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The fetal three-vessel and tracheal view revisited

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SUMMARY

The routine use of four-chamber screening of the fetal heart was pioneered in the early 1980s and has been shown to detect reliably mainly univentricular hearts in the fetus. Many conotruncal anomalies and ductal-dependent lesions may, however, not be detected with the four-chamber view alone and additional planes are needed. The three-vessel and tracheal (3VT) view is a transverse plane in the upper mediastinum demonstrating simultaneously the course and the connection of both the aortic and ductal arches, their relationship to the trachea and the visualization of the superior vena cava. The purpose of the article is to review the two-dimensional anatomy of this plane and the contribution of colour Doppler and to present a checklist to be achieved on screening ultrasound. Typical suspicions include the detection of abnormal vessel number, abnormal vessel size, abnormal course and alignment and abnormal colour Doppler pattern. Anomalies such as pulmonary and aortic stenosis and atresia, aortic coarctation, interrupted arch, tetralogy of Fallot, common arterial trunk, transposition of the great arteries, right aortic arch, double aortic arch, aberrant right subclavian artery, left superior vena cava are some of the anomalies showing an abnormal 3VT image. Recent studies on the comprehensive evaluation of the 3VT view and adjacent planes have shown the potential of visualizing the thymus and the left brachiocephalic vein during fetal echocardiography and in detecting additional rare conditions. National and international societies are increasingly recommending the use of this plane during routine ultrasound in order to improve prenatal detection rates of critical cardiac defects.

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1. Introduction

Four-chamber screening of the fetal heart was pioneered in the early 1980s and was gradually accepted as part of antenatal screening for the detection of fetal anomalies during the following 20 years. Its success in detecting major congenital heart disease (CHD) was only modest; training of those performing the screening was limited and highly variable, and many important and life-threatening cardiac malformations have a normal four-chamber view. Most cases of CHD were therefore missed at screening and many questioned the ability of antenatal screening programmes to detect malformations. The unexpected delivery of a baby with a duct-dependent lesion may be associated with a delay in diagnosis and result in increased morbidity and mortality.[1–5] Early teaching of the complete fetal echo recommended using sagittal views of the aortic and ductal arches, often described as the 'candy cane' aortic arch and 'hockey-stick' ductal arches. These planes produced sonographic images similar to those used in paediatric cardiac practice which in part explains their popularity, even to this day. However, while continuity of the arch may be confirmed if ideal views can be obtained in this plane, because both arches cannot be visualised simultaneously discordance in size or sometimes lack of continuity may be misinterpreted.

The concept of the extended fetal echocardiogram was proposed by Achiron and his group as early as 1992.[6] These authors later proposed routine incorporation of the outflow tracts and the three-vessel and tracheal view (3VT) into the screening for fetal abnormalities.[7] Some ultrasound organisations such as the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommended the incorporation of the 3VT in their new guidelines for cardiac screening to look for anomalies of the outflow tracts.[8]

The relative slowness to incorporate these views into routine screening and to recommend the 3VT in national programmes may be because views of the outflow tracts moving cephalad are perceived as difficult. The concept of the three-vessel view was proposed as an alternative to the dynamic scan demonstrating the great arterial crossover.[9] The three-vessel view shows the position of the pulmonary trunk and its branches, the aorta and right-sided superior vena cava viewed from the transverse plane in the fetal

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chest. The authors felt it was as simple to achieve as the four-chamber view but alerted the examiner to abnormalities of the outflow tracts. Under normal conditions the vessels are in straight alignment with a reduction in size from left to right. The aortic and ductal arches, however, are not seen in this plane as it is obtained at the level of the carina and this limits its diagnostic ability to detect important pathology. The 3VT is obtained in the same plane as the three-vessel view, but a few millimetres cephalad, and is the gold standard to detect duct dependent lesions, including those with abnormality confined to the aortic arch such as interrupted aortic arch and coarctation of the aorta, which are life-threatening if undiagnosed early after delivery.[1,3,5] The aim of this review is to present a practical approach on how to examine and interpret the 3VT in normal conditions and to highlight typical suspicious 3VT findings.

2. Ultrasound anatomy of the 3VT on two-dimensional and colour Doppler

The 3VT plane is an axial plane at the level of the upper mediastinum demonstrating simultaneously the course and the connection of both the aortic and ductal arches, their relationship to the trachea and the visualization of the superior vena cava to the right of the aortic arch and anterior to the trachea (Figs. 1 and 2). The three vessels in the 3VT are arranged in an oblique line, with the pulmonary artery in the most anterior position, the superior vena cava in the most posterior position, and the aorta in between. The pulmonary artery continuing to form the arterial duct (ductus arteriosus) lies on the left and appears slightly larger than the aortic arch and isthmus, which are more central (Fig. 3). On the right and most posterior, the superior vena cava can be identified in its cross-section. Directly anterior to the spine the trachea is recognized as a circular structure with an echogenic wall and a black lumen (Fig. 3). One of the main advantages of this plane is in demonstrating aortic and ductal arches together in any axial insonation of the upper mediastinum, whereas the longitudinal demonstration

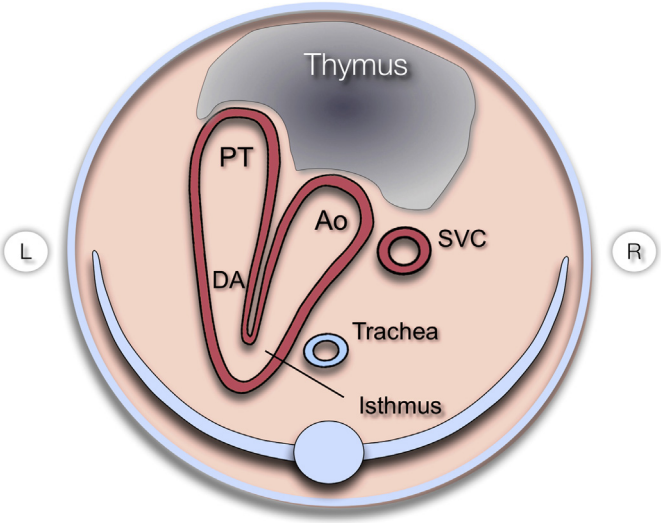

Fig. 1. Schema of a cross-section of the upper thorax at the level of the three-vessel and tracheal view. In this plane the transverse aortic arch (AO) and isthmus merge with the pulmonary trunk (PT) and arterial duct (DA) into the descending aorta in a 'V-shape' configuration (cf. Fig. 2), Both vessels point to the left of the trachea, which is found central, anterior to the spine. The superior vena cava (SVC) is seen on the right of the aortic arch, anterior to the trachea. The space between the great vessels and the sternal wall is occupied by the thymus, which is well developed in the normal fetus. L, left; R, right.

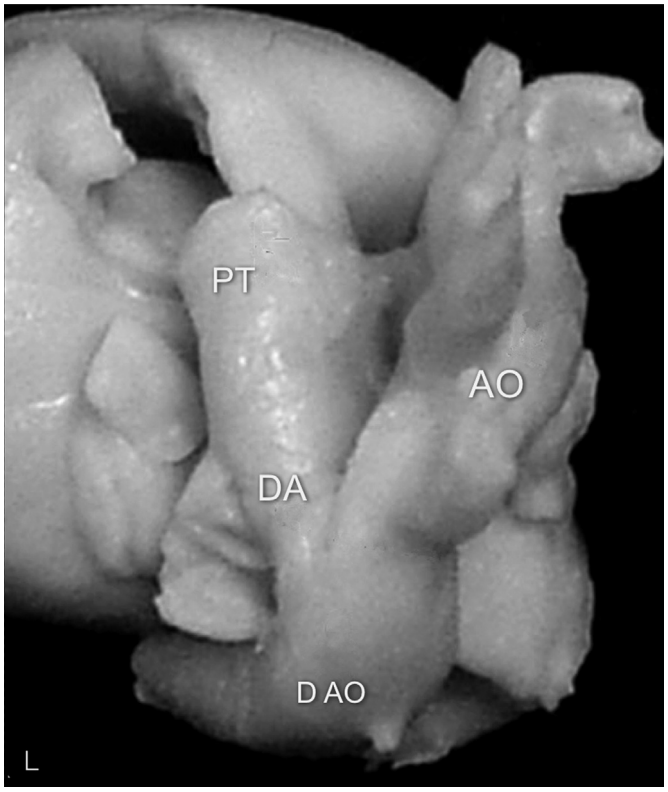

Fig. 2. Pathological specimen of the V-shaped great vessels with the aortic arch (AO) junction with the arterial duct (DA) into the descending aorta (DAO). PT, pulmonary trunk; L, left. (From Pasquini et al.[17] with permission of *Ultrasound Obstetrics Gynecology*.)

of these arches is limited to a few exact planes. In addition in malformations with abnormal great vessel size or course, both structures are even more difficult to identify and to understand in a longitudinal plane.

The use of colour Doppler increases the accuracy of the visualization and understanding of the 3VT plane (Fig. 3). Under normal scanning conditions colour Doppler enables the demonstration of antegrade flow across both aortic and ductal arches, confirming laminar flow and the shape and course of both vessels, which is sometimes better visualized on colour Doppler than on two-dimensional ultrasound alone. Colour Doppler is a very useful modality when scanning conditions are restricted, such as when there is an adipose maternal abdominal wall, in unfavourable fetal lie, or in early gestation. It helps to visualize the presence of the two arches and confirm that they are of normal size and shape with antegrade flow, easily ruling out many abnormal conditions which are presented below.

Colour Doppler is particularly helpful in identifying abnormal anatomy of the 3VT when a vessel appears dilated, tiny or is not visualized, or when there is suspicion of an abnormal course. Experienced examiners have integrated the colour Doppler 3VT as a standard plane in their fetal echocardiogram, and the recent ISUOG cardiac guidelines[8] present this plane as an important one to be used in screening.

3. Checklist for interpreting the 3VT at screening

Screening views should be simple and sensitive and the screening protocol must work well within the confines of time and the examiners' ability. At screening the 3VT view can be imaged and interpreted as shown in Figs. 1 and 3. One important practical

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