Fetal Lateral Ventricular Width: What Should Be Its Upper Limit?
A Prospective Cohort Study and Reanalysis of the Current and Previous Data

Benny Almog, MD, Ronni Gamzu, MD, PhD, Reuven Achiron, MD, Ofer Fainaru, MD, Yaron Zalel, MD

Objective. The upper limit of the fetal atrial width in normal fetuses is debated. This was a prospective cohort evaluation of the lateral ventricular width with special regard to the upper limit of its size. Methods. Measurements of fetal atrial ventricular size were obtained by abdominal ultrasound in 427 male and female fetuses between 20 and 40 weeks’ gestation of normal singleton pregnancies. In addition, reanalysis of previous data (8 studies) and the current data was performed to produce a pooled mean and SD. Results. The mean ventricular width ± SD was 6.2 ± 1.2 mm. The ventricular width did not show significant modification throughout gestation. Reanalysis of the current and previous studies (8216 cases) yielded a pooled mean of 6.4 ± 1.2. Conclusions. According to the current and previous studies, the upper cutoff of fetal ventricular atrium width should be 10 mm. This cutoff represents a range of approximately 3 SDs above the pooled mean, corresponding to a 99.74% confidence interval. Key words: fetal cerebral lateral ventricle; mild ventriculomegaly; prenatal diagnosis; ultrasonography.

Ventriculomegaly is one of the most common sonographically detected fetal abnormalities. It has a substantial adverse effect on fetal outcome and may be associated with additional abnormalities. Because of its serious implications, it has become an important part of routine prenatal ultrasonographic evaluation. Various components of the ventricular system can be measured and used to define ventriculomegaly. Currently, transverse measurement of the atrium is commonly suggested as the point of reference. A measurement of greater than 10 mm, which represents 2.5 to 4 SDs above the mean, has been considered abnormal in most series. Nonetheless, many fetuses with isolated mild ventriculomegaly, i.e., atrial enlargement of greater than 10 mm, turned out to have no abnormalities on neonatal assessment. This finding raises the question of whether the statistically computed cutoff value of 10 mm is appropriate. Differences in fetal measurements in different population groups and differences between sexes...
should make this decision even more complicated.12–15

Accordingly, we conducted a prospective cohort study in 427 normal pregnancies and reanalysis of additional 7789 cases to evaluate the atrial size of the lateral ventricle throughout gestation with special regard to its upper limit.

Materials and Methods

A prospective cohort study was conducted to establish the range of the atria of the cerebral lateral ventricle in normal gestation. The study group consisted of pregnant women who fulfilled the following criteria: (1) history of regular menses and a known date of the beginning of the last menstrual period; (2) gestational age based on sonographic measurement of the crown-rump length in early pregnancy (in cases in which the last menstrual period–crown-rump length difference was >10 days, the pregnancy was dated by the crown-rump length measurements); (3) a fetus whose estimated fetal weight was between the 10th and 90th percentiles; (4) absence of maternal disease; and (5) absence of fetal malformations.

Ventricular size was obtained during routine ultrasonographic examination performed to rule out malformations and during routine third-trimester ultrasonographic follow-up. Each patient was examined only once during the study by 1 examiner (Y.Z.). Ultrasonography was performed with an abdominal 3.5- to 5-MHz curvilinear transducer (Synergy; Diasonics, Tirat Carmel, Israel; or Ultramark HDI 3000; Philips Medical Systems, Bothell, WA). Freeze-frame ultrasonographic capabilities and electronic on-screen calipers were used for the measurements. Ventricular width at the atria was measured slightly above the level of the thalami. The electronic calipers were positioned perpendicular to the falx along the inner aspect of the echogenic line corresponding to the ventricular wall (Fig. 1). Each measurement was repeated 3 times in each fetus, and the mean size was determined. The coefficient of variation was 2.2%. The mean ventricular width ± SD was 6.2 ± 1.2 mm. The ventricular width did not show significant modification throughout gestation. Table 1 presents the means, SDs, 5% and 95% CIs, and 4 SDs above the means of ventricular width for consecutive gestational ages between 20 and 40 weeks. Ventricular width as a function of gestational age was expressed by the following regression equation: atrial width (millimeters) = 3.87 + 0.09 × gestational age (weeks). The correlation coefficient, \( r = 0.38 \), was found to be highly statistically significant (\( P < .0001 \)). However the positive statistical correlation was not clinically significant. Figure 2 presents a scatterplot of ventricular width (millimeters) in relation to gestational age (weeks), showing a regression line with the 98% CI.

Results

Measurements of ventricular width were obtained in 427 fetuses between 20 and 40 weeks’ gestation. The intraobserver variability, as determined by the coefficient of variation, was 2.2%. The mean ventricular width ± SD was 6.2 ± 1.2 mm. The ventricular width did not show significant modification through the entire gestation. Table 1 presents the means, SDs, 5% and 95% CIs, and 4 SDs above the means of ventricular width for consecutive gestational ages between 20 and 40 weeks. Ventricular width as a function of gestational age was expressed by the following regression equation: atrial width (millimeters) = 3.87 + 0.09 × gestational age (weeks). The correlation coefficient, \( r = 0.38 \), was found to be highly statistically significant (\( P < .0001 \)). However the positive statistical correlation was not clinically significant. Figure 2 presents a scatterplot of ventricular width (millimeters) in relation to gestational age (weeks), showing a regression line with the 98% CI.
Table 2 presents mean ventricular widths and SDs of this study and 8 previous studies. The pooled mean (6.4 mm) ± 3 SDs correspond to 10 mm as an upper limit.

Discussion

We conducted this study to obtain data on the normal upper limit of fetal ventricular atrial width in fetuses without abnormalities and, thus, to reanalyze the upper limit of these measurements in the literature. The mean ventricular width ± SD was 6.2 ± 1.2 mm. The ventricular width did not show significant modification throughout gestation, as was previously stated. This stability gives the atrial size great potential utility for sonologists in prenatal diagnosis.

McGahan and Phillips were the first to turn attention to the ventricular atrium in 1983. Siedler and Filly retrospectively reviewed 90 examinations and showed a range of atrial measurement between 4 and 8 mm. Cardoza et al retrospectively evaluated 100 healthy fetuses and found a mean atrial size ± SD of 7.6 ± 0.6 mm. These authors were the first to suggest 10 mm as the upper cutoff, being computed as 4 SDs above the mean. Other studies presented lower averages, however, usually with a higher SD (Table 2), as in this and our past series.

Several studies supported the use of 10 mm as the upper limit of the ventricular atrial width by the use of either 2 or 4 SDs above the mean. Conversely, Pretorius et al and Hilpert et al suggested higher upper normal limits such as 11 and 12 mm, respectively. The pooled average of all these studies (8216 cases) ± SD is 6.4 ± 1.2 mm. The 10-mm cutoff represents a range of approximately 3 SDs above the mean, corresponding to a 99.74% CI. This upper limit, however, should also be validated by the clinical outcomes of borderline dilatation (10–12 mm).

The clinical significance of isolated mild ventriculomegaly, i.e., an atrial diameter of 10 to 15 mm, was recently evaluated in 2 reviews. It was concluded that even in its mildest form (10–12 mm of dilatation), a 3.7% rate of abnormal karyotypes and a 7.7% rate of developmental delay were encountered. Thus, it should be suggested that atrial size of 10 to 12 mm should be defined as a borderline pathologic condition, which requires further follow-up and consideration of additional diagnostic studies.

Figure 2. Scatterplot of ventricular width (millimeters) in relation to gestational age (weeks) showing the regression line with the 98% CI.
evaluations (i.e., karyotype). Accordingly, ventriculomegaly represents a range of pathologic conditions from isolated mild ventriculomegaly to the dismal situation of hydrocephalus with associated defects.

This study further highlights the upper limit of ventricular size, which is highly significant with regard to fetal abnormalities in the presence of ventriculomegaly.

References


Table 2. Measurement of the Lateral Ventricular Atrium in Populations Without Abnormalities According to Different Series

<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of Cases</th>
<th>Ventricular Width, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Hilpert et al³</td>
<td>608</td>
<td>6.5</td>
</tr>
<tr>
<td>Cardoza et al⁴</td>
<td>100</td>
<td>7.6</td>
</tr>
<tr>
<td>Pilu et al⁵</td>
<td>171</td>
<td>6.9</td>
</tr>
<tr>
<td>Heiserman et al⁶</td>
<td>52</td>
<td>6.5</td>
</tr>
<tr>
<td>Achiron et al⁷</td>
<td>5400</td>
<td>6.6</td>
</tr>
<tr>
<td>Patel et al⁸</td>
<td>219</td>
<td>6.1</td>
</tr>
<tr>
<td>Farrell et al⁹</td>
<td>739</td>
<td>5.4</td>
</tr>
<tr>
<td>Alagappan et al¹⁰</td>
<td>500</td>
<td>6.6</td>
</tr>
<tr>
<td>This study</td>
<td>427</td>
<td>6.2</td>
</tr>
<tr>
<td>Calculated average</td>
<td>8216</td>
<td>6.4</td>
</tr>
</tbody>
</table>


