionally the retina is hazy from serous infiltration from the choroid.

The termination of this disease is almost invariably fatal to vision, unless the malady be early recognized, and promptly and energetically treated; it may be taken, as a rule, that the only hope of saving the second eye lies in the removal of the primarily diseased and offending eyeball, as counselled by Mr. Prichard, of Bristol, in the *Association Medical Journal* for 1854, and now almost universally practised. Even this procedure, however, although successful in the majority of cases, fails occasionally in arresting the disease.

LECTURE XII.

ON

GLAUCOMA.

THE ancients used the term glaucoma almost indifferently to denote any opacity in or behind the pupil, and up to comparatively recent years the designation was commonly and erroneously applied to cataract. Brisseau demonstrated in 1705 that the seat of cataract was in the crystalline lens, and then commenced discussions and controversies respecting the name, nature and treatment of glaucoma which have continued down to the present day. O'Halloran,[a] a celebrated man of letters, surgeon and founder of the Limerick Infirmary and one of the first to extract cataract, says in his treatise *On the Glaucoma or Cataract* published in 1750, but probably written a couple of years previously, "the glaucoma [is] not a different disease [from cataract] but a different name to express the disorder by." Mackenzie gives a learned history of glaucoma and hypochyma in his *Practical Treatise on the Diseases of the Eye* tracing these names from Hippocrates downwards; the best chronological account with which I am acquainted is that given by v. Jaeger in the July and August numbers of the *Zeitschrift der k. k. Gesellschaft der Aerzte zu Wien* for 1858; in it the author briefly alludes to the various writings on the subject, from Rufus of Ephesus in the first century down to v. Graefe's publications in 1858. It would appear from the various authorities that glaucoma was supposed to be a disease of the lens until

[a] See Sir Wm. Wilde's masterly memoir of him and his times in the *Dublin Quarterly Journal* for 1848, in which much information is contained on the medical and general history of Ireland.

Brisseau, Maitre-Jean and Heister showed that the lens was the seat of cataract; then glaucoma was universally held to be a disease of the vitreous humor until 1807, when Autenrieth of Tübingen rejected this doctrine and demonstrated it to be a choroidal disease; and in this view the majority of modern observers coincide. With the invention of the ophthalmoscope the inquiries respecting glaucoma received a fresh impulse, and many discoveries have been made of late years, chief amongst which are excavation of the nerve and the arterial pulsation. Jaeger, who was the first to direct special attention to the nerve, considered it to be convex and button-shaped, projecting into the vitreous; to a person unacquainted with the appearances and nature of the malady, the optic nerve entrance does undoubtedly at first sight convey this idea; in 1855 Weber demonstrated that the apparent convexity was in reality an excavation; v. Graefe, whose name must ever remain associated with glaucoma, first observed the arterial pulsation and gave a true explanation of this phenomenon.

The term glaucoma is now employed to express a series of symptoms and of pathological and physiological conditions in the eye, the real cause and mode of origin of which are even still somewhat obscure, but which may probably all be referred to an inflammation or alteration of the choroid with serous effusion and increase of the liquid contents of the globe. The appearances and symptoms of glaucoma vary according to the stage and the form of the malady; it is therefore difficult to give a brief definition which would include all varieties and convey a true idea of the affection. Taking its most constant and prominent features, it may perhaps be approximately defined as a choroiditis serosa together with augmented intra-ocular tension, inervation of the iris, glaucous turbidity of the transparent media, excavation of the optic papilla, and more or less loss of vision; but even this definition will not suit each and every case and will be found perhaps too ample in some instances or defective in others; I regard every eye in which the optic papilla is pathologically excavated and cupped as glaucomatic.

The most frequent and the usual symptoms in fully established glaucoma are: pain in and around the eye, injection and tortuosity of the subconjunctival veins, hardness of the eyeball, anæsthesia and loss of polish of the cornea, diminution of the anterior chamber and turbidity of the aqueous humor, slaty discoloration of the iris, dilatation, sluggishness or immobility of the pupil, glaucous reflection from the pupil, spontaneous pulsation of the central

artery of the retina, excavation of the optic papilla and loss of vision. Let us now consider these symptoms in detail.

Pain.—This is often intermittent and of a neural character, at first confined to the eyeball but subsequently attacking the forehead, temple and entire side of the head; in some forms of the disease the pain is very intense and excruciating and causes loss of rest and sleep, incapacitating the patient from any physical or mental exertion; it is due probably to pressure on and irritation of the ciliary nerves and reflex irritation; in some forms of glaucoma there is a total absence of all pain.

Subconjunctival vascularity.—The external veins are gorged and almost varicose, very dark coloured and prominent, owing very likely to mechanical obstruction of the deep-seated return circulation. The whole sclerotic assumes a dirty yellowish-white tinge.

Hardness of the globe is one of the earliest effects of the glaucomatic process and is attributable to an increase in volume of the fluid contents of the eye, it often precedes for a long time an actual outburst of inflammation and is a symptom of the highest importance in the recognition of the malady. Mr. Bowman has adopted symbols for briefly denoting the tension or degree of hardness or softness of the globe, and his method is now largely adopted. The tension is expressed by T, its augmentation by + (*plus*) its diminution by − (*minus*) and according to the numeral attached will be the degree of hardness or of softness; thus for example a glaucomatic eye of stony hardness is expressed by T + 3, a soft globe commencing to collapse by T — 3. Mr. Bowman recognizes four degrees of each variety of tension the fourth being doubtful (?), the normal tension is expressed by T. n. More recently the increased intra-ocular tension is simply denoted by T without the +; thus T 1? signifies that there is a suspicion of increased intra-ocular pressure, but that the hardness of the globe is so slight as to be doubtful. To ascertain the tension, the eyelids should be gently closed, the examiner then places the points of his two index fingers over the globe about $\frac{1}{4}$ inch apart and makes alternate pressure with each finger as if feeling for fluctuation and institutes a comparative examination of the second eye, or if that eye be diseased and the examiner is in doubt, of some healthy eye; the softness of the globe may become very manifest by pressing on the upturned globe at the position of the inferior rectus.

Anæsthesia of the Cornea.—The cornea becomes sometimes so

insensitive that it may be freely touched with the finger; it also becomes dulled and loses its polish—owing in a great measure to alteration in its epithelium. It is not uncommon in chronic glaucoma to find the epithelial layer of the cornea lifted into little blisters, this condition is accompanied by pain which quickly subsides on opening the little vesicles. The membrane of Descemet on the back of the cornea is also occasionally slightly opaque. These conditions are attributable to paralysis of the nerves supplying the cornea.

The *anterior chamber* is diminished in size by the pressure within the vitreous chamber pushing forward the lens and iris; the aqueous humor is rendered muddy by serous or even sanguineous effusions.

The *iris* becomes discolored from interrupted nutrition and obscure mollecular changes of its pigment as well as from degeneration of its tissue. The pupil becomes dilated owing to paralysis of the ciliary nerves from pressure; in some forms of glaucoma however neither the iris nor pupil exhibit much alteration from health.

The *glaucous* or *sea-green reflection*, from which the disease derives its name, is not necessarily a constant symptom, it is however nearly invariably present in chronic glaucoma; it is owing to a diffused discoloration of the vitreous humor and of the lens. The crystalline lens assumes a greenish-amber opacity and in old and long standing cases becomes completely opaque; although the lens appears quite opaque it really is frequently not so, and it is sometimes astonishing to find it so translucent as to allow of the fundus being seen by ophthalmoscopic illumination; this is owing in part to the natural reflection peculiar to the lens in advanced life and in part to the dilated pupil; such lenses when removed from the eye lose their greenish color and are of an amber or reddish-brown color, and to a great extent transparent. Mackenzie, who was the first to point this out, believes the discoloration to be due to the absorption of the extreme prismatic rays and the reflection of the middle ones by the lens, and in confirmation of his assertion that the greenish color is caused by the lens remarks that if the lens be removed from the pupil the glaucous appearance vanishes; he adds that various substances assume a different color, according as they are viewed by reflection or refraction; thus if the infusion of lignum nephriticum be held between the light and the eye it appears of a golden color, while it appears of a blue color if held otherwise so that the light falls on it; purpurate of ammonia appears of a deep red by one method of viewing it and of a brilliant green by another;

he explains the glaucous appearance to be owing to similar causes; it is at all events certain that many of these glaucomatic lenses which appear by ordinary incident light opaque are nevertheless sufficiently transparent to allow the fundus being seen by transmitted light. The vitreous humor is frequently so clouded and opaque in glaucoma as to conceal the fundus.

The *arterial pulsation* is produced by the pressure within the globe being as great, or greater than the force communicated by the heart's action to the column of blood entering the globe; hence the entrance of the blood into the retina is impeded, retarded or even altogether arrested; by this opposing and resisting force complete stoppage of the retinal circulation takes place probably in acute glaucoma, and the retina being deprived of its vascular supply as well as being pressed upon is paralysed and blindness ensues. This arterial pulsation must not be confounded with the venous pulsation alluded to at page 49, it occurs in the arteries and is synchronous with the radial pulse; in the early and very mild stages of glaucoma it is easily produced by even slight digital pressure on the globe; it is a very important symptom, indicative of increased intra-ocular tension and characteristic of glaucoma.

Excavation or *cupping* of the optic papilla is altogether the result of undue pressure within the globe. This symptom being of all others the most eminently characteristic one of glaucoma we should study it carefully and make ourselves thoroughly familiar with it. The optic papilla instead of being slightly prominent or in a level with the retina, is represented by a cup-like depression, from which its nervous elements have disappeared. Figs. 4, 5 and 6 on Plate II. are examples of glaucomatic optic nerve entrances, Fig. 5 being highly magnified. A very common appearance is that of a white or yellowish-white ring encircling the disc; it always surrounds the disc completely, is almost invariably of the same width all round and the retinal vessels run undisturbed across it up to the margin of the disc; the adjoining choroid is generally quite healthy. These circumstances will serve to distinguish it from staphyloma posticum; its nature is however similar to the latter, it is caused by a complete atrophy of the choroid at the choroidal ring around the nerve entrance, the white color being that of the denuded sclerotic; this ring and the disc together may be mistaken for the optic papilla, but the uninterrupted course of the retinal vessels and their sudden disappearance at a slightly shaded circle, which latter represents the margin of the disc, will show its nature. As I have already stated

the lamina cribrosa is formed in part by prolongations from the choroid and when the cribriform layer is pushed backwards, as it is in glaucoma, the prolonged choroidal layer must be put upon the stretch in consequence of which the adjoining choroid all around the nerve becomes atrophied.

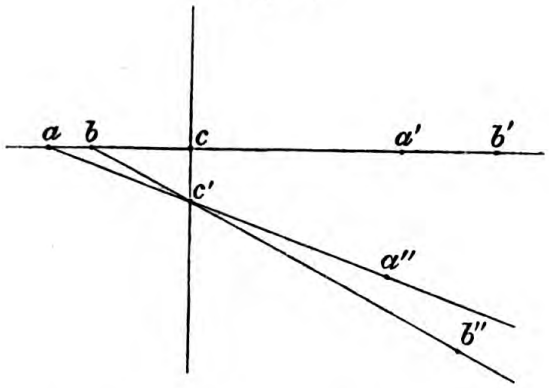
The boundaries of the glaucomatic excavation are the choroidal margin, the sclerotic opening, and its bottom or floor is formed by the lamina cribrosa; this latter is seen as a glistening white surface with a number of bluish spots which represent the openings for the transmission of the denuded optic nerve fibres; this appearance is represented in Fig. 5, Plate II.

The excavation is recognized in the reversed monocular ophthalmoscopic image by means of the vessels. As shown in the three drawings on Plate II. the vessels have a normal course up to the margin of the disc, here they seem to take a different direction, either appear to bend round and run along the margin of the disc, or they disappear altogether and are again faintly visible and having a different direction to the one they possessed in the retina, or again they may seem to end at the margin in a hook-like termination and disappear altogether. The reason of these phenomena is that the vessels have to bend over a more or less sharp corner formed by the projecting margin of the excavated disc and to run down on the sloping or even concave sides of the cup, to gain the bottom along which they run to the central canal; the bottom lies in a plane behind that of the retina, its focus is therefore different from that of the retina and consequently the parts lying in it are indistinctly visible when we have focussed for the general fundus. Supposing the papilla to be greatly excavated and its sides concave as is the case in Fig. 29, it will be readily understood how impossible it would be to view with the ophthalmoscope the vessels on these concave walls; the axial lines in which the optic image is formed must always pass through the pupillary space of the examined eye; and we are therefore unable to view the parts from different sides. In some instances the walls of the excavation slope gradually downwards funnel-like and we are then able to trace the vessels downwards on the side directed to the yellow spot, but as we are looking perpendicularly down on the vessel it appears very short.

The excavation is plainly seen as a cup-like depression by means of the binocular ophthalmoscope. When examining the reversed image with the ordinary monocular ophthalmoscope the depression or difference of level may be readily demonstrated by a very simple

manœuvre; this consists in making slight lateral movements of the object lens without altering its focal distance or our visual line; the margin of the excavation in the plane of the retina and the vessels thereon will then appear to move across the bottom of the excavation. The accompanying diagram copied from Schweigger's *Vorlesungen über den Gebrauch des Augenspiegels* will serve to explain this phenomenon. Let *a* and *b* in Fig. 28 be points lying in the

Fig. 28.



visual line of the observer; *c* the centre of a convex lens, then *a' b'* will represent the reversed images of these points. If now without altering the observer's visual line the convex lens be moved laterally so that its centre shall be at *c'* then the image of the point *a* will be found in the line *a c'* at *a''* and that of *b* in the prolongation of the line *b c'* at *b''*. It will be seen that the image of *b* has moved farther away from the observer's visual line than that of *a ;* in other words the image of the nearer lying point *b* has undergone a greater distantial displacement than that of the point *a* lying further back. This is what actually occurs in glaucomatic excavation; *a* represents a point in the bottom of the cup, *b* a vessel just in front of it at the margin of the cup, if the object lens be moved laterally the bend of the vessel will appear to move and undergo a greater displacement than the point in the lamina cribrosa; this latter may even appear not to be displaced at all. By means of this parallactic displacement the existence of the cup may be demonstrated and its depth estimated. This experiment will of course also assist us to recognize any other difference of level which may exist elsewhere in the fundus, such as choroidal exudations or a swollen optic nerve, the vessels on the prominent parts moving to and fro across the parts lying in a lower plane according as the object lens is moved laterally

The color of the excavation is generally white, often glistening white, it may be a dirty or yellowish white or greenish; the overhanging borders often cause shadows.

Excavation being pathognomonic of glaucoma it is very important that we should not confound it either with physiological or atrophic excavation; the physiological excavation never occupies the entire nerve surface, is usually confined to one side or to the centre, there is always a circle of healthy nervous structure at the periphery in the same plane as the retina, and there is no arterial pulsation, whereas in glaucomatic excavation the entire nerve surface is engaged; in atrophy the excavation, if it does exist, is very shallow and there is neither pulsation nor apparent interruption of the vessels and no appreciable parallactic displacement.

Excavation of the optic nerve is as I have already remarked produced by the intra-ocular pressure; in the aged the sclerotic becomes firm, dense and unyielding, and the opening for the optic nerve, closed in by the lamina cribrosa, is the weakest spot in the case of the globe, hence when undue pressure arises within the eyeball it exerts its greatest force on this the least resisting part and the lamina cribrosa yields outwards; the nervous elements become atrophied, or disappear, and the excavation is occupied by vitreous humor and the cellular tissue-like remains of the papilla. In young persons the sclerotic is yielding and if undue tension does occur the sclerotic yields and staphyloma posticum results.

The *loss of vision* is easily accounted for by the loss of the vascular supply of the retina and by the compression of the retina throughout, put particularly at the papilla; at the margin of the excavation the nerve-fibre layer is reduced to a minimum (Fig. 29), a mechanical interruption occurs of the communication between the eye and the brain and atrophy of the ganglion cells of the retina and of the nerve fibres ensues.

Glaucoma is divided into—1, acute, 2, chronic, 3, simple, 4, consecutive glaucoma. This natural classification holds good in the large majority of cases met with in practice, but now and then one variety merges into the other insensibly or two co-exist, so that it is impossible to place the affection presented to our notice under either of the three first headings.

Acute glaucoma; arthritic ophthalmia; arises suddenly with or without any premonitory symptoms, in a previously apparently healthy eye or in a previously diseased eye; it frequently supervenes upon chronic glaucoma, even without any assignable cause.

Acute glaucoma commences very frequently at night, analagous in this respect to the attack of acute myringitis described by Sir Wm. Wilde; the patient wakes up with pain in and around the eye, sometimes of a very excruciating character, he is tormented with this pain and with flashes of light, scintillations and luminous sensations and in the morning he finds his vision either very much impaired or possibly even altogether lost; vision may be obliterated in the course of even a few hours. When we come to examine an eye affected with acute glaucoma the disease has generally lasted a couple of days and its symptoms are well marked, but even the morning after the attack the disease is quite unmistakable; there is lachrymation, slight chemosis, pink zonular vascularity, injection of the large ciliary veins, dulness, loss of polish and insensibility of the cornea, opacity of the membrane of Descemet, muddiness of the aqueous humor, discolorization and convexity forwards of the iris, diminution of the anterior chamber, oval dilatation and greenish color of the pupil and hardness of the globe. The vitreous humor is generally occupied by a diffused opacity which together with the muddiness of the aqueous humor prevent a satisfactory ophthalmoscopic examination. The entire vitreous may be opaque or only a portion of it; I have seen a large cloud-like opacity conceal the greater part of the fundus, and present a sharply-defined margin, outside which the vitreous was quite clear and transparent, and allowed of a portion of the fundus being distinctly seen. When the fundus is visible it is seen dotted over with circular effusions of blood and other pigmented extravasations, the retina is hazy from serous infiltration and the brilliant reflection from the fundus is damped; the optic papilla is also hazy and indistinct, sometimes of a yellowish hue, occasionally though rarely at this early period it is found to be cupped; the central veins are large, gorged and prominent, the arteries small and pulsating either spontaneously or on slight pressure. The following brief notes from my case book refer to acute glaucoma of the right eye: Man aged 65 had been in his usual health up to the occurrence of the attack, he had spent the greater part of the day previous in reading, had worn spectacles for a great number of years. Late in the evening " a mist" came over his sight and he went to bed and fell asleep, but woke up not long after with pain in the eye and temple, and some faint luminous sensations. In the morning there was slight conjunctival and sclerotic vascularity, the cornea was hazy but sensitive, the anterior chamber normal, pupil greenish

and muddy, lens glaucous, veins of retina gorged and tortuous, entrance cupped, globe hard. Cannot read any type nor see his way about, but just discerns indistinctly large objects. The left eye had been completely collapsed for the last twenty years. Next day the conjunctiva was much more vascular and red, the other appearances being nearly the same; he had passed a very restless and sleepless night, suffering considerable pain and mental anxiety. Iridectomy was performed, and the pain ceased, the vascularity subsided and vision returned the day following the operation, the cornea and media became quite clear and he could tell what o'clock it was on my watch.

Acute glaucoma is sometimes accompanied by severe febrile disturbances, gastric derangement and even vomiting so that the malady may simulate gastric, cerebral or cranial diseases; vision may be extinguished and remain obliterated and the disease gradually assume the chronic form; or the attack may terminate after some days or weeks duration. In exceptional instances acute glaucoma becomes, idiopathically or in consequence of injury, an almost veritable panopathalmitis; the cornea ulcerates and bursts allowing the humors and even the lens exit; when this does occur the pain and sufferings are at once relieved and the globe probably collapses.

The attack of acute glaucoma may subside, the eye regain apparently perfect health and vision may be completely restored. After a few days or weeks interval however a second similar attack supervenes and is again possibly followed by recovery—but with partially impaired vision; and in this manner several relapses of and recoveries from the disease may occur, each succeeding recurrence of the disease leaving behind it a more narrowed field and a more impaired acuity of vision than its predecessor, until finally vision is completely extinguished and the disease becomes chronic. The pain may continue, though less intense and remain permanent or intermittent and periodic; the globe remains hard, the cornea dull, its epithelium raised up or even peeling off, the iris discolored and advanced forwards, its pupillary margin occasionally adherent to the capsule of the lens, or largely dilated.

Although not anatomically demonstrable there can be but little doubt that acute glaucoma depends essentially upon an inflammation of the choroid and iris with a more or less abundant secretion of serous fluid; this is manifested by the muddiness and opacities in the aqueous humor, by the condition of the iris, the diffused opacities in the vitreous humor, the hardness of the globe, turgescence of

the veins of the fundus, and the sanguineous effusion. The opacities of the media disappear, and the inflammatory symptoms subside as the internal pressure diminishes. The acuteness and intensity of the attack will depend upon the rapidity and abundance of the effused fluid and the resistance of the coats of the eyeball.

Acute glaucoma is preceded generally by premonitory symptoms; these *prodromal signs*, as they are styled, occur according to v. Graefe in about 70 per cent.; they consist of presbyopia or even hypermetropia, colored spectra, partial and occasional obscurations of visions and pain. These symptoms may appear for a year or more, prior to the attack. The *presbyopia* is due probably to functional impairment of the ciliary muscle from pressure; it is one of the earliest symptoms, and wherever we find a person obliged to change his glasses frequently and increase their power we should be suspicious of the existence of glaucoma. The *hypermetropia* is produced by the shortening of the antero-posterior diameter of the globe in consequence of the internal pressure rendering the eyeball more spherical. *Colored rings* are often seen round a flame similar to what occurs in chronic catarrhal ophthalmia, and is due to slight disturbances in the transparent media. *Temporary obscurations* occur after meals, violent exercise, mental excitement or any cause which may produce determination of blood to the head; objects appear clouded and indistinct for a few moments, minutes or even hours; this is due probably to temporary increased intra-ocular pressure. *Periodic pain* in and around the eyeball is due to irritation of the ciliary nerves.

Chronic or *Subacute Glaucoma* is almost identical with acute glaucoma excepting in the suddenness and intensity of the attack; it occurs slowly and gradually, may result from acute glaucoma or may arise as an independent disease. The prodroma are rarely absent, the temporary and paroxysmal obscurations being almost invariably present; the subconjunctival veins gradually enlarge, become gorged, tortuous and appear as dark cord-like projecting vessels, the sclerotic assumes a dirty greyish hue, the globe hardens, the cornea becomes dull, insensible and rough like muffed glass, the aqueous humor muddy and the anterior chamber contains occasionally even sanguineous effusion, the iris is of a slate color, the pupil enlarged, immobile and glaucous, the lens is of a greenish or dirty yellowish-grey color and semi-opaque, the optic nerve is excavated and its arteries pulsating. The field of vision is at first obscured on the internal side, then on its superior and inferior sides

and finally altogether obliterated or reduced to a mere slit. Very frequently the patients cannot really distinguish between light and darkness, although they generally believe they can even see objects. The eyeball acquires a dull unpolished appearance and a manifestly *blind* look and vacant expression which is apparent even to a non-professional person; the patient faces the strongest light without evincing any perception thereof, the eyes roll about in an objectless manner such as is rarely witnessed in health or other diseases, there is "no speculation in those eyes," they do not convey any idea of mind or soul but merely one of material tissue. There may be no suffering and possibly no pain at all; chronic glaucoma is very liable to become acute and give rise to most intense pain and suffering; as a rule there is always more or less uneasiness and trouble caused by the disease, lachrymation, slight conjunctivitis with a feeling of sand in the eye, and very slight neural pain are common symptoms. The retinal veins present sometimes a beaded and gorged appearance.

Simple Glaucoma (Donders), *Amaurosis with excavation of the optic nerve* (v. Graefe). While the two forms just described are essentially inflammatory, simple glaucoma would appear to be a non-inflammatory affection; it arises, progresses and blinds the person without any of the phenomena usually ascribed to inflammation. So little alteration from health does this disease present that it was formerly regarded as possibly an amaurosis due to extra-ocular causes with which excavation of the optic nerve became accidentally associated; it is now however regarded as a true though an exceedingly chronic form of glaucoma. Externally the globe presents often a perfectly normal appearance, occasionally there is a vacant blind look; the cornea is bright and clear and all the media transparent; the iris is generally sluggish in its action, so that when it is artificially dilated it remains enlarged for a considerable time; the globe is frequently but not constantly abnormally hard—so little pain or inconvenience of any kind is experienced indeed that it is often by mere accident that the patient discovers that the eye is blind. On ophthalmoscopic examination the papilla is found deeply excavated and white, and the choroidal epithelium frequently atrophied. The obscuration of the field of vision occurs concentrically as in some forms of amaurosis dependent upon optic nerve atrophy. Simple glaucoma may at any time become acute or subacute.

Consecutive Glaucoma is, as its name denotes, a glaucoma which supervenes upon and arises in consequence of previously existing

diseased conditions of the structures within the eyeball, such as old iritis and choroido-iritis with closed pupil, adhesions of the iris to extensive cicatrices of the cornea, sclerotico-choroiditis posterior, intra-ocular tumors, cataract operations by the needle may also be followed by glaucoma from swelling of the lens and pressure. When the pupil is closed and adherent to the capsule of the lens and all communication between the chambers is cut off there occurs an interruption of equilibrium, the pressure within the vitreous increases, the ciliary and optic nerves are unduly pressed upon and glaucoma results. Pressure excavation together with choroidal atrophy is not of uncommon occurrence in staphyloma posticum with myopia. I have seen acute glaucoma arise in eyes which had long been blind and diseased from injury. A very marked instance of this was under my care recently; a man aged 40 received a blow on the right eye about 18 months ago, but beyond the almost immediate loss of sight he suffered little inconvenience until the end of January of this year, when the eye became slightly inflamed. I advised its removal as the vision of the other eye, which presented old choroidal atrophy and myopia, was becoming impaired. The man hesitated having the operation performed and I did not again see him for a fortnight when he came to me begging to have the eye removed. He was in great agony, suffering torturing pain in the eye but more particularly in the whole right side of the head; there was great lachrymation, the eyeball was considerably injected, the cornea slightly dull, the iris slate-colored lying up against the back of the cornea, the pupil normal in size, adherent to a greenish-yellow cataractous lens which prevented all ingress of light; the globe was abnormally hard and the second eye presented also slightly increased tension; the eye was totally blind, no perception of light even remaining. In deference to the opinion of others I substituted iridectomy for enucleation; the tension was lessened, the pain ceased, and the vision of the left eye became improved.

The *termination* of glaucoma is, as may be inferred from the foregoing, almost invariably a most disastrous one to vision; and not only does the sight become impaired or lost but pain of a more or less intense character and periodic or enduring render the patient's life often miserable and unsuit him for any active engagements. The disease is a most intractable one and but little amenable to the ordinary methods of treating disease; without treatment recovery never takes place and up to recent times and the introduction of iridectomy

glaucoma was an absolutely incurable disease; that operation if performed at a sufficiently early period undoubtedly holds out a hope of a favourable result, either in restoring vision, arresting the inevitable blindness which must otherwise ensue, or in alleviating pain. Both eyes may be simultaneously attacked; where but one eye is originally attacked the second one is almost certain to become affected sooner or later.

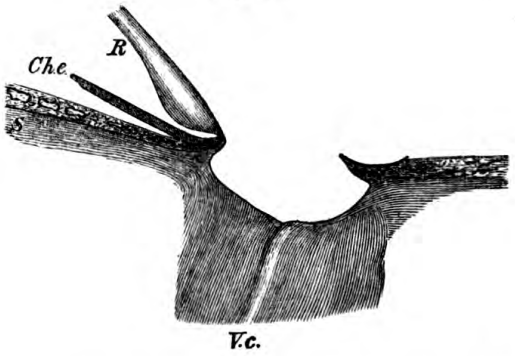
The *causes* and *ætiology* of glaucoma are still somewhat obscure, various hypotheses and theories have been started and most of them refuted; some suppose the disease to be of rheumatic origin, others attribute it to gout. The disease is peculiar to advanced life, it occurs chiefly between the ages of 40 and 70 and most frequently between 50 and 60; it is more frequent in females than in males and coincides not unfrequently in the former with the cessation of the catamania; its occurrence under the age of 30 is exceptional; the youngest person in whom it has been recorded is probably a girl aged nine, mentioned by Mooren; it is said to be hereditary and to be very frequent amongst the Jews, owing to consanguinity. So far as my experience goes it is a comparatively rare disease amongst the purely Irish population in this country; the majority of persons affected with glaucoma that have come under my observation were foreigners (*i.e.* not Irish) or of foreign extraction, or had lived abroad; one of the drawings on Plate II. was taken from a Londoner resident at the time in Ireland on whom I performed iridectomy, another was taken from a person of French name and origin and the third from an Irishman long settled in America who came home to have advice about his failing sight and who returned to America after I had performed iridectomy on him with satisfactory results. Glaucoma arises generally as a primary disease in elderly persons who exhibit a marked tendency towards the disease; this disposition is due according to Stellwag v. Carion to atheromatous degeneration of the vessels at the base of the brain causing disturbances in the vascular supply of the globe through the ophthalmic artery and vein; this degeneration is, he says, rarely absent in glaucoma and it may be found even extending to the vessels of the retina and choroid. Whatever may be the predisposing cause it is now pretty certain that v. Graefe's views are correct and that the immediate cause is an inflammation of the choroid and uveal tract with serous effusion; this inflammation will, when occurring in youthful persons in whom the sclerotic is still yielding, produce staphyloma posticum; in elderly persons in whom

the sclerotic is rigid and firm it will result in glaucoma. While v. Graefe and a host of followers support this doctrine of the inflammatory origin of glaucoma, Donders and some others consider glaucoma to result from neurosis of the secretory nerves of the globe, this neurosis causes a hypersecretion of liquid within the globe which reacts and presses upon the nerves and keeps up the irritation, thus cause and effect alternate and keep up a reciprocal action; the iris is pushed forwards and put upon the stretch by the increased amount of liquid, this traction of the iris reacts on the nerves of secretion so that the effect becomes a cause and the cause an effect; this circle of action and reaction explains the incurability of the disease. Donders bases this view in part on the circumstance of the globe becoming soft in paralysis of the fifth nerve; section of this nerve in rabbits is followed by softening of the eyeball, while irritation of the secretory nerves causes increased secretion and augmented tension within the eyeball. Donders regards simple glaucoma as the type of glaucoma, to which inflammation may or may not be added.

Pathological Anatomy.—The vitreous humor is fluid, clear or yellowish, increased in volume, and contains sometimes diffused opacities and neoplasms; the corneal structure is possibly inflamed, the iris atrophied, the choroid also more or less atrophic; as a rule its epithelium pigment and cells have disappeared; the whole membrane may be found represented by a thin layer of cellular tissue adherent perhaps to the sclerotic; the sclerotic is sometimes staphylomatous and thinned; the retina may be occupied by ecchymoses, some of its vessels ruptured, and its nervous elements more or less atrophied; it may be still unaffected by atrophy in the early stages of the disease, or found to consist simply of cellular tissue in advanced and long-standing disease. The principal and diagnostic peculiarity consists in the cup-like excavation of the optic papilla; the nervous elements of the papilla have disappeared and are replaced by connective tissue; the bottom of the cup is formed by the lamina cribrosa; this latter instead of being situated in the plane of the choroid is pushed backwards and is found sometimes in a plane posterior to the outer surface of the sclerotic; in the removal of a globe recently in St. Mark's Ophthalmic Hospital, for very painful old glaucoma and sympathetic irritation of the other eye, the nerve was divided so close to the globe and the excavation was probably so deep that the lamina cribrosa remained in the orbital side of the divided nerve leaving a circular opening in the globe

where the end of the nerve and the lamina cribrosa should have been. Figure 29 reduced one half from Schweigger's beautiful lithographic plates affords an excellent representation of the excavation. In order to make sections for the microscope as well as for

Fig. 29.



other purposes it is well to harden preparations in Müller's solution which consists of about 1 part of bichromate of potash 2 parts of sulphate of soda and 20 parts of distilled water. The specimen from which Fig. 29 was drawn had been hardened in this solution and then the cellular tissue-like remains of the papilla dissected out of the cup; these remains are transparent during life but become opaque by the hardening process and should therefore be removed in order to see the parts as they present during life. The above section is made in the direction of the horizontal meridian and close to the central vessels *V.c.*; the retina *R* remained adherent to the brim of the excavation on the side of the yellow spot, but became detached elsewhere and is absent on the inside; the choroidal epithelium *Ch.e.* was also separated from the choroid in consequence of the preparation; it will be seen that the retina has dwindled into extreme tenuity at the margin of the excavation from pressure and atrophy and it can be readily comprehended how even mechanically there must have been almost complete interruption of continuity as well as of the conductile function of the nerve fibres at this place; the wall of the depression in this outer side is almost perpendicular and slightly indented, but yet not so concave as that of the opposite side, this concavity is owing to the considerable projection inwards of the choroid beyond the sclerotic boundaries. This is in part due to the normal anatomical configuration of the parts and in part to the intra-ocular pressure; the nerve is found sometimes naturally bellied out at the lamina cribrosa instead of being perfectly cylindrical,

and this normal bulging will of course be increased and exaggerated by the lateral pressure from within. A glance at Fig. 29 will suffice to explain the ophthalmoscopic peculiarities of the vessels, which are necessitated to pass over the sharp margin of the excavation and to descend on its walls. The floor of the excavation may present a funnel-shaped depression instead of being uniformly plane or slightly concave as in the above figure; this is due to a long continued extreme pressure operating on the canal for the transmission of the vessels, dilating and widening it, so that the depression continues backwards beyond the lamina cribrosa; in consequence of this the vessels are pushed to one side and the bottom of the excavation may appear ophthalmoscopically to be altogether devoid of vessels.

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BOUND
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