CORNEAL POWER IN MYOPIC CHILDREN*

BY

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DONDERS (1866) showed that there was a difference in corneal power between male and female adults and the extension of this observation to the myopic child is the subject of this communication.

As the cornea is concerned in the total refraction of the eye, consistent variation in its curvature for a given total refraction must be compensated for by a consistent variation in one or more of the other components of total refraction behind the cornea. The consequence will be discussed later.

This difference can legitimately be obtained by studying the keratometry values for each sex at various ages and at various levels of myopia. Such a cross-sectional study also illuminates some of the problems of the association of corneal power with the development of myopia and the growth of the eyeball.

Keratometry was performed with the Haag-Streit keratometer on 318 myopic eyes, 142 male and 176 female. These children were all attending a clinic for juvenile myopes at Guy's Hospital and probably formed a reasonably unselected group of myopic children, though in the strict sense their attendance at this clinic was to some extent governed by their parents' willingness to let them do so and to some extent in the first instance by the desire of the ophthalmologist either to halt myopia at an early stage or to control it because it was feared that deterioration was too rapid.

The children were also refracted under cycloplegia. The mean of the horizontal and vertical measurements was taken as the corneal power so that astigmatic conditions were eliminated. Similarly, the amount of spherical error with the addition of half the astigmatic error was taken as the degree of myopia.

In the first instance the children were grouped into those aged 13 years and over and those under 13. Figs 1 and 2 (opposite) show that, though there appeared to be an age relationship in boys between the power of the cornea and a given amount of myopia, this did not obtain in girls, and in neither case was there any correlation of the corneal power with the degree of myopia.

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FIG. 1.—To show the effect of age on the corneal power of myopic boys.

FIG. 2.—To show the effect of age on the corneal power of myopic girls.

In Fig. 3 (overleaf), except at the level of -5 D, all values of the corneal power were higher for girls than for boys. Similarly, when corneal power is plotted against age, the female cornea is at any given age more curved than the male, and no relationship with age is shown in either case (Fig. 4 overleaf).

A statistical note on some of these relationships has been provided for me by Mr. N. Please of the Department of Statistics, University College, London (Table I, overleaf).

Corneal Power.—A regression line relating corneal power to age was fitted to the data for each sex. Although the slopes were negative in both cases, implying a decrease in corneal power with age, for neither boys nor girls was the relationship significant.

FIG. 3.—To show the effect of sex and degree of myopia on the corneal power of myopic children.

FIG. 4.—To show the effect of sex and age on the corneal power of myopic children.

There is thus no strong evidence that corneal power is related to age.

However, the difference in mean corneal power of boys and girls (corrected for age) is significant at the 1 per cent. level. This can be seen from the distribution for the two sexes plotted in Fig. 5 (opposite).

(The diagrams show the numbers of children with each amount of corneal power. The corneal power is not corrected for age since this makes little difference. It is seen that, although there is a great overlap, the distribution for boys is shifted to the left).

FIG. 5.—Distribution of corneal power in myopic girls and boys.

The mean corneal power for girls was 44.418, and that for boys was 43.605, a difference of 0.813 (Table I).

TABLE I
ANALYSIS OF VARIANCE ON WHICH CONCLUSIONS ARE BASED

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square
Between sexes (corrected for age)	46.830	1	46.830†
Overall slope	11.456	1	11.456
Between slopes of the sexes	2.434	1	2.434
Variation about regression lines	137.231	35	3.921
Residual	504.640	115	4.384

† 1 per cent significance.

The apparent change with age in boys shown in Fig. 1 was not significant. Longitudinal studies would be necessary to confirm this finding which would then be in line with the results obtained for girls.

Table II (overleaf) gives an idea of the range of corneal power found for a given degree of myopia and also shows that, in all except two instances, the girls showed both a higher maximum and a higher minimum value for corneal power at each level.

The biggest difference in girls between maximum and minimum was 7.9 D and in boys it was 6.5 D; the smallest difference was 5 D and 2.8 D respectively.

TABLE II
RANGE OF CORNEAL POWER AT VARYING STAGES OF MYOPIA

Sex	Corneal Power	Level of Myopia (dioptries)					
		0/0.9	1/1.9	2/2.9	3/3.9	4/4.9	5 +
Boys	Minimum	41.6	39.7	40.6	40.0	41.7	41.5
Girls		42.1	42.2	41.5	41.8	41.1	42.1
Boys	Maximum	47.5	46.2	47.0	46.5	44.5	46.1
Girls		47.2	47.5	47.2	49.2	49.0	47.1

Discussion

A difference in corneal curvature not related to the degree of myopia is seen between the sexes in myopic children by the age of 9. Figures for younger children were not always reliable, but their trend was similar and it is impossible to say at what age this difference may first be found. It seems very unlikely that it is anything to do with the sexual changes of puberty since it appears rather early and may therefore be a congenital characteristic.

Stenstrom (1946) analysed a series of adults, of whom 315 were female and 685 males, but in his comparison he mentioned the difference in distribution of refractive errors in his two groups, myopes being more numerous amongst the females than the males. He did not consider that in adults the difference between the sexes in corneal curvature was significant because of this difficulty, and he quoted Steiger (1895), who also failed to find any significant difference between the means for corneal curvature. None the less, both these authors found that the female cornea was more curved than the male, and their reasons for dismissing its significance on grounds of lack of homogeneity of the refractive errors they were studying do not obtain in considering the present results. Since there appears to be no correlation between corneal power and the degree of myopia it is not evident that there is any need for their reasoning.

Sorsby, Benjamin, Davey, Sheridan, and Tanner (1957) reported a small series of 23 children, 10 female and 13 male, who showed wide variations in refraction, and in whom there was no difference between male and female corneal curvatures, but with such small numbers this might well happen by chance.

A possible, but unlikely, alternative explanation of these discrepancies is that these differences between male and female are found only in myopes.

A longitudinal study is in preparation to show how the corneal power changes in the individual myopic child with growth. The fact that there is a difference between the sexes indicates that great care must be taken in selecting a population for these studies.

Furthermore, studies in which any measurement of the differential optical contents of the parts of the eye are being considered should also be strictly governed by the sex of the individuals concerned. This follows from the fact that, if the total refraction is in part due to the anterior curve of the cornea, then at any given level the part of the system posterior to this curve must compensate for a given total refraction. A careful differentiation along these lines might show that some of the rather baffling difficulties arising out of analyses of these values may be more easily resolved. For instance, in these children the corneal power related to age in Fig. 4 showed little or no relationship between the two, though it would have done if these had been mainly boys at the lower ages and mainly girls at the older ages in a study of a mixed population. The evidence, such as it is (though Fig. 1 suggests that further investigation into boys is necessary), indicates that corneal power changes remarkably little in these children with age, even though in the main their myopia is slowly increasing.

Although this work has been carried out on myopes only, an extension of it to cover other types of refractive errors in children would be advisable and longitudinal studies may be helpful.

Conclusion

The corneal power in myopic children is unrelated to the degree of their myopia, but is related to their sex.

It is probably not related to their age, more certainly in girls than boys. Longitudinal studies might be of help in deciding this.

It is desirable, as a consequence of this finding, that surveys of the optical contents of the different parts of the eye should be performed separately for each sex.

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