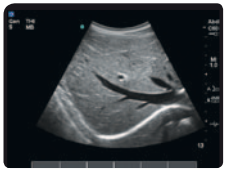
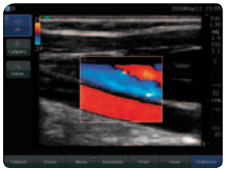
SonoSite
FUJIFILM

Quick Guide

EMERGENCY MEDICINE AND ULTRASOUND





Universitat de Lleida

SEMES.ORG
Sociedad Española de Medicina de Urgencia y Emergencias

EMERGENCIAS + ECOGRAFIA = VIDA

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http://www.montserrat.nehos.com

ADDITIONAL INFORMATION AND WEBSITES OF INTEREST

http://www.formacionurgencias.com, http://www.ecosemesmadrid.es, http://www.winfocus.org

This booklet was originally produced in Spanish by the above authors and has been translated to English. Some image annotations are still in Spanish, translations are shown at the bottom of the page.

Emergency Medicine and Ultrasound

1. INTRODUCTION

1. INTRODUCTION

WHAT IS THIS GUIDE FOR?

The usefulness of ultrasound in patients with acute pathologies is undoubted. Ultrasound, integrated into the clinical and physical examination of the patient, obtains relevant information in a quick, harmless, non-invasive and reproducible way. It defines potentially critical anatomical and functional changes and makes it easier to perform techniques and procedures. Moreover, current portable ultrasound units make this possible in almost any environment.

This form of clinical examination – ultrasound or "sonography" is designed to answer precise questions in specific clinical contexts where a complete ultrasound examination is not possible.

This quick guide is intended to provide some basic, practical, and essential guidelines for getting started in the exciting world of clinical ultrasound in emergency pathologies. With a little common sense and the appropriate training, you will acquire the necessary skills to perform an adapted scan and interpret this correctly, with the aim of helping confirm a diagnosis or select a treatment.

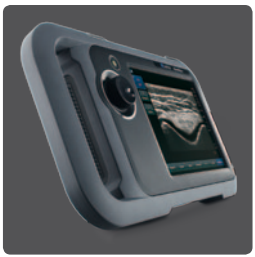
ULTRASOUND PRINCIPLES IN ACCIDENTS AND EMERGENCIES

- Examinations focused on detecting specific injuries quickly, clearly, and based on fundamental aspects, with the aim of limiting inter-operator variability.
- Must be performed at the right time and in the right place for making decisions.
- The scan must be performed at the same time as the other therapeutic diagnostic measures required.
- Scans will be carried out by the team that first attends to the patient, without ruling out an expert opinion if this is available and is deemed necessary.
- "Sound detection" must be integrated into the physical examination of the patient.
- The information should be interpreted by the team that attends the patient and applied by following validated clinical ultrasound guides. (Important: image recording and video clips for subsequent "cold" assessment.)

BASIC OPERATION OF AN ULTRASOUND DEVICE

Since the first ultrasound machines were developed in the 1950s, they have continued to evolve. Image quality has progressively improved, the machinery is increasingly simple to operate, it has become smaller and some models are now portable, without sacrificing image quality. Current performance levels make ultrasound a very powerful and versatile diagnostic technique, easy to use in all areas of practical medicine.



1950´s

21st Century

Emergency Medicine and Ultrasound

2. OVERVIEW

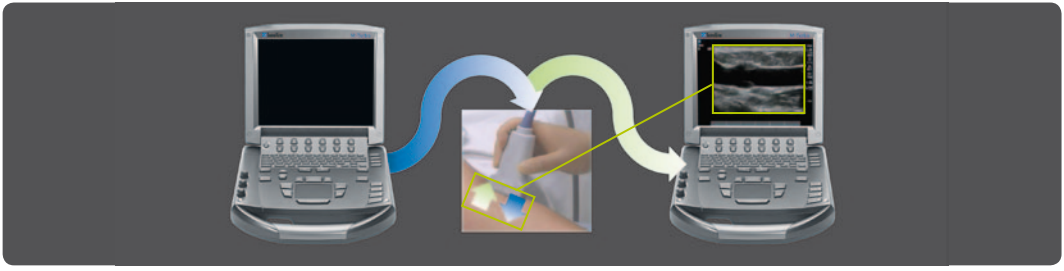
WHAT IS ULTRASOUND?

Ultrasounds are waves with a frequency higher than 20,000 Hz.

Ultrasound machines emit a sequence of ultrasonic beams, called pulses, from a transducer which spread inside the area of the body being studied. The transmission speed depends on the density and elasticity of the tissues; these two variables determine the resistance or "acoustic impedance".

The reflected echoes are received by the transducer which acts as a receptor. They generate an electrical signal with an amplitude which is determined by the echo. This signal is then transformed into a grayscale image.

Ultrasound frequencies used in ultrasound scans: between 2 and 15 MHz. (1MHz = 1 million Hz).

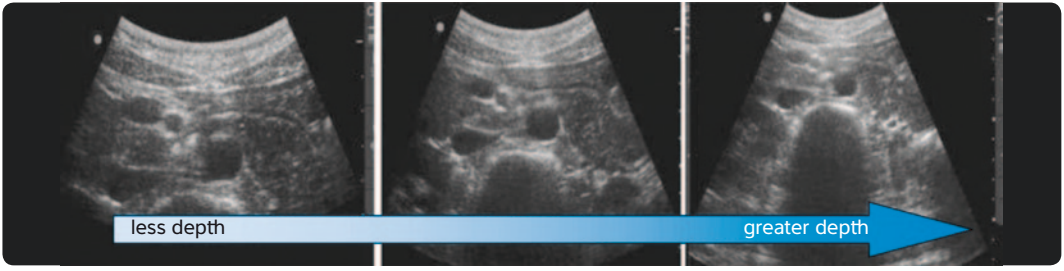


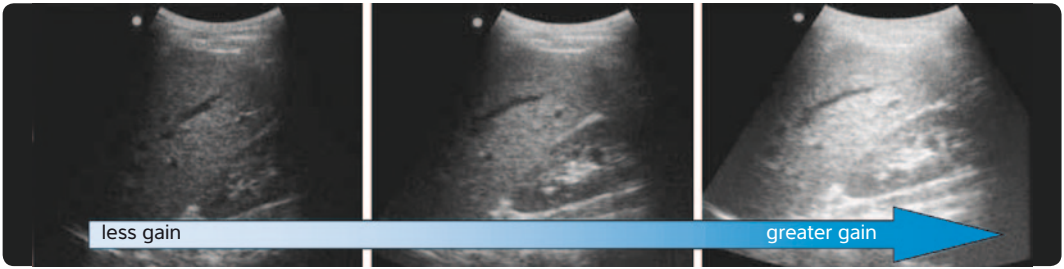
HOW IS AN ULTRASOUND SCAN USED?

1. **DON'T be afraid.** Ultrasound machines have thousands of buttons but fortunately they do NOT self-destruct if you hit the wrong one.
2. Identify the following keys, buttons or indicators (depending on the model).

A. Essential:

1. **ON/OFF.** NOT easy to find on lots of ultrasound machines.
2. **2D Mode.** Bidimensional image. Always appears by default.
3. **Depth:** changes the screen penetration.
4. **Gain:** amplification of the returning echoes to get homogeneous grey images across the depth.





B. Highly recommended:

1. **Pause/Freeze:** freezes the on-screen image.
2. **Cineloop:** enables several seconds of previous scanning to be shown on the screen. The arrows can be used to fast forward or rewind the image.
3. **Save/Print**. Images and small video clips can be saved.

C. What about the rest?

They are all useful but not essential to begin with. Their use will come with practice.

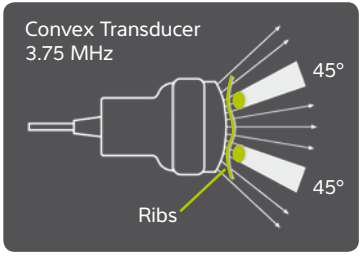

Depth
Gain
TGC : Time Gain Compensation
Freeze Cineloop
2D
Setup
Report
Review
Patient
Zoom
Depth
A
B
Exam
AutoGain
Set
Select
Save Calc
Update
Caliper
Calcs
Clip
Save
M Mode
Doppler
Color
Freeze
2D

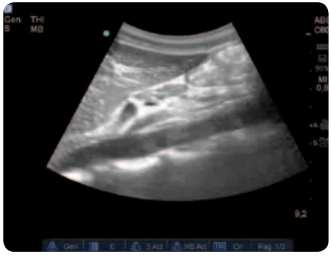
WHICH TRANSDUCERS SHOULD BE USED?

The type of transducer used depends on the area being studied:

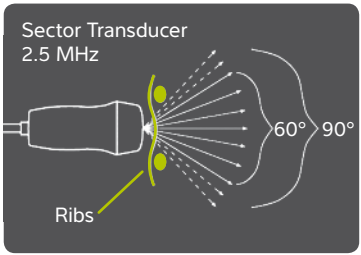
- **Low frequency** transducers (between 2 MHz and 6 MHz).
- Greater tissue penetration (examination of deep organs – FAST, echocardiography, renal, cranial, etc.).
- Lower resolution.
- Truncated conical image.
- More versatile.

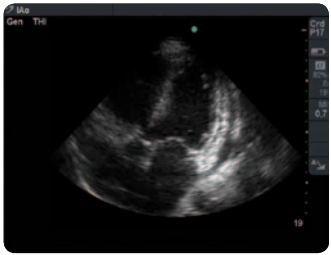
Abdominal transducer





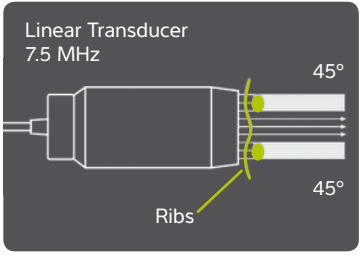
Cardio-cerebral transducer





- **High frequency** transducers > 6 MHz
- Less tissue penetration (superficial structural examination – vascular, musculoskeletal, etc.).
- Better resolution.
- 7–10 MHz for vascular scans. 10 to > 15 MHz for soft tissue.
- Rectangular image.
- Less versatile.

Linear Transducer



HOW DO YOU POSITION THE TRANSDUCER?

1. The Marker

This is an indentation/notch at one end of the transducer that corresponds to a signal on the screen. It is used to situate the transducer spatially and to provide appropriate anatomical reference points. The marker ● can normally be found in the upper left-hand corner of the screen.

2. Scan planes

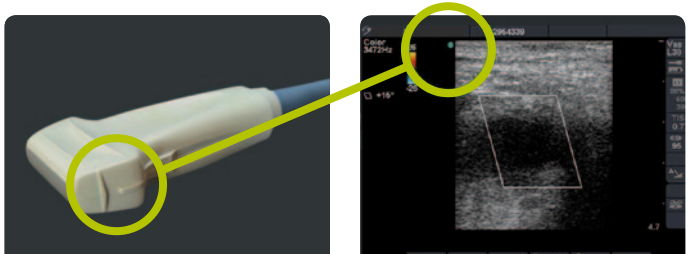
The position of the marker defines different scan planes. For practical purposes three "pure" or basic planes are shown which enable orientation. These are the starting points for an infinite number of oblique planes.

Identify the following from the pictures in this section:

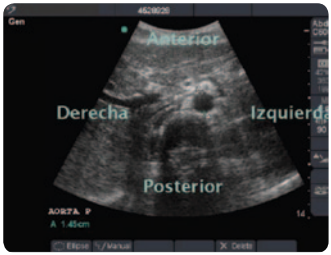
i. The different transducers used.

ii. The scan depth.
Figure in the lower right part of the screen (in cm).

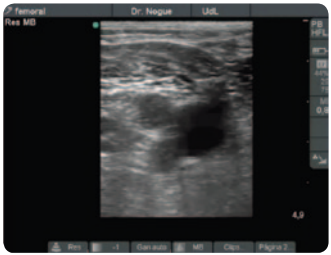
iii. Try to recognise the structures shown in the ultrasound.



a) **Transverse plane:** with the transducer held perpendicular to the patient's major axis or to the structure under investigation. The transducer marker will always be to the right of the patient with the mark ● to the left of the screen.



Epigastrium



Femoral Region

Translations: derecha – right, izquierda – left

b) Sagittal plane: with the transducer parallel to the patient´s major axis or to the structure under investigation. The transducer´s marker will point towards the patient´s head (cephalic orientation).

The mark ● will remain situated on the left. The image obtained will show the patient´s head to the left of the screen and the feet to the right.

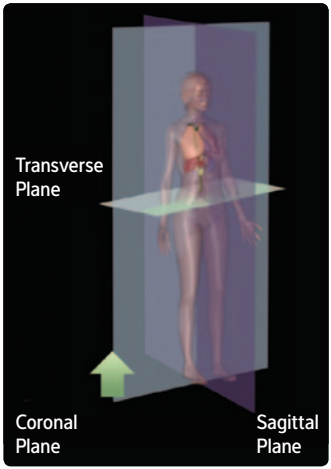
Epigastrium

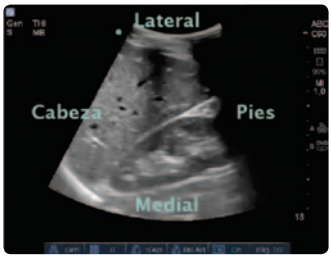
Femoral Region

Translations: cabeza – head, pies – feet

c) **Coronal plane:** with the transducer in a lateral position to the patient. The marker will point to the patient's head.

The mark ● will remain situated on the left of the screen, the head towards the left, the feet towards the right, however the upper part will correspond to the lateral part of the body and the lower part to the medial.





Morison's pouch

Translations: cabeza – head, pies – feet

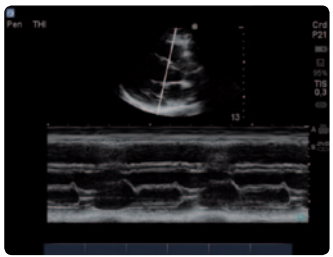
ULTRASOUND MODES

The machine interprets the ultrasounds received using different MODES, which essentially consist of the following:

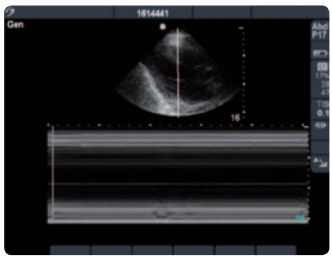
a) **B Mode (or 2D):** A bidimensional, real-time image is obtained. This is the most common mode. It provides a dynamic, anatomical image.

b) **M Mode:** This is the one real-time representation of a B Mode beam. This is basically used to assess clinical situations where there is no sign of movement (echocardiography, pulmonary ultrasound, foetal heartbeat). It is also widely used in measurements.

Morison's pouch



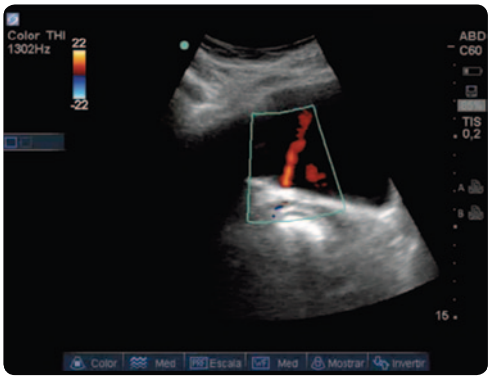
Heartbeats



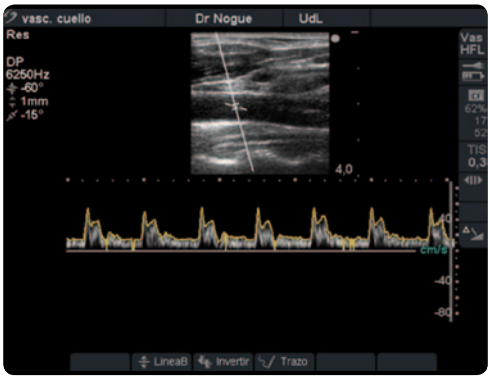
Cardiac Arrest

c) **Doppler Mode:** This uses the frequency change produced by movement in the tissues (chiefly that of the blood, urine and lungs). There are two ways of recording these movements:

1. **Colour Doppler:** Everything flowing away from the transducer is assigned the colour blue and everything flowing towards the transducer is assigned the colour red.
2. **Pulsed/continuous Doppler:** A graph is generated in wave form that is positive or negative depending on whether the flow is approaching or departing.



Ureteral Jets (red)

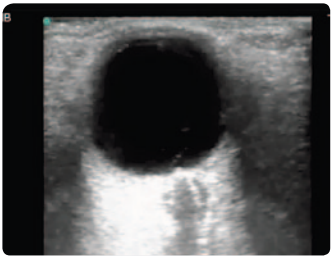


Carotid Artery

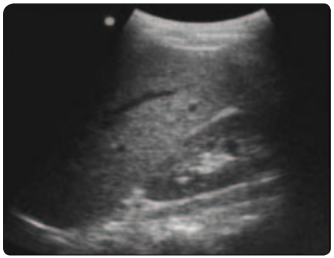
BASIC ULTRASOUND IMAGES

The following images can be defined, based on echogenicity and their representation in grayscale:

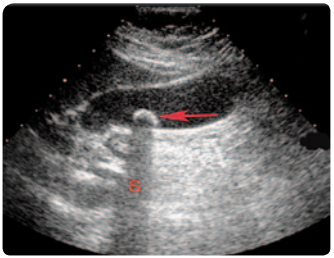
ANECHOIC	HYPOECHOIC	HYPERECHOIC
No echoes black image	+- echoes image from dark to light grey	Many echoes, image from grey to white
bladder, blood, vessels etc.	muscles, liver etc.	diaphragm, bone etc.
if liquid = tail +- white (post reinforcement)	no shadow produced – later reinforcement	if solid = tail +- black (acoustic shadow)



Eyeball
Black + white tail



Liver – Kidney
No shadow, no reinforcement



Gallstone
White + black tail

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- Lichtenstein, D. Whole Body Ultrasonography in the Critically Ill. e-ISBN: 978-3-642-05328-3. Springer-Verleg Berlin Heidelberg 2010.
- Greco, F. Echography in anesthesiology, intensive care and emergency medicine: A beginner´s guide. ISBN: 978-2-8178-0015-8. Springer-Verleg France, Paris 2010.

Emergency Medicine and Ultrasound

3. EMERGENCY ULTRASOUND IN BLUNT ABDOMINAL TRAUMA

F.A.S.T. PROTOCOL

WHAT IS THIS FOR?

The acronym F.A.S.T. (Focused Assessment with Sonography for Trauma) first appeared in the US in 1996. The ultrasound scan is performed by doctors, rather than radiologists, in the context of a thoracoabdominal trauma, to identify the presence or absence of free intraperitoneal fluid and/or pericardial effusions, with the aim of increasing survival prospects by reducing the time until surgical treatment. The "E" (E.F.A.S.T.) was added in 2009 when lung ultrasound scans were included for a rapid search for pneumothorax (see the chapter on lung ultrasounds in this guide). It currently forms part of the skills needed in A.T.L.S. (Advanced Trauma Life Support) courses.

HOW IS A F.A.S.T. EXAM PERFORMED?

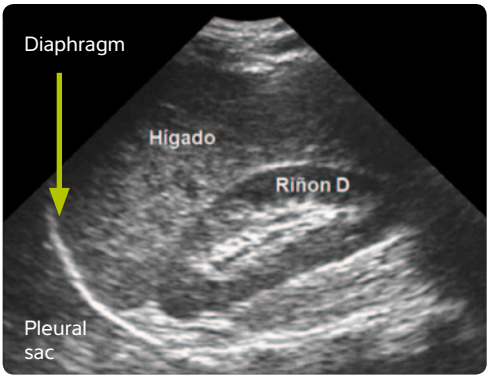
Use a convex transducer (3.5 to 5 MHz)
Select the abdominal preset.

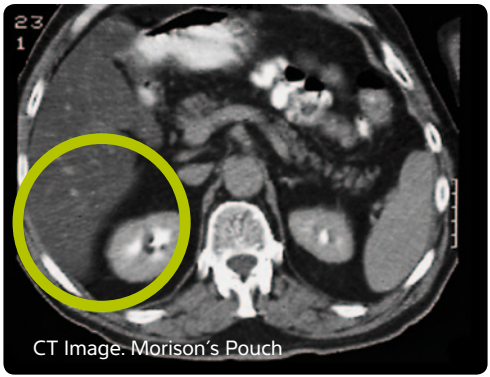
WHAT ARE THE ESSENTIAL VIEWS?

A. Hepatorenal recess or Morison's pouch

1. Place the transducer longitudinally with the marker towards the patient's head.
2. Locate it over the last ribs on the right side at the level of the anterior axillary line. If you cannot see the structures, move towards the midaxillary line.

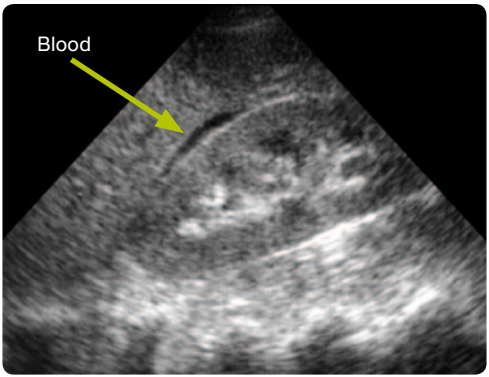
3. Identify the bottom of the pleural sac, diaphragm, liver and kidney, from L to R on the screen.
4. Slide the transducer to see the largest segment possible of the hepatorenal recess, including the lower pole of the right kidney (important).

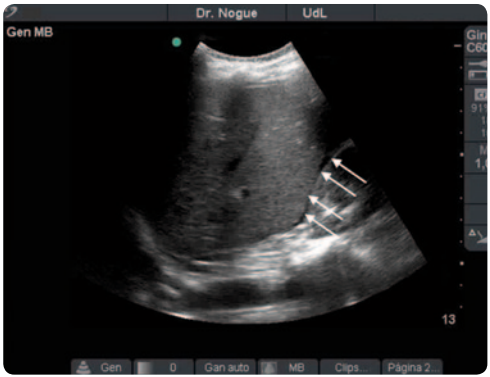




Translations: Higado – Liver, Rinon D – R Kidney

5. Look for free fluid (black) in the hepatorenal recess (Morison's pouch) and paracolic gutters (at the level of the lower pole of the kidney).

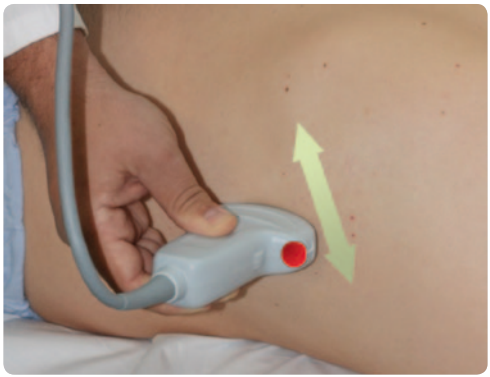




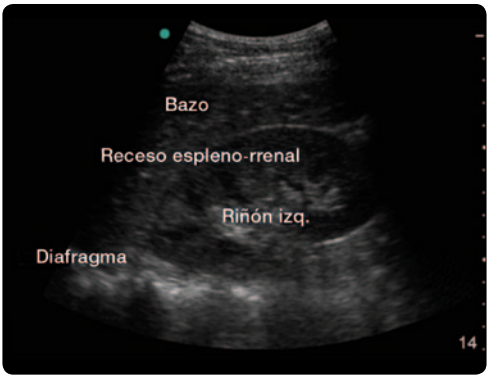
B. Splenorenal recess

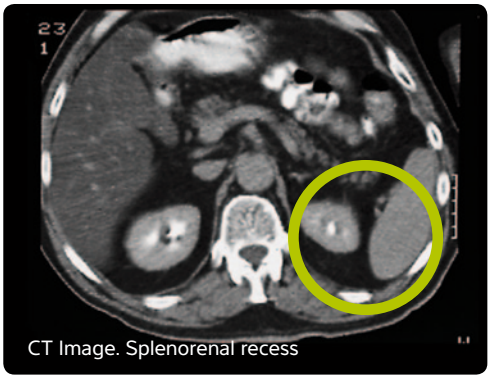
1. Place the transducer longitudinally with the indicator ● positioned towards the patient's head. Locate it over the lower ribs on the left-hand side at the level of the post-axillary line.

   If you do not see the structures, move towards the midaxillary line, or towards the patients head.



2. Identify the bottom of the pleural sac, diaphragm, spleen and kidney, from left to right on the screen. Gently slide the transducer to see the largest segment possible of the splenorenal recess.

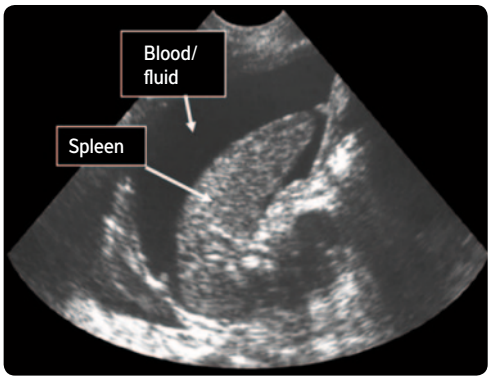


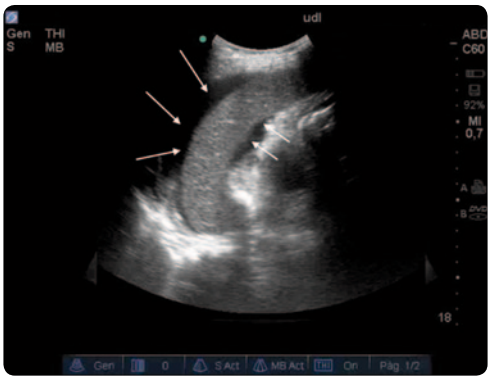


CT Image. Splenorenal recess

Translations: Bazo – Spleen, Receso Esplenorrenal – Splenorenal Recess, Riñón izq. – Left Kidney, Diafragma – Diaphragm

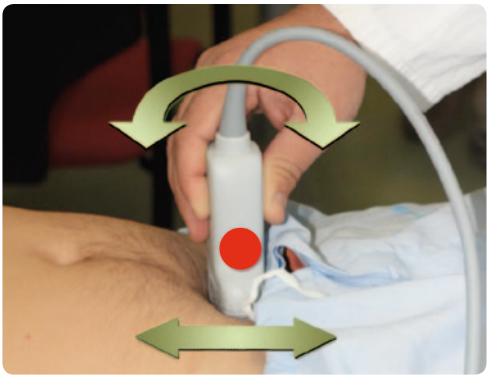
3. Look for free fluid (black) in the splenorenal recess and paracolic gutters (level of the lower pole of the kidney).

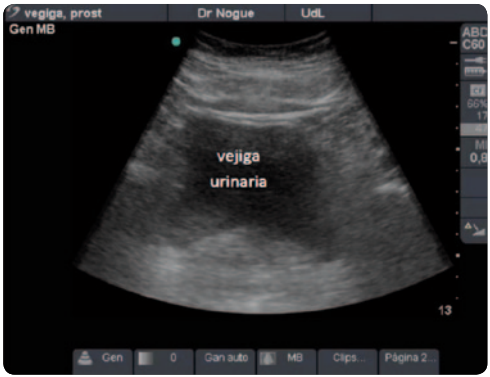




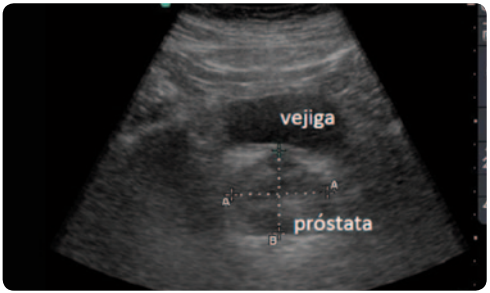
C. Pelvis

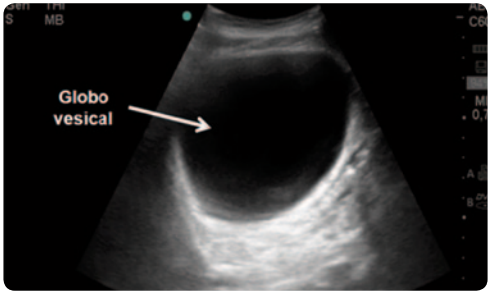
1. Place the transducer transversally with the indicator ● oriented towards the patient's right, between the navel and the pubic symphysis. Identify the bladder (prostate – uterus, if possible).
2. Make a sweep from top to bottom looking for free fluid (black) above, below or to the sides of the bladder.
3. Assess the filling of the bladder (overdistention of the bladder??). If you do not see the structures, move towards the symphysis pubis.



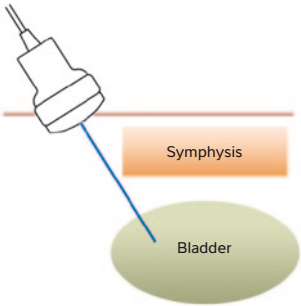


Translations: Vejiga urinaria – Urinary bladder



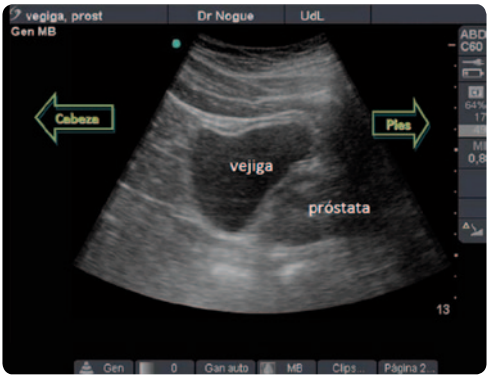


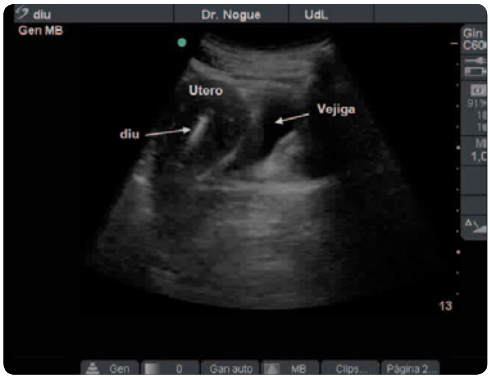
4. Turn the transducer 90°, orienting the indicator towards the patient´s head.



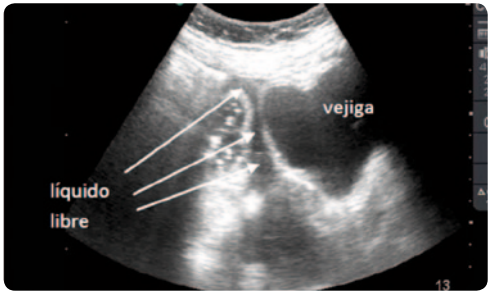
Translations: Vejiga – Bladder, Prostata – Prostate, Globo Vesical – Distended Bladder

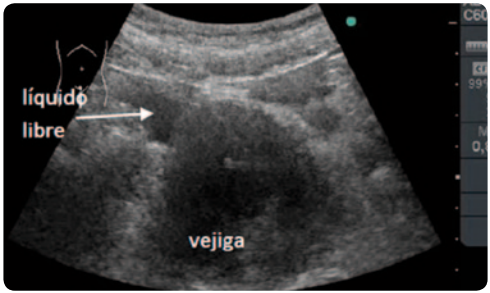
5. Look for free fluid (black) behind (recto-vesical pouch in men, Pouch of Douglas in women) and to the sides of the bladder. If you cannot see the bladder, move the transducer towards the symphysis pubis.

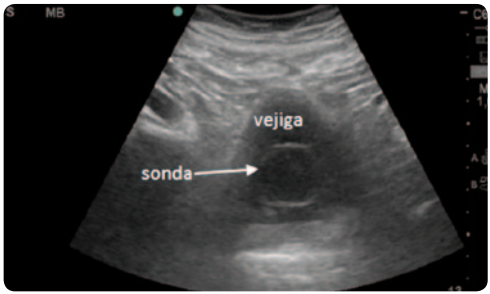


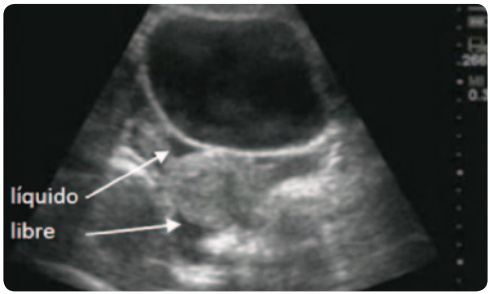


Translations: Vejiga – Bladder, Prostata – Prostate, Cabeza – Head, Pies – Feet, Utero – Uterus







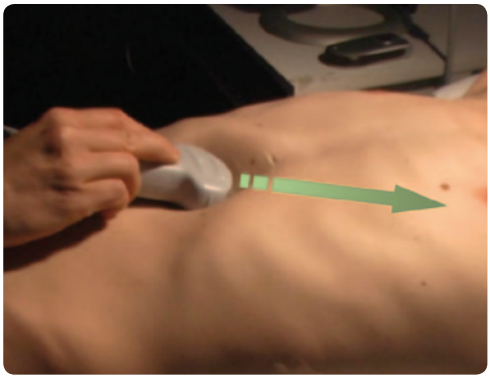


Translations: Vejiga – Bladder, Liquido libre – Free fluid

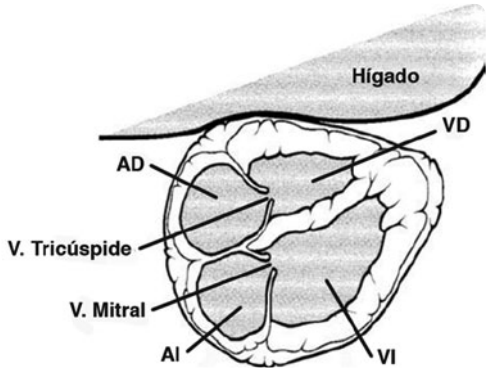
D. Pericardial sac

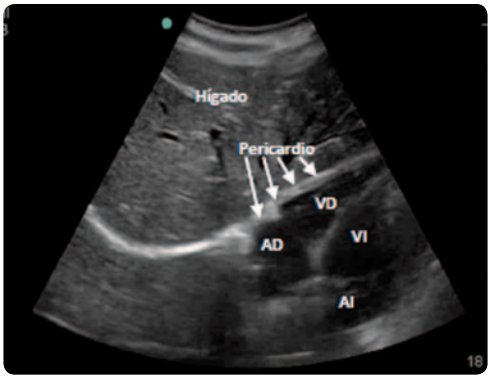
Subxiphoid window: (preferred).

1. Place the transducer transversally with the indicator oriented towards the patient's right in the epigastrium, below the xiphoid process and slightly to the right half.
2. Tilt the transducer to an angle of roughly 30°, directing the ultrasound beam towards the left shoulder, trying to pass through the liver.



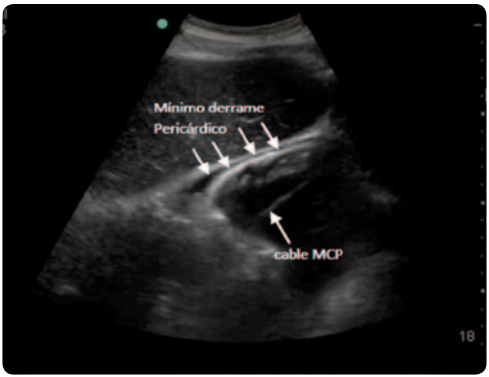
3. Identify the right heart chambers immediately below the liver and the left heart chambers towards the right of the screen.
4. Identify the pericardium and the hyperechoic membrane surrounding the heart.
5. Look for free fluid between the layers of the pericardium: anechoic space (black) between two hyperechoic lines (parietal and visceral pericardium) around the heart. The more liquid, the easier it is to find.
   NOTE! DO NOT confuse this with pleural effusion.

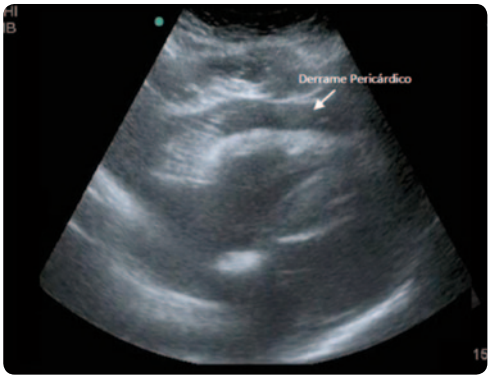




Translations: Hígado – Liver, Pericardio – Pericardium
VD – Right Ventricle, VI – Left Ventricle, AD - Right Atrium, AI – Left Atrium, V. Mitral – Mitral Valve, V. Tricuspide - Tricuspide Valve

6. In the event of a poor subxiphoid window, use the parasternal long-axis view: see the chapter on cardiac ultrasound in this guide.





Translations: Minimo derrame – Minimum spill, Cable MCP - Pacemaker Cable, Derrame Pericardico – Pericardial Effusion

WHAT IMAGES AND VIDEO CLIPS SHOULD BE SAVED?

- Hepatorenal recess: liver, kidney, diaphragm and the inferior portion of the pleural sac.
- Splenorenal recess: spleen, kidney, diaphragm and the inferior portion of the pleural sac.
- Pelvis in sagittal and transverse planes: bladder and recto-vesical pouch in men, Pouch of Douglas in women.
- Heart with 4 chambers and surrounding pericardium.
- Any other view demonstrating pathology.

WHAT ARE THE ADVANTAGES?

- Fast.
- Non-invasive.
- It can be repeated.
- Concomitant with resuscitation.
- Effective cost.
- It can be reproduced.
- No exposure to radiation or contrast media.

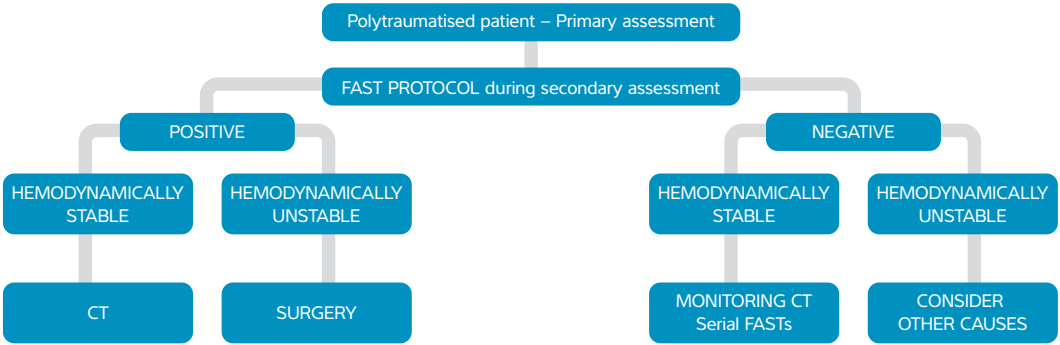
WHAT ARE THE DISADVANTAGES?

- Obese patients, although obesity is not necessarily synonymous with a bad image.
- Subcutaneous emphysema.
- Diaphragmatic, pancreatic, visceral and retroperitoneal lesions.
- Open trauma.
- Does not rule out potentially fatal abdominal lesions.

WHAT ARE THE MISTAKES TO AVOID?

- **Not taking 4 views**
- **Not performing the examination dynamically**
- **Not seeing blood clots (echogenic)**
- **Not performing serial F.A.S.T. Examinations**
- **Not seeing:**
  - The lower pole of the right kidney
  - The subdiaphragmatic region on the left
  - The sagittal view of the bladder
- **Not taking the ultrasound's lack of sensitivity to solid organ lesions into account**

WHAT ALGORITHM OR GUIDE SHOULD BE FOLLOWED?



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Emergency Medicine and Ultrasound

4. ULTRASOUND PROCEDURES

VASCULAR PUNCTURES

WHAT IS THIS FOR?

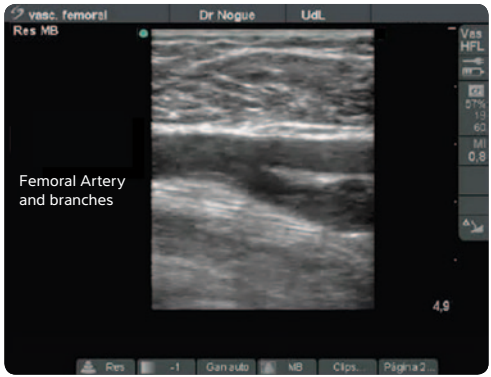
Complications with a central line placement are common and potentially serious. Depending on the line used, literature shows a complication rate of around 15% (mechanical, infectious, thrombotic, etc.).

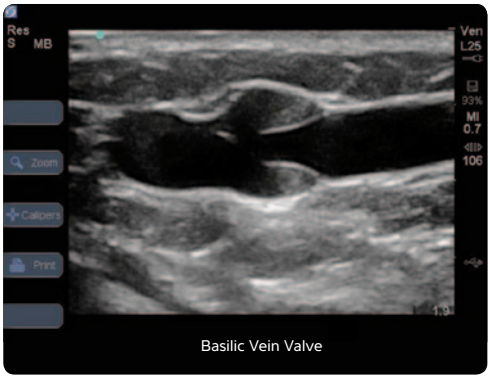
Ultrasound is an important aid in venous catheterisation. It is the difference between SEEING and NOT SEEING. There is multiple scientific evidence to support this.

The aim when using ultrasound is to reduce the rate of complications, the number of attempts and the time spent on the puncture, bearing in mind the importance of the physician's previous experience. The greatest benefit is gained by doctors with little experience and patients with a high risk of complications such as: coagulopathy, mechanical ventilation, a patient in a semi-recumbent position, obesity, venous thrombosis, anatomical variations, and unstable patients, all frequent occurrences in the emergency and resuscitation departments.

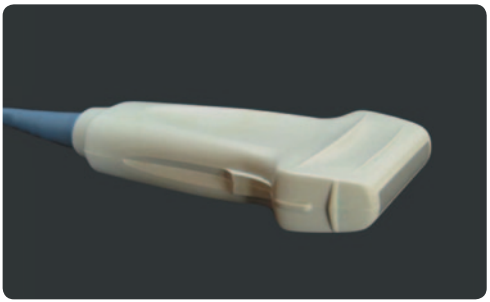
WHAT DO I NEED?

1. **B Mode:** (or 2D: brightness mode): selected to view vascular structures. These are characterised by their anechoic appearance (black) in the vessel lumen and hyperechoic appearance (whiter) in the walls.
   - Arteries: thicker walls, pulsating, and not easily compressed.
   - Veins: thinner walls, can be seen pulsating to a certain extent because of contiguity and are easily compressed with the transducer when they are not thrombosed. The use of Doppler improves identification.





2. **Linear transducers:** offer optimal visualisation of the vascular structures. Their ultrasound frequency range is between 7 and 15 MHz. It is possible to use lower frequency transducers to locate vessels at the expense of losing resolution.
3. **Sterility:** sterile barriers between the transducer and the patient (sterile covers or sheaths) and also using sterile ultrasound gel or, if this is not available, non-alcoholic disinfectant gel.
4. **Needles:** the best calibre lower than 16 G. The ultrasound image is hyperechoic, linear, or dotted depending on the orientation of the transducer. Certain needles use materials that increase echogenicity or ultrasounds that enhance the metallic image. Guides mounted on the transducer which can vary the angle as required can be used as an additional support.



Linear transducer

Searching for femoral vessels

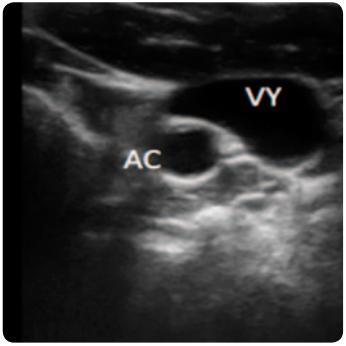
WHICH TECHNIQUE SHOULD YOU USE?

There are two possible methods:

1. **Ultrasound-assisted catheterisation. VIEW AND ASSESS.**

   Ultrasound enables the best available vessel to be selected and located. This facilitates the subsequent puncture, even if this is performed "blind". Even if just choosing which side to puncture or the best calibre vessel, the use of ultrasound will contribute to the success of the procedure.

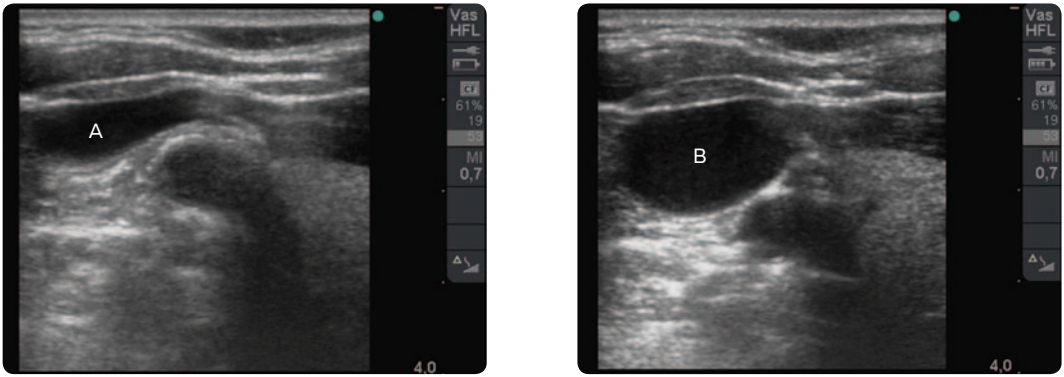
Locating the left internal jugular and the left cartoid artery



B Mode view of the internal jugular vein (VY) and the left carotid artery (AC)

Longitudinal subclavian vein image captured with a low frequency transducer

The vein can be better visualised by performing Valsalva manoeuvre, elevating the legs or by applying compression below the jugular scanning area with the free hand. This increases the calibre of the nearby vein, facilitating its puncture.



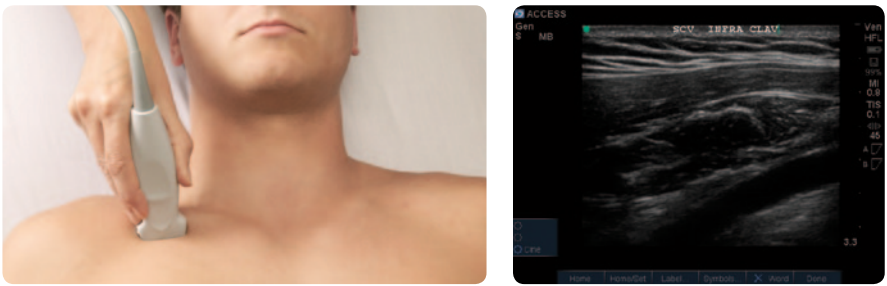
Variations in the calibre of the right jugular vein upon application of the Valsalva manoeuvre. **A** before. **B** during the manoeuvre.

2. Ultrasound-guided catheterisation. VIEW AND PUNCTURE.

The transducer used (preferably linear) can be positioned in two ways:

A. Longitudinal technique.

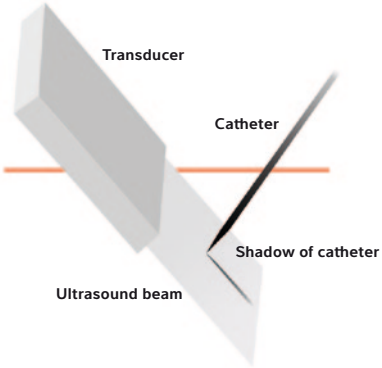
Longitudinally to the vessel and at an angle of +- 45° between the transducer and the catheter, which provides better visualisation of the needle tip and the needle along its trajectory (hyperechoic linear image). The vein is viewed on its major axis and the puncture is made on its most direct route. This technique could reduce punctures on the distal vessel wall, however it provides little margin for error in the alignment of the transducer. One of its drawbacks is that it does not usually enable visualisation of the artery. In practice it is the preferred technique, although it involves a steeper learning curve.



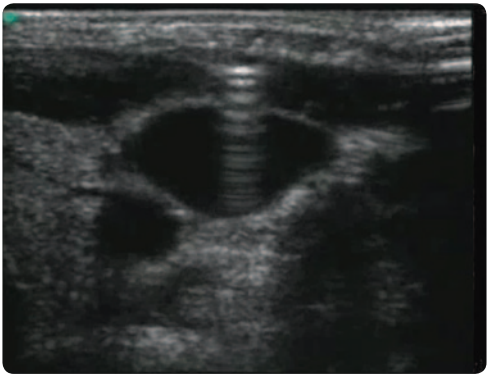
Longitudinal technique for ultrasound-assisted puncture of the right subclavian vein

B. Transverse technique.

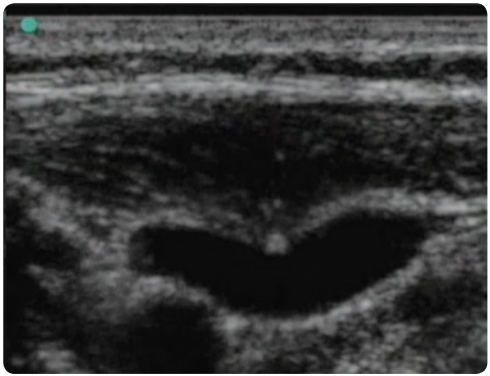
The transducer is positioned to visualise the vein in short axis. The artery is clearly visible and it is the best technique when space is limited. Smaller vessels are more easily visualised. Does not require such a steep learning curve. Its main drawback is that the tip of the needle is not visible, although its path can be extrapolated indirectly.



Transverse technique, showing sterile conditions both of the area and the transducer. Note the needle is at a 45° angle.



Needle progression at the start of the puncture. Note the posterior shadow.

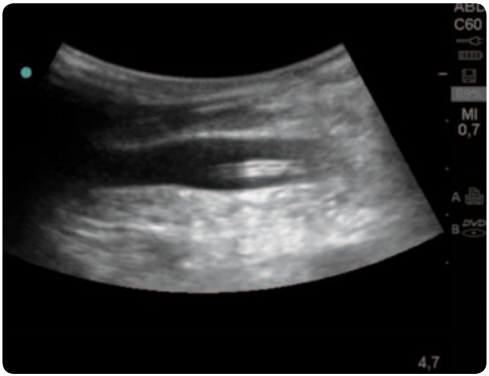


Tip of the needle puncturing the vessel. Note the pressure that it exerts on the walls.

ADDITIONAL APPLICATIONS

Ultrasound also enables:

- The safe location of the pleural cupula in subclavian punctures. This minimises the risk of pneumothorax, even in ultrasound-assisted procedures, by assessing the distance between the puncture zone and the pleura.
- Ruling out with almost complete certainty the presence of a pneumothorax after a subclavian catheterisation. (See lung ultrasound.)
- Assessing the migration of the catheter to the internal jugular vein on the same side. Viewing the catheter or the metallic guide in the jugular vein enables the correction of the direction. In anticipation of this problem, the initial sterile field should be extended to include the jugular region, enabling the transducer to be placed on this area.
- Searching for and catheterising peripheral veins, above all the cephalic or basilic vein in patients with puncture difficulties. Some of the studies have been carried out by nurses with equal success rates.



Triple lumen catheter in the jugular vein, captured with an abdominal transducer.

Triple lumen catheter in the jugular vein, captured with a linear transducer.

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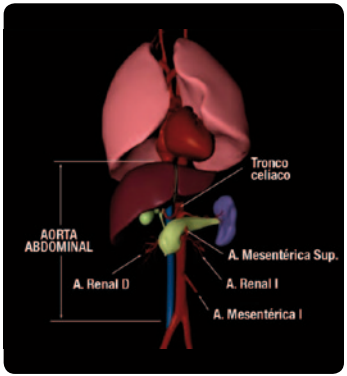
Emergency Medicine and Ultrasound

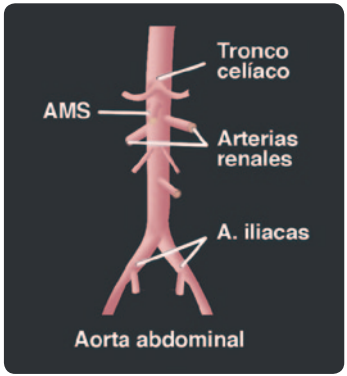
5. ULTRASOUND OF THE ABDOMINAL AORTA

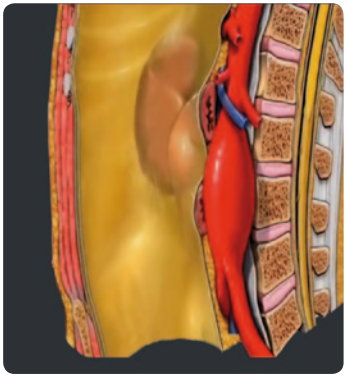
ULTRASOUND OF THE ABDOMINAL AORTA

WHY?

In certain clinical contexts, ultrasound identifies abnormalities with the aorta, primarily involving its size, which can improve diagnostic accuracy and guide the therapeutic procedure to be followed. An ultrasound of the aorta is focused on patients with lumbar or abdominal pain in order to rule out an aneurysm of the abdominal aorta.







Translations: Aorta Abdominal – Abdominal aorta, Tronco Celiaco – Celiac Trunk, A. Renal D – Right renal artery, A. Mesenterica Sup. (AMS) – Superior mesenteric artery, A. Renal I – Left renal artery, A. Mesenterica I – Inferior mesenteric artery, Arterias renales – Renal arteries, A. iliacas – Iliac arteries

Anatomy:

The aorta runs along the curve of the spine (approaching its surface), immediately anterior and to the left. It enters the abdomen via the diaphragmatic hiatus (D12). The upper portion of the aorta contains the end of the first arterial branches. The aorta's first branch is the celiac trunk. Ultrasound distinguishes two of its three branches (the hepatic and splenetic branches). It leaves from the anterior wall and in a cross-section it has the shape of a gull's wings or the tail of a diving whale. The next branch is the superior mesenteric artery which has a round cross-section surrounded by a hyperechoic halo (fat, connective tissue). The aorta's middle section does not have any branches that are usually recognisable. The aorta bifurcates into the iliac arteries along its lower section. The inferior vena cava runs parallel and to the right of the spine.

WHICH TRANSDUCER SHOULD BE USED?

Convex or phased array. 2.5-5.0 MHz
Select the abdominal preset

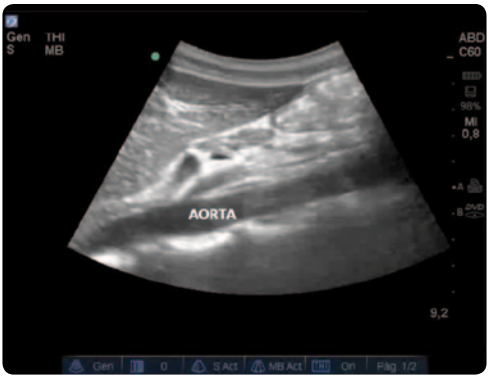
WHICH AORTA PATHOLOGY SHOULD WE LOOK FOR?

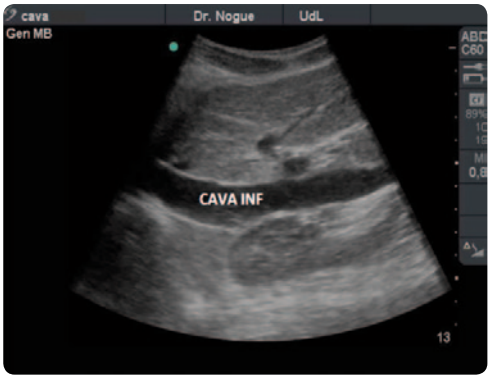
- Aneurysm of the abdominal aorta, dilation of the aorta is visible.
- Dissection and atherosclerosis, the presence of intraluminal echoes.
- Rupture of the aortic aneurysm. NOTE! Difficult. Free fluid is rarely seen in the abdomen as this is a retroperitoneal structure. CT assessment.

Distinguish the inferior vena cava (IVC):

- The aorta is to the patient's left and the IVC to the right.
- The aorta is behind the liver and the IVC crosses the liver.
- It is rounded and tubular and its walls are hyperechoic and thick. The IVC is oval or shaped like an italic "S" with thin walls.
- The cava ends in the auricle. It compresses and varies with respiratory movements.

Measure from wall to wall and take these measurements in its proximal, middle, and inferior segments. An aneurysm of the abdominal aorta is defined when it is > 3cm or 50% > than the unaffected proximal segment.

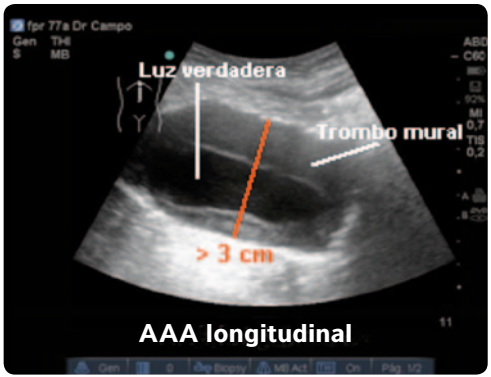


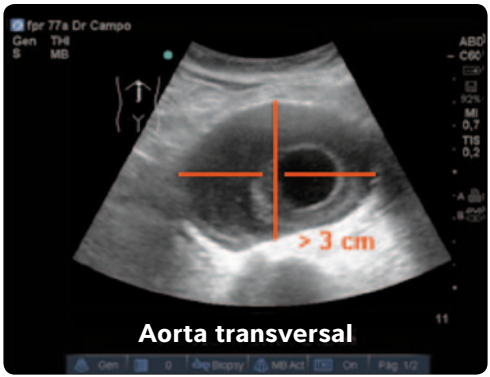


The ultrasound correctly diagnoses the aneurysm but not its complications (rupture).

The intimal flap is a mobile echogenic line within the aortic lumen, visible in some aortic dissections.

Intestinal gas limits some scans. In this case applying continual firm compression helps move it to the sides. We can also try cutting accessories in the right midaxillary line.





Translations: Luz verdadera – True Lumen, Trombo mural – Mural thrombus

WHICH ULTRASOUND IMAGES?

A. Longitudinal
- Superior
- Middle
- Inferior

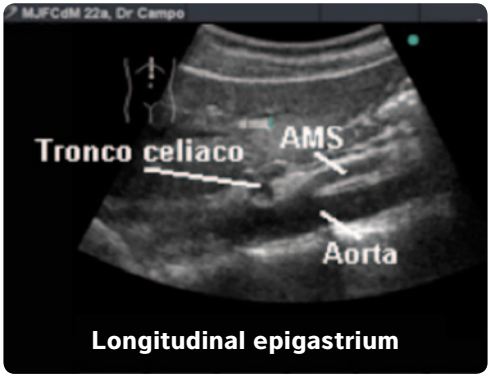
B. Transverse
- Superior
- Middle
- Inferior

A. Longitudinal

Place the transducer in the epigastrium, with the reference mark towards the patient's head. Scan the aorta to its bifurcation into the iliac arteries, as far as the navel.

- **Superior aorta reference points:**
  - Spinal column, celiac trunk, superior mesenteric artery.
- **Inferior aorta reference points:**
  - Shadows of the vertebral bodies.
- **Image:**
  - Contour of the aorta, main branches, and interior content.

Aorta longitudinal



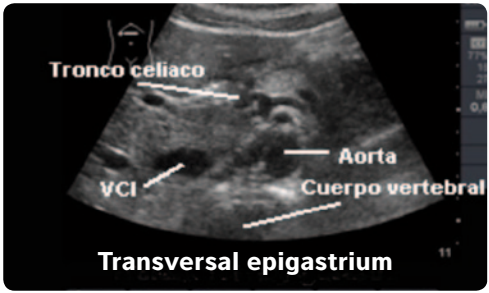
Longitudinal epigastrium

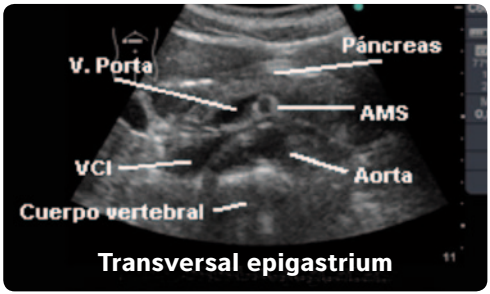
B. Transverse

Place the transducer in the epigastrium with the reference mark to the right of the patient. In the epigastrium below the xiphoid appendix. Scan up to the navel (division into iliac arteries).

- **Reference points:**
  - shadow of the spinal column, celiac trunk, superior mesenteric artery, left renal vein and splenic vein.

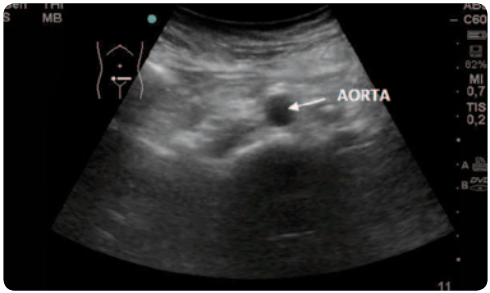
Translations: AMS – Superior Mesenteric Artery, Tronco celiaco – Celiac trunk



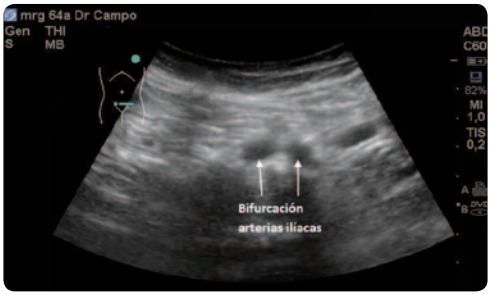


Translations: Tronco celiaco – Celiac trunk, VCI – IVC, Cuerpo vertebral – Vertebrae

Aorta transversal media



Aorta transversal superior



Translations: Birfurcacion arterias iliacas – Iliac arteries bifurcation

Anteroposterior measurements may be overestimated if the scan plane is not fully perpendicular to the vessel (fully perpendicular to the abdominal wall because the vessel is parallel to the lumbar lordosis).

WHICH IMAGES/VIDEO CLIPS SHOULD BE SAVED?

1. Transverse view of the proximal aorta, above the superior mesenteric artery (SMA) with the measurement of the aortic diameter.
2. Transverse view of the middle aorta, with measurement of the aorta.
3. Transverse view of the distal aorta, on or above the bifurcation of the iliac arteries, with measurement of the vessel diameter.
4. Longitudinal view of the proximal aorta, with measurement of the aortic diameter.
5. Longitudinal view over the distal aorta with its measurement.
6. Additional cuts showing whether there is a pathology.

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Emergency Medicine and Ultrasound

6. THORACIC ULTRASOUND

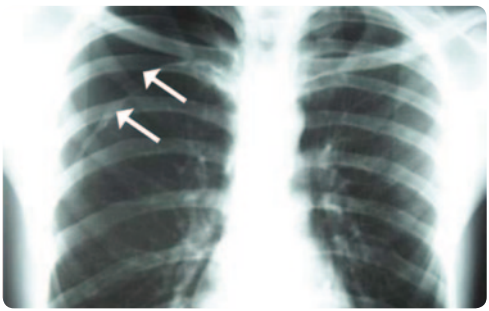
THORACIC ULTRASOUND: PNEUMOTHORAX

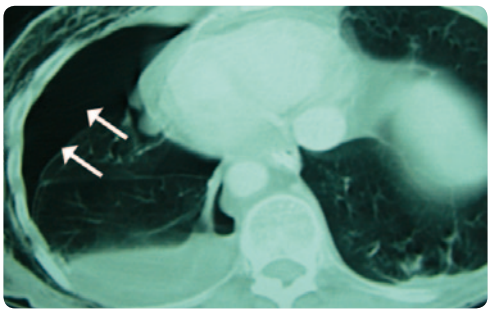
WHY?

In the context of suggestive clinical signs or an unstable situation, one of the clinical outcomes to be aware of is pneumothorax. Ultrasound enables this to be ruled out in almost every case and to be identified in most cases quickly, accurately, and harmlessly, unlike thoracic x-rays or CT scans.

WHICH TRANSDUCER SHOULD BE USED?

Preferably a high frequency linear transducer, although low frequency transducers with reduced depth may be used, making allowances for a loss of quality.





Thoracic X-Ray and CT scan showing pneumothorax

WHICH SCANNING TECHNIQUE SHOULD BE USED?

1. Supine position.
2. Transducer on the thoracic wall´s anterior wall. 2nd or 3rd intercostal spaces.
3. Parasternal or midclavular line. Also in other locations to determine the extent of the pneumothorax.
4. Transducer marker towards the patient´s head.
5. Image obtained between the two ribs.
6. Observe several respiratory cycles.

Longitudinal, right parasternal

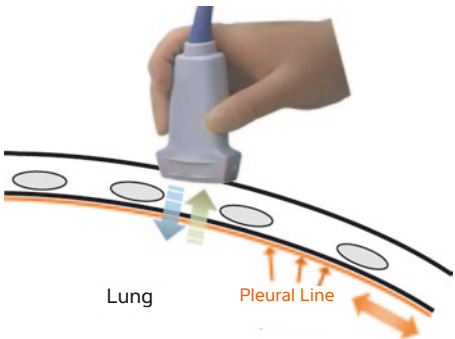
Longitudinal, left parasternal

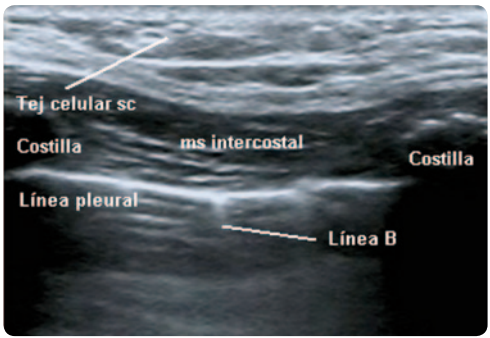
WHICH ANATOMICAL STRUCTURES SHOULD BE TAKEN INTO ACCOUNT?

Ribs, lung, pleura, intercostal musculature. BAT image.

WHICH NORMAL ULTRASOUND IMAGE SHOULD BE USED?

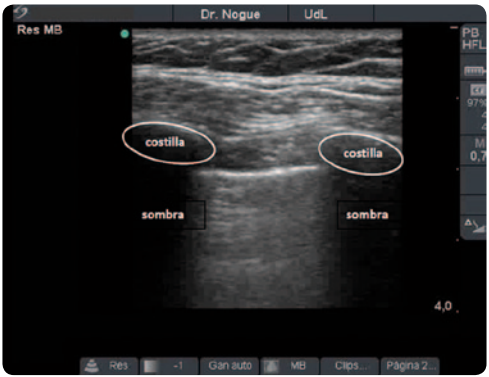
1. Ribs: hyperechoic image with posterior acoustic shadow.
2. Intercostal musculature: image of the muscle tissue.
3. Pleural line: hyperechoic line from contact with the two pleural leaves. Ultrasound cannot distinguish the parietal pleura from the visceral.



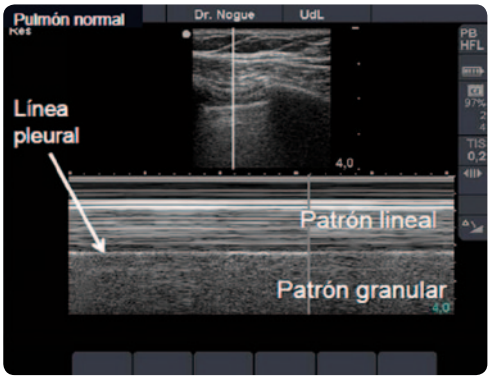


Translations: Tej celular sc – Subcutaneous tissue, Costilla – Rib, Línea pleural – Pleural line, MS Intercostal – Intercostal musculature, Línea B – B Line

During respiratory movements the pleural line makes a reciprocal movement called pleural sliding. The pleural line has a comet-tail artifact perpendicular to the pleura (B lines). In M Mode we can see the image known as the seashore sign. We use the power Doppler mode to accentuate the movement of the pleura (Power slide, sliding beneath the pleural line) and save images.



Ultrasound image of a normal lung



Same image in M Mode

Translations: Costilla – Rib, Sombra – Shadow, Línea pleural – Pleural line, Patrón lineal – Linea pattern, Patrón granular – Granular pattern

HOW DO YOU IDENTIFY A PNEUMOTHORAX WITH AN ULTRASOUND?

Pleural sliding and B lines are absent. In M Mode the pattern is known as the stratosphere sign. The only specific sign of pneumothorax is the lung point, the transition between the pneumothorax and the attached pleura.

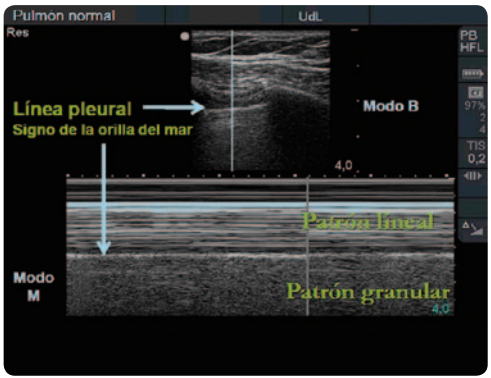


Image of normal lung in M Mode

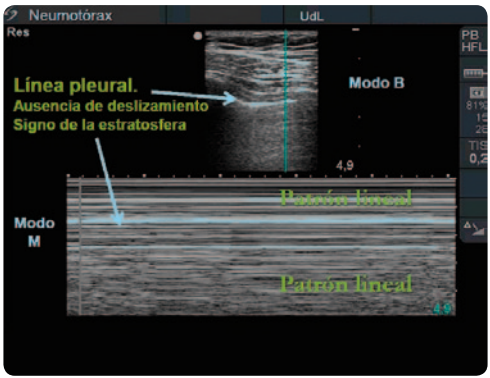
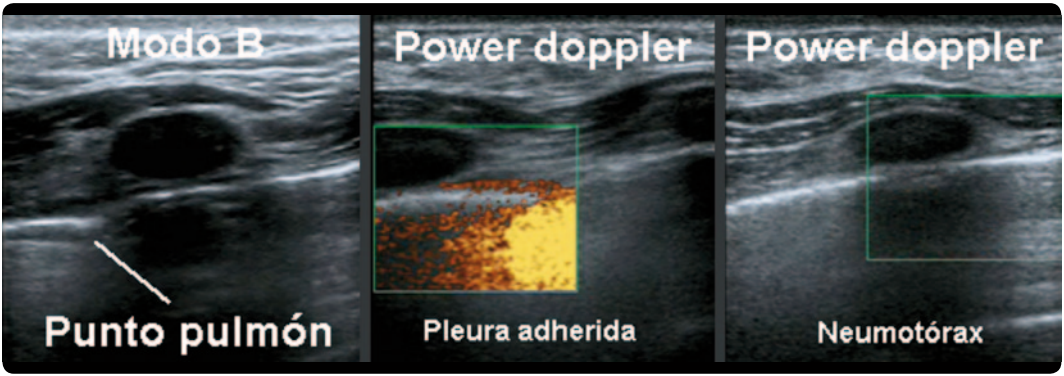


Image of pneumothorax

Translations: Linea pleural – Pleural line, Signo de la orilla del mar - Seashore sign, Patron lineal – Linea pattern, Patron granular – Granular pattern
Signo de la estratosfera - Stratosphere sign

WHAT IMAGES/VIDEO CLIPS SHOULD BE SAVED?

- Videos of pleural sliding and B lines if present.
- Colour power slide.
- M Mode: stratosphere or seashore sign.
- Include any additional view in the event of a pathology.



Absence of sliding with power Doppler

Translations: Punto pulmón – Lung point, Pleura adherida – Attached pleura, Neumotórax – Pneumothorax

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Emergency Medicine and Ultrasound

7. CARDIAC ULTRASOUND

BASIC CARDIAC ULTRASOUND IN EMERGENCIES

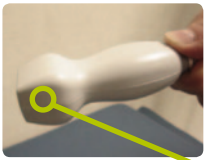
WHY?

Numerous references have provided sufficient evidence that, following a short period of training ultrasound can be used in the field of acute and/or emergency illnesses by focusing the scan on specific aspects requiring less "operator dependence".

TECHNICAL INFORMATION

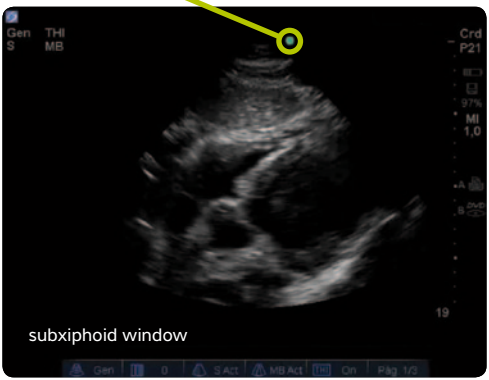
Use the sector transducer (2.5-5 MHz).
To assess functionality, use the cardiac preset.
To just assess the image use the abdominal preset.

Although the patient's theoretical position is left lateral decubitus as it offers a better window through the ribs, this study can be performed in the supine position because of the difficulty of moving emergency patients.



Cardiac transducer/cardiac preset.

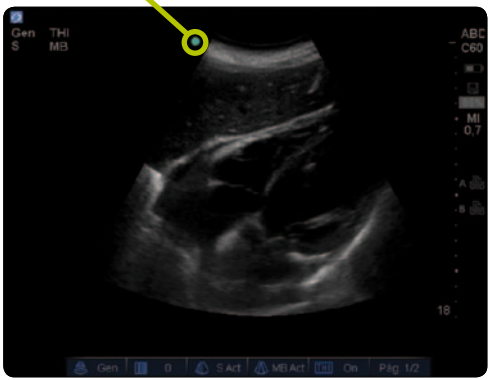
Note the position of the marker is to the right of the image



subxiphoid window

Abdominal transducer/ abdominal preset.

Marker to the left of the image



WHICH ARE THE ESSENTIAL VIEWS?

Ultrasound provides numerous views but four are fundamental at the basic level:

A. Subcostal or subxiphoid.

Similar to that obtained using the F.A.S.T. protocol for assessing pericardial effusion. See the F.A.S.T. chapter. Section D.

B. Parasternal long axis.

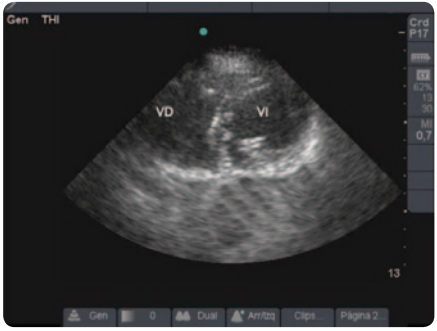
1. If using an abdominal transducer, position the transducer on the theoretical long axis of the heart (running from the right shoulder to the left hip), with the marker pointing to the LEFT HIP. The mark will appear in the upper left-hand corner of the screen.
2. If using a cardiac transducer, place the transducer with the marker oriented towards the RIGHT SHOULDER. The mark will appear on screen to the upper right-hand side of the image.
3. The transducer must be applied fully perpendicular to the surface of the skin.
4. Identify the left of the heart along with a small portion of the right ventricle and the pericardium.

Parasternal view, long axis

Translations: VD – Right Ventricle, VI – Left Ventricle, AI – Left Atrium, VM – Mitral Valve

C. Parasternal short axis.

1. From the position outlined above, rotate 90° with the marker pointing towards the patient's RIGHT HIP.
2. A transverse cross-section of the left ventricle and part of the right ("donut" image) should be observed.
3. A left cross-section may be performed at various levels, from the LV point to the base of the heart. To assess overall contractility, take the cross-section in the papillary muscles.

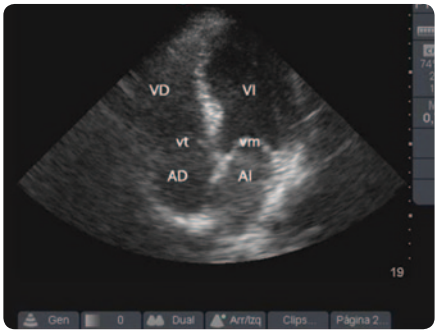


Parasternal view, short axis

Translations: VD – Right Ventricle, VI – Left Ventricle

D. Apical 4-chamber view.

1. Place the transducer under the left nipple in the palpable area of the cardiac apex, or slide the transducer through the intercostal space in which the parasternal cross-section is observed.
2. Position the marker approximately towards the patient's RIGHT HIP.
3. A 4-chamber view is observed (auricles and ventricles), with the marker being towards the right-hand side of the heart.



Apical, 4-chamber view

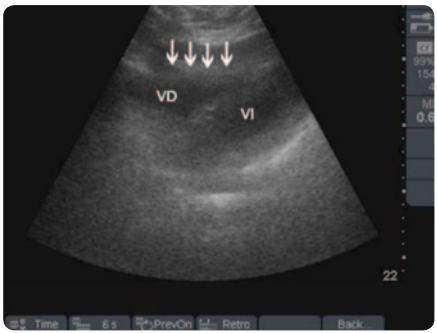
Translations: VD – Right Ventricle, VI – Left Ventricle, AD – Right Atrium, AI – Left Atrium, VM – Mitral Valve, VT – Tricuspid Valve

WHAT IMAGES/VIDEO CLIPS SHOULD BE SAVED?

Firstly, it is best to save videos (clips) because they are the only images that show movement and enable subsequent analysis. Failing this, save images in modes B and M. For the study to be valid, at least 2 of the above mentioned views should be included.

WHAT CAN BE ASSESSED?

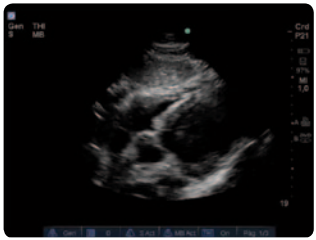
For emergencies, the following points need to be assessed:
1. Pericardial effusion: mainly subcostal.



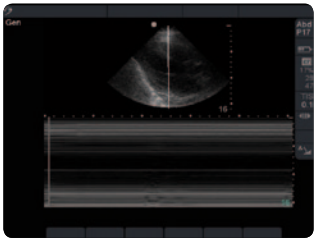
Pericardial effusion with tamponade: shows collapse of the RV (right ventricle – VD in the figure) (ultrasound sign of tamponading) indicated by arrows.

Translations: VD – Right Ventricle, VI – Left Ventricle

2. Ejection fraction (EF): in visual mode, categorised as normal, reduced, and very reduced. Basically with the parasternal long and short axes.

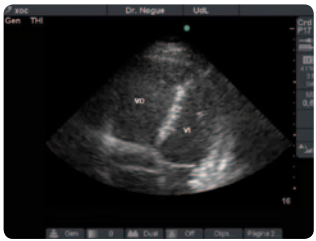


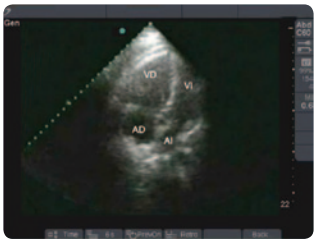
LV dilation, contractility deficit



No cardiac activity in M Mode

3. RV enlarged compared with LV: visualised with an apical 4-chamber view. This refers to RV enlargement exceeding a 0.6:1 ratio with the LV.





4-chamber view of acute pulmonary thromboembolism.
Note the dilation of the RV compared with the LV

Translations: VD – Right Ventricle, VI – Left Ventricle, AD – Right Atrium, AI – Left Atrium

WHAT MISTAKES SHOULD BE AVOIDED?

1. Not taking at least 2 views.
2. Trying to diagnose a specific pathology (this is the job of a cardiologist). This tool must be used in addition to the patient's Clinical History, an examination, an ECG, and routine supplementary tests.
3. Using ultrasound in emergency medicine for purposes other than assessing pericardial effusion, qualitative assessment of EF, and assessment of the size of the RV.

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