Congenital heart diseases that are detectable using the three-vessel view

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Abstract

Congenital heart defects are the most common congenital malformation found in fetuses. The majority of ultrasound screening protocols recommend as mandatory the following views for the examination of the fetal heart: 4 chamber and ventricular outflow tracts. The 3-vessel view alongside its variant, the 3-vessel trachea view, are considered optional planes for routine screening. A series of congenital heart defects are mainly visible and detectable in these two views, so including these views in the screening protocol may be beneficial. We identified three types of congenital heart defects that are usually detected using the 3-vessel and 3-vessel trachea views: aortic coarctation, right aortic arch, and the persistence of left superior vena cava. All three malformations had a characteristic appearance on the aforementioned views. Taking into account the role they have in detecting these specific congenial heart defects, the 3-vessel and 3-vessel trachea view prove their role in evaluating the fetal heart and may improve the detection of ultrasound screening.

Keywords: *3-vessel view, conotruncal malformations, congenital heart defects, aortic coarctation, right aortic arch, left superior vena cava*

Rezumat

Defectele cardiace congenitale reprezintă cel mai frecvent tip de malformație congenitală întâlnită la făt. Majoritatea protocoalelor de screening ecografic recomandă ca obligatorii următoarele imagini sau secțiuni ecografice pentru evaluarea cardiacă: imaginea de 4 camere, imaginile cu tracturile de ejecție a ventriculilor. Imaginea de 3 vase, alături de varianta sa, imaginea de 3 vase și traheea, sunt considerate secțiuni opționale pentru screeningul ecografic. O serie de defecte cardiace congenitale sunt vizibile și detectabile pe aceste imagini, astfel încât includerea lor în protocolul de screening poate fi benefică. Am identificat trei tipuri de malformații care sunt detectate, de obicei, folosind secțiunea de 3 vase și secțiunea de 3 vase și traheea: coarctația de aortă, arcul aortic drept, persistența de venă cavă superioară stângă. Toate cele trei malformații au un aspect caracteristic pe secțiunile ecografice menționate anterior. Având în vedere rolul pe care îl au în detectarea acestor malformații cardiace, imaginea de 3 vase, alături de imaginea de 3 vase și traheea își dovedesc rolul pe care îl au în evaluarea cardiacă fetală și ar putea îmbunătăți rata de detecție a screeningului ecografic.

Cuvinte-cheie: *imaginea de 3 vase, malformații conotruncale, defecte cardiace congenitale, coarctație de aortă, arc aortic drept, venă cavă superioară stângă*

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Malformații cardiace fetale detectabile pe secțiunea de trei vase

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Introduction

Congenital heart defects (CHD) are the most frequent type of malformations found in fetuses. The incidence varies between 12-14 per 1000 live births, but can be as high as 50 per 1000 live births if less severe CHD such as the persistence of left superior *vena cava* are taken into account[1,2]. Although some of them may be only minor, they must not be overlooked, as they can be a sign of a genetic disease or of more severe malformations. The majority of ultrasound screening protocols state only the 4-chamber and ventricular outflow views as mandatory, but encourage the visualization of other views used in fetal echocardiography when possible[3-5]. The 3-vessel view (3VV) and its slightly more cephalic variant, the 3-vessel trachea view (3VT), are usually considered optional scanning planes in screening protocols. Nonetheless, a series of CHD are visible mainly on these two planes, so by making them mandatory screening planes, the rate detection for CHD might be increased. We set out to describe the ultrasound elements that define the normal 3VV and 3VT views. Also, we will present three types of CHD that are detected using only or mainly these two planes.

Method

To define the normal ultrasound appearance of the 3VV and 3VT views, we used the original articles of Yoo et al. and Yagel et al.[6,7] for documentation, who described these views, and also the 2013 updated ISUOG guideline[4]. Although there are numerous articles in literature on this topic, the basic definition and ultrasound characteristics of the two views have remained largely unchanged.

Regarding the CHD that are detected with the help of the 3VV and 3VT, we analyzed the cases included in the PhD thesis "Secțiunile 4 camere și 3 vase – rol în

evaluarea cardiacă fetală". These cases were scanned by ultrasound and collected by Dr. Doru Herghelegiu and Dr. Cătălin Gabriel Herghelegiu between 2016 and 2019. The gestational age of the fetuses varied between 20 and 30 weeks. The ultrasound examinations were performed using Voluson 730Expert, E8 ultrasound machines, and transabdominal curvilinear transducers were used. Only those cases with abnormal 3VV and/or 3VT views, but normal 4 chamber and outflow tract views were included.

Results and discussion

The 3VV is a transverse section of the thorax at the level of the upper mediastinum. To avoid slightly oblique planes, it is recommended that only one rib should be visible on each side of the thorax. From right to left and from posterior to anterior, 3 vessels are observed: the superior vena cava, the ascending aorta, and the pulmonary trunk continuing posteriorly with the *ductus arteriosus* (Figure 1A). The 3 vessels are arranged in a straight line and from small to large, the inferior *vena cava* being the smallest and the pulmonary trunk being the largest. The 3VT is located slightly more cephalic and has the advantage of allowing the visualization of a transverse section of the aortic arch. In this plane, the aortic arch and *ductus arteriosus* converge towards the descending aorta and form a characteristic "V" sign and both vessels are similar in dimension (Figure 1B). Also, the relationship of the two arteries with the trachea can be assessed in this view. Normally, they are both situated to the left of the trachea.

A total of 8 cases of CHD with abnormal 3VV and/or 3VT views, but normal 4 chamber and outflow tract views were identified. Regarding the types of CHD, there were encountered the following: three cases of aortic coarctation (AoCo), two cases of right aortic arch (rAo), three cases of persistent left superior vena cava (LSVC).

Aortic coarctation

Only 3 cases of the total of 9 cases of AoCo identified had a normal 4-chamber view (the ventricles having roughly the same size) and were included in the study. In only one case, the 3VV view was abnormal, with the diameter of the ascending aorta being slightly diminished in comparison with the pulmonary trunk and having a dimension similar to that of the superior *vena cava* (Figure 2A). This is because only in severe cases of AoCo the whole aortic arch is narrowed, most of the times only the distal portion being affected. On the 3VT, all three cases had an abnormal appearance, with the aortic arch being considerably stenotic in the isthmus portion and considerably smaller than the *ductus arteriosus* (Figure 2B). It is recommended to orient the thorax with the spine at 3 or 9 o'clock, in order to avoid ultrasound shadowing from the vertebra and to better assess the size of the aorta and *ductus arteriosus*. Although the diagnosis of aortic coarctation is best to be established on sagittal planes, which allow the visualization of the whole aortic arch, these planes are often hard to be obtained, especially near the end of the pregnancy, because of the fetal position and the ultrasound shadowing produced by the ossified vertebra and scapula. Thus, in these suboptimal (examination) conditions, the 3VT can be a valuable tool in diagnosing AoCo, a pathology that in some cases evolves and aggravates towards the end of the pregnancy.

Right aortic arch

The two isolated rAo cases displayed a characteristic pattern on the ultrasound images. On the 3VV, the

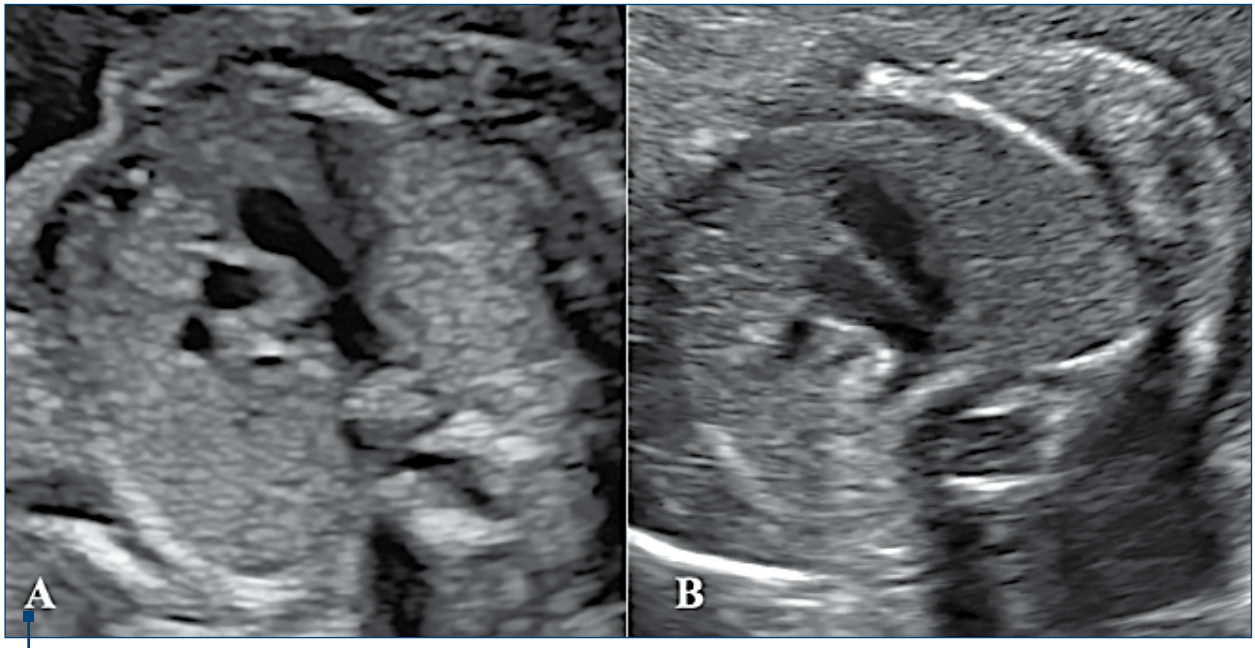

Figure 1. *Normal 3VV view (A) and 3VT view in 23-week and 22-weeks fetuses*

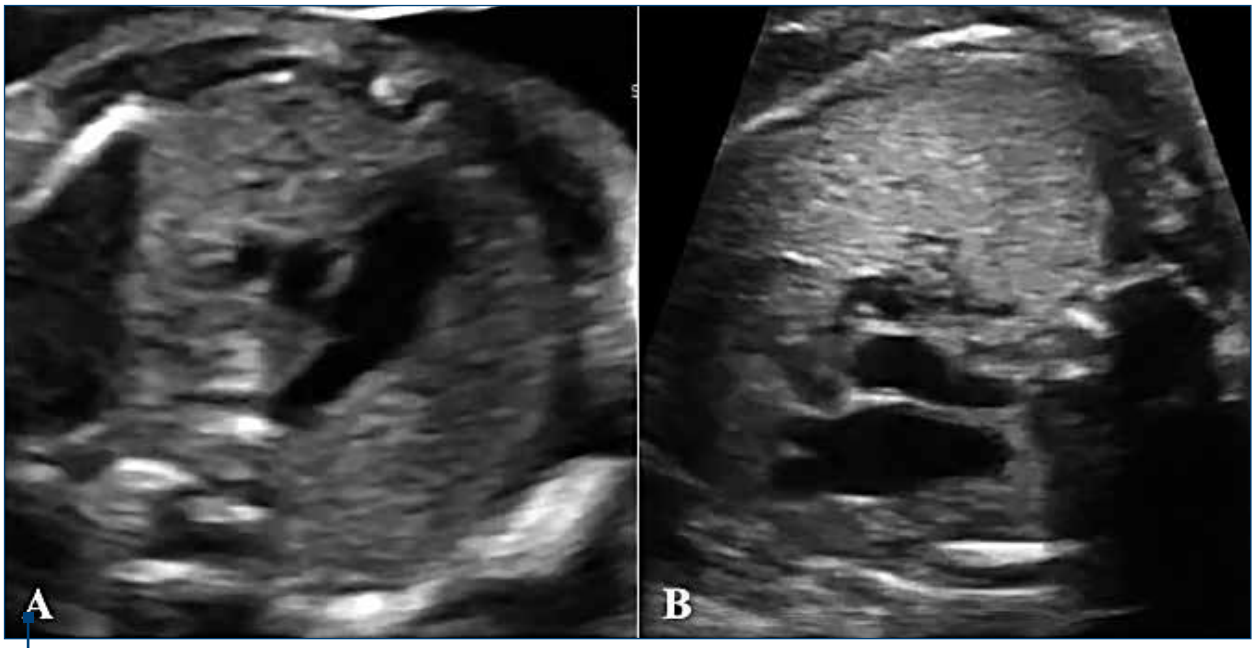

Figure 2. A. *3VV view of a 24-week fetus with AoCo. The aorta appears smaller in size than normal, closer in size to the superior vena cava.* ***B.*** *3VT view of a 29-week fetus with AoCo. The aorta is clearly smaller than the ductus arteriosus, especially at the level of the isthmus*

ascending aorta appears pushed to the right, into the superior *vena cava*, being further away than normal from the pulmonary trunk (Figure 3A). The *ductus arteriosus*, in its distal region, has a slightly abnormal course to the right, ending near the midline and not to the left of the vertebra, as it should be normal. On the 3VT, the diagnosis becomes clearer, as the aortic arch is located to the right of the trachea (Figure 3B). Thus, the aorta and the *ductus arteriosus* form a "U" sign, encircling the trachea, and not the typical "V" sign seen in normal cases.

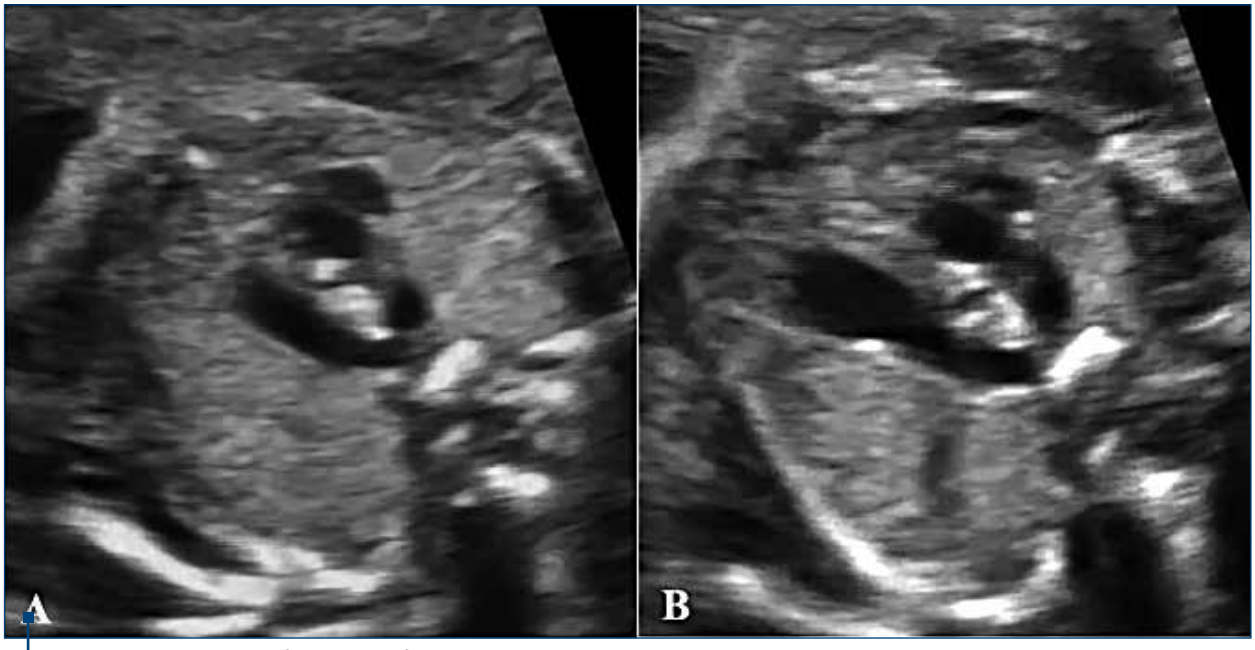

Figure 3. A. *3VV view of a 22-week fetus with rAo. The ascending aorta is pushed to the right, leaving a gap between it and the pulmonary trunk.* ***B.*** *3VT of a 24-week fetus with rAo. The aortic arch has a course to the right of the trachea, forming a "U" sign with the ductus arteriosus*

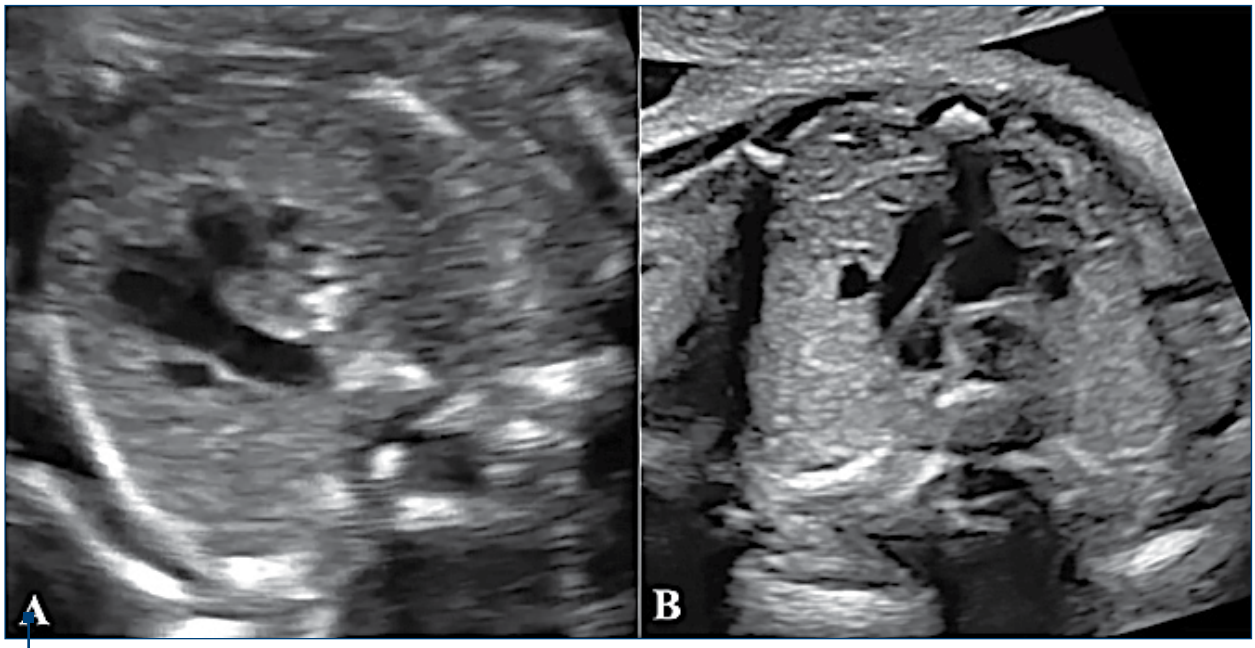

Figure 4. A. *3VV view of a 23-week fetus.* ***B.*** *3VT view of a 30-week fetus, both with persistent LSVC. A fourth vessel, represented by the LSVC, is seen to the left of the pulmonary trunk and ductus arteriosus*

Left superior *vena cava* (LSVC)

The persistence of the LSVC can be an isolated CHD or it can be a sign for a much more complex CHD or even a genetic disease. A total of three cases of isolated persistence of LSVC were found in the analyzed cases. Both the 3VV and the 3VT views were abnormal, as a small forth vessel, represented by the LSCV, could be observed (Figure 4). The LSVC is located to the left of the pulmonary trunk and *ductus arteriosus*. The diagnosis becomes more obvious after the second half of the second trimester, when the vessel grows in size and is easier to spot.

Conclusions

The 3VV and 3VT views are transverse planes at the level of the upper mediastinum and are easy to be obtained during routine ultrasound screening. There are a series of ultrasound elements that define the normal appearance of the two views. Both the 3VV and 3VT represent a valuable method of detecting CHD, especially those that involve the great vessels[8]. The current study highlights a series of CHD (AoCo, rAO, LSCV) that are detectable using these two views, as the views recommended by screening protocols (4-chamber view and ventricular outflow tract views) are normal. Still, for a complete evaluation of the fetal heart, all the transverse planes aforementioned and also sagittal ones are recommended to be obtained. ■

Conflict of interests: The authors declare no conflict of interests.

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