CHAPTER VI.

PRESBYOPIA.

THE first symptom of presbyopia is, that small objects (small type, fine needlework, etc.) cannot be seen with such ease, or so clearly as before; but for distant objects vision is perfect. In order to see minute objects more distinctly, the patient has to remove them further from the eye, or even to seek a bright light, so as to diminish the circles of diffusion upon the retina by narrowing the size of the pupil. But as the retinal images of these fine objects are very small, on account of the distance at which they are held, he will soon experience a commensurate difficulty in clearly distinguishing them, the print, for instance, will get indistinct and confused, and the eyes become fatigued and aching.

In simple presbyopia, the far point is at a normal distance from the eye, parallel rays are united upon the retina, and neither concave nor convex glasses (even after the instillation of atropine) at all improve distant vision. The eye is

neither myopic nor hypermetropic. There is in fact no anomaly of refraction, but only a narrowing of the range of accommodation; the near point is removed too far from the eye, and hence the difficulty of accurately distinguishing small objects.

Amblyopia sometimes co-exists with presbyopia, and may even be mistaken for it, as the amblyopic patient likewise cannot see small objects distinctly, and convex glasses also improve his sight by affording him larger retinal images. In a purely presbyopic eye (which is free from amblyopia), we should, by means of the proper convex glass, be able to restore a normal acuteness of vision and a normal range of accommodation. With this glass the patient should be able to read No. 1 of Snellen at a distance of about 8″. If he cannot do this, but only perhaps decipher No. 4 or 6, or if he is obliged to hold the object very near his eye (nearer than is warranted by its size), he is not only far-sighted, but also amblyopic. It may, therefore, be laid down as a practical rule that the nearer we can approximate, by means of convex glasses, the vision and range of accommodation of a presbyopic eye to that of a normal one, the less is the impairment of sight due to amblyopia, and *vice versâ*.

Donders has found that in the normal (emme-

tropic) eye the near point gradually recedes, even from an early age, further and further from the eye, and that, in consequence of this, vision of very minute objects becomes proportionately more and more difficult. This recession of the near point commences already about the tenth year, and progresses regularly with increasing age. At forty it lies at about 8″ from the eye, at fifty at 11″ or 12″ and so on. In the normal eye no inconvenience or annoyance is experienced from this recession till about the age of forty or forty-five.

This change in the position of the near point is met with in all eyes,—the emmetropic, the hypermetropic and the myopic (if the latter remains healthy).

But the far point also begins in the emmetropic eye to recede somewhat about the age of fifty, so that the eye then becomes slightly hypermetropic (distant vision being improved by convex glasses). At seventy or eighty years of age, the hypermetropia may = $\frac{1}{24}$, *i.e.*, the patient can see distinctly at a distance with a convex glass of 24″ focus. This hypermetropia, which is at first only acquired, may afterwards become absolute; so that the patient is not only unable to accommodate for divergent, but even for parallel rays.

This recession of the near point from the eye,

and the consequent narrowing of the range of accommodation, is chiefly due to a change in those parts within the eye which are passively changed during the act of accommodation, and not so much to an alteration in those which through their activity bring about the accommodation. For, the ciliary muscle, the active agent of accommodation is generally normal, although it may, later in life, undergo senile changes. Whereas the passively changed organ of accommodation, the crystalline lens, gradually becomes more and more firm with advancing years, and in consequence of this increased consolidation, the same amount of muscular action cannot produce the same change in the form of the lens as formerly.

At first, of course, no inconvenience is experienced from this gradual recession of the near point; we do not, in fact, notice it until the distance is so considerable that we cannot easily distinguish small objects. When are we, then, to consider an eye presbyopic? Donders thinks this should be done as soon as the near point has receded further than 8″ from the eye; for as soon as this is the case, patients generally begin to complain that continued work at small objects has become irksome and fatiguing. We, however, sometimes meet with persons with very strong

sight, who can read and write for hours without experiencing any inconvenience, even although their near point may be 11″ or 12″ from the eye. But these cases are exceptional. Let us, therefore, with Donders, consider presbyopia to begin when the near point is removed further than 8″ from the eye.

The degree of presbyopia may be easily found if we have decided upon a definite distance as the commencement of presbyopia (Pr.). According to Donders, its degree may be found in the following simple manner. He says "if, that is to say, p^2 (the presbyopic near point), be situated at n Parisian inches from the eye, then assuming the above-mentioned limit, $\text{Pr} = \frac{1}{8} - \frac{1}{n}$. Thus if p^2 lie at 16 inches, $\text{Pr} = \frac{1}{8} - \frac{1}{16} = \frac{1}{16}$; if p_2 lie at 24″ $\text{Pr} = \frac{1}{8} - \frac{1}{24} = \frac{1}{12}$. For this, glasses of about $\frac{1}{8} - \frac{1}{n}$ are required, and in the examples given, glasses of $\frac{1}{16}$ and $\frac{1}{12}$, to bring p_2 to 8″, and so to neutralize the presbyopia."*

The reader will have been struck by the fact, that if we consider an eye presbyopic when the near point is removed further than 8″ from the

* Donders' "Anomalies of Refraction and Accommodation," p. 212.

eye, not only the emmetropic (normal), but even the myopic or hypermetropic eye may suffer from presbyopia. If, for instance, a short-sighted person suffers from a myopia $= \frac{1}{16}$ (his far point lying at 16″ from the eye), and his near point lies at 12″, he is both short and long-sighted. His myopia $= \frac{1}{16}$, his presbyopia $= \frac{1}{24}$. This cannot, of course, occur when the myopia is considerable, *e.g.*, $\frac{1}{6}$ (the far point lying at 6″ from the eye).

In hypermetropia the same thing may happen.

If, with the convex glass, which neutralizes the hypermetropia—which renders the hypermetropic eye capable of uniting parallel and divergent rays upon the retina—the near point lies at 12″ from the eye, the patient is not only hypermetropic, but also presbyopic. He will require two different sets of convex spectacles, one pair which will enable him to see from 12″ to infinity, and another stronger pair which will bring his near point nearer than 12″.

The range of accommodation of a presbyopic eye is easily found by the formula $\frac{1}{A} = \frac{1}{P} - \frac{1}{R}$. If such an eye can see from 10″ to an infinite distance, (∞), its near point (p) will lie at 10″, its far point (r) at ∞, its range of accommodation, therefore $= \frac{1}{10} - \frac{1}{\infty} = \frac{1}{10}$. $\frac{1}{A} = \frac{1}{10}$.

There can be no question as to the advisability and necessity of permitting far-sighted persons the use of spectacles. They should be furnished with them as soon as they are in the slightest degree annoyed or inconvenienced by the presbyopia. Some medical men think that presbyopic patients should do without spectacles as long as possible, for fear that they should, even at an early period, get so used to them as soon to find them indispensable.

This is, however, an error, for if such persons are permitted to work without glasses we observe that the presbyopia soon rapidly increases.

It has been already stated how the proper glasses may be readily calculated. If p (the near point) lies 16″ from the eye, $\mathrm{Pr} = \frac{1}{8} - \frac{1}{16} = \frac{1}{16}$. A convex glass of 16″ focus will bring the near point back again to 8″ from the eye. We must generally, however, give somewhat weaker glasses, because, on account of the greater convergence of the optic axes, the near point will through these glasses (convex 16) be in reality brought nearer than 8″. Late in life, when there is some diminution in the acuteness of vision, the near point may sometimes be brought even to 6″ or 7″, and it may be approximated the more, the greater the range of accommodation.

If no hypermetropia exists, the weakest glasses

with which No. 1 of Snellen can be distinctly and easily read at about 12″ distance may generally be given. But I have often found that if the person is much employed in reading and writing, and has always been accustomed to hold his book at a considerable distance, he will be at first much inconvenienced if his near point is brought to 10″ or 12″. We shall, therefore, have to give him glasses which will bring it only to about 16″. With these he will be able to work with ease for a considerable length of time. They may afterwards be gradually changed for rather stronger ones.

In choosing spectacles for far-sighted persons, we must also be particularly guided by the range of their power of accommodation. If this is good, we may give them glasses which bring their near point to 8″; but if it is much diminished, weaker glasses should be chosen, so that it may lie at 10″ to 12″ from the eye.

In conclusion, I would particularly call the reader's attention to the very important fact that a very rapid increase of presbyopia is one of the premonitory symptoms of glaucoma. If a patient therefore tells us that his far-sightedness has rapidly increased within a few months, so that he has had repeatedly to change his spectacles during that time for stronger and stronger ones, our sus-

picions should be aroused, and we should without fail examine him as to the presence of other premonitory symptoms of glaucoma—*e.g.*, rainbows round a candle, periodical obscurations, &c. Von Graefe thinks that this rapid increase of presbyopia is most likely due to an increase of intra-ocular pressure and flattening of the cornea. But it is, more probably, owing to the action of this pressure upon the nerves supplying the ciliary muscle, thus causing paralysis of the latter.

CHAPTER VII.

HYPERMETROPIA.

It has been already stated (p. 27) that by the term hypermetropia is meant that peculiar condition of the eye in which its refractive power is too low, or the optic axis too short, so that the focal point of the dioptric system lies behind the retina, and, when the eye is in a state of rest, even parallel rays are not brought to a focus upon the retina, but behind it, and only convergent rays are united upon the latter.

The emmetropic eye unites parallel rays upon the retina without any effort of accommodation, and it also possesses the power of accommodating itself without difficulty for divergent rays, coming from objects 6″ or 8″ from the eye ; for a short time it can even unite upon the retina rays which come from 3″ to 4″ distance. The focal point of the dioptric system lies in the emmetropic eye exactly upon the retina, Fig. 10, p. 24.

In the myopic eye, it will be remembered, the state of refraction is too great, or the optic axis