Introduction to transthoracic echocardiography

Philips tutorial

Welcome to this abridged version of the Introduction to transthoracic echocardiography tutorial.

To view the complete tutorial, visit the education section of the Sparq webpage at www.philips.com/Sparq or the Philips critical care and emergency medicine ultrasound education webpage at www.philips.com/CCEMeducation

Material written and developed by:
Anne-Sophie Beraud, MD
Division of Cardiovascular Medicine
Stanford University School of Medicine

Toni Burkett
Philips Healthcare – Ultrasound
## Table of contents

**The basics** .................................................. 3
- The transducer and its manipulation .................................................. 4
- Ergonomics and set-up ............................................................................ 7

**Transthoracic echo views** .................................................. 8
- Main transthoracic echo (TTE) windows ........................................... 8
- Parasternal ........................................................................................................ 9
  - Parasternal long-axis ........................................................................ 9
  - Parasternal short-axis ...................................................................... 11
    - Papillary muscle level .................................................................. 12
- Apical ................................................................................................................. 13
  - Apical four-chamber ........................................................................ 13
- Subcostal .......................................................................................................... 15
  - Subcostal four-chamber ................................................................ 15
  - Subcostal inferior vena cava ................................................................. 17

**Abbreviations** .................................................................................. 19

**Additional resources** ....................................................................... 20

---

To view the complete version of the *Introduction to transthoracic echocardiography tutorial*, visit the education section of the Sparq webpage at [www.philips.com/Sparq](http://www.philips.com/Sparq) or the Philips critical care and emergency medicine ultrasound education webpage at [www.philips.com/CCEMeducation](http://www.philips.com/CCEMeducation)
The basics

The transducer

Orientation marker

The optimal transducer for transthoracic echo is a phased array. The typical frequency range for adult echo is 1-5 MHz.

Orientation of the ultrasound image for echo

• Every transducer has an orientation marker on one side (usually a notch, groove, or ridge).

• The orientation marker on the transducer corresponds to the orientation marker on the ultrasound monitor.

• By convention, for echo, the orientation marker on the ultrasound monitor is located to the upper right of the ultrasound image.

In this example, the transducer orientation marker is pointing to the patient’s left, thus, the patient’s left will be on the right side of the ultrasound image.
The transducer is the most fragile part of the ultrasound system. Damage can occur if the transducer is dropped or hit against a hard surface. Proper transducer placement and manipulation are required to optimize ultrasound images.

- The placement and manipulation of the transducer will differ with each patient depending on body habitus and the position of the heart in the chest.
- A subtle change in the transducer position and manipulation can have a significant impact on the quality of the image.

Getting started

Apply the gel, and then place the transducer on the patient’s chest with the orientation marker aimed at the appropriate landmark (example: for the apical four-chamber view, the orientation marker will be toward the patient’s left). Make sure that the transducer is making good contact with the skin.

Ultrasound gel is required for good conduction of ultrasound between the skin and transducer.

The transducer is the most fragile part of the ultrasound system. Damage can occur if the transducer is dropped or hit against a hard surface.
Use the following techniques to adjust the transducer

**Align**
Place the transducer so the ultrasound beam is aligned with the anatomy.

**Rotation**
Clockwise or counter-clockwise rotation of the transducer is required to change views and to optimize the image.
The basics

**Tilt**

Tilt the transducer to identify and optimize the anatomy of interest.

Tilt may be upwards/downwards or side-to-side depending on the ultrasound view.
The basics

Ergonomics and set-up

• Stand at the level of the patient’s shoulders, facing the ultrasound system.

• Adjust the height of the patient’s bed and ultrasound system so you are in a comfortable position while scanning.

• Scan either with your left or right hand; it is recommended to always use the same hand (this will help you to acquire better and more consistent scanning skills).

The patient

• The patient should be supine.

• If possible, turn the patient onto his or her left side for the parasternal and apical views – this will bring the heart closer to the chest wall. The patient can be supported by placing one or more pillows behind the right shoulder if necessary.

• Abduct the patient’s left arm – this will open the intercostal spaces.
Transthoracic echo views
Main transthoracic echo (TTE) windows

1. Parasternal window
2. Apical window
3. Subcostal window
Transthoracic echo views

Parasternal long-axis

- Transducer is placed in 3rd-4th intercostal space.
- Transducer orientation marker is pointing toward the patient’s right shoulder (~10 o’clock).
- Depth 12-16 cm.
- For assessment of a pericardial and pleural effusion use a depth of 20-24 cm.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV (right ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>LV (left ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>Ao (ascending aorta)</td>
<td>size</td>
</tr>
<tr>
<td>AV (aortic valve)</td>
<td>motion, opening and calcification</td>
</tr>
<tr>
<td>MV (mitral valve)</td>
<td>motion, opening and calcification</td>
</tr>
<tr>
<td>Pericardium</td>
<td>pericardial fluid</td>
</tr>
</tbody>
</table>
Parasternal long-axis view – right side of the image is cephalad. The pericardium is a strong echo reflector and appears as a bright white echo.

**Video**  Parasternal long-axis view.

View this video in the online tutorial or go to [www.philips.com/CCEMeducation](http://www.philips.com/CCEMeducation)
Transthoracic echo views

Parasternal short-axis – papillary muscle level

• From the parasternal long-axis view, rotate the transducer 90 degrees clockwise.

• Transducer orientation marker is pointing toward the patient’s left shoulder (~2 o’clock).

• Tilt the transducer face slightly downward toward the patient’s left flank.

• Depth 12-16 cm.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV (right ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>IVS (interventricular septum)</td>
<td>systolic and diastolic shape</td>
</tr>
<tr>
<td>LV (left ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>Inferior wall</td>
<td>thickening and motion</td>
</tr>
<tr>
<td>Anterior wall</td>
<td>thickening and motion</td>
</tr>
<tr>
<td>Pericardium</td>
<td>pericardial fluid</td>
</tr>
</tbody>
</table>
Parasternal short-axis view – papillary muscle level. The LV should be round and in the center of the image.

Video  Parasternal short-axis view at the papillary muscle level.

View this video in the online tutorial or go to www.philips.com/CCEMeducation
Apical four-chamber (A4C)

- The transducer is placed on the apical impulse.
- Tilt the face of the transducer up until the ultrasound beam cuts through the long axis of the heart.
- Transducer orientation marker is at ~3 o’clock.
- Depth: 14-18 cm.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV (right ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>LV (left ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>LA (left atrium)</td>
<td>size</td>
</tr>
<tr>
<td>RA (right atrium)</td>
<td>size</td>
</tr>
<tr>
<td>MV (mitral valve)</td>
<td>motion and regurgitation</td>
</tr>
<tr>
<td>TV (tricuspid valve)</td>
<td>motion and regurgitation</td>
</tr>
</tbody>
</table>
Apical four-chamber view (A4C)

Apical four-chamber view – tilt the transducer up until all four chambers are visualized and the long axis of the heart is vertical.

Video Apical four-chamber view.

View this video in the online tutorial or go to www.philips.com/CCEMeducation
Subcostal four-chamber

- Patient is supine.
- Transducer is placed 2-3 cm below the xyphoid process.
- Direct the transducer toward the patient’s chin/left shoulder.
- Transducer orientation marker is at ~3 o’clock.
- Hold the transducer palm down to facilitate cephalad angulation of the ultrasound beam.
- Depth 16-24 cm.

### Structure

<table>
<thead>
<tr>
<th>Structure</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV (left ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>RV (right ventricle)</td>
<td>size and function</td>
</tr>
<tr>
<td>LA (left atrium)</td>
<td>better assessed from A4C view</td>
</tr>
<tr>
<td>RA (right atrium)</td>
<td>better assessed from A4C view</td>
</tr>
<tr>
<td>MV (mitral valve)</td>
<td>motion and regurgitation</td>
</tr>
<tr>
<td>TV (tricuspid valve)</td>
<td>motion and regurgitation</td>
</tr>
<tr>
<td>Pericardium</td>
<td>pericardial fluid</td>
</tr>
</tbody>
</table>
Subcostal four-chamber view – directing the ultrasound beam too posterior is a common mistake in the subcostal view.

Video Subcostal four-chamber view.

View this video in the online tutorial or go to www.philips.com/CCEMeducation
Subcostal inferior vena cava (IVC)

- From subcostal four-chamber view, rotate the transducer 90 degrees counter-clockwise, always keeping the right atrium on the screen.
- Transducer orientation marker at ~12 o’clock.
- Depth 16-24 cm.
- It is important to see the IVC merging into the RA. This will confirm that you are not visualizing the aorta.

**Structure**

- IVC (inferior vena cava)

**Assessment**

- size and respiratory variations
Subcostal inferior vena cava (IVC)

Subcostal inferior vena cava view – the IVC should be seen merging into the RA.

Video Subcostal inferior vena cava view.

View this video in the online tutorial or go to www.philips.com/CCEMeducation
Abbreviations

Ao – ascending aorta
AV – aortic valve
CVP – central venous pressure
Desc Ao – descending aorta
EF – ejection fraction
IVC – inferior vena cava
IVS – interventricular septum
LA – left atrium
LV – left ventricle
LVED – left ventricular end diastolic
LVES – left ventricular end systolic
LVOT – left ventricular outflow tract
MV – mitral valve
P – pressure
RA – right atrium
RV – right ventricle
RVOT – right ventricular outflow tract
RVSP – right ventricular systolic pressure
SV – stroke volume
TR – tricuspid regurgitation
V – velocity
VTI – velocity time integral
Additional resources

Additional resources related to critical care and emergency medicine ultrasound can be found at:

www.philips.com/CCEMeducation

For additional resources related to ultrasound-guided regional anesthesia and pain medicine procedures visit:

www.philips.com/RAPMEducation

For more information about Philips Sparq ultrasound system go to:

www.philips.com/sparq
This paper reflects the opinion of the author, not Philips Healthcare. Before performing any clinical procedure, clinicians should obtain the requisite education and training, which may include fellowships, preceptorships, literature reviews, and similar programs. This paper is not intended to be a substitute for these training and education programs, but is rather an illustration of how advanced medical technology is used by clinicians.

© 2014 Koninklijke Philips N.V. All rights are reserved. Philips Healthcare reserves the right to make changes in specifications and/or to discontinue any product at any time without notice or obligation and will not be liable for any consequences resulting from the use of this publication.

Published in the USA.
JUL 2014