Incidence:

- Fetal arrhythmias accounts for up to 20% referrals for fetal echocardiography and may occur in as many as 2% of pregnancies.
- Indications for echocardiographic evaluation of fetal heart rhythm are:
  - Sustained fetal heart rate below 100 beats/minute.
  - Sustained fetal heart rates above 180 beats/minute.
  - Unexplained nonimmune hydrops fetalis.
  - Frequent and repetitive irregular heart beats.
Echocardiographic Assessment of fetal rhythm

- 2D echocardiography
- M-mode Echocardiography.
- Pulsed Doppler.
- PWD –Tissue Doppler imaging
- Color –Tissue Doppler imaging.

Two dimensional Echocardiography

- The heart beats are regular or irregular, too fast or too slow,
- hydrops fetalis is present or absent.
- A search for a structural abnormality is also carried out, as certain rhythm disturbances are associated with congenital heart anomalies.
M-mode:
A simultaneous recording of both ventricular and atrial contractions.

Pulsed Doppler

Simultaneous superior vena cava and ascending aorta (SVC/aorta)
Simultaneous mitral valve and ascending aorta
**Tissue Doppler Imaging (TDI)**

- Tissue Doppler imaging measures the motion of the myocardium and allows precise timing of atrial and ventricular events.

**Advantage:**
- TDI can define the mechanical relationship of atrial and ventricular wall motion thus permitting evaluation of beat-to-beat variability in the case of premature beats and in the setting of tachycardia.

**Color TDI**
Fetal ectopy

Causes:
- Idiopathic.
- Fossa ovalis aneurysm.
- Myocarditis.
- Cardiac tumors
- Ventricular aneurysm or diverticulum.
- Maternal stimulants.

Diagnosis: PWD

Conducted PAC

Non-conducted PACs
Pulsed TDI

Non conducted PAC

Conducted PAC
Management of fetal Ectopy

- Medical treatment is not recommended for either conducted or blocked atrial premature contractions.
- Weekly auscultation of the fetal heart by the obstetrician is recommended if frequent PAC are present. Until resolution of arrhythmias is documented.
Fetal Tachycardia

Pathological fetal tachycardias:
- Fetal heart rates above 180–200 b/m
- Most affected fetuses have ventricular rates ranging from 220 to 300 b/m

Types of fetal tachyarrhythmias:
- Sinus tachycardia
- Supraventricular tachycardia (re-entrant orthodromic type)
- Atrial flutter
- Ventricular tachycardia
- Multifocal atrial tachycardia
- Atrial ectopic tachycardia
- Persistent (permanent) junctional reciprocating tachycardia
- Atrial fibrillation
• The most common type of fetal tachyarrhythmias is reentrant orthodromic supraventricular tachycardia (66–90%) followed by atrial flutter (10–30%).

<table>
<thead>
<tr>
<th>SVT</th>
<th>Atrial Flutter</th>
<th>Ventricular tachycardia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1 A:V ratio</td>
<td>fixed or variable AV block, as the AV-node is not able to conduct every contraction of the atrium which results in a 2:1 or 3:1 conduction to the ventricles.</td>
<td>the ventricular rate is in excess of the atrial rate, &amp; there is AV dissociation</td>
</tr>
<tr>
<td>Heart rate that is usually 240-260 beats /min</td>
<td>The atrial rate is typically 300-500 beats/min, (higher than the re-entrant AV tachycardia)</td>
<td></td>
</tr>
<tr>
<td>SHORT VA or Long VA</td>
<td>a re-entry circuit confined to the atrium</td>
<td>With long QT syndrome</td>
</tr>
<tr>
<td>90% of fetal tachycardia</td>
<td>10-30%</td>
<td>1-2 %</td>
</tr>
</tbody>
</table>
Differential diagnosis of fetal tachycardia

Diagnosis of fetal SVT
PWD : SVT

Short VA tachycardia

Long VA tachycardia

Atrial Flutter with variable block
M-mode
PWD
PWDAFL

Courtesy of Prof. Dr. Hala El Marsafawy, Mansoura University

SVT:M-mode

Courtesy of Prof. Dr. Hala El Marsafawy, Mansoura University
Intervention in fetal tachycardia

When faced with a fetus with a tachycardia there are a number of options available including:

- **Delivery** of the baby for postnatal management;
- **Transplacental treatment** by maternal administration of drugs.
- **Direct administration** of antiarrhythmic drugs into the fetal circulation.
- **Observation** of the fetus without therapy.
Fetal Bradycardia

Fetal bradycardia is defined as a heart rate <110 bpm.
Types of fetal bradycardia

1- Fetal sinus bradycardis:

**Causes:**

- Pressure on maternal abdomen from U/S probe, which resolve after removal of the probe (transient vagotonia)
- Cord compression (when the umbilical cord is located around the fetal neck)
- Sinus node dysfunction and impending foetal demise from extracardiac causes.
- Infiltrative cardiomyopthies affecting conductive system

2- Non conducted premature atrial beats:

- Bradycardia may be due to non-conducted premature atrial beats (blocked PACs).

3- Fetal AV block:

- First-degree heart block:
  the AV conduction time (the mechanical PR interval) is prolonged beyond the upper limit of normal.

- Second-degree heart block:
  There is either a fixed ratio of AV contractions e.g. 2 : 1 or 3 : 1 block, or progressive prolongation of the PR interval until an atrial beat is non-conducted (Wenkebach).

- Complete heart block there is complete dissociation between atrial and ventricular contractions.
Causes of fetal AV block:

1-AV block associated with *structural heart defects* that anatomically displace the distal conduction system. (Left isomerism, AV discordance)

2-AV block related to the presence of maternal anti SSA/Ro or anti SSB/La antibodies (immune mediated AV block)

Diagnosis: PWD

Fetal sinus bradycardia
Diagnosis PWD:

Fetal first degree AV block:

First degree AVB
3\(^{rd}\) Degree AVB

2\(^{nd}\) Degree AVB

Doppler

M-Mode

Courtesy of Prof. Dr. Hala El Marsafawy, Mansoura University
Differential Diagnosis of fetal bradycardia

Interventions in fetal bradycardia

Prophylaxis & Treatment.
Prophylaxis against Fetal Av block

Treatment of fetal AV block

1-steroids:
• 1\textsuperscript{st} degree: reversible
• 2\textsuperscript{nd} degree: controversial.
• 3\textsuperscript{rd} degree: Irreversible.
2-B2 agonists.

3- Intravenous immunoglobulin(IVIG)

4-Fetal Temporary pacing:
Few attempts.
Echocardiography & prognosis of fetal arrhythmia

- Fetal echocardiography allows not only for the diagnosis of arrhythmias but also for the monitoring of the fetal hemodynamics for the possible signs of congestive heart failure.

(Arrhythmia-induced Cardiomyopathy)

1- Cardiovascular Profile score (CVPS)

<table>
<thead>
<tr>
<th>Hydrops</th>
<th>Normal</th>
<th>+1 point</th>
<th>+2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous Doppler (umbilical vein)</td>
<td>None (2 points)</td>
<td>Ascites or pleural effusion or pericardial effusion</td>
<td>Skin edema</td>
</tr>
<tr>
<td>UV</td>
<td>UV</td>
<td>UV pulsations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heart size (Heart area / chest area)</th>
<th>Normal (DV) and ≤ 0.35 (2 points)</th>
<th>&gt;0.50 or &lt; 0.20 (2 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal TV and MV RV/LV BF &gt; 0.28 Biv- phased diastolic filling (2 points)</td>
<td>Holosystolic TR or RV/LV BF &lt; 0.28</td>
<td>Holosystolic MR or TR dP/dt &lt; 400 or monophasic filling</td>
</tr>
</tbody>
</table>

Cardiac function

<table>
<thead>
<tr>
<th>Arterial Doppler (umbilical artery)</th>
<th>Normal (UA)</th>
<th>+1 point (AEDV)</th>
<th>+2 points (REDV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA (2 points)</td>
<td>UA (AEDV)</td>
<td>UA (REDV)</td>
<td></td>
</tr>
</tbody>
</table>

The heart failure score is 10 if there are no abnormal signs and reflects 2 points for each of five categories: hydrops, venous Doppler, heart size, cardiac function, and arterial Doppler.

AEDV, absent end-diastolic velocity; dP/dt, change in pressure over time of TR jet; DV, ductus venosus; LV, left ventricle; MR, mitral valve regurgitation; MV, mitral valve; SF, ventricular shortening fraction; TR, tricuspid valve regurgitation; TV, tricuspid valve; REDV, reversed end-diastolic velocity; RV, right ventricle; UV, umbilical vein.
CVPS

Cardiomegaly

Ascites, skin edema

Courtesy of Prof. Dr. Hala El Marsafawy, Mansoura University

CVPS

Umbilical artery: REDV

Ductus venosus: Atrial reversal

Courtesy of Prof. Dr. Hala El Marsafawy, Mansoura University
2- Fetal 2D Speckle Tracking

- Intermittent tachyarrhythmia could cause **fetal LV systolic dysfunction** that can be identified early by **fetal Speckle tracking of Left ventricle**.

- **Speckle tracking** is a novel ultrasound tool to assess cardiac ventricular function.

- It allows quantitative calculation of the actual myocardial displacement, velocity, deformation (strain), and velocity at which deformation occurs (strain rate) in the cardiac walls.
Speckle Tracking

Longitudinal Strain (endo)

<table>
<thead>
<tr>
<th>Seg.</th>
<th>Pk %</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-basal septal</td>
<td>-1.711</td>
</tr>
<tr>
<td>09-mid septal</td>
<td>-2.962</td>
</tr>
<tr>
<td>14-apical septal</td>
<td>-32.952</td>
</tr>
<tr>
<td>17-apex</td>
<td>-51.027</td>
</tr>
<tr>
<td>16-apical lateral</td>
<td>-20.405</td>
</tr>
<tr>
<td>12-mid lateral</td>
<td>-7.247</td>
</tr>
<tr>
<td>06-basal lateral</td>
<td>-5.997</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>-9.890</td>
</tr>
<tr>
<td><strong>GLS</strong></td>
<td>-16.83%</td>
</tr>
</tbody>
</table>

LV, LA, RV, RA
Speckle Tracking:

• Early diagnosis of fetal LV dysfunction due to arrhythmias will be possible by speckle tracking before affection of cardiovascular Profile score (CVPS).

• Deformation analysis provides insight into cardiac function beyond that obtained with conventional approaches as shortening or the ejection fraction.
Assessment of Fetal Myocardial Deformation Using Speckle Tracking Techniques

Show full citation

Abstract

Prospective assessment of fetal cardiac function with speckle tracking in healthy fetuses and recipient fetuses of twin-to-twin transfusion syndrome.

Show full citation

Abstract

BACKGROUND: The aim of this study was to assess fetal cardiac function in a normal population and in recipient fetuses of twin-to-twin transfusion syndrome (TTTS) using speckle tracking imaging (STI).

METHODS: A case-control study was conducted of 28 uncomplicated singleton pregnancies and 17 recipient fetuses of TTTS. Peak systolic strain, strain rate, velocity, and deformation on endocardial tracking were evaluated.

Myocardial strain abnormalities in feto congenital heart disease assessed by speckle tracking echocardiography.

Show full citation

Abstract

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METHODS: A case-control study was conducted of 28 uncomplicated singleton pregnancies and 17 recipient fetuses of TTTS. Peak systolic strain, strain rate, velocity, and deformation on endocardial tracking were evaluated.
Modalities other than echocardiography

• Fetal ECG
• Fetal Magnetocardiography

Take home messages

• Fetal arrhythmias can be accurately diagnosed by prenatal echocardiography.

• Modalities of Echocardiography are complementary in identifying the electrophysiological mechanism of fetal arrhythmias & detecting their complications for the aim of selection of the proper antiarrhythmic drug therapy.
• **Selection of Fetal drug therapy** is considerably affected by fetal cardiac function,

**So,** Precise diagnosis of early LV dysfunction by Novel echo techniques as *speckle tracking* will add insights in management of *arrhythmia-induced fetal congestive heart failure.*