

SECOND EDITION

Fetal Heart

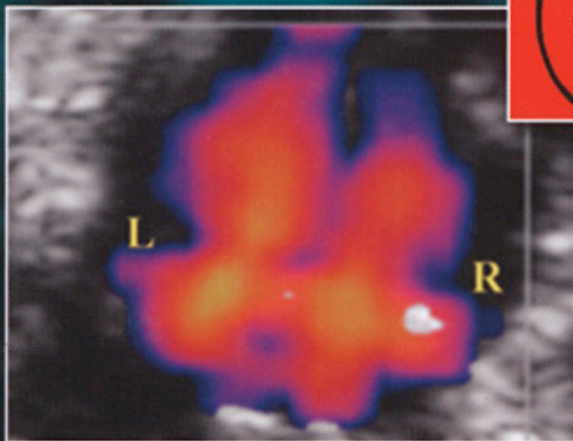
ULTRASOUND

HOW, WHY AND WHEN

3 STEPS AND 10 KEY POINTS



Catherine Fredouille
Jean-Eric Develay-Morice
Claudio Lombardi



Includes accompanying online materials

CHURCHILL
LIVINGSTONE
ELSEVIER

Fetal Heart Ultrasound

How, Why and When

3 Steps and 10 Key Points

Second Edition

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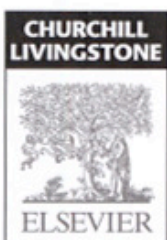
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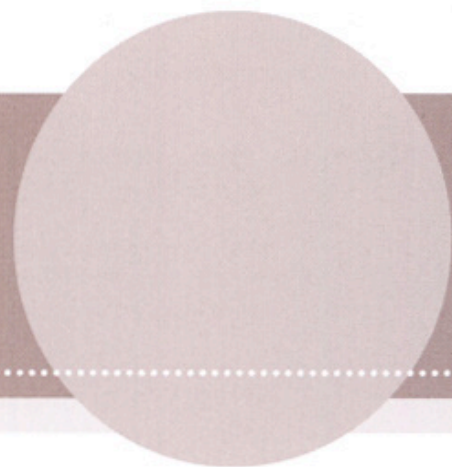
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Website contents

Clip 1: AVSD is the most common defect at 12 weeks

Clip 2: AVSD can be difficult in some cases

Clip 3: Disproportion: many defects can be grouped in this category: LV < RV

Clip 4: Disproportion: many defects can be grouped in this category: RV > LV

Clip 5: Disproportion: many defects can be grouped in this category: Ao < Pa

Clip 6: Hypoplastic left heart

Clip 7: Pulmonary atresia

Clip 8: TGA at 12 weeks

Clip 9: TOF at 12 weeks

Clip 10: TOF can be the most difficult defect to diagnose at 12 weeks

These carefully selected clips highlight one of the major problems with studying the fetal heart at an early stage of its development, which is that the quality of the image can be poor.

Each of the scans presented on the website was undertaken using a transabdominal 9 Mhz linear probe (see Chapter 5, *First trimester cardiac scan and study*, for more details).

This dedicated website also shows several examples of congenital heart disease (CHD). The characteristics are substantially the same as those displayed further on in gestation.

The first two videos present examples of atrioventricular septal defect (AVSD), which is the most common type of CHD at first trimester. This is the only malformation where at early scan we must rely only on 2-D images; in short sequences we show that this defect can be missed if the equipment or setting are not appropriate.

Three further clips are dedicated to the problem of disproportion in the size of cardiac chambers and vessels. At first trimester we cannot make a diagnosis on this basis, but we should be aware that further controls are necessary.

We also show examples of left heart hypoplasia and pulmonary atresia to make clear that some major cardiac defects are really simple to rule out at this gestational stage.

It is the authors' opinion that most benefit should be taken from early diagnosis of transposition of the great arteries (TGA) as all features of this anomaly are detectable without moving the transducer, as in the case included on the website.

Tetralogy of Fallot (ToF) is a diagnosis that even the sharpest of expert eyes could fail to spot, because at an early stage, the heart can be, or appear to be, of normal size.

Why: fetal heart ultrasound

This chapter is also covered by accompanying online material

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Catherine Fredouille

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The heart examination is a critical moment in fetal ultrasound (US). After birth, cardiologists carry out this examination, but before then the fetal heart is seen by non-cardiologists. While it is not necessary to have the level of knowledge of a pediatric cardiologist to perform this systematic prenatal check-up, it is essential to acquire a simple, solid knowledge base if we are to carry out fetal heart examinations that are valid and have a long-term prognostic value.¹

We hope that this will be the sort of book that we would have wanted to find years ago when we began studying fetal hearts. There are now excellent “classical” reference books that teach fetal cardiology. They usually contain much more than what is needed in our daily practice, and because of this, require long and attentive research to find the answers essential to fetal US. What we are trying to do here is provide a practical guide for the US practitioner, underlining the elements that we have found to be essential based on our experience.

The three of us are practicing fetal US specialists, each with different but constantly evolving and complementary interests and skills. Claudio Lombardi joined our team for this new edition because of his expertise in first trimester examination.²

Jean-Eric Develay-Morice is still involved in the technical aspects of our craft, specifically concentrating on finding new ways to diagnose previously “undiagnosable” pathologies. I spent many years in the anatomic examination of thousands of normal and pathological fetal hearts, using a strict segmental analysis. I apply this work to US-anatomic correlations. Over the years of close collaboration, we found that, above all, the US specialist needed tools to test for what we call “normality”.

Our experience has shown that the pathologies involved in the fetuses with the worst prognosis were always of the same type. We learned that what is “essential” is to be able to say that a fetal heart looks normal by checking for simple warning signs, rather than being able to precisely diagnose all types of pathologies. This is seen to be true in a great majority of cases.

When faced with a cardiopathy, the first role of the practitioner is to ensure that there is not an associated extracardiac pathology.

The warning signs we propose are simple, and we explain how to check for them. We do this using visual comparisons, which come from our experience gained during teaching numerous workshops in France and the Mediterranean region. We also kept what worked best in our original French edition, the same style, and the same conscious insistence on repetition.

Repetition has proved to be an essential part of our methodology, providing a book that is fundamental and practical for daily use. To increase its value as a training and reference tool, we have added references and clips which include US sequences, a large section on fetal heart anatomy,

and anatomic and US correlations. We hope that you will find in this book and its clips practical keys to the practice of fetal heart US.

One of our primary intentions is to introduce information that is indispensable for verifying normal fetal heart architecture, as well as information useful in the detection of important pathologies. **The precise diagnosis of cardiopathies, and their prognoses, remains the realm of the pediatric cardiologist.**

The US practitioner has several aims. One is to verify normal fetal cardiac architecture, which also involves looking for cardiopathies in the case where another anomaly has presented itself during morphological examination. The discovery of an isolated cardiopathy is a rare event.

Here we will lay out a simple methodology capable of verifying normal fetal cardiac architecture in **3 steps and 10 key points**. These key points have been defined through a series of US–anatomic correlations and tested by numerous US specialists. The diagnostic criteria are easily accessible and allow us to eliminate the cardiopathies as defined by an expert consensus.³

We begin by reviewing the knowledge essential in understanding what is normal, as well as pathologic, in the fetal heart. We then touch on those physical principles crucial in optimizing the examination itself, finally introducing our methodology. Next, we study the pathologies themselves, outlining the pitfalls involved in studying each one while proposing the best methods for avoiding these traps. Finally, we will describe the type of morphological examination necessary in those cases where a cardiopathy has been discovered, concluding with a review of points to remember.

GENERAL NOTIONS

In the fetus there are two types of cardiopathies that are important to detect:

- Cardiopathies that are **warning signs** of chromosomal anomalies, syndromes or associations. Our own fetal pathologic experience, as well as that of other teams,⁴ has shown that they mostly belong to two families: atrioventricular septal defects (AVSD) and conotruncal cardiopathies (CTC). In these pathologies, the cardiopathies are almost always

linked to other markers essential when performing morphological US examinations.

- Complex cardiopathies (those that will become **critical at birth**). These cardiopathies are well tolerated in utero due to the presence of physiologic shunts. The karyotype and morphological studies are normal. After a very attentive verification of their isolated character during the morphological examination, the fetus is referred to the pediatric cardiologist. The pediatric cardiologist will then further clarify the diagnosis, considering the prognosis and organizing appropriate care at birth. In this category of critical cardiopathies we find complete transposition of the great vessels (TGV) that should be an obsession of every US specialist during examination of the fetus.

In this category of cardiopathies, you must equally eliminate the possibility of:

- An interruption of the aortic arch (IAA).
- An abnormal total anomalous pulmonary venous return (TAPVR)
- Critical pulmonary stenosis.

When faced with certain cardiopathies whose prognosis is very bleak, or when the cardiopathy itself is a warning sign of a more complex pathology, the pediatric cardiologist might be led to propose a medical termination of pregnancy (MTP). Fetal pathologic verification is therefore highly recommended.⁵ With the family's agreement, the fetal pathologist searches for those markers that were not visible during US in order to determine if the cardiopathy can be classified as a genetic syndrome or association. The results of this research allow us to propose appropriate genetic counseling for future pregnancies.

Half of the observed cardiopathies, with a frequency that has been consistently estimated at around 8 per 1000 births,^{6,7} will only develop after hemodynamic modifications take place after birth. Only 1 fetus in 250 carries a cardiopathy that is possibly detectable in utero.

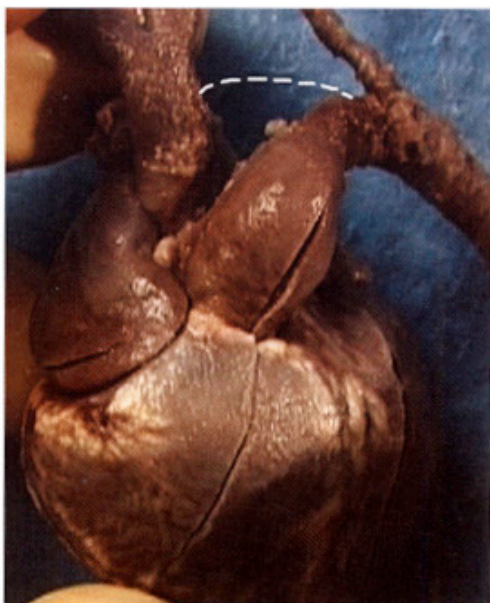


Figure 1.5 • Heart with a B2 IAA (dotted line) in a fetus with 22q11 deletion.

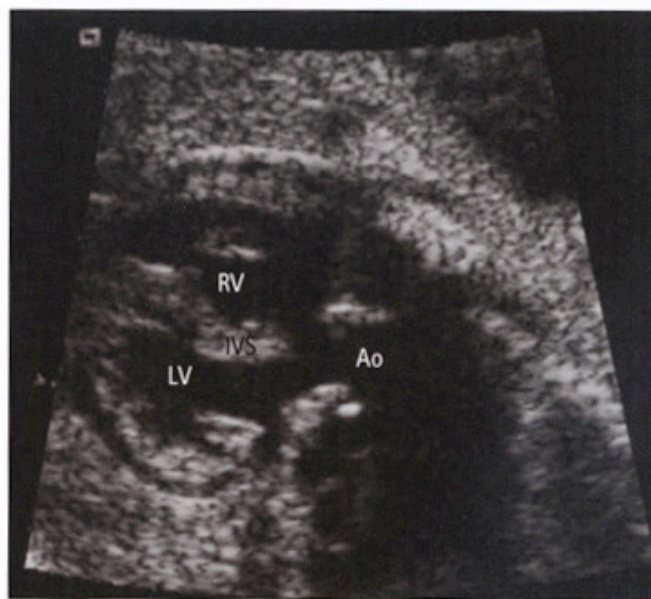


Figure 1.7 • US view: aorta overriding an outlet VSD.

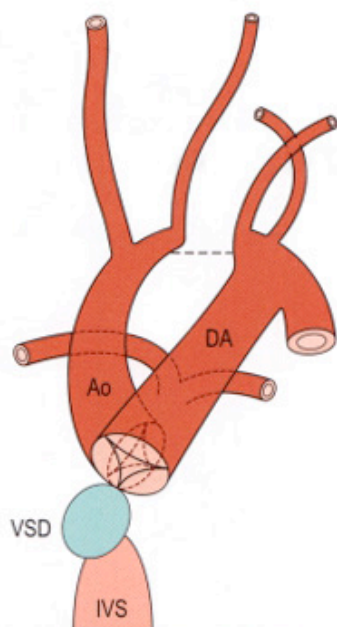


Figure 1.6 • Diagram of an IAA in a B2 fetus.

These findings have led us to focus our research, not on *all* the important pathologic elements that *could be* detected, but rather to identify the *minimum diagnostic criteria necessary*, which, when used through systematic US examination of the heart, *allow us eliminate* these suspect pathologies.

The key to understanding our methodology is that it is based on the verification of *the* criteria for normality allowing us to eliminate any suspicion of important pathologies, rather than a strict sequential, segmental analysis,²³ which creates an exhaustive search for each marker or each sign of any individual pathology. To use our method, we must clearly identify those elements that allow this verification, determining which views and images make this possible.

Fetal Heart ULTRASOUND

HOW, WHY AND WHEN

3 STEPS AND 10 KEY POINTS

Fetal Heart Ultrasound, now in its second edition, has been written as a practical guide for the ultrasound examination of the fetal heart. The fetal heart is considered to be the most important and difficult part of a fetal examination. This book aims not only to clarify and simplify the approach to this examination, but also to define what a normal fetal heart should be, and underline just why this organ remains one of the best warning signs for fetal pathology. It will be useful to trainee and practicing ultrasonographers, ultrasound departments providing obstetric ultrasound services, and obstetricians, gynecologists, radiologists and midwives undertaking courses in fetal ultrasonography.

KEY FEATURES

- Illustrated with over 400 pathological and ultrasound diagrams and images
- Clarifies what makes the fetal heart normal, and what signs point to the pathologies that are important to diagnose
- Step-by-step guide to establishing different views, illustrating the correlations between technique and medical image, and outlining the pitfalls, obstacles and errors and how to recognize and avoid them
- Accompanying online ancillary material: original anatomical videoclips, ultrasound scans and self-assessment questions

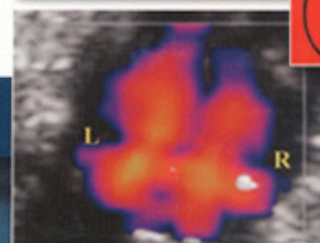
NEW TO THIS EDITION

- A chapter on first trimester ultrasonography covering the early detection, diagnosis and confirmation of fetal cardiac anomalies
- New videoclips relating to first trimester ultrasonography
- 50 scored online self-assessment questions with images

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