THE DEVELOPMENT OF INTERATRIAL ORRIFICE, MORPHOMETRIC STUDY

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Summary

Introduction: The early diagnosis of the cardiac malformations involves a permanent clinical evaluation of the fetal heart development. The correct assessment of the fetal heart dimensions and their evolution through the study of the aborted fetuses in ontogenesis could offer useful dimensional landmarks.

Materials and methods: For an accurate assessment of interatrial orifice size and variability based on gestational age, we studied a number of fifteen fetal hearts harvested from aborted fetuses aged between 150 and 210 days. Initially we have separated the heart-lung block and then we have isolated the heart. We used as a mode of dissection the incision and transection. We measured the height and width of each interatrial and interventricular septum, the dimensions of Botallo’s foramen at different ages. Finally the results were statistically processed and they were correlated with the size of heart and the foetal age.

Results and discussion: During early fetal development increased interatrial orifice size is proportional to the increase in heart size and gestational age and follows a relatively steep upward curve. Subsequently, there is a decrease in hole size of Botallo’s foramen curve, becoming steep downward with the same issue.

Conclusions: The ratio between the surface of Botallo’s foramen and the surface of interatrial septum presents a linear variation of reverse type fetal age.

Key words: morphology, heart development, interatrial foramen.

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Introduction

Prenatal diagnosis is essential in the evolution of pregnancy.

The illustration of the cardiac structure is essential for definitive diagnosis of cardiac anomalies and has significant implications for prenatal therapy and choose how to complete the task (Gembruch, 1997; Jaeggi et al, 2001).

For early and correct diagnosis, we considered necessary the practical assessment of fetal heart dimensions and following in dynamic some parameters, through the study of aborted fetuses.

We tried to obtain, through macroscopic measurements, some dimensional and structural landmarks for the development of interatrial opening.

Clinical monitoring of the fetal heart development is currently done by modern methods such as: tridimensional fetal echocardiography, dynamic 3D Color Doppler to analyze blood flow (Helberg et al, 2003; Bhat et al, 2004).

These studies are performed on fetuses with or without congenital heart disease, of different ages, in order to establish the normal cardiac morphology, physiological growth rate and to early detection of the anomalies (Helberg et al, 2003).
Tridimensional echocardiography is an innovative method for diagnosis and evaluation of congenital heart disease (Vogel et al, 1994; Marx et al, 2002).

This method has some limitations still unresolved.

One is to establish accurately with the time, the three-dimensional image during the cardiac cycle.

Static reconstruction of the cardiac structure, using this method, can not be performed correctly due to dynamic changes in anatomy of the heart, during the cardiac cycle.

**Materials and methods**

For an accurate assessment of interatrial orifice size and variability based on gestational age, we studied a number of fifteen fetal hearts, harvested from aborted fetuses aged between 150 and 210 days.

Initially we have separated the heart-lung block and then we have isolated the heart. We used as a method of dissection the incision and transaction.

We opened the pericardial sac and heart was revealed, then we showed interatrial and interventricular septa, the atrio-ventricular valvular apparatus.

We measured the height and width of each interatrial and interventricular septum, the dimensions of Botallo’s foramen at different ages (Fig. 1, 2, 3).

Finally the results were statistically processed and they were correlated with the size of heart and the foetal age.

Knowledges of the normal dimensions of the interatrial orifice and their variability, depending on gestational age, is necessary to diagnose the interatrial septal defect (Cheng, 2000)).

Through this study we proposed the exact assessment of dynamic interatrial orifice dimensions, and the amount of the ratio between the surface of Botallo’s foramen and interatrial septum.

Anatomopathologically, the interatrial septal defects are observed in 10% of necropsy cases of fetuses died in perinatal period (Keeling, 1987).

We considered to be interatrial septal defect when the orifice size is larger than 10 mm, with persistent postnatal or when there is premature closure, prenatal of the orifice.

The latest situation has the effect of intrauterine fetal death.

Interatrial septum is formed by fusion of the septum primum with septum secundum, septum intermedius and septum spurium.
During dissection, after entering the left atrium, we evidence the interatrial orifice and we measured longitudinal and transverse diameters of its (Fig. 4, 5, 6).
Fig. 6. Morphological appearance of the interatrial opening.
(fetal age 28 and 30 weeks)

After measuring the diameters, we calculated the surface of the interatrial orifice, considering the opening ellipsoidal in shape. Subsequently we performed measurements of the width and height of interatrial septum. After measurements of the septum base length and height, we proceeded to calculate its surface.

Results and discussion
Measurement results were expressed in millimeters and are represented in the table below (Table. I).

The values of the transverse diameter of the interatrial orifice, obtained by anatomical study and directly measured, ranged from 6.8 mm at 26 weeks to 2.6 mm at 30 weeks.

Larsen WJ. (Larsen, 1997) considered as normal the interatrial orifice size from 3 mm at 18 weeks to 6 mm at 40 weeks.

After his studies, Pelinescu-Onciul (Pelinescu-Onciul, 1998) considers that the normal value of the interatrial opening at birth is 5 mm.

As can be seen from the table presented, some of the values obtained in this study are consistent with these limits.

Values greater than 8 / 12 mm are considered to be interatrial septal defect (Jamjureeruk, 2003; Kiserud, 2001).

Table 1

<table>
<thead>
<tr>
<th>Fetal age</th>
<th>150</th>
<th>160</th>
<th>169</th>
<th>179</th>
<th>189</th>
<th>197</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse diameter of the Botallo’s foramen</td>
<td>3.8</td>
<td>4.6</td>
<td>6</td>
<td>6.8</td>
<td>6.5</td>
<td>4.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Longitudinal diameter of the Botallo’s foramen</td>
<td>2.7</td>
<td>3.3</td>
<td>4</td>
<td>4.7</td>
<td>4</td>
<td>2.8</td>
<td>1.8</td>
</tr>
<tr>
<td>I-A septal area</td>
<td>63.24</td>
<td>72.75</td>
<td>80</td>
<td>111.24</td>
<td>110</td>
<td>127.56</td>
<td>142.08</td>
</tr>
<tr>
<td>Area of Botallo’s foramen</td>
<td>32.23274</td>
<td>47.68938</td>
<td>75.36</td>
<td>100.4053</td>
<td>81.64</td>
<td>36.94513</td>
<td>14.70265</td>
</tr>
<tr>
<td>Area of Botallo’s foramen / Area IA Sept</td>
<td>0.509689</td>
<td>0.655524</td>
<td>0.942</td>
<td>0.902601</td>
<td>0.7421</td>
<td>0.289698</td>
<td>0.103482</td>
</tr>
</tbody>
</table>
During early fetal developmental period, increased interatrial orifice size is proportional to the increase in heart size and gestational age and follows a relatively steep upward curve.

Subsequently, there is a decrease in the size of the Botallo’s foramen, the curve becoming steep downward with the same appearance (Fig. 7).

Regarding the surface of the Botallo’s foramen, I noticed that during the entire studied period, presents a non-linear correlation with fetal age (CI = 0,150199916).

The growth is not uniformly accelerated, fact attested by different growth rates.

In the first 10 days of this period we noticed a slight decrease within the septal area which coincides with the start shrinking of the Botallo’s foramen area (about 20 mm²).

If we considered the fetal age and the ratio of surface area of the Botallo’s foramen and the interatrial septum we observed an inverse linear variation (CI = -0, 50).

As fetal age increases, the ratio between Botallo orifice area /IA septal area decrease because first decreases the orifice area and, on the other hand, increased interatrial septal area (Fig. 8).

In the period between 150-170 days, Botallo’s foramen area reaches 0, 94% of septal area and keep it until day 180 to 0.90%.
Is a critical period in fetal development, in the transition from II to the III trimester of pregnancy, when its metabolic needs require a greater quantity of blood received from the placenta (Fig. 8).

Preparation for the end of the gestational period materializes by relatively abrupt and significant reduction of size of Botallo’s foramen which shrinks from about 100 mm² until 14.70 mm².

Is a new critical period for a fetus that has largely defined its functional systems, going to improve them to support the stress of birth and transition to life outside the mother's habitat.

Sometimes, the lack of cardiac morphofunctional adaptation can lead to serious circular consequences, in the absence of any injuries or congenital malformations.

**Conclusions**

Morphometric parameters of the heart changes continuously during fetal development. During early fetal development, increased interatrial orifice size is proportional to the increase in heart size and gestational age and follows a relatively steep upward curve.

Later there is a decrease in the size of the Botallo’s foramen, after a sharp curve downward with the same issue. The ratio of surface area of the Botallo’s foramen and the surface area of the interatrial septum, presents a linear variation of reverse type with the fetal age (CI = -0, 50).

**References**


