

UVSQ

université PARIS-SA

01. TRANSTHORACIC ECHOCARDIOGRAPHY

The transthoracic route is often difficult in intensive care, because of the examination conditions (supine patient, patient suffering pain, patient with tachypnea, assisted ventilation), but allows rapid patient management.

The following principal views should be obtained where possible :

(i) Apical four-chamber view

An apical four-chamber view this enables assessment of the size of the cardiac chambers, detection of any mitral and aortic valve disease, Doppler echocardiography of the mitral annulus and of the LV outflow tract of the left ventricle (calculation of cardiac

flow).

Film no. 1 : TTE – apical four-chamber view

RV: right ventricle, LV: left ventricle, RA: right atrium, LA: left atrium.

- » *This view reveals the apex and the lateral wall of the left ventricle as well as the interventricular septum. It shows the free wall of the right ventricle at the level of its filling chamber.*
- » *This view can be used to (i) evaluate any dilatation of the right ventricle by calculating the ratio between the end-diastolic areas of the RV and LV, the normal value being below 0.6; (ii) measure the end-diastolic and end-systolic volumes of the left ventricle and thereby to deduce its ejection fraction. The simplest method of measurement is probably the area-length method, $V = 8 A^2 / 3 \pi L$, where A is the area and L the long axis from the plane of the mitral annulus to the apex of the left ventricle.*

(ii) Two-dimensional long-axis parasternal view

A two-dimensional, long-axis parasternal view completed using motion mode : this enables measurement of the size of the two ventricles, calculation of the left ventricular ejection fraction from estimated volumes (Teicholz), and examination for paradoxical septal movement.

Film no. 2 TTE – parasternal long-axis view of the left ventricle

RV: right ventricle, LV: left ventricle, IVS: interventricular septum

This view shows the interventricular septum and the postero-lateral wall of the left ventricle. It also visualizes the anterior wall of the right ventricle. Also seen is the LV outflow tract of the left ventricle with the root of the aorta.

Film no. 3

This is the same view as in film 2.

By coupling the two-dimensional mode with the motion mode, it is possible among other things to measure the dimensions of the left ventricle (end-diastolic, end-systolic diameters) and to deduce the fractional contraction of the diameter. From the formula $V = D^3$ or Teicholz's formula [$V = 7D^3 / (2.4 + D)$], the measurement of diameters can be used to calculate the volume of the left ventricle. The two-dimensional mode/motion mode

coupling is used to visualize a paradoxical septal movement and to localize it in the cardiac cycle.

(iii) Short-axis parasternal view

A short-axis parasternal view is the most sensitive route for detection of paradoxical movement of the septum, and enables measurement of the LV fractional area contraction, close to its ejection fraction.

Film no. 4 : TTE – parasternal short-axis view of the left ventricle.

RV: right ventricle, LV: left ventricle, IVS: interventricular septum.

Ideally this view should aim at the cords of the mitral valve, i.e. at the median portion of the left ventricle. Tilting the probe upwards unveils the basal regions up to the vessels at the base of the heart (film 5). Tilting downwards uncovers the more apical regions. In addition to the interventricular septum, this view visualizes the anterior, lateral, posterolateral and inferior walls of the left ventricle. It also reveals the anterior wall of the right ventricle at its LV outflow tract. This is often the best view for detecting a paradoxical septal movement. By tracing the areas of the left ventricle, it also allows calculation of the LV fractional area contraction close to the ejection fraction.

From this view one can also obtain a view of the vessels at the base of the heart, thus enabling Doppler echocardiography of the pulmonary artery, which is very often informative in pulmonary arterial hypertension.

Film no. 5

TTE – parasternal short-axis view of the vessels at the base of the heart.

RV: right ventricle, PA: trunk of the pulmonary artery.

This view is obtained from the view visualized in film 4 by tilting the probe upwards. By using pulsed Doppler, this view can be used to record the ejection flow of the right ventricle just upstream of the pulmonary valve. This enables measurement of the area under the flow curve (VTI, time-velocity integral) as well as the diameter of the pulmonary annulus to calculate the stroke volume of the right ventricle ($SV = TVI \times \pi D^2 / 4$). It is also possible to find indicators of pulmonary hypertension: (i) measurement of the acceleration time (from the start of flow to peak velocity) rather suggestive of pulmonary hypertension when it is shortened ($T_{acc} < 100$ ms); (ii) appearance of the flow: the

biphasic appearance of the flow visualized on this clip was recorded in a patient presenting massive pulmonary embolism. This appearance is entirely consonant with the diagnosis.

(iv) Subcostal view

Finally, the subcostal view is important as it visualizes the inferior vena cava and its variations during ventilation, and because it is often available and of good quality in a mechanically ventilated patient.

Film no. 6 : Echocardiography by the subcostal route - IVC: inferior vena cava.

This view visualizes the inferior vena cava from its suprarenal path to its entry in the right atrium. This film was recorded in a spontaneously breathing dyspneic patient. Note the large changes in caliber of the inferior vena cava during respiration (inspiratory collapse). The measurement of the inferior vena cava diameter must be done at the end of expiration, whether the patient is breathing spontaneously or is mechanically ventilated. This film well illustrates the difficulty of using the inferior vena cava diameter for hemodynamic purposes, as it differs considerably depending on the site of measurement. Certain authors have proposed calculating the percentage change in diameter during ventilation (spontaneous or in positive pressure) to evaluate central venous pressure or to predict the efficacy of volume expansion.