



Morphological Study of Eyeball in Developing Human Foetuses

KEYWORDS

Gestational Ages, Human Foetal eyeball, Dimensions.

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ABSTRACT *The eyeball is the organ of vision. The eyeball begins to develop at 4th week of gestation and at term, the eyeball is relatively well developed compared to the rest of the body. There have been very few studies on the morphological development of the eyeball during foetal life. So the aim of the present study was to measure the dimensions of the eyeball of human foetuses from 13 weeks to 40 weeks of gestational age. The antero-posterior, transverse and vertical diameters of eyeball were measured by using vernier calliper in 112 eyeballs from 56 foetuses. All the diameters of eyeball increases as gestational age increases linearly up to the 32 weeks after 33 weeks the diameters were increases but slower. The antero-posterior diameters of eyeball were greater than transverse and vertical diameter.*

Introduction

The eye begins to develop as a pair of optic vesicles on each side of the forebrain at the end of the 4th week of pregnancy. Optic vesicles are outgrowing of the brain which makes contact with the surface ectoderm and this contact induces changes necessary for further development of the eye. Several layers such as the neural tube, neural crest, surface ectoderm, and mesoderm contribute to the development of the eye. At term, the eyeball is relatively well developed compared to the rest of the body, and the most active stage of its development is between 6 months and term, time normally spent in utero².

There have been very few studies on the morphological development of the eyeball during foetal life. Most of the morphological studies of the eyeball have been done on children and human adults in vivo with help of MRI or ultrasound and have required correction for optical or sonic distortion³.

Till recently measurement of eyeball dimensions and lens diameter was performed only in vitro. Many of the measurements of other ocular dimensions would be easier and more

accurate if also conducted in vitro. However, because of the limited availability of ex vivo

Human tissues, very few data have been obtained on the human foetal eyeball. So the aim of the present study was to examine growth of the human eyeball from midgestation to gestation up to the birth.

Materials and Methodology

56 Foetuses from 13 to 40 weeks were collected from MGM Hospital Kalamboli and MGM Hospital Aurangabad, Maharashtra, India after the approval from institutional

ethical committee of MGMIHS. CRL (crown rump length), CHL (crown heel length) and foot length were measured with thread and scale in cm. for estimating the gestational weeks followed by recording the weight of foetus in grams. Then we were done the grouping of foetuses and each group contains 4 foetuses.

The studies were carried on 112 eyeballs from 56 male foetuses at MGM Medical College, Kamothe, and Navi Mumbai, India.

Inclusion criteria: spontaneous aborted foetuses from normal mother.

Exclusion criteria: Decomposed and developmental anomalies foetuses.

The Eyeballs were taken out through the orbit its anterior aspect with help of dural forceps (figure-1) and then the superior and temporal side of the eyeball marked with waterproof colour pen for the determination of side. In a small number of cases, where the foetal eyeball was flaccid, the eyeball was re-inflated by injecting balanced salt solution (BSS, Alcon Inc, Fort Worth, TX) into the vitreous cavity, via an oblique self sealing insertion of a 30 ga needle through the posterior sclera, until IOP, assessed by palpitation (Birnbach and Leen, 1998) reached about 20 mmHg⁵. Measurements of eyeball dimensions were performed, after removing surrounding fat and extra-ocular muscle stumps, using digital vernier calipers (0.01 mm readout) as first described by Nakagawa et al. (2000)¹⁴. The anterior-posterior diameters of the eyeball were measured from the corneal apex and a point on the posterior sclera at the temporal side of the optic nerve insertion. The transverse diameter measured between nasal and temporal side of the eyeball and vertical diameter measured between the peak of superior and inferior side of the eyeball (figure -2, 3, 4).



Figure-1 showing the enucleating eyeball



Figure-2 showing the measurement of vertical diameter of eyeball



Figure-3 showing the measurement of transverse diameter of the eyeball



Figure-4 showing the measurement of anterior-posterior diameter of eyeball

Observation and Results

Diameters of the eyeball were obtained from 56 human foetuses (112 eyeballs from both side) ranged from 13 to 40 weeks. The antero-posterior (AP), transverse (T) and vertical diameters of the eyeball, as a function of age since conception, are presented in table-1. The AP, transverse and vertical diameters of eyeballs were increases rapidly from 13weeks to 32 weeks of gestational age thereafter the diameters of eyeballs increases but slowly. Also the anterior-posterior diameter was greater than the transverse and vertical diameter and the vertical diameter was the shortest throughout the 12th to the 40th week of gestational ages (table-1 and graf-1). There was no difference between the right and left side of eyeball.

Following tables and figures showing the diameters of the eyeball in developing human foetuses.

Figure – 5 showing the graphical presentation of the diameters of eyeball.

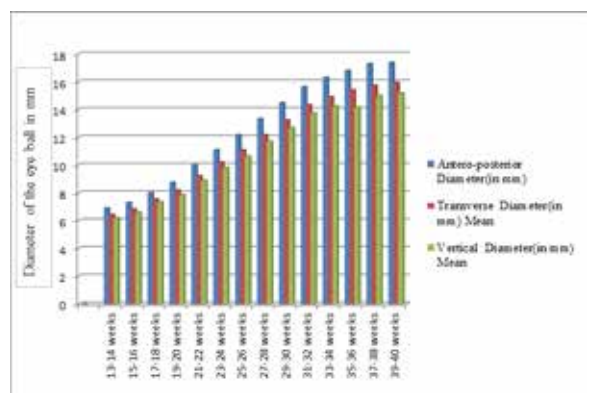


Table – 1 showing the diameters of the eyeball.

Gesta-tional weeks	No. of Fe-tuses	No. of Eye-ball	Antero-posterior Diameter(in mm) Mean	Transverse Diameter(in mm) Mean	Vertical Diameter(in mm) Mean
13-14 weeks	4	8	6.9	6.43	6.2

15-16 weeks	4	8	7.3	6.83	6.6
17-18 weeks	4	8	8	7.55	7.35
19-20 weeks	4	8	8.75	8.18	7.86
21-22 weeks	4	8	10	9.23	8.89
23-24 weeks	4	8	11.1	10.20	9.82
25-26 weeks	4	8	12.18	11.08	10.64
27-28 weeks	4	8	13.33	12.18	11.69
29-30 weeks	4	8	14.48	13.23	12.69
31-32 weeks	4	8	15.63	14.33	13.74
33-34 weeks	4	8	16.30	14.90	14.25
35-36 weeks	4	8	16.80	15.40	14.17
37-38 weeks	4	8	17.30	15.73	15.00
39-40 weeks	4	8	17.39	15.94	15.18

Discussion

In the present study we have collected the morphological measurements of the human foetal eyeball from midgestation to the birth. Our results indicate that the growth of the eyeball increases linearly parallel throughout the 13th to the 32th weeks of gestational age and after 33weeks the growth of the eyeball was parallel but slower. So our results are matching with the Kenji Harayama et.al¹⁰.

Also the Ewa Tomasik et.al showed that the anterior-posterior and transverse diameter of the eye as well as depth and width of the orbit increases with age⁶. An increase in the anterior-posterior length of the eye is associated with the increase of orbital depth, while the increase in the transverse diameter of the eye is associated with the increase in orbital width.

In a recent review Park and Karesh, 2006 was stated that the horizontal diameter of the eyeball is slightly greater than the vertical¹⁵. Some earlier studies Weale, 1982 also appear to suggest this, but no statistical evaluations were performed¹⁹. We found the same difference that is anterior-posterior diameter was greater than transverse and vertical diameter.

According to the previously reported data, the eyeball is about 1.0 mm in its average sagittal diameter at 9 weeks and from 3 to 7 mm during the 4th month. The average sagittal diameter of the eyeball reaches 10 to 14 mm during the 7th month and 16-17 mm in the 9th month. The present study showed that the anterior-posterior diameter at 4th month was 6.9 to 7.3mm, in 7th month 12.18 to 13.33mm and in 9th month 16.30 to 16.80mm. Data on the transverse and vertical diameters of the eyeball are even more scanty. For the transverse diameter there are the observations at birth by von Jaeger (50 eyes), Weiss (14 eyes) and Schneller (33 eyes), and the respective averages are 17.2, 16.4 and 17.0 mm. For the vertical diameter the only relevant data are those by Weiss, who recorded an average of 15.0 mm. Scammon & Armstrong give computed values of 17.1 mm. for the transverse and 16.5 for the vertical diameter^{16,17,18,19}. In the present study the mean transverse diameter of the eyeball at the birth 15.94mm and vertical diameter 15.18mm.

So the present study will give detailed knowledge of eyeball dimensions and how they change with age are of considerable value in understanding ocular growth in premature babies and the development of pathologies such as myopia.

Conclusion

All the diameters of the eyeball increases as gestational age increase from midgestation upto the birth. Anterior-posterior diameter of the eyeball was greater than transverse and vertical diameter and the vertical diameter of the eyeball was smaller than the transverse diameter.

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