

as this varies considerably, different numbers must be tried until the best is found, and it must be remembered that in these lenses of high power, a slight difference may exert a very considerable effect upon the sight. In order to remedy the great spherical and chromatic aberration of light which is produced in these lenses from the difference in their thickness at the centre and at the edges, such spectacles are generally set in a broad horn or tortoise-shell frame, which leaves only the more central portion of the glass exposed.

CHAPTER IX.

PARALYSIS, SPASM, AND ATONY OF THE CILIARY MUSCLE.

CONSIDERABLE diminution, or even complete loss of the power of accommodation is occasionally met with. We have seen that the range of accommodation is often greatly diminished in presbyopia, for the near point may have receded to 16" or 18" from the eye, so that the range of accommodation is reduced to $\frac{1}{16}$ or $\frac{1}{18}$, instead of being as in the normal eye, = $\frac{1}{4}$ or $\frac{1}{5}$. The range of accommodation is also frequently considerably diminished in persons who are very short-sighted, and who have worked much at near objects, so that the ciliary muscle has lost some of its elasticity and become somewhat rigid.

Diminution or loss of the power of accommodation, is often due to paralysis, spasm, or atony of the ciliary muscle.

The fact that we frequently meet with loss of accommodative power, together with a general or

partial paralysis of the third nerve, is of great interest, for it tends to prove that the ciliary muscle is most likely supplied by a branch of the third nerve; this view is now generally accepted, and it is thought that the loss of accommodation is, in such cases, due to a paralysis of the branch supplying the ciliary muscle, therefore to a direct paralysis of the muscle itself.

The fact that loss or diminution of the power of accommodation frequently co-exists with dilatation of the pupil, due to the paralysis of the pupillary branch of the third nerve, is of importance in the consideration of the mechanism of accommodation. As long as ophthalmologists, agreeing with Cramer's theory, considered the iris to play a principal part in the production of the necessary convexity of the lens during adjustment for near objects, it was supposed that the dilatation of the pupil was the cause of the loss of accommodation. It was thought that the anterior surface of the lens was rendered more convex by the pressure of the radial fibres of the iris upon the periphery of the lens. But in order that the iris may exert such pressure, anterior and posterior fixed points are necessary. The contracted sphincter pupillæ (the pupil is, as we have seen, contracted during accommodation for near objects) is the anterior fixed point, the ciliary

muscle, which also contracts, the posterior. Now, when the pupillary branch of the third is paralysed, dilatation of the pupil ensues, the anterior fixed point is lost, the radial fibres can no longer exert a sufficient pressure upon the periphery of the lens, and hence, it was argued, arose the loss of accommodation in such cases.

But that the loss of accommodative power does not depend upon the dilatation of the pupil, and the consequent inefficient action of the iris, is proved by the following facts:—

1. The accommodation may be paralysed without any dilatation of the pupil.
2. The pupil may be dilated, from paralysis of the pupillary branch of the third, without the accommodation being affected.
3. We sometimes find that after the pupil has regained its contractility (after paralysis of the nerve to the constrictor pupillæ), the power of accommodation remains yet for some time impaired.
4. With a weak solution of atropine (1 part to 2,000 parts of water) we may dilate the pupil fully without completely paralysing the muscle of accommodation; a solution of 1:9600 produces dilatation in about an hour; in 1½ hour the pupil is perfectly dilated, and the power of accommodation

but very little affected (De Kuyper). In order completely to paralyse the power of accommodation, a very strong solution (1 : 120) is required, and this takes about three hours to act thoroughly.

5. That the iris is not of any particular importance in bringing about the accommodative changes of form in the lens, is thoroughly proved by Von Graefe's interesting case of total absence of the iris, in which the power of accommodation was normal.

We must therefore look upon the ciliary muscle as the principal, if not the sole, factor in producing the necessary changes in the form of the lens during accommodation.

Occasionally the branch to the ciliary muscle is alone paralysed, all the other branches of the third being intact. The isolated paralysis of the branch to the ciliary muscle sometimes co-exists with paralysis of other nerves, particularly of branches of the facial nerve. Paralysis of the ciliary muscle is at times due to cerebral causes; indeed, mydriasis, with loss of accommodation, is not an unfrequent precursor of cerebral affections. It may also be caused by syphilis, rheumatism, low, debilitating fevers, and diphtheria.

Diminution or loss of accommodation is occa-

sionally met with after severe illnesses, the whole muscular system being greatly debilitated; it is then sometimes mistaken for amblyopia, or weakness of sight, dependent upon general debility. Paralysis of the accommodation is also often met with after diphtheria; here, however, it appears to be less due to general constitutional weakness than to some special process, the exact nature of which is yet undetermined.

The symptoms of paralysis of the accommodation are very marked in emmetropic eyes. The patients find that they cannot accurately distinguish near objects, so that they are perfectly unable to read, write, or sew; but at a distance they can see quite distinctly. The far point has undergone no change of position, but the near point has receded far from the eye. If we test their sight with a convex lens of 6" focus, we perhaps find that the near point has receded to 5" or 5½" from the eye, and that the far point lies at 6" (the focal distance of the lens), hence that the power of accommodation is almost entirely lost. The position of the near point varies, of course, with the degree of the paralysis, if this be but slight (paresis), the near point may be but little removed from the eye, and the disturbance of vision be but slight.

The sight is far less impaired in short-sighted persons, for if their myopia does not exceed $\frac{1}{2}$ or $\frac{1}{4}$, then they are still able to read at the distance of their far point (12" or 14"), as only the near point undergoes a change; it coincides, in fact, with the far point in cases of complete paralysis of the accommodation, and the far point lies here sufficiently near to the eye to permit of small objects being seen distinctly. But the case is very different in hypermetropic persons, for their sight suffers both for near and distant vision, as both the near and far point are affected.

When the paralysis is incomplete, the symptoms often resemble those of asthenopia, and the cause of the affection may escape detection, if the range of accommodation and the state of refraction be not accurately examined.

The treatment of these cases of paralysis of the accommodation must depend upon the cause. If the patient has been suffering from diphtheria, or any debilitating disease, tonics must be our chief remedy, and the affection will then generally yield in the course of from two to three months. The same occurs also in the rheumatic form, in which flying blisters to the temples, and the veratrine ointment may be employed with advantage, together with the *secale cornutum*. In the cases

which are supposed to be due to syphilitic origin, an antisiphilitic treatment should be had recourse to.

In the rheumatic and diphtheritic form I have largely tried the effect of the solution of the Calabar bean, and with good results. I employ it of sufficient strength to cause considerable contraction of the ciliary muscle, and of the constrictor pupillæ, without, however, fatiguing them too much. I then allow the effect to pass off entirely, and after a few days' rest, re-apply the extract, and thus stimulate the muscles periodically.

The action of the Calabar bean, and its peculiar effect upon the pupil were fully investigated in 1862, by Dr. Fraser,* in his valuable graduation thesis for the University of Edinburgh, on the "Characters, Actions, and Therapeutic uses of the Ordeal Bean of Calabar." And in 1863, Dr. Argyle Robertson discovered its effect upon the accommodation.†

On the application of a very little of the strong

* Further investigations on the physiological action of the Calabar bean are contained in a more recent paper by Dr. Fraser, in the "Transactions of the Royal Society of Edinburgh," vol. 24.

† Shortly after this discovery of Dr. Argyle Robertson, I had the opportunity of carefully studying the effect of the Calabar bean upon a case of paralysis of the ciliary muscle; a full account of which will be found in the "Med. Times and Gazette," May 16, 1863.

solution (1 drop = 4 grains of the bean) to the inside of the lower eyelid, a little irritation and redness is produced, but this passes off very rapidly. Within 5 or 10 minutes, the pupil begins to contract, and at nearly the same time the spasm of the ciliary muscle commences. The contraction of the pupil reaches its maximum degree (about 1" in diameter) in about 30 or 45 minutes. After about 2 or 3 hours it gradually dilates again, but it does not regain its normal size till after the lapse of 2 or 3 days, when it may even become somewhat larger than before. Even during its greatest contraction, the pupil is still under the influence of light.

The spasm of the accommodation commences about the same time as the contraction of the pupil, and both the near and far point become greatly approximated to the eye, which becomes, in fact, strongly myopic. The far point in the emmetropic eye may be brought to 5" or 6" from the eye, and the near point to 3" or 3½". The effect upon the accommodation passes off much sooner than that upon the pupil, for three or four hours generally suffice to restore the state of refraction and accommodation to its normal condition.

That the spasm of accommodation is due to

the action of the drug upon the muscles of accommodation, and not upon the iris, was incontrovertibly proved by Von Graefe,* who tried its effect upon the afore-mentioned case of complete absence of the iris (p. 42), and found that the action upon the accommodation took place at about the same time, and in exactly the same manner, as in eyes in which the iris was present. The action of the Calabar bean is, therefore, upon the ciliary nerves, and completely independent of its effect upon the iris.

The effect of the Calabar bean, in counteracting the action of atropine, has also been proved by many experiments. The weaker solutions of atropine are easily overcome by a strong solution of Calabar. But the complete paralysis of the accommodation by a strong solution of atropine (4 grains to the ounce) is only temporarily overcome even by a very strong solution of Calabar, 1 drop = 4 grains of the bean; the pupil becomes smaller, and the power of refraction increased, but the action of the atropine re-asserts itself in the course of a few hours. In such cases we must repeat the application of the Calabar when necessary, until the effect of the atropine upon the accommodation has disappeared.†

* Archiv. ix. 3, 113.

† Instead of the extract, the more elegant preparation of

We find that a considerable amount of asthenopia is sometimes produced by over-exertion of the eyes at near objects. The asthenopia does not, in this case, depend either upon hypermetropia or insufficiency of the internal recti muscles, but simply upon fatigue of the muscle of accommodation, through continued work at near objects; this state being, in fact, analogous to that produced in other muscles by long-continued over work. In order to treat this form of asthenopia effectually, total rest of the eyes is essentially necessary, and a complete abstinence from all accommodative exertions must be enforced. The patient should, therefore, be supplied with convex spectacles of sufficient strength to render rays emanating even from very near objects parallel, *i.e.*, as if they came from distant objects (from the far point); thus there will be no exertion of the accommodation during reading, writing, &c. After these spectacles have been used for some time, Von Graefe advises that the eye should be methodically exercised as to its accommodation, by gradually accustoming it to weaker convex glasses,

the gelatine discs may be employed. But these do not answer so well when we wish to stimulate the partially paralysed muscle, as we cannot regulate the strength so well as in the solution.

the distance of the object remaining the same. The spectacles should be of a blue tint, in order to diminish the irritation of the retina, which has, in most cases, been produced by the circles of diffusion, caused by the inefficient action of the accommodative apparatus.

We may also rest the accommodation by paralysing it by a strong solution of atropine. In such cases, a pair of dark blue eye-protectors should be worn in bright light, so as to prevent the photophobia dependent upon the great size of the pupil.

Spasm of the ciliary muscle is of rather rare occurrence, and is especially met with in cases of hypermetropia in youthful persons, who have strained their eyes without using convex glasses; this continued tension of the accommodation producing a spasmodic contraction of the ciliary muscle. In such cases, we find that the patient is apparently suffering from myopia, requiring concave glasses for distant objects, and yet on examining his eye with the ophthalmoscope, the refraction is found to be hypermetropic.

These cases of spasm of the ciliary muscle are often mistaken by a superficial observer for myopia, more especially if the state of refraction is not examined with the ophthalmoscope. The patient

should be directed either to look vacantly before him or to regard some far distant object in order that his accommodation may be relaxed to the utmost, and the ophthalmoscopic signs of hypermetropia become apparent. If the spasm is at all severe, the patient is unable to distinguish distant objects without the aid of concave glasses, and it is only after the oft-repeated application of a strong solution of atropine (gr. iv to ʒj of water) that the ciliary muscle becomes paralysed and the hypermetropia apparent. The atropine may have to be repeated two or three times daily for several days, or even longer, before this effect is gained. The paralysis should be maintained for some weeks by the instillation of atropine two or three times a week. Afterwards, the proper convex glasses should be prescribed for reading, sewing, etc., and, if necessary, also for distance.

CHAPTER X.

SPECTACLES, ETC.

THE spectacles which are generally used for the purpose of correcting some optical defect in the eye are either spherical or cylindrical lenses, or a combination of both. The properties of such lenses have been already sufficiently explained, (p. 4), and I shall therefore now only add a few remarks as to the different kinds of spectacles and their construction.

From the perusal of the different anomalies of refraction and accommodation, the reader will have been sufficiently impressed with the importance of the proper and scientific selection of spectacles. I have already (p. 3) insisted upon the necessity of the surgeon himself determining the number of the glass which the patient is to wear, and not entrusting this to the optician, to whom, however, written directions should be sent as to the strength of the required lenses, etc. The surgeon should, therefore, possess a box of trial lenses, such as are made by Paetz and Flohr, of Berlin, and which