**MR Imaging of the Fetal Eyes: Normal and Abnormal Development**

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**Purpose**
To define easily identifiable and reproducible measurements of normal anatomic development of fetal eyes in vivo.

**Introduction**
Current measurements of binocular and interocular distances are defined by ultrasound and are measured according to the bony landmarks of the medial and lateral orbital walls. These bony landmarks cannot be seen on fetal MR, and therefore these ultrasound criteria cannot be directly applied to MR imaging. The vitreous, however, is well-defined and easy to measure.

**Materials & Methods**
Retrospective analysis of the coronal and axial orbital views was performed in 190 consecutive fetal MR examinations obtained for CNS and non-CNS indications. Analysis included measurement of binocular distance, interocular distance and ocular diameter (usually calculated). These were plotted against gestational age. Fetuses with abnormalities affecting the eyes were evaluated separately.

**Normal Measurements by Ultrasound**

Measurements should ideally be made in the axial plane, with both eyes of equal and largest possible diameter.

The binocular distance is measured between the two malar margins.

The interocular distance is measured between the two ethmoidal margins of the orbits.

On US, the lenses and vitreous are both hypoechoic. The lens outlines however can be seen as hyperechoic ovoids anteriorly.

On MRI the whole lens is low-signal compared to the high-signal of the vitreous.

**Normal Measurements by MRI**

**Binocular Distance (BOD)**
The binocular distance (BOD) is measured between the two malar margins of each vitreous.

**Interocular Distance (IOD)**
The interocular distance (IOD) is measured between the two ethmoidal margins of each vitreous.

**Ocular Diameter (OD)**
The ocular diameter (OD) is measured between the malar and ethmoidal margins of the vitreous. If the eyes are symmetrical, it can be calculated:

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\text{OD} = \frac{(\text{BOD} - \text{IOD})}{2}
\]

**Abnormal fetal eyes by MRI**

- **Hyperelorism** in frontonasal dysplasia
- **Cyclopia** in holoprosencephaly
- **Exophthalmos & hypertelorism** in Pfeiffer syndrome
- **Coloboma & severe microphthalmia** with occipital flattening in Cat Eye syndrome, partial trisomy 22q
- **Microphthalmia & anophthalmia** in Matthew-Wood syndrome
- **Microphthalmia – asymmetric** in Walker-Warburg syndrome (fetus also had typical cortical & brainstem features)
- **Microphthalmia, hypertelorism & irregular lens** persistent hyperplastic primary vitreous in trisomy 22

**Scan technique**
Measurements were performed using Single Shot Fast Spin Echo images. Our standard sections are 3mm @ 1.5mm intervals (256x256 matrix) & 4mm at 3mm intervals (256x256 or 512x512 matrix), respiratory gated.

**Results**
Of 197 scans evaluated, 146 had suitable images for measurements, and 16 of these were abnormal. Normal growth of binocular distance, interocular distance and ocular diameter are charted below, with the respective measurements by ultrasound for comparison.

**Conclusion**
There is linear growth of the binocular distance, interocular distance and ocular diameters throughout gestation. These biometric measurements can now be easily made and compared against our normal growth charts to support suspected orbital pathologies and syndromes that may give rise to them.

**Suggested reading:**