of the tape is placed against the forehead of the patient, and the frame moved to the nearest point at which the individual wires still look clearly and sharply defined; the distance of this point from the eye is read off from the graduated scale, and put down as the near point (p). The frame is then removed to the greatest distance at which the individual wires still appear sharply defined, and this is noted as the far point (r). The distance between p and r gives the range of accommodation. The wires only appear sharply defined when the eye accommodates itself perfectly for them, directly there is the slightest deviation from this perfect accommodation (the frame being too far from or too near to the eye), the wires seem indistinct, thickened, or as if surrounded by a halo; or coloured double images of them may even appear in the transparent intervals. With the test types, the examination is still easier, the nearest point at which No. 1 (Snellen) can be distinctly and comfortably read is ascertained, and noted as the near point, and then the furthest point (in an emmetropic eye No. 1 of Snellen should be read up to 1′, No. xx up to 20′), is measured and noted.

CHAPTER III.

MYOPIA.

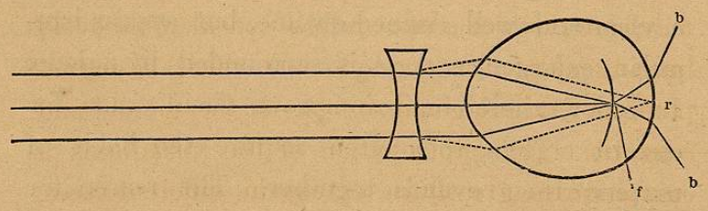
Short-sighted persons generally apply to us with the complaint that, although they are able to distinguish the very finest objects near at hand, they cannot see well at a distance. This depends upon the fact, that the refracting power of the eye is increased in myopia, or that the antero-posterior axis of the eyeball is too long, so that parallel rays (emanating from objects at an infinite distance), or even not sufficiently divergent rays, are brought to a focus before the retina; circles of diffusion are formed upon the latter, and in consequence of this, the distant object does not appear clear and sharply defined, but indistinct and blurred. Such patients notice, for instance, that the stars, the moon, or a gas-lamp in the streets, do not present a clear and well defined outline, but appear irregular, enlarged, and as if surrounded by a halo. In order, therefore, to improve their vision for distant objects, they often acquire the habit of nipping their eyelids together. The reason for

which is two-fold : (1) by this means they narrow the opening between the eyelids, and thus cut off some of the peripheral rays of light, and consequently diminish the circles of diffusion upon the retina, which causes the object to gain in distinctness of outline ; (2) by nipping the eyelids together, a certain amount of pressure is exercised upon the eyeball, the cornea is rendered somewhat flatter, and the far point removed further from the eye, and the latter, therefore, rendered less myopic.

We have already stated that in the short-sighted eye the principal focus of the dioptric system does not lie, as is the case in emmetropia, upon the bacillar layer of the retina, but in front of it. Hence, only such rays as come from a finite distance, and impinge in a sufficiently divergent direction upon the eye, are united upon the retina.

Fig. 16 represents a myopic eye, in which, either on account of its being too long in the

Fig. 16.



antero-posterior axis, or its possessing too high a power of refraction, parallel rays are not brought to a focus upon the retina (*r*), but in front of it (*f*) ; circles of diffusion (*bb*) are, consequently, formed upon the retina, and the object looks blurred and indistinct. In order, therefore, to enable the myopic eye to see distant objects (the rays from which impinge upon it in a parallel direction), we place that concave lens before it which will give the parallel rays such a degree of divergence that they are united upon the retina.

Myopia is frequently congenital, and often hereditary. We may sometimes trace its existence back through several generations, and may meet with it in several members of the same family. It may also show a tendency to increase in degree in each successive generation, but this will depend greatly upon individual circumstances.

The most frequent cause of myopia is an abnormal increase in the length of the eyeball in its antero-posterior axis. This extension chiefly occurs at the posterior portion of the globe, and may here produce a more or less considerable ovoid bulging (posterior staphyloma), which is accompanied by thinning and atrophy of the choroid and sclerotic. This prolongation of the visual axis of course varies greatly in extent in different cases,

and thus gives rise to very varying degrees of short sight. In cases of considerable myopia, we find that this peculiar atrophy of the choroid (posterior staphyloma, sclerotico-choroiditis posterior) is almost always present. Von Graefe lays it down as a general rule, that when the far point lies nearer than 5 inches from the eye (the myopia exceeding $\frac{1}{5}$), we may almost with certainty foretell the presence of sclerotico-choroiditis posterior. But we very frequently meet with it in much slighter degrees of myopia; indeed, I have often seen it in cases where the myopia did not exceed $\frac{1}{12}$ or $\frac{1}{18}$. But even if the eye is but slightly short-sighted, we may often observe a thinning and atrophy of the choroid round the optic nerve entrance, even although there may be no defined crescent. It is of consequence, therefore, that all short-sighted persons should be examined with the ophthalmoscope, in order that the presence and extent of the posterior staphyloma may be carefully and accurately noted, for it is always a more or less serious complication, more particularly if the affection is extensive and progressive. But even if the presence of sclerotico-choroiditis posterior be not suspected, the ophthalmoscopic examination should not be neglected, in order to ascertain whether the condition of the optic nerve and retina be normal

or whether they are hyperæmic and congested; a condition which is frequently met with in short-sighted eyes that are overworked, and which demands careful treatment.

There is no doubt that continued tension of the accommodation for near objects is a very frequent cause of myopia. This is the reason why this affection is so much more frequently met with amongst the higher and literary classes, amongst those who employ their eyes much in reading, writing, sewing, &c., than amongst the lower orders.

The production and increase of myopia by continuous use of the eyes at near objects appears to find its explanation chiefly in the fact that the inner tunics of the eyeball become congested. The near approach of the object necessitates a strong convergence of the optic axes, which causes an accumulation of blood in, and congestion of, the inner tunics of the eyeball, these conditions being increased still more by the stooping position generally indulged in during such employment. We can easily understand that this congestion and this augmentation in the pressure of the ocular fluids must, if long continued, necessarily lead to an extension of the tunics at the posterior pole, and thus give rise to posterior staphyloma.

Again, long-continued working at near objects may probably also produce myopia in the following manner:—Persons thus employed continually accommodate for a very near point, their crystalline lens has, therefore, constantly to assume a more convex form, and after a time it may not be able quite to regain its original form, even when the necessity for adjusting itself for near objects no longer exists. This occurs particularly when the lens possesses but a slight degree of elasticity, for then, after it has been for some length of time accommodated for near objects, it gradually, like a bad watch-spring, loses the power of springing back to its original form; it remains too convex, even when the pressure upon its periphery ceases. In consequence of this, the focal point of the dioptric system becomes shorter, and, when the eye is in a state of rest, lies in front of the retina, and the eye has thus become myopic. This form of acquired myopia is generally, however, only slight in degree.

The seeds of short-sightedness are frequently sown in childhood, either through a premature over-exertion of the eyes at near objects, or through some affection of the refractive media (the cornea or lens). The cornea may, for instance, be clouded, and then the patient often brings the object very close

to the eye, in order to obtain larger and more distinct retinal images, and thus myopia may be soon induced. The same thing may occur when the lens is somewhat opaque; thus it is well known that lamellar cataract frequently becomes complicated with short sight.

There can be no doubt that the degree of myopia is often greatly increased during childhood by long continued study, more especially by insufficient illumination, and a faulty construction of the tables or desks at which the pupils read and write. An insufficient illumination necessitates a close approximation of the object, which gives rise to straining of the accommodation and congestion of the eyes. A faulty construction of the tables, or an inconvenient distance between them and the seats, is also injurious, by forcing the children to stoop. An interesting and valuable monograph has been written by Dr. Cohn* upon this subject. He examined the eyes of 10,060 school children, and could distinctly trace the increase in the proportion of the myopia according to the construction of the desks and the lighting of the school-rooms.

It was formerly supposed that increased convexity of the cornea was the cause of myopia, but

* Dr. Cohn, Untersuchung der Augen von 10,060 Schulkindern. Leipsic, 1867.

this is erroneous, for Donders has found that the cornea is, as a rule, less convex in myopic persons than in the emmetropic. Increase of the curvature of the cornea (as in conical cornea) may, however, give rise to myopia. We sometimes also find that persons suffering from incipient cataract become somewhat myopic, and see better at a distance with concave glasses. The real explanation of this fact is still uncertain, but, it may perhaps be due to a slight swelling (?) of the lens, and a consequent increase in its power of refraction.

The diagnosis of myopia is generally a matter of no difficulty. The far point of distinct vision is more or less approximated to the eye, in consequence of which, distant objects cannot be clearly distinguished, and a suitable concave lens is required to render them distinctly perceptible. We must be upon our guard, however, not at once to pronounce a person short-sighted because he holds small objects (such as small print) very close to the eye, or because he cannot see well at a distance, for we shall hereafter find that this may likewise occur in hypermetropia, in which case, convex and not concave glasses are required to remedy this defect.

Myopia might also be confounded with weak sight (amblyopia), for we find that weak-sighted

persons likewise approximate small objects very closely to the eye, in order to obtain larger and more clearly-defined retinal images; but they are unable to distinguish very small objects, and in this they differ from the short-sighted. Concave glasses, moreover, do not enable them to see further off, indeed they see worse through them, as they diminish the size of the retinal images too much. If a person has to hold small print very near the eye, he may be suffering either from short sight or from amblyopia (I purposely pass over the possibility of the presence of hypermetropia). Now if we have no concave lenses at hand, the following will be found a ready method of distinguishing between weak sight and myopia: if it be a case of amblyopia, and the patient can see No. 2 of Snellen's test-types at 5″, he should be able to see print of double this size at twice this distance, for the size of the retinal images increases in proportion to that of the print, and all that the weak-sighted require are large retinal images. In myopia, however, it is different, for although the short-sighted eye will be able to see large print further off than small, the proportion between the distance and the size of the print is far less.

We find that myopia and amblyopia often coexist. Persons suffering from sclerotico-choroiditis

posterior are generally somewhat amblyopic. Again, I have already pointed out that affections which produce weakness of sight, such as opacities of the cornea and lens, often lead to myopia, by necessitating the close approximation of very small objects. We may easily distinguish simple myopia from myopia complicated with amblyopia, by the fact that the former can be completely corrected by suitable concave glasses. A person suffering from simple, uncomplicated myopia should, with the aid of the proper concave lens, be able to read the same sized print as the normal eye, and at the same distance. Thus, No. XX of Snellen should be read at a distance of 20 feet. If, with the most carefully selected glasses, only No. XXX or No. XL can be read at this distance, the eye is not only myopic, but its acuteness of vision is also impaired, it is amblyopic. The less the concave glasses correct the myopia, the greater is the degree of the co-existing amblyopia, and *vice versâ*.

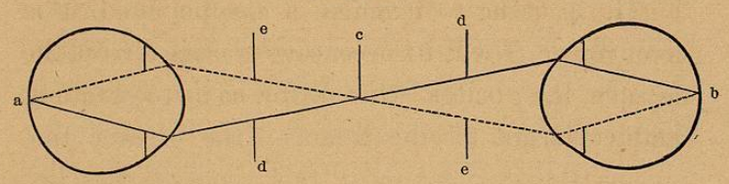
Ophthalmoscopic diagnosis of Myopia.—We may also recognise the existence of myopia, and ascertain its approximative degree by means of the ophthalmoscope, and this will often be found very useful in practice, particularly when the patient's statements are not very trustworthy. We can

diagnose the existence of myopia by the following appearances :—

I. If we examine a highly myopic eye in the erect image (that is, merely with the mirror, without any convex lens before it), we are at once struck by the fact that we can see the details of the fundus at some distance from the eye. If we regard one of the retinal vessels or the optic disc, and move our head slightly to one side, we notice that the image moves *in the contrary direction*; if we move to the right, it moves to the left, and *vice versâ*, so that we obtain a reverse image of the background of the eye.

Fig. 17 will at once explain the reason of this. Let *a* be a very short-sighted eye ($m = \frac{1}{4}$), and *b*,

Fig. 17.



the eye of the observer : *a* being in a state of rest is adjusted for its far point (*c*), which lies 4″ in front of the eye. The rays from the fundus, therefore, pass out of the eye in a strongly convergent direction, and meet at *c*, and, crossing there, fall in a divergent direction upon the eye of the observer.

If the latter be myopic (accommodated for divergent rays when his eye is in a state of rest), they may be united upon his retina (*b*) without the aid of any correcting lens behind the ophthalmoscope. But if his eye is emmetropic he will, if adjusted for his far point, require a suitable convex lens behind the mirror, in order to render the divergent rays parallel. If he, however, accommodates himself for a sufficiently near point, he will be able to unite the divergent rays upon his retina without any correcting lens. The reversed image of the eye represented in Fig. 17 (the myopia of which $= \frac{1}{4}$) will be seen at a distance of about 7″—8″, because as the rays from it cross at *c*, the upper ray, *e*, becomes the lower ray after they have crossed, and the lower ray, *d*, becomes the upper.

II. In order to examine a myopic eye in the erect image, it will be necessary to place a suitable concave lens behind the mirror, so as to obtain a distinct image of the fundus; the greater the myopia the stronger must this concave glass be, and the nearer must the observer approach to the eye. The strength of this correcting concave lens will also enable us approximately to estimate the degree of the myopia,* which will be always some-

* For a very full and valuable explanation of the determination of the state of refraction by the aid of the ophthalmoscope, I must refer the reader to Mauthner's Lehrbuch der Ophthalmoscopie.

what less than the strength of the correcting lens. The field of vision will appear smaller, and the image nearer the eye of the observer, than in the emmetropic eye. The image is also less bright in colour and less illuminated, but apparently larger, for we cannot, as in the emmetropic eye (the size of the pupil being equal) overlook the whole expanse of the optic disc at a glance, but only a portion of it. In the indirect mode of examination, the image of the disc will be less than that of the emmetropic eye, on account of its being formed nearer to the object lens.

Myopia may run a very variable course. In some cases its progress is marked and rapid, in others slow and insidious; in the most favourable cases it remains stationary at the adult age. It is generally, however, somewhat progressive, especially between the ages of 15 and 25, and often markedly so in hereditary myopia, or if the patients employ their eyes a great deal in reading, sewing, etc. A moderate degree of stationary or but slowly progressive myopia causes but little annoyance to the patient; but it is very different if its degree is very considerable and its progress marked and rapid, for in the latter case it is almost always

accompanied by symptoms of irritation and inflammation of the inner tunics of the eyeball, giving rise to redness, heat, and ciliary neuralgia during prolonged work at near objects. We must, however, be upon our guard not to confound these symptoms with those of muscular asthenopia, dependent upon weakness of the internal recti muscles.

It is of great consequence in the prognosis and treatment of short-sightedness that its progress should be carefully watched, and that the degree of the myopia should from the first be accurately ascertained and noted; so that we may, hereafter, be able at once to determine whether the disease has remained stationary, or whether it has progressed, and, in the latter case, note the extent and rate of such progress.

The popular idea that myopia diminishes in old age is erroneous. This error is partly due to the fact that it was formerly thought possible to determine the degree of myopia by the position of the near point, and not by the far point, as is now done. It will be evident at once, that if the myopia be but slight (say $\frac{1}{16}$) the near point may, with advancing years, remove further from the eye, perhaps to 10″ or 12″, and the eye will thus have become presbyopic and the patient suppose

that his myopia has decreased. The increasing diminution in the size of the pupil, which occurs in old age, also tends to improve the distant vision of the myopic eye, by diminishing the circles of diffusion upon the retina, and thus rendering the image more distinct and well defined. Again, the senile changes (sclerosis) which the lens undergoes with advancing years, may suffice in a very slightly myopic eye greatly to diminish the short sight, or even perhaps almost to neutralize it.

There is nothing to be feared from a slight, stationary myopia. But it is very different indeed if the disease is progressive, for then it is always a source of danger to the eye. Upon this important point Donders speaks with great decision and earnestness. He says, "The same causes which give rise to myopia are still more favourable to its further development. I have always with great care watched the course of myopia. I attach to it a special importance. The well-known fact that myopes, with little light, can recognise small objects, and especially the circumstance that, at an advanced period of life, they need no glasses to enable them to see near objects, procured almost general acceptance for the prejudice, that near-sighted eyes are to be considered as particularly strong. Many medical men even partici-