The Value of the 3rd Trimester Echography in Fetuses with Cardiac Malformations

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Abstract

Objective: *Analysis of ultrasound diagnostic concordance between fetuses diagnosed with heart abnormalities and newborn babies.*
Material and method: *The present study was conducted over a period of 13 months, from January 2009 to January 2010, in Targu-Mures. Were studied 16 pregnancies addressed to Obstetrics and Gynecology Clinic I and Pediatric Cardiology Clinic, for fetal cardiac anomalies. Were used ultrasound sections described the International Society of Ultrasound in Obstetrics and Gynecology.*
Results: *The 16 newborn babies were evaluated with a concordance of diagnostic ultrasound in 15 of 16 fetuses, the diagnosis of large coarctation of aorta and valvular aortic stenosis, being established only in one neonate.*
Conclusions: *Accurate diagnosis cardiac anomalies in the third quarter of pregnancy can be very good, when exploring a fetus already suspected this type of malformation is made by a team of obstetricians and pediatric cardiologists.*
Keywords: *congenital fetal heart malformations, ultrasonography*

Introduction

Congenital heart malformations vary according to different authors between 4-13 for 1000 live new born infants[6,11,13,14,15,18,22, and 34]. Between 1950 and 1994 the World Health Organisation reported a percentage of 42% from the deaths of children being caused by heart defects[17,28]. The percentage of prenatal diagnosis of heart anomalies varies between 17,9 and 55,6%, and of these the majority was diagnosed between 20 and 24 weeks[29].

The growth in the percentage of the diagnosis of fetal heart malformations in utero was reached through training echographists and increase in device resolution[27]. Factors that influence the diagnosis of fetal heart anomalies are related to the training of echographists, the complexity of the lesions, other structural or fetal chromosomal anomalies, and the patient's index of body mass[33]. The heart anomalies can be emphasized within the fetal screening of 18-22 weeks, in the percentage described above, which is why an ultrasound test at a more advanced pregnancy doesn't bring supplementary structural data according to some authors[32]. However echographies from the 3rd semester are useful for the evaluation of possible complications (e.g. a progressive heart insufficiency on a tricuspid valve displasy with insufficiency). The neonatal results are obviously better for fetuses with diagnosis known ante partum, especially in the case of complex malformations such as the transposition of large vessels[5,35], as well as in the case of lesions dependent on the persistent arterial canal. There are also anomalies of aortic coarctation type, which poses major problems of safe diagnosis in utero even when other heart anomalies are suspicioned or associated[3]. The echographic follow up of fetal heart pathology is necessary for the choice of the way of birth, the moment of labour beginning, or of a planned cesarean operation[12]. Birth through cesarean operation in fetuses diagnosed in utero with heart anomalies may reach a percentage of 41,5% and 70% from the total of births are planned[20].

Preoccupations regarding the echographic methodic evaluation of the fetal chord and of the new born exist from years 1970-1980[2,30,31]. The years 2000 reaffirm the necessity of the segmentary analysis of the fetal or neonatal chord, with three stages: the atria, ventricles and great vessels[7,8, and 17]. The present study proposes to analyze the concordance of echographic diagnosis, between the fetuses found with heart anomalies and the new born ones.

Material and method

The present study was performed over a period of 13 months, from January 2009 to January 2010, in Targu Mures. In this period we chose a cohort of 16 pregnant women, addressed to the Clinic of Obstetric Gynecology I and the Clinic of Pediatric Cardiology respectively, for known fetal heart anomaly, detected in different regions of the country, at the echographic pregnancy screening. Pregnant women had a 3rd semester pregnancy, with unique fetus and without other fetal anomalies, and all the new born had a normal phenotype.

Each fetus with heart anomalies was examined by a staff composed of at least two obstetricians and two pediatric cardiologists. Each pregnancy was examined in the 3rd semester (average gestational age 33 weeks). The same day we practiced a 2D fetal echocardiography, in B-mode, Doppler CFM and pulsed Doppler, using two devices for each fetus - a Voluson730 Pro and a Philips I U 22, by the entire medical staff. Postpartum specialists in pediatric cardiology did an echocardiography to the newborn infant, the first day and then repeated after 5 and 14 days, using Philips echograph.

The exploration methodology of the fetal chord

We used the sections described by the International Echography Society in Obstetrics and Gynecology in 2006 and by different authors[7,10,15,17,24,34] making up the fetal echocardiogramme. The normal echographic sections, upon first recognizing the fetal presentation and position, are:

- **Plan 0** - section at high abdominal level that emphasizes the left position of the stomach and spleen, in comparison to the vertebral body. The descending aorta is found in front of the vertebral body and towards the left and the inferior vena cava forward and to the right of the aorta. The liver is found in the right side of the abdomen, with the hepatic veins;
- **Plan 1** - is the four room section, which is obtained from plan 0, through translating the probe in fetal cranial direction. Usually this plan is slightly transversal through the fetal thorax for the optimal simultaneous image of both atria, both ventricles, both atriventricular valves, the interventricular and interatrial septum, foramen ovale. Often in this plan we have the connections of the lung veins with the left atrium. The pericardium may have a minimal anecogene zone that is not to confuse with a collection. This plan evaluates the localization of the chord in the thorax with the apex on the side of the stomach, with two thirds from the surface of this heart section in the left hemithorax. The direction of the interventricular septum is synonymous with the cardiac axe that makes 45 degrees (± 15 degrees) with the anteroposterior thoracical diameter. The size of the fetal chord in this plan does not have to surpass a third of the thorax surface. The heart rhythm and contractility may be evaluated in this plan, as well as the mobility and closing of tricuspid and mitral valves, in B-mode, M-mode, Doppler Color Flow Map (CFM) and pulsed Doppler. The tricuspid is inserted somewhat closer to the heart apex than the mitral. The right ventricle is the one near the sternum, it has obvious trabecules and moderating band - the papillary muscle, the lumen extends less close to the apex as compared to the left ventricle;
- **Plan 2** - through the sweeping or leaning (angulation) towards the fetal skull of the echographic probe, without translating it, starting from "4 rooms" section (plan 1) we can get the section with apparent 5 rooms, in fact the origin of the aorta from the left ventricle. Upon passing from the "4 rooms" section to the "5 rooms" section we emphasize the ventricular septum continued with the aorta, we can exclude the defect of perimembranous ventricular septum and the possible dextroposition of the aorta ("riding aorta");
- **Plan 3** - continuing the sweeping of the transductor more cranial than plan 2, we get the lung trunk that normally proceeds from the right ventricle. In this plan the lung trunk with fork in the two lung arteries, is found left from the aorta, and the aorta in its turn at its left from superior vena cava. Plan 2 and 3 indicate the ventriculo-arterial concordance. Through the method of sweeping we can evaluate perpendicularity of the aorta towards the lung trunk and the origin of these. The lung trunk is normally bigger than that of the aorta and the caliber of the lung valve is 1, 2 times that of the aortic valve. The use of Doppler CFM in plan 2 and 3 may follow the direction of the ventriculo-arterial flow;
- **Plan 4** - through the translation of the cranial probe to plan 1, 2 and 3, we get the thoracic transversal plan with the three great vessels - anterior from the left to the right, the three vessels are collinear: the lung trunk, then somewhat smaller in diameter - the ascending aorta, then smaller and to the right on the imaginary line - the superior vena cava. Posterior towards the line of the three great vessels, but anterior to the vertebral we find again the descending aorta;
- **Plan 5** - derives from plan 4, through a sweeping of the transduction from plan 4, we get a tangential section to the aortic arch and isthmus, as well as at the communication with the lung trunk through ductus arteriosus. The lung trunk, situated to the left, forms a "V" with the aorta. In front of the arterial duct, the top of this "V" is situated backwards and slightly to the left from the vertebral body. Right from this "V" we find the inferior vena cava and at its rear, echogenic, the trachea. This plan is very important to be analyzed with Doppler CFM, the blood flow from both "arms of the V" following the direction through the descending aorta and normally having the same colour[8,9,23];
- **Plan 6** - is a longitudinal section of the heart, anteroposterior and paravertebral, that emphasizes the aortic arch and its three vessels from posterior to anterior: the left subclavian artery, the common left carotid artery and anterior to the brachycephalic trunk. Through the probe translation we can also get a sagital plan through the right atrium, called by others "the bicaval plan" in which we emphasize the connections between the two cava veins. From this position of the trasductor we can sweep towards the fetal caudate right part, and we get images with the umbilical vein, ductus venosus, hepatic veins and the connection with the right atrium;

■ **Plan 7** - is a parasagital plan, derived, also like plan 8 from the standard examination in "4 rooms" and "2 rooms" from the pediatric and adult echocardiography, that emphasizes the left atrium, the left ventricle, the mitral valve ("the left ventricular inflow tract") as well as the left ventricle, the aortic valve and the aorta ("left ventricular outflow tract");

■ **Plan 8** - is the "short axe" of the heart, which is obtained at the level of the aortic valve, perpendicular to the parasagital plan. It consists of the structures that seem to "surround" the aorta: the right atrium, the tricuspid valve and the right ventricle ("right ventricular inflow tract") as well as the right ventricle with the valve and the lung fork ("right ventricular outflow tract").

All the observations related to anomalies found by the team of specialists in the 9 section plans were written down and finally we formulated a diagnosis of the fetal chord.

In new born infants, we got a bidimensional echocardiography with at least four localizations of the transductor: parasternal, apical, subcostal and suprasternal[25,34]. The use of 2D, B-mode, M-mode and Doppler CFM, Doppler pulsed echography led to the formulation of a diagnosis in the new born infants with heart anomaly.

In the new born the echocardiographic examination was done sequentially. We started by establishing the abdominal and atrial situs from the subcostal incidence, using the transversal plan, longitudinal respectively. We visualize both the systemic and lung veins. For the identification of the innominated vein and lung veins we use the suprasternal incidence. The lung can also be visualized from 4 rooms apical. The interatrial septum is optimally examined from the subcostal incidence - the coronal and sagital plan.

The echocardiographic examination continued by establishing the atrioventricular connection from 4 rooms apical, identifying, based on anatomic criteria, the two atrioventricular valves, mitral, tricuspid respectively, knowing that atrioventricular valves correspond to the ventricles. An atresic atrioventricualar connection, a ventricular hypoplasia respectively is easy to identify from 4 rooms apical. We continued with the examination of the interventricular septum - the membranous portion, muscular respectively (inlet, trabecular, and outlet). For the visualization of all interventricular septum components we approached a series of incidences - apical 4, parasternally long axe, basally short parasternal axe. The echocardiographic examination continued with the establishment of the ventriculoarterial connection possible from the parasternal long and short axe incidences, 5 rooms apical, the coronal and sagital subcostal incidences.

The atrioventricular connection may be consistent, when the aorta emerges from the left ventricle and the lung artery from the right ventricle, or inconsistent, when the aorta emerges from the right ventricle and the lung artery from the left ventricle. The third possible type of ventriculoarterial connection is the "double outlet" type. We also followed the relation of the great vessels from parasternal high short axe and from suprasternal incidences, the last being useful for the visualization of lung branches. The anatomy of coronary arteries was established from the parasternal short axe an incidence. The anatomy of coronaries has a great importance especially in the transposition of great vessels[1].

Outcomes

The 16 fetuses were grouped according to the type of malformation described intrauterinely:

- 3 fetuses with transposition of great vessels;
- 2 fetuses with tricuspid dysplasia;
- 1 fetus with right ventricle with double exit way with "side by side"vessels, ventricular septal defect, hypoplasic left ventricle, average mitral stenosis;
- 1 fetus with syndrome of left hypoplasic heart, atresia of mitral valve, atresia of aortic valve, aorta hypoplasia;
- 1 fetus with atresy of lung valve, right ventricle severely hypoplasic, severe tricuspidian insufficiency;
- 2 fetuses with common atrioventricular canal;
- 1 fetus with heterotaxic syndrome - heart dextroposition with the vessels on the right, the hepatic veins are drained directly in the right atrium, the bicuspid aortic valve;
- 1 fetus with isthmic aorta coarctation, aortic bicuspidy;
- 1 fetus with common arterial trunk type I;
- 2 fetuses with supraventricular paroxistic tachycardia;
- 1 fetus without certain diagnosis in utero, as new born in echographic diagnosis - large aorta coarctation, valvular aortic sthenosis.

The 16 new born infants were echographically evaluated with a diagnosis concordance of 15 from 16 fetuses, the diagnosis of large aorta coarctation and valvular aortic sthenosis, being established only in the new born.

A single new born baby died 2 days postpartum - the fetus with syndrome of left hypoplasic heart (unique functional ventricle), atresia of mitral valve, atresia of aortic valve, aorta hypoplasia.

Other 6 new borns suffered surgical interventions, and the two with paroxistic tachycardia are under treatment with amiodarone. The other 7 new born are in the evidence of the Clinic of Pediatric Cardiology, some of them being already scheduled for surgical interventions.

Discussions

The "in utero" diagnosis concordance with the postnatal one of the heart anomalies is, according to different studies, of:

- 91% on a cohort of 260 fetuses with heart anomalies[26];
- 84.21% on a cohort of 95 fetuses with heart anomalies [19]
- 80.8% - 97 fetuses of 120 new born with heart malformation[16];
- 62% of 209 fetuses with heart anomalies confirmed by the pediatrician cardiologist, of 268 fetuses suspected of malformations by the obstetrician[21];
- 87% on 31 fetuses evaluated by the obstetrician and 92% on fetuses evaluated by the pediatric cardiologist only[4].

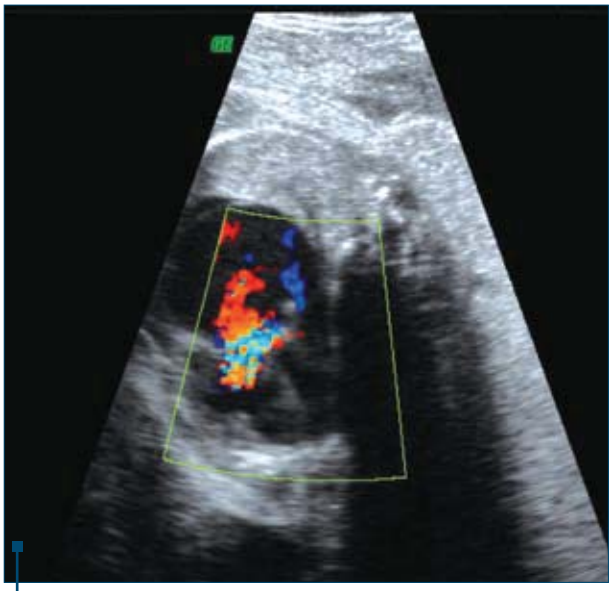

Figure 1. Displasy of tricuspid valve in the 4 rooms section in fetus, with CFM Doppler

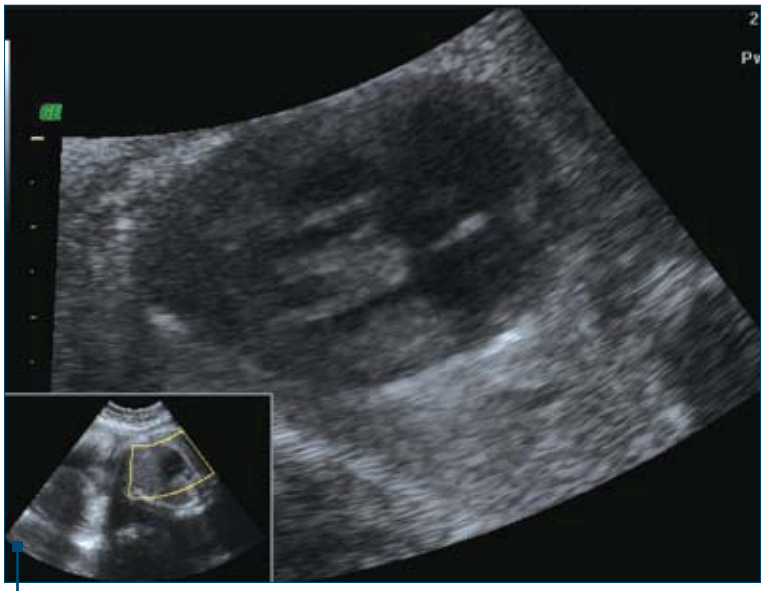

Figure 2. Common atrioventricular canal in the 4 rooms section in fetus

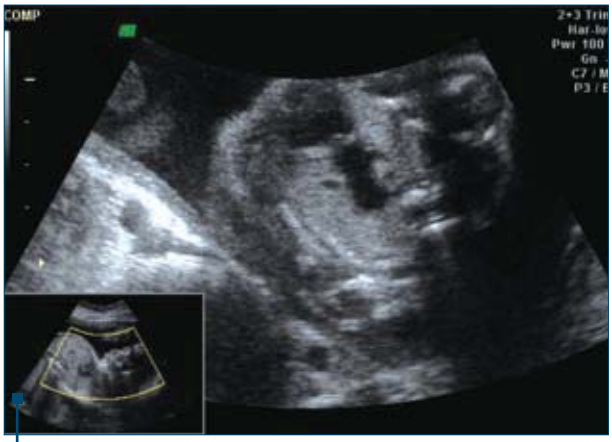

Figure 3. Common arterial trunk type I in fetus, section 3 great vessels

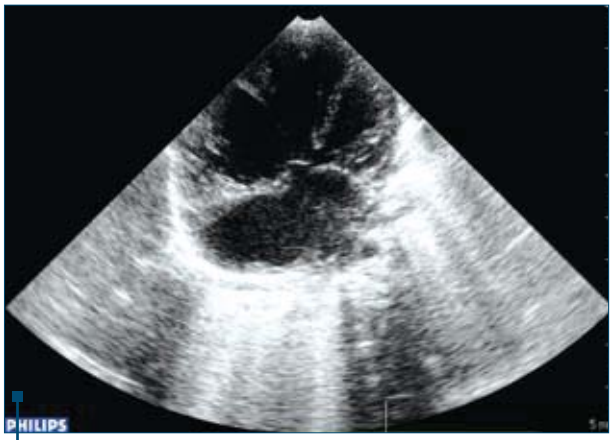

Figure 4. Common atrioventricular canal in the 4 rooms apical section - in new born

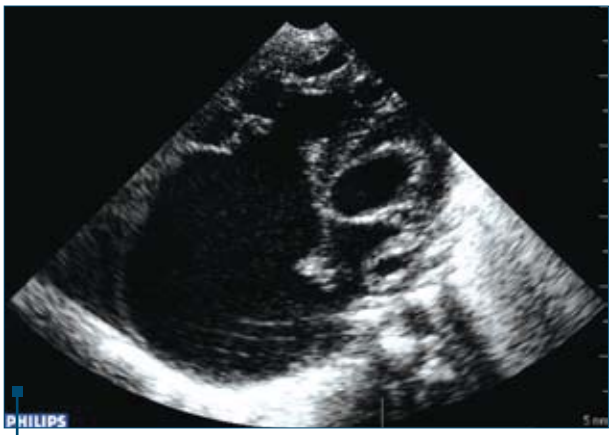

Figure 5. Displasy of tricuspid valve in 4 rooms apical section - in new born

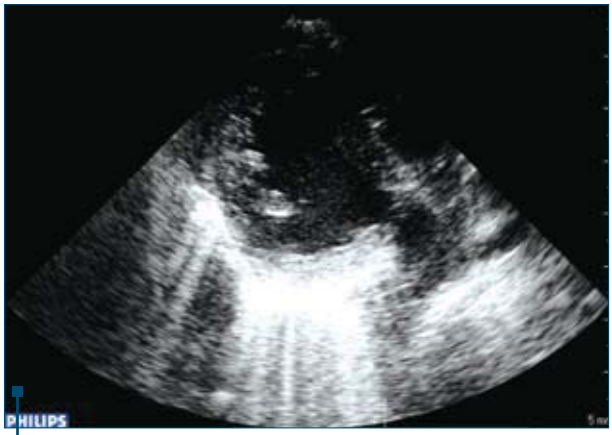

Figure 6. Transposition of great vessels with interventricular septal defect in the parasternal incidence - long axe, in new born

The reduced numerical cohort, presented in this study, as well as the different examination methodology, make comparison to other studies difficult. In the studies presented we discuss about the physician's specialization - obstetrician or pediatrician cardiologist - that established the "in utero" diagnosis, usually on a single type of echography device. In our present study each examination was conducted the same day on two types of devices, with the pros and cons of each regarding 2D standard image and Doppler, and the medical team formed each time tried to add experience from both specialties which practice echography - obstetrics and pediatric cardiology. The sole fetus with uncertain diagnosis of heart anomaly is part of the pathology that still represents a real challenge for the "in utero" diagnosis - the large aorta coarctasis[3]. The good results obtained so far make us want to be perseverant in our methodology, but also to use new devices, softs or ultrasound applications.

Conclusions

The accuracy in the diagnosis of heart anomalies in the 3rd trimester of pregnancy may be very good, when the exploration of a fetus already suspected with this type of malformation is done by a mixed team of obstetricians and pediatric cardiologists. The permanent training and interdisciplinary cooperation in the cardiofetal echography may bring only advantages to the patient "in utero". ■

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