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ON MYOPIA.

By Dr. E. Landolt, Paris.

Myopia is a subject concerning which not a little has already been spoken and written. Perhaps, however, the last word has by no means as yet been uttered. My personal experience induces me to adopt views differing somewhat from those which are generally held. I venture to hope nevertheless, that my doctrines may add something to the knowledge we possess of myopia, and thus be a contribution towards its more suitable treatment.

Myopia (short sight) is that condition of the eye in which vision is distinct for short distances only, and in which, for vision to be distinct at long distances, concave glasses are required. This condition arises from the fact that the focus of the dioptric system of such an eye falls in front of the retina. In order that the image of an object may fall upon the retina itself, a condition essentially necessary to distinct perception, the object must be approached to the eye until it actually does so fall.

If the object be at a considerable distance the refractive force of the eye must be lessened by a quantity such that the resulting image shall form itself further back, upon the retina. This diminution in the refractive power of the eye is precisely what is obtained by concave glasses.

Myopia is therefore the sign of a disproportion between the refractive power and the length of the eye; we may either say that the myopic eye is too long as regards the focus of its dioptric apparatus, or that the dioptric apparatus is too powerful as regards its length.

This disproportion need not be great in appearance in order to produce a degree of myopia tolerably high. Thus I have shown by calculation that each millimetre of increase in the distance, which intervenes between the retina and the focus, produces a myopia of 3·3 D. (old system $\frac{1}{12}$).

If, for instance, the retina be situated at one millimetre behind the focus of the eye, we have a myopia of 3·3 D.; in other words, the eye for distant vision requires − 12, and can only see clearly at 12 inches. If the retina be separated another millimetre from the focus, the individual will see clearly only at a distance of 6 inches, and will require − 6 or 6·5 D. A separation of three millimetres between the focus and the retina produces a myopia of $\frac{1}{4}$; that is to say, that the individual requires concave glasses − 10 dioptrics of four inches focus, and can no longer see clearly beyond 4 inches.

When we seek to explain how it is that this disproportion between the length and the refractive power of the eye is produced, we are seeking, in fact, the *cause of the myopia.*

I recognise three special causes of myopia.

1. An eye may be absolutely sound in all its parts; its functions normal, its cornea and crystalline correctly formed, its membranes healthy, and its accommodation perfect, only the whole eye is slightly too long. In other words the focus of its dioptric system is situated in front of its retina, instead of actually upon it. There is nothing surprising in this, if we consider the slight increase in length required to produce myopia, and if we further consider, that there exists a much greater number of eyes in which, independently of any morbid cause, the focus is situated behind the retina, such eyes being hypermetropic, or having too long sight. Nay, the wonder would rather be, if all eyes were so regularly developed, that the foci of their dioptric systems always fell exactly upon their retinæ.

Eyes which suffer from this form of myopia are not diseased. They are, indeed, to the full as healthy as the eyes of hypermetropes or emmetropes. With the aid of proper correcting lenses, they can distinguish objects at considerable distances quite as well as normal eyes, while at short distances they are independent of glasses. Such eyes can bear close work with greater ease, and for a

longer time, than normal ones, precisely because by their constitution they are already adapted to short distances, and are consequently able to see with little or no accommodation.*

The public has possibly a better acquaintance with this class of shortsighted persons than oculists. Such patients, in youth, select their own correcting glasses, and wear them continuously, perhaps even uselessly, for reading and writing. As age comes on, and the accommodation begins to grow weaker, these myopes make use of their concave glasses only for distant vision; near objects they see remarkably well without any glasses, while on the contrary, normal eyes at the same age have become presbyopic and require convex ones.

This variety of myopia is not, fortunately, so rare as might be supposed from books. But, as I have said, it is characterised by one feature, namely, that the affected eyes present nothing abnormal, either externally or internally. They can see distinctly at a distance with proper correcting glasses, and they also can see near objects without fatigue. This explains why an oculist so seldom has the chance of meeting with such patients. When, however, they do consult him, he is struck by the precision of their answers as regards the choice of glasses; unless indeed their myopia happens to be complicated with astigmatism. They will at once single out the glass that suits their myopia, refuse any that are too weak, and still more emphatically any that are too strong. Furthermore, the degree of myopia, shown by the ophthalmoscope will generally agree with the glass which the patient has chosen.

This variety of myopia is often congenital. It has little or no tendency to increase. It cannot be cured, that is to say changed into emmetropia, which, moreover, for low degrees, would scarcely be desirable.

* They even distinguish details which are imperceptible to a normal eye, because they receive larger retinal images.

2. The second form of myopia is due to spasm of the ciliary muscle. In consequence of this the lens becomes more convex, unites parallel rays in front of the retina, and adapts the eye to divergent rays, that is, to objects situated at shorter distances.

This form of myopia is met with chiefly in early youth. Those suffering from it cannot see at a distance, except with the aid of concave glasses. They generally work at near objects, without glasses, and are inclined to bring objects very close to their eyes. Contrary to what is observed in myopes of the preceding category, they complain of fatigue, of a sensation of smarting in the eyes, of headache, and, in a word, of the symptoms of asthenopia. In such cases it is not uncommon to find an insufficiency of the internal recti muscles. When you come to select glasses for these patients, their answers lack precision; they choose glasses that are too strong rather than too weak, even though the former do not improve in any degree their visual acuity.

If we determine the amplitude of accommodation in such an eye, and compare it with the degree of myopia present, it will appear extraordinarily weak, until the determination of the refraction by the ophthalmoscope yields an explanation of the phenomenon. During the ophthalmoscopic examination, the eye relaxes its accommodation, as it does on every occasion when an object is not being fixed (as, for instance, during sleep); then it reveals its true refraction. In such cases we are consequently often surprised to find a degree of myopia much lower than what was apparent from the trial of glasses; nay, we may actually have emmetropia or even hypermetropia.

This form of myopia, which might be called apparent myopia, may be cured by a course of atropine rationally carried out, and combined at times with the use of convex glasses and prisms. I have succeeded in curing many such myopes. I may here cite a typical case which recently came under my notice. It was that of a youth,

aged 16, who had distinct vision for distance only with the aid of—6 D, and who, without glasses, could not see any of the large test-types. His myopia had increased with considerable rapidity. He used of his own accord glasses for work, and made marked complaints of asthenopic pains. He was very much alarmed at the idea of his myopia getting progressively worse, as had been the case for some years past. The ophthalmoscope revealed the fact that with relaxed accommodation, the myopia changed to a slight degree of hypermetropia. A course of atropine was immediately commenced, and the myopia cured. The headaches and fatigue of the eyes disappeared, and at the present time the patient can see at a distance without glasses, and can accomplish near work without fatigue.

Such cases are veritable victories, due solely to the ophthalmoscopic determination of refraction. Doubtless atropisation might have led to a diagnosis, but then it is no pleasant thing for the patient, in order to obtain exact results, to have his accommodation paralyzed during several days, and, as we know, thorough paralysis is essential to a knowledge of the true state of the refraction. Hence, perhaps, an oculist who is unable to diagnose a spasm of accommodation by means of the ophthalmoscope, will scarcely venture, and for good reasons, to propose a course of atropine to his patient. On the other hand, he who has mastered thoroughly the refraction of an eye both when in repose and when fixing an object, and who knows the difference between the respective conditions, may with confidence assure a patient that the symptoms he suffers from will be removed.

3. Myopia may be produced by a disease of the eye, *i.e.*, by choroiditis.

The choroid placed between the retina and the sclerotic forms the major portion of the uveal tract (the iris, ciliary body, and choroid). It forms more especially the membrane of nutrition of the eye. When it becomes the seat of any alteration, the whole globe sympathises with it.

Let us review the group of phenomena which characterize choroiditis, an affection which has been with very little reason divided up into different diseases, and called by different names, but which is essentially one disease, exhibiting itself under a variety of forms.

Choroiditis begins by hyperæmia of the choroid, and nearly always of the optic nerve. Then follow exudations under the retina, into the retinal tissues and into the vitreous humour. While the retinal exudations sometimes result in detachment, those into the vitreous become a cause of increased intra-ocular tension, and of opacities. Simultaneously with the above changes there is noticeable an alteration in the disposition of the pigment. From some localities it disappears; in others it is heaped up, in the form of dark-coloured patches. The nutrition of the crystalline and vitreous is thereby impaired; the latter becomes in many cases fluid, as all know who have had to operate for cataract on eyes of this kind, which is by no means an uncommon occurrence, inasmuch as the crystalline often becomes opaque from this very cause. Similarly and for the same reason, the zonula of Zinn may atrophy in part, and under the influence of the traction exercised upon it as the result of an increase in size of the globe, may be ruptured. In such cases we have a dislocation of the lens, and its subsequent escape into the fluid vitreous.

Owing to exudation into the vitreous, intra-ocular tension is necessarily augmented. But as I have already said, the sclerotic, which is so intimately united with the choroid, participates in the pathological process. Its tissue loses the power of resistance; it yields, stretches, and becomes translucent in parts, as may be seen every day in eyes affected with choroiditis of the anterior portions of the globe, and more especially with cyclitis. The sclerotic, thus vitally altered, yields to the increased intra-ocular tension. Hence a reason why this increase of tension is seldom revealed by tenometry.

If the choroiditis is seated anteriorly, we have ectasiæ

of the anterior portions of the globe; if posteriorly, of the deeper portions of the eye, constituting the so-called posterior staphyloma. The retina necessarily yields along with the other membranes; it covers the staphyloma. Now, if the retina was at some former period situated in front of the focus of the dioptric system of the eye, if, that is, the eye was hypermetropic, the hypermetropia will in every case grow less in consequence of the displacement of the retina, which has now receded towards the focus. When the retina has arrived as it were actually at the focus, the eye has become emmetropic; when it has passed beyond it, myopic.

Such a myopia will be high in degree, exactly in proportion as the choroiditis has developed itself in an eye which was long to commence with. The ectasia of the sclerotic can spread to the equatorial regions of the globe; nay, even to the entire globe. Still, whatever has been the nature of the lengthening process, whether limited to the posterior pole or implicating the entire globe, from the moment that the eye has become longer than the focal length of its dioptric system, it has necessarily become myopic.

Thus then we find myopia to be in such a case, the consequence of a deep-seated affection of the eye. This myopia will be progressive, because the choroiditis is progressive.

Other and subjective symptoms are not wanting, such as a sensation of tension, especially at the fundus of the orbit, phosphenes, muscæ volitantes, diminution in visual acuity. In one word, asthenopic troubles of every kind, even scotomata, may result from this very treacherous affection.

Do not the pathological disturbances just enumerated tally exactly with the symptoms laid down in the text-books under the head of "pathological anatomy of the myopic eye," as being peculiarly characteristic of myopia? The anatomy is after all simply that of an eye which has become the subject of choroiditis, and which may often

indeed, be myopic, but is not always necessarily so. Indeed it is no rare thing to find the same anatomical lesions in a hypermetropic or an emmetropic eye.

In fact the supporters of the current theory, which considers myopia as a specific disease, are not a little embarrassed when it comes to be a question in a hypermetropic eye of explaining the presence of a staphyloma posticum, with pigmental changes at the fundus. To the advocates of the theory such changes are among some of those most characteristic of myopia. According to my view I find nothing surprising in these symptoms. Choroiditis may develop itself in any eye whatever, quite apart from the question of its length or refractive power.

As regards the therapeutics of this variety of myopia, they are necessarily those of choroiditis. We must, and this is peculiarly important, remove all sources of irritation from the inflamed membranes. We must endeavour, as in all inflammations, to avoid congestion, especially of the head and affected organ, together with excessive light and excessive fatigue of the eye or the accommodation.

The muscle of accommodation, indeed, forming as it does an important part of the uveal tract, may, if unduly or too often put upon the stretch, exert a pernicious influence upon the choroiditis, and thus indirectly become a cause of the myopia. But the accommodation is not, as some have maintained, a primary cause of myopia. Were that the case, then all the hypermetropes who make much greater demands upon their accommodation ought within a given time to become myopes.

It is not the myopia *per se* which, through the medium of the accommodation, leads to staphyloma, but rather, it is the accommodation which by aggravating the choroiditis leads to staphyloma with progressive myopia. Therefore it is, that, in this variety of myopia, close work and the use of concave glasses may become injurious, only, however, when the latter are too strong, for the

distance for which the patient uses them, for then it is that they fatigue the accommodation.

Derivatives of every kind may be considered as indicated in cases of choroiditis, but not of myopia as a rule. Moreover, when it becomes a question of guarding against or curing this particular choroidal form of myopia, it is of the first importance to know the cause or causes of the choroiditis.

Recapitulation.

I recognize three varieties of myopia :—

1. The myopia of an eye perfectly healthy.

2. Functional myopia, due to spasm of the accommodation.

3. Myopia, symptomatic of a disease of the eye, of choroiditis.

The proofs on which I found the explanation I have given of myopia are furnished in abundance, both by clinical observation and by pathological anatomy.

Some of the causes of myopia as given by authors will apply to one or other of the above varieties. There does not, however, exist any uniform and specific cause of myopia, precisely because myopia is not a disease. It is only the sign of a disproportion between the length of the eye and the refractive power of its dioptric system.

An excessive development of the cranium anteroposteriorly, a marked depth of the orbital cavity, may be connected with the first variety. For spasm of the accommodation we must seek another cause. Fatigue and dazzling of the eye, insufficient illumination, hours passed in unhealthy schoolrooms, a faulty position of the body, the abuse of concave glasses, may all conduce indirectly to the third variety. That is to say, in eyes either predisposed to choroiditis or already attacked by it, myopia may be produced or aggravated by causes such as the above. Thousands of eyes, on the other hand, are daily exposed to these influences without becoming

myopic, and that because they are not suffering from choroiditis.

If we come to inquire the causes of the essentially progressive or malignant form of myopia, we shall find they can be explained reasonably and consistently by the presence of choroiditis. These causes will in the vast majority of cases be of constitutional origin. If we direct our attention to the nutritive condition of an individual with choroiditis, we shall often find a condition of low vitality and a feeble and strumous constitution. This applies not only to the individual but to the race. If to this be added excessive and long-continued fatigue of the eyes, choroiditis will become further developed, and may lead to progressive myopia.

It has long been known that myopia occurs with unusual frequency among the inhabitants of certain countries, while others enjoy a practical immunity from it. Various explanations have from time to time been attempted of this fact. Some writers have considered it mainly due to the type of frontal or cranial development, others to excessive employment of the eyes at near work, others to the comparatively feeble solar light which reaches some latitudes. It has also been suggested that the inordinate length of the lines in the journals which circulate in some communities may be an exciting cause! In terminating this article, I will endeavour to give my own views on this subject.

The countries, in which myopia may be said to be characteristically endemic, are countries which are little favoured either by climate, soil, or commercial wealth. The inhabitants are by nature intelligent and active-minded, and keenly alive to the advantages of procuring for themselves a share of those riches which their more fortunate neighbours have inherited from nature. They have therefore, for a long series of generations, been obliged to procure by their own efforts, what a niggard soil, an ungenial climate, or a disadvantageous geographical posi-

tion has denied them. In a country so situated, it is necessary for individuals to seek extraneous and artificial sources of wealth. Some, therefore, will apply themselves to various handicrafts, others to scientific or speculative pursuits, and will dispose of their work, their business knowledge, or their scientific acquirements to neighbouring peoples. Among themselves the special training necessary for such pursuits must, in order to be successful and to reach its highest possible development, be commenced at an early age. It requires for its successful cultivation, a class of men possessed of either natural or acquired abilities as teachers. Hence in addition to a student class, there will be another of secular teachers of all kinds, of pedagogues, clerks, and penmen, and these will form no small percentage of the population.

Success in such a calling depends, as already stated, in great part on a sufficiently early training. Hence in such a community schools will multiply rapidly, while with the increase of competition, the scholars frequenting them must commence their studies at progressively earlier ages. Schools built in poor districts may be expected to suffer from the surrounding poverty, and to be lacking in many requirements of hygiene and comfort. For exactly the same reasons, those who attend them will not have that fund of constitutional strength, that latent power of resistance, necessary to neutralise the noxious influences to which their visual organs, as portions of a common whole, would be especially exposed. Hence, in the sequel, choroiditis, induced in the first instance by deficient nourishment, and aggravated by precocious and undue application of the eyes.

Myopia may thus in time, I believe, become endemic throughout a district or a whole nation, and will continue to exist or even become intensified, so long as the causes which induced it remain in force.

The mere fact that myopia is not most widely prevalent in some countries which are very advanced in civilisation,

or very active in industrial pursuits, is not incompatible with my theory. In the first place, many such countries are essentially rich by nature. The population is better nourished as a whole, and is consequently as a whole better able to resist those causes which produce choroiditis. In the second place, in order to estimate the influence of excessive eye work in its relation to myopia, it is necessary to compare, not the intellectual results obtained in any two countries, but the percentage of school-goers in each. Let the population of the most physically favoured country, suddenly or gradually, from any cause outstrip its food supply, let there be failing crops or famine, in a word, let there be a pressing necessity for a large amount of intellectual labour to compensate some physical deficiency of sustenance, and in no long time myopia will develop itself in that people, quite independently of cranial conformation, bright skies, or the manner or type in which the daily papers are printed.

Nor is it a sound objection to allege, that there are many nations or tribes typically poor and ill-fed, who have, nevertheless, for ages escaped all taint of myopia. So long indeed, as such countries will content themselves with the most meagre diet and the most scanty clothing, with rice or seal oil, with plaited leaves, or the skins of wild beasts, so long in a word as they will consent to remain strangers to all desire for the benefits which are linked with civilisation, just so long will they escape the perils to their eyesight inseparable from all systematic education.

Nevertheless, I do not by any means propose to apply to each particular and individual case, a law which I believe holds good for a nation. I am well aware of the numbers of persons who, surrounded as they are, by most favourable physical conditions and influences, have never unduly tried their eyes and are nevertheless sufferers from myopia. For the first form of myopia I have described, the explanation of such cases is easy. A man

may of course congenitally have too long an eye antero-posteriorly, just as he may have too long a nose for perfect symmetry of face. As regards the myopia dependent on posterior staphyloma, the explanation is not less simple. A father or more remote ancestor procures ease and affluence for his descendants at the price of an enfeebled constitution and impaired vision.

Another worker, though living under bad conditions of hygiene and taxing his eyes early and late, yet does not become myopic, for the reason that he has inherited a good constitution, or in other words, normal powers of resistance. But should children be born to him in poverty and in want, and should they be exposed as time goes on to all the depressing influences of excessive work and scanty nourishment, it is morally certain that in their cases choroiditis, with its accompanying myopia, will sooner or later develop itself.

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