

REFRACTION OF PREMATURE BABIES' EYES

BY

M. V. GRAHAM, M.B., F.R.C.S.
F.R.C.S.Ed., D.O.M.S.
Consultant Ophthalmologist, United Cardiff
Hospitals

O. P. GRAY, M.B., M.R.C.P., D.C.H.
Senior Lecturer, Department of Child Health, Welsh
National School of Medicine; Consultant
Paediatrician, United Cardiff Hospitals

The only large survey of the refractive state of the eyes of premature babies to be conducted in the neonatal period was that of Fletcher and Brandon (1955). These authors studied 462 premature infants and followed them up for at least six months. They found a high and fluctuating myopia during the neonatal period which was more exaggerated in smaller infants than in those with more mature eyes. They noted that there was a close relationship between myopia and retrolental fibroplasia and found no fewer than 136 infants with the latter condition. They stated as early as 1950 that all premature infants had myopia.

There have been other studies of the eyes of children born prematurely. These have been conducted when the children were aged 3 years and over, and done with standard ophthalmological technique, and may therefore be regarded as accurate and representative of the refractive state of the children at this later age.

The present study was stimulated because of the almost total disappearance of retrolental fibroplasia in recent years and the much greater attention paid to the control of oxygen therapy to premature infants. Moreover, it was felt that previous reports of the refractive status in the neonatal period may have been inaccurate because of the technique employed.

Method of Examination Employed

Cycloplegia of the infants was obtained by instillation of two drops of 0.05% hyoscine into each conjunctival sac one hour before examination. This is the method recommended by Sorsby *et al.* (1955). The baby is removed from the incubator and held by a nurse on a trolley. He is coaxed into sucking a teat dipped into glycerin. He at once opens his eyes and the gaze becomes directed downwards and forwards. Sometimes gentle elevation of the upper lid by the examiner is

necessary to produce good exposure. Spectacle refraction is performed in both the vertical and the horizontal meridian, placing corrective lenses 12 mm. from the cornea and correcting for working distance. The streak retinoscope is used for this purpose. The corrective lenses are graded in 0.5 dioptres. Ophthalmoscopy completes the examination.

The observations were made as soon as it was deemed reasonable to remove the baby from the incubator for the brief time necessary for the examination. Table I shows that the majority of the babies were examined within the first four weeks, but a few were 5 weeks old before the initial examination was carried out. There was no case selection; all the premature babies admitted to the unit were examined. This consecutive series started in October, 1960, and the results up to July, 1962, are presented. In compiling the results the figures obtained from the vertical meridian of the right eye only were used. All babies weighing less than 5½ lb. (2,500 g.) were included in the series.

Table II shows that the majority of the infants were in the larger weight group and only 16 were less than 3 lb. (1,360 g.). This is the distribution of the weights of premature babies to be expected in any random series. There were only 15 babies of weight greater than 5 lb. (2,270 g.) in this series, because in this hospital babies

TABLE I—Age of Premature Babies at Examination

Age in weeks	1	2	3	4	5	6	8	Not known
No. examined	26	36	46	20	6	2	1	13

TABLE II.—Weight Distribution of Premature Babies

Birth weight in pounds and ounces	<2	2-2.15	3-3.15	4-4.15	5-5.8
No.	2	14	52	67	15

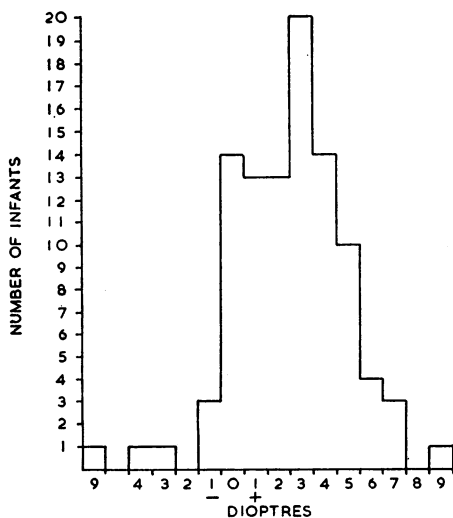


FIG. 1

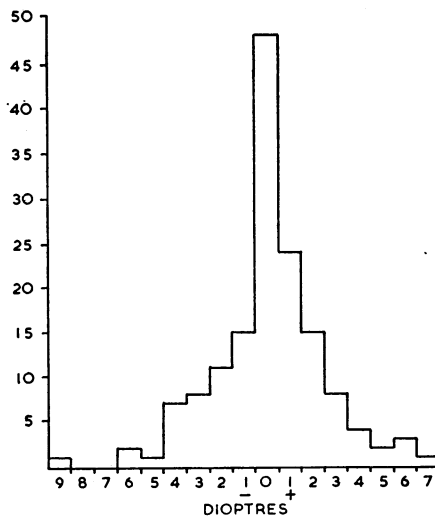


FIG. 2

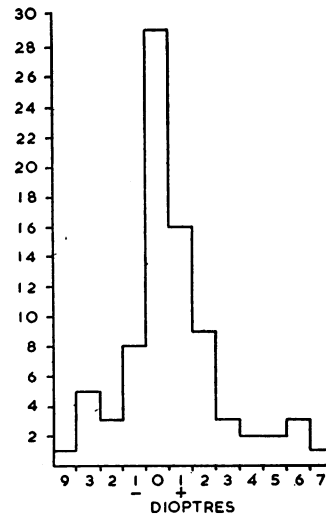


FIG. 3

FIG. 1.—Refractive state of normal full-term infants. FIG. 2.—Total premature babies. FIG. 3.—Refractive state of infants weighing 4 to 5½ lb. (1,815 to 2,500 g.).

over 4½ lb. (2,040 g.) are not admitted to the unit unless there is need for special care.

Results

A control series of 98 full-term normal infants were examined within the first week of life. The results are shown in Fig. 1. It would seem that moderate hypermetropia is the rule for the normal full-term baby in the first week of life.

The total number of premature babies to be examined was 150 (Fig. 2). The range of the refractive errors encountered was from -9 to +6.5 D: 72 (48%) of the babies were within the range of emmetropia to +1 D and 102 (68%) were within the range -1 to +2 D.

While 45 of the premature babies were myopic by more than -0.5 D, the greater proportion were hypermetropic. There were 82 infants within the weight range of 4-5½ lb. (1,815-2,500 g.). Their refractive state is shown in Fig. 3. The range of refractive errors in this group extended from -9 to +7 D. The majority of these babies were emmetropic: 45 (55%) were within the range of emmetropia to +1 D, and 62 (75%) were

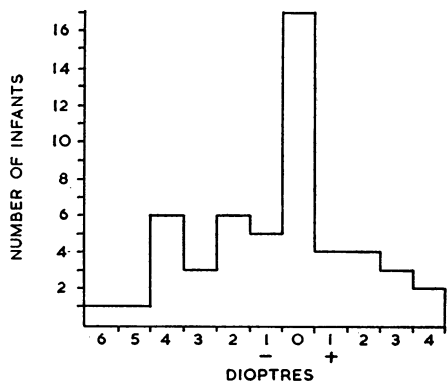


FIG. 4.—Refractive state of infants weighing 3 lb. to 3 lb. 15 oz. (1,360 to 1,785 g.).

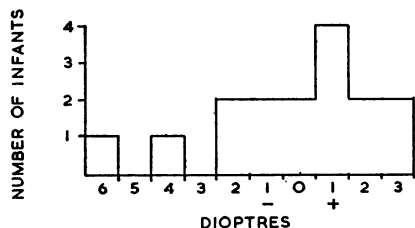


FIG. 5.—Refractive state of infants weighing less than 3 lb. (1,360 g.).

within the range of -1 to +2 D. Again, while there were 17 infants with myopia, more (36) had low degrees of hypermetropia.

There were 52 infants weighing from 3 lb. to 3 lb. 15 oz. (1,360 to 1,785 g.). The result of their refraction is shown in Fig. 4. The numbers with emmetropia were smaller proportionately than in the higher weight group: 21 (40%) were within the group 0 to +1 D and 30 (58%) were within the range -1 to +2 D. Twenty-two of the babies were myopic and 13 were hypermetropic in this weight group.

Sixteen of the babies weighed less than 3 lb. (1,360 g.) (Fig. 5). The range of refraction was from -6 to +3 D. Six (27%) of these babies were within the range of emmetropia to +1 D, and 10 (62%) were from -1 to +2 D. Once again there is the tendency for these babies to have low degrees of hypermetropia.

Table III shows the deviation of the horizontal from the vertical meridian in both eyes of premature babies. The total number with astigmatic errors was 23 out of the total of 300. The maximum deviation encountered was 7 D.

Table IV shows the difference between the vertical meridians of both eyes. The total number of babies having a difference of more than 1 D was 45. The

TABLE III.—Astigmatic Error in Either Eye of Premature Infants (Total 300 Eyes). Deviation of Horizontal from Vertical Meridian

From To	-6.0 D -6.9 D	-3.0 D -3.9 D	-2.0 D -2.9 D	-1.0 D -1.9 D	+1.0 D +1.9 D	+2.0 D +2.9 D	+3.0 D +3.9 D	+4.0 D +4.9 D
No.	1	3	3	6	4	3	2	1

TABLE IV.—Difference Between Vertical Meridians of Both Eyes of Premature Babies (Total 300 Eyes). Deviation of Left Eye from Right Eye

From To	-4.0 D -4.9 D	-3.0 D -3.9 D	-2.0 D -2.9 D	-1.0 D -1.9 D	+1.0 D +1.9 D	+2.0 D +2.9 D	+3.0 D +3.9 D
No.	3	1	10	14	14	2	1

maximum deviation noted between the two eyes was 5.5 D.

Relationship to Oxygen Administration.—The practice in this unit for infants requiring oxygen is to administer it in an incubator at the rate of 1 to 1.5 litres per minute. The concentration achieved at this rate is measured frequently and has not exceeded 38%. We have plotted the refractive error against the duration of oxygen therapy in Fig. 6. In the 105 cases analysed there was no connexion between the two.

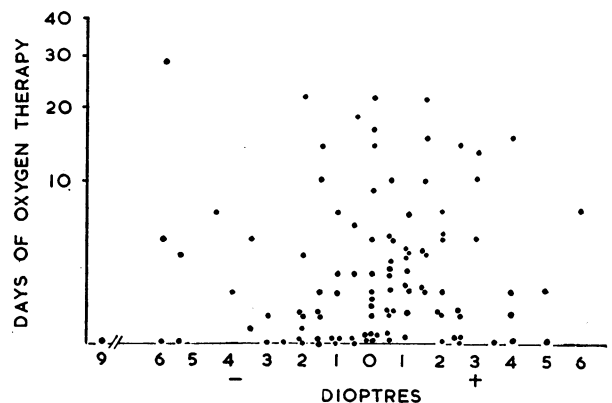


FIG. 6.—Refractive error plotted against duration of oxygen therapy.

Discussion

A comparison of the refraction of full-term and premature babies (Fig. 7) shows that there is a definite tendency towards myopia in premature infants. This myopia when present is low in degree; only one case of more than -6 D was found; a baby with -9 D. A similar single instance of -9 D was found in the full-term series. In no case of myopia was a myopic crescent noted.

The results obtained in the premature babies' eyes in this investigation differ sharply from previous series in their tendency to follow the pattern of the adult curve. Wagner (1957) surveyed the eyes of 104 children who were born prematurely and found that 25 of these were emmetropic. Two (8%) of these emmetropes had oxygen during their first week. Fifty children were

hypermetropic. Six (12%) of these babies had oxygen for an average of four days. He stated that the more severe the hypermetropia the lower the birth weight, and noted that girls were more frequently affected. Wagner concluded that hypermetropia should be expected in children of low birth weight who have had either anaemia or oxygen therapy. Myopia was found in 28 children (26.9%). Again it was found that there was an increase in myopia with the decrease in birth weight. Wagner stated that, whereas the hypermetropic children had neither needed oxygen treatment nor been

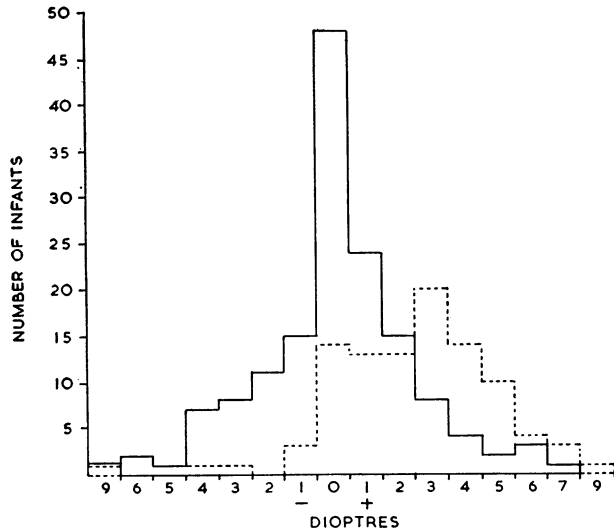


FIG. 7.—Comparison of refraction of full-term and premature babies. Continuous line=premature babies. Dotted line=full-term babies.

anaemic in 90% of cases in the first week of life, in these 28 babies with myopia only 5 (17%) were without these complications (presumably anaemia and oxygen therapy are meant). In other words, 23 out of 28 babies with myopia had had oxygen or been anaemic. Later in the paper that author says that there were 10 who had myopia and who had not had oxygen. Further, he states that in the years 1951-3, in which his patients were born, oxygen was given in an open system, but the exact regulation of the dosage and concentration was not made. It should be noted that although he refracted the eyes after atropine instillation the children were between the ages of 3 and 5 years at the time of the investigation. Therefore this is not a series describing the eyes of premature babies in the neonatal period.

Castrén (1955) quotes Brander's study of 375 premature infants with the finding of myopia in 2.4%; systematic ophthalmological examinations of his patients were not made. In Castrén's own study of premature babies there was hypermetropia in 90% and myopia in 3.7%, whereas with full-term infants there was hypermetropia in 94% and myopia in 2.3%. These babies were examined at school at the age of 9-11 years.

Fletcher and Brandon's (1955) examination of 462 premature infants' eyes was prompted by their observation in 1950 that all premature infants had a high and fluctuating myopia. Their data suggested a significantly higher degree of myopia in the small infant weighing less than 1.5 kg. compared with the larger infants weighing more than 1.7 kg. at birth. They also noted a significantly higher degree of myopia in infants who subsequently developed retrolental fibroplasia. They also observed that small infants weighing less than

1.5 kg. have immature eyes with a myopia from -10 to -20 D, and this myopia may fluctuate as much as 20 D. While it appears that their infants were examined fairly shortly after birth, the method of estimating the refraction of the eye is inaccurate and the details of opening the infants' eyes are not given. They recorded the least minus lens of the ophthalmoscope necessary to focus clearly on the retinal vessels at the disk margin. They recognized that the method was inexact for determining the degree of myopia, but stated that considerable effort was made to find the degree of error induced by accommodation on the part of the infant or the examiner. Only 45 infants in this series received atropine and approximately 10 infants were retinoscoped with and without atropine or cycloplegic. They recorded in these approximately 10 cases the same high and fluctuating myopia, but they noted it was slightly less with the cycloplegic. Two infants weighing approximately 1.5 kg. were retinoscoped and found to be accommodating rapidly but infrequently by at least 6 D. Despite this, the authors concluded that accommodation was probably of little significance in the observed myopia of prematurity, but thought changes in curvature and position of the lens may be important.

In the present series great care was taken to eliminate infants' accommodation on every occasion by the careful instillation of hyoscine. We agree with Fletcher and Brandon's (1955) observation that even very small babies can accommodate several dioptres, and in order to be of value any estimations of an infant's refraction must be made with the infant's eye paralysed for accommodation. Likewise, the only method of eliminating observer accommodation is by using retinoscopy.

We believe that it is important to open the infant's eyes with least interference. Instrumental retraction of the lids is not easy. It may not be possible to avoid compression of the eyeball in an infant who is crying and resisting examination. It is possible that pressure on the eyeball in previous series has led to the erroneous conclusion of a fluctuating myopia. The method employed in the present investigation ensured easy opening of the babies' eyes without any instrumentation, and hence there was no possible deformation of the globe.

Summary

A series of 150 premature babies and 98 full-term babies were retinoscoped after cycloplegia in the neonatal period. Moderate degrees of hypermetropia are the rule in full-time infants. Premature infants showed a tendency to low myopia or emmetropia. There was no relationship between the present oxygen regime and the refractive state.

We are indebted to Professor A. G. Watkins and Professor Arnold Sorsby for their generous help, encouragement, and advice; to Sister N. M. Lloyd Jones, the nursing staff of the Cardiff Maternity Hospital, and the registrars in the Department of Ophthalmology for their assistance in the examinations; to Dr. F. K. Storrington, who kindly assisted with foreign translations; and to Mr. Ralph Marshall, Department of Medical Illustration, Cardiff Royal Infirmary, for preparing the diagrams. Finally we are indebted to Miss E. Heide and to Mrs. J. Flache for secretarial assistance.

REFERENCES

- Castrén, J. (1955). *Acta ophthalm. (Kbh.) Suppl.* 44.
 Fletcher, M. C., and Brandon, S. (1955). *Amer. J. Ophthalm.*, **40**, 474.
 Sorsby, A., Sheridan, M., Moores, N., and Haythorne, J. (1955). *Lancet*, **2**, 214.
 Wagner, G. (1957). *Klin. Mbl. Augenheilk.*, **131**, 326.