Emergency Ultrasound Course

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Introductory Course Manual:
FAST / EFAST, AAA, basic procedures

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- *Emergency Ultrasound Made Easy 2nd ed (in press),* Justin Bowra & Russell McLaughlin
- Ulster Community Hospital Emergency Department Ultrasound Manual, Belfast
- Cork University Hospital Emergency Department Ultrasound Manual, Fergal H. Cummins

Contents

Introduction

Ultrasound was first utilized for the examination of trauma patients in the 1970s in Europe, where its qualities for being a non-invasive, rapid, safe, accurate, and repeatable bedside assessment were first appreciated. Its' uptake in North America and the United Kingdom did not occur until the 1990s. Since that time a considerable body of data has been produced to support its use in the assessment of the trauma patient.

This course offers a mixture of lectures and practical skills sessions. The key educational objectives are:

Knowledge

To introduce participants to basic ultrasound concepts relating to:

- Physics
- Equipment
- Artefact
- Abdominal aortic aneurysm
- FAST
- Basic procedures
- Credentialing and maintenance of standards

Skills

To provide an opportunity to demonstrate the following skills:

- Equipment identification
- Image identification
- Perform AAA scan and identify pathology
- Perform FAST scan and identify free abdominal fluid
- Utilize ultrasound for basic procedures

Terminology

Anechoic
Fluids such as blood, urine and bile appear black or anechoic.
Attenuation
Progressive weakening of the ultrasound beam as it passes through the tissues.
B Mode Brightness Modulation
Echo signals are amplified, electronically processed, pre and post processing to compensate for loss of energy with depth in tissue. Displayed in shades of grey {strong reflectors = white; echo free areas appear black}.
Duty Factor
The ratio of time spent sending signals to the time spent receiving signals. The duty factor for diagnostic ultrasound is less than 1%.
Frequency
The number of times the wave is repeated per second.
Gain
This refers to the overall brightness of the image.
Hyperechoic
Bone transmits very little sound energy and therefore produces a bright image (hyperechoic).
Image Resolution
Spatial- detects anatomically separate structures
Contrast- show tissues of different characteristics
Temporal- changes over time eg. cardiac
Colour- Spatial and temporal aspects of blood flow
Interfaces
Differences or variations in acoustic impedance.
The magnitude of the acoustic impedance mismatch determines the strength (amplitude) of the echo arising from it, described as “strong” or “weak” reflector.
Piezoelectric Element
A substance capable of converting electrical energy to sound energy and vice versa. This conversion is called the piezoelectric effect.
Period
Time taken for one wave cycle.
Probe
See *transducer*
Pulse Duration
The time taken to complete one short burst of sound waves in pulse echo mode.
Pulse Echo Mode
A system where the transducer sends a short burst or “pulse” of sound waves and then waits for the “echo” to return.
Resolution
The ability to distinguish between two close objects. High resolution means a clear picture and is improved by using higher frequency ultrasound; related to frequency.
Resolution is a trade-off for penetration.
2-3 MHz- Multipurpose
5 MHz- Moderate resolution
7 MHz- High resolution
12-14 MHz- Ultra high resolution.
Sagittal Plane
Divides the body into a right half and a left half.
(NB see also *transverse plane*, below)
Spatial Pulse Length
The distance occupied by one short burst of sound waves in pulse echo mode. Short SPL improves resolution. Short SPL obtained by using higher frequency.

Spatial Resolution
Axial- along the axis of the US beam.
Lateral- perpendicular to the beam axis (less accurate).
Scan Converter
The Gray scale image depends on:
-strength of echoes and
-the length of time until the echo returns (distance from the transducer).
Shadow
An object that does not let ultrasound through casts an acoustic shadow. On the screen one sees the bright object with a black shadow distally.
T.G.C.
Time Gain Compensation knobs allow one to augment weaker echoes to obtain an even picture. Echoes from deeper structures have to pass through more tissue and are therefore weaker than echoes from superficial structures. TGC allows you to adjust for this.
Transducer
The object held in the hand. The transducer contains the piezoelectric element or crystal. This crystal produces the ultrasound beam which travels into the body and then reflects off the tissues back to the crystal.
Transverse
Plane divides body into a top half and a bottom half.
Ultrasound
Audible frequency range ends at 20 000 Hz. Anything above 20 000 is defines as ultrasound. Frequencies used for medical imaging are above 1 million Hz (1 megahertz). When people say a transducer is a “3.5” or a “5.0” they mean 3.5 or 5.0 megahertz.

Wavelength
The distance occupied by one wave cycle. Resolution improves with higher frequency ultrasound. Unfortunately, higher frequencies cannot penetrate deeply into the tissue. An obese patient may require a lower frequency to obtain enough penetration. Along with the penetration comes worse resolution.

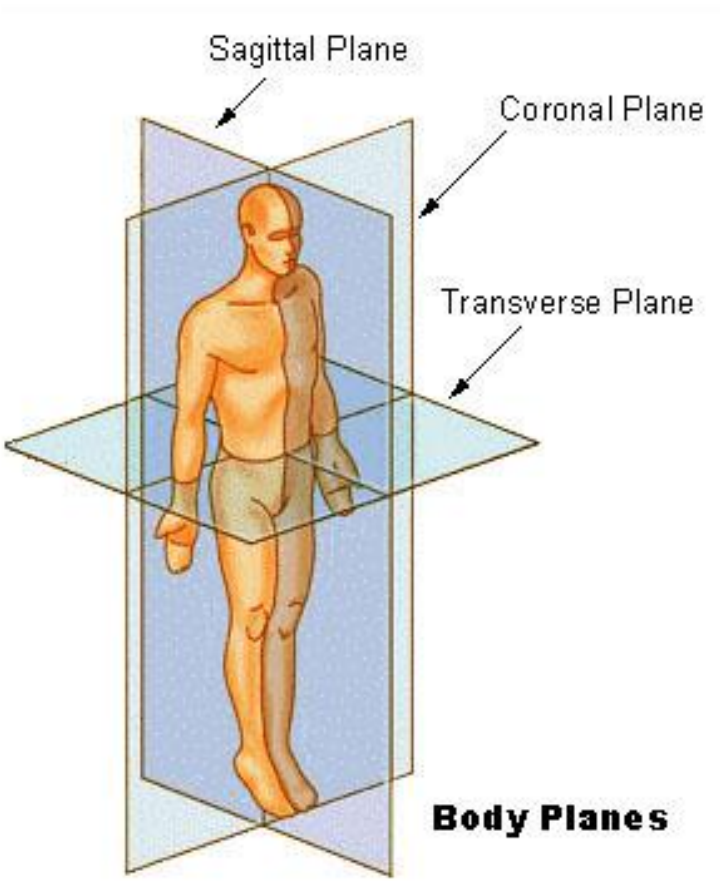


Image from www.answers.com

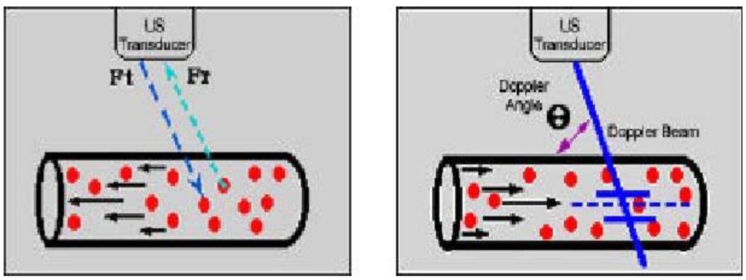
Doppler

The **Doppler shift** is the difference in sound frequency between the US beam transmitted into tissue and the echo produced by reflection from the moving red blood cells. The Doppler beam intercepts moving blood within a blood vessel at an angle called the **Doppler angle**. If an object moves away from the ultrasound transducer, the wavelength increases and frequency decreases based on velocity (v) = frequency (f) x wavelength (λ). If the object moves towards the transducer, the wavelength decreases and the frequency increases. The amount of frequency shift is proportional to the velocity of the moving RBCs. By using the **Doppler equation** and the computer intrinsic to the US units, the Doppler shift can be measured.

Doppler equation =

(2 x f x v x cosine of Doppler angle)/C

f = transducer frequency (MHZ)
v = velocity of RBCs
C = constant (velocity of sound in soft tissue)



[Left]. Drawing illustrates the Doppler frequency shift. Ft is the frequency of the transmitted Doppler beam and Fr is the frequency of the Doppler echo returned to the transducer. [Right]. Drawing illustrates the Doppler beam and Doppler angle used to communicate to the US computer the estimated direction of blood flow. Image from www.mymedicineworld.net

1. The Doppler equation demonstrates that the maximum frequency shift will be obtained by directing the Doppler interrogation beam at a Doppler angle of 0 degrees since cosine of 0 degrees is 1. In addition, no Doppler shift is obtained at 90 degrees since cosine of 90 degrees is 0. However, most blood vessels course parallel to the skin and zero Doppler angle is seldom obtainable. Thus, for practical purposes the optimal Doppler angle lies between 45 and 60 degrees, and remember to avoid using Doppler at right angles to the structure of interest.

Equipment

Machines
Transducers

Machines

A variety of ultrasound machines exist. For the purposes of an Emergency/Resuscitation room scan, the priority is a limited, goal directed scan used to answer a specific clinical question.

Whichever machine is used it must be immediately available for use in the resuscitation room.

Transducers

The transducer contains the piezoelectric element or crystal. This crystal produces the ultrasound beam which travels into the body and then reflects off the tissues back to the crystal.

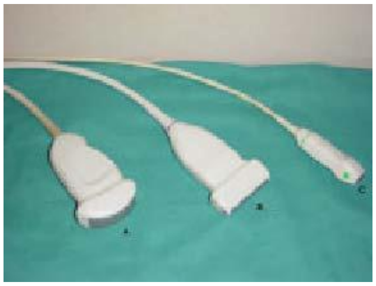
The transducer translates one form of energy to another. An ultrasound transducer contains a piezoelectric crystal that can translate electrical signals into mechanical energy or mechanical energy into electrical signals.

The transducer uses a pulse echo technique to obtain an image. Initially, a sound wave is produced by electricity within the transducer and directed into the patient. The reflected sound waves are received by the transducer and converted into electrical signals, and an image can be created.

Types of transducers

Linear, sector and curved array are three formats of a transducer that determine the shape and field of view.
Linear array transducers produce rectangular images and offer the best overall image quality.
Sector array transducers produce slice of pie shaped images and are optimal for examining larger organs from between the ribs.
Curved array transducers combine advantages of the sector and linear formats and are optimally used when the sonographic window is large.

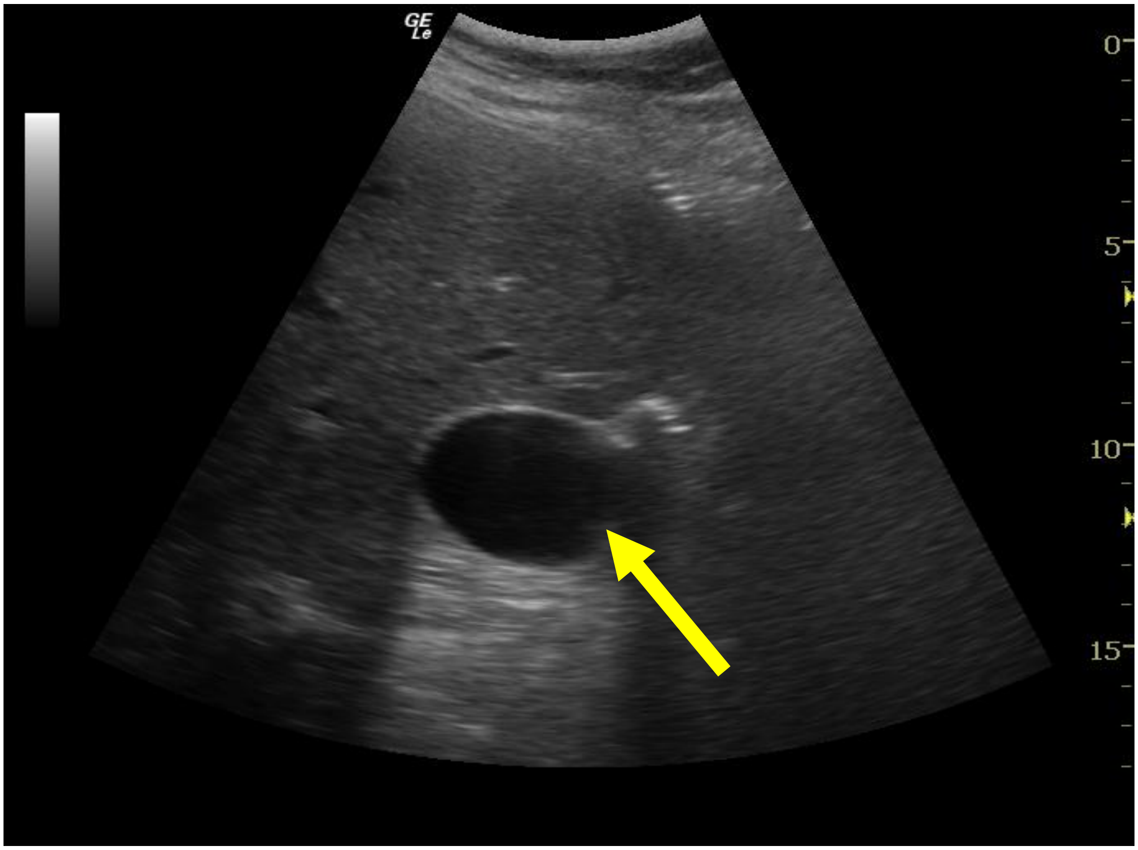
High frequency = better resolution but less penetration (depth) (eg good for children & vascular access)
Low frequency = the opposite (eg good for obese patients)



Curved (A), linear (B), and sector (C) array transducers provide differing shapes in the ultrasound field-of-view.

US appearance of normal tissues

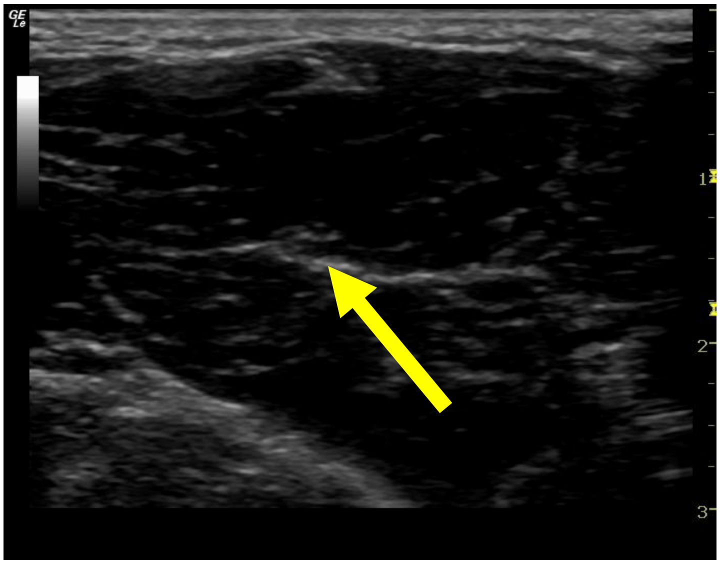
Simple fluid is black (lacking internal echoes).
Fluids such as blood, urine and bile appear black or anechoic and exhibit posterior acoustic enhancement (see *artefacts*, below). This helps identify cystic structures (such as cysts, bladder and gallbladder) and tubular structures (ducts and vessels). See image below. The galbladder (arrowed) is dark, well demarcated, and demonstrates posterior enhancement.

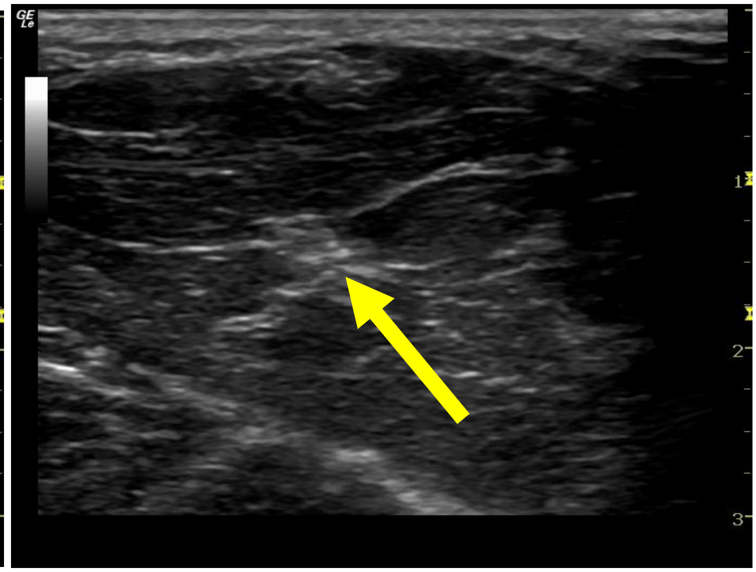


Some structures are grey.
Organ parenchyma and Examples include liver, kidney, uterus and heart. See image above: the liver (arrow) is grey.

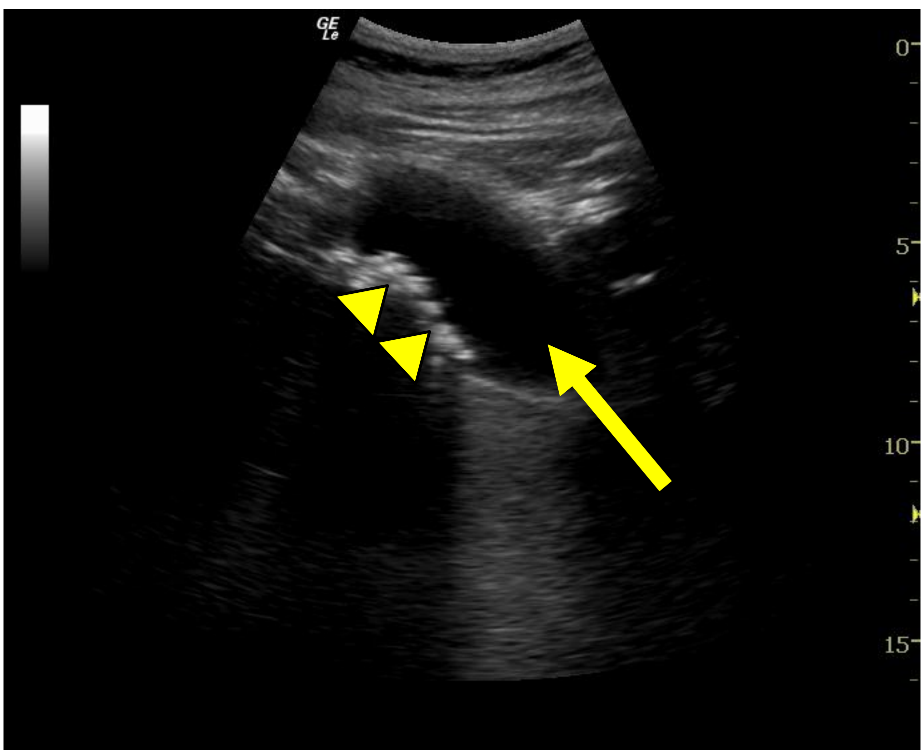
Some structures are anisotropic.
This means that their appearance depends on the angle of the sound waves. Typically these are fibrous structures such as nerves, tendons and bones. These structures appear ‘grainy’, and if the transducer is perpendicular to the direction of the fibres then they are bright. The closer the transducer parallels the fibres, the darker they appear because less sound is reflected.

In the 2 images below, the same median nerve (arrowed) and surrounding forearm flexor muscles are viewed from slightly different transducer angles. On the left, the transducer is angled. On the right, the transducer is held perpendicular to the forearm.





Some structures are bright = echogenic (highly reflective) and cast posterior acoustic shadows because they reflect all or almost all of the sound wave (see *artefacts*, below). Examples include bone, metal implants, stones, bone and calcified vessels. The sound wave cannot penetrate beyond the surface so only the outer surface is visualised. See image below: the gallstones (arrowheads) within the gallbladder (arrow) are bright and cast a shadow.



Some structures vary because of their contents.
This is typical of the GI tract.
If the stomach is fluid filled it appears black.
If the stomach is gas filled it appears bright white, as the air 'scatters' the sound wave.

Artefacts and Shadows

Artefact

An artefact is echo information that does not correspond to anatomic information as it is positioned and reflected from within the patient. It may be:

1. Problematic- artefact may obscure detail and mimic pathology leading to diagnostic uncertainty or error.
2. Diagnostic- artefact such as acoustic shadowing is used in diagnosis of soft tissue foreign body and other conditions such as cholelithiasis.

Acoustic shadow

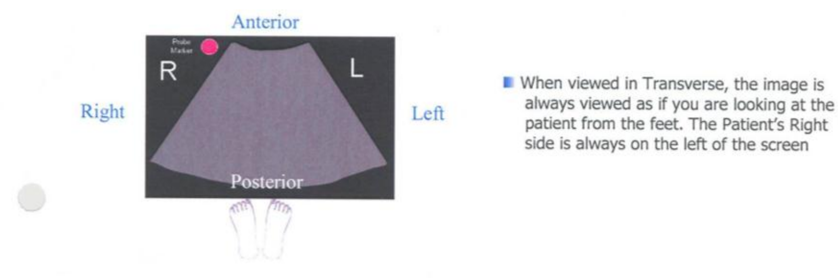
A very dense object that does not let ultrasound through casts an acoustic shadow. On the screen one sees the bright object with a black shadow distally. See image of gallstones above.

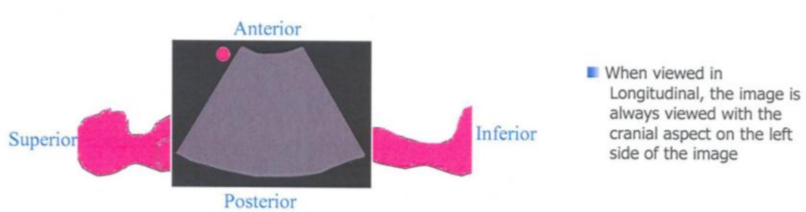
Acoustic enhancement

Occurs when sound passes through an anechoic structure. No echoes are reflected and so they are all available to pass through. More echoes are seen deep to the anechoic structure because more sound is available. See images of gallbladder above.

Getting Started

To orient yourself to the transducer, **touch your finger to one side** of it and observe which part of the screen records a signal. Choose the highest frequency that gives adequate penetration.





Adjust the TGC controls so that structures on the bottom of the screen have the same brightness as similar structures on the top of the screen.

How to improve your image

- Use more GEL
- Alter transducer frequency (increase or decrease)
- Place focal zone at area of interest
- Narrow field of view
- Decrease depth of tissue of interest
- Avoid non-uniform tissue which causes beam distortion
- Move the patient! Eg get them to roll on their side
- Try tissue harmonics. This works with mid-depth structures but doesn;t usually help with very superficial or deep structures.

F.A.S.T.

F.A.S.T.

The Question: Is There Free Fluid?

Focused Assessment with Sonography in Trauma (FAST) is a means of detecting free intraperitoneal fluid in the traumatised abdomen. Using ATLS principles, the FAST scan is used as an adjunct to the primary survey assessment of circulation. It relies on the principle that in the supine patient, free fluid (FF) such as blood collects in certain anatomical sites.

In the thorax, FF may be found in one of two potential spaces: the pericardium and pleural space. Pericardial blood, particularly if it collects rapidly, will progressively impair right ventricular diastolic filling until tamponade occurs. Haemothorax is blood in the pleural space and in the supine patient will initially collect at the posterior lung bases. Like pericardial tamponade, massive haemothorax is a life-threatening condition that requires immediate drainage. The authors advise that the lung bases should routinely be included in FAST views. (See *EFAST*, next section.)

In the supine abdomen, the most dependent potential spaces are scanned by FAST. Morison's pouch is found between the liver and the right kidney. FF will collect here first. The lienorenal interface is the analogous potential space between the spleen and left kidney. Fluid on the left side will collect here or above the spleen (subphrenic fluid). In the pelvis, FF will collect in the Pouch of Douglas (rectovesical pouch in the male) behind the bladder.

Why Use Ultrasound?

- Traumatic cardiac tamponade and massive haemothorax may be rapidly fatal if not detected and treated in the ED.
- Physical examination is unreliable for detection of cardiac tamponade in the ED setting
- US can be used to guide emergent peicardiocentesis and intercostal catheter placement.
- Physical examination is only 50% to 60% sensitive for detecting abdominal injury following blunt trauma.
- FAST is easy to learn. Reliable and repeatable results can be achieved after as little as 10 proctored scans.
- FAST is non-invasive, rapid, repeatable and can be performed at the bedside.
- FAST has supplanted diagnostic peritoneal lavage (DPL) as a reliable and non invasive means of detecting abdominal FF in trauma patients.
- FAST is up to 90% sensitive and up to 99% specific for traumatic haemoperitoneum.

Clinical Picture

The patient will have suffered a form of trauma in which cardiac tamponade, intrathoracic or intraperitoneal bleeding is a possibility.

Cautions and Contraindications

- The only absolute contraindications to performing a FAST scan are the presence of a more pressing problem (such as airway obstruction) or a clear indication for emergency laparotomy (in which case FAST is not indicated)
- FAST is indicated only if it will affect patient management. For example, in the stable patient with blunt abdominal trauma, a negative FAST gives no information about solid organs or hollow viscus injury. Such patients may require other imaging such as CT and/or small bowel series.
- Children: FAST can be performed in children but CT scanning remains the investigation of choice in paediatric abdominal trauma. The threshold for operative intervention in paediatric blunt abdominal trauma is higher than for adults.
- Timing: A very early scan may be falsely negative as sufficient intra-abdominal blood may not have collected in the dependent areas. Furthermore, occasionally a late scan may be falsely negative as clotted blood is of similar echogenicity to liver and may not be easily identified in Morison's pouch.

- Operator: the accuracy of FAST is operator-dependent and the inexperienced scanner should be particularly wary of *ruling out* FF. For example, clotted blood may appear grey and even bright on US, leading to an false interpretation of such a view as negative. (see image below of echogenic clotted blood, Morison's Pouch)

Before You Scan

- Move the patient to the resuscitation area and assemble trauma team.
- Primary survey and resuscitation according to ATLS principles.
- The doctor performing the scan should not also be resuscitating the patient.

Patient Position

The patient should be in the supine position with arms abducted slightly or above the head to allow visualisation of Morison's pouch and the spleen. Alternatively the patient may be asked to fold their arms across their chest. This manoeuvre will be determined by consciousness level of the patient and the presence of any upper extremity injury.

Probe and Scanner Settings

A low frequency (4-7MHz) probe should be used with the focus depth and depth set according to the patient's body habitus and the initial image obtained.

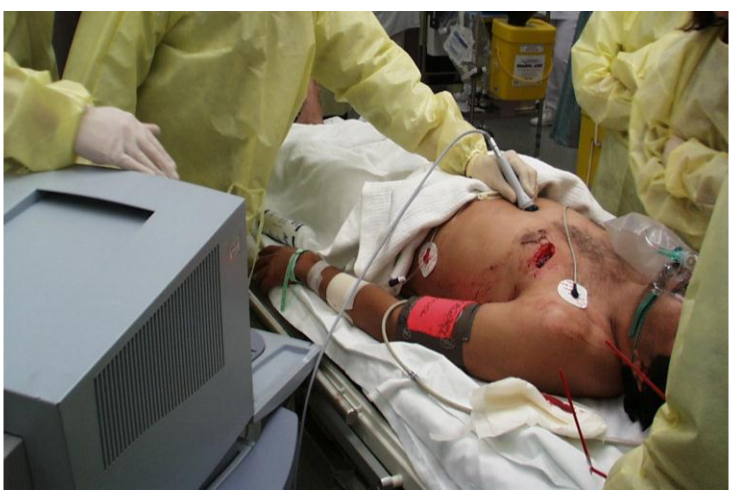
FAST: The 5 Views

1. Pericardium

The most common view used in this situation is the subxiphoid view. The probe is laid almost flat on the patient's epigastrium and angle towards the head. Advance the probe towards the xiphisternum. Apply enough pressure to allow the probe to indent the epigastrium , thus placing the probe deeper than the xiphisternum and costal margin. Then sweep the probe in a left to right axis until the pulsation of the myocardium is visualised. The view obtained utilises the liver as an acoustic window and should demonstrate the four chambers of the heart. Pericardial fluid appears as a black stripe. In true cardiac tamponade the right ventricle will collapse during diastole. However, this can be difficult to assess for the non-echocardiographer, so *clinical* likelihood of tamponade must be taken into consideration when acting on a positive scan.

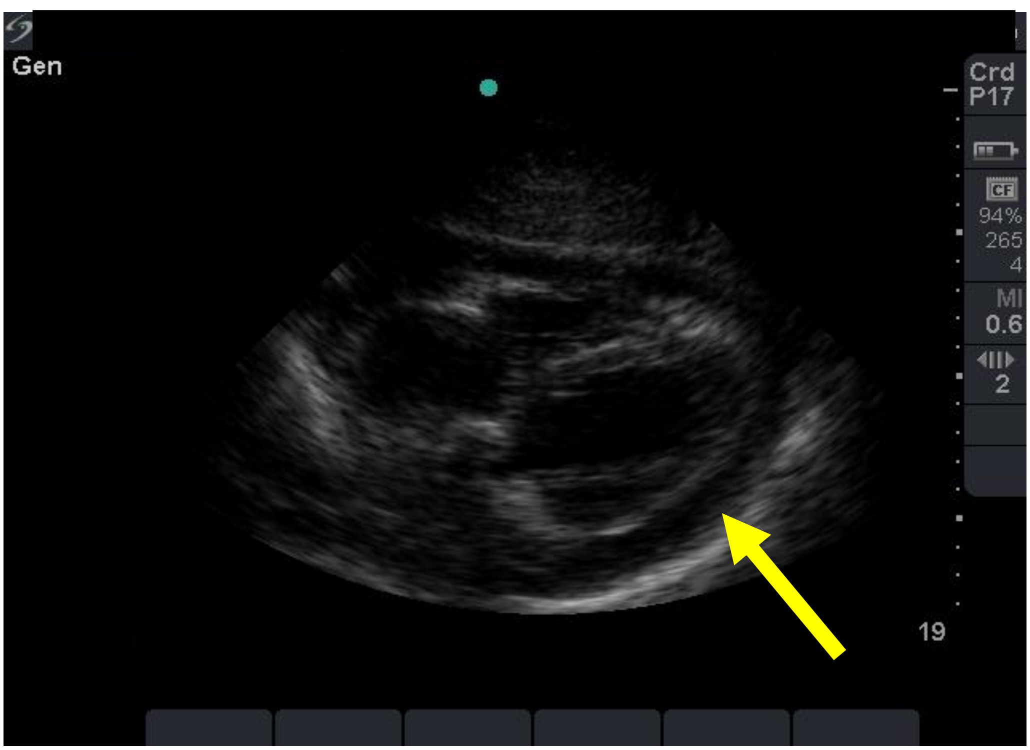
In some patients, particularly the obese, it may be difficult to obtain clear subxiphoid images. Alternative methods in these patients include the left longitudinal parasternal view or the apical view used in echocardiography. (See *EDUS Course Manual: Critical Care*)

Probe position for subxiphoid view



Normal subxiphoid view, no pericardial effusion

Pericardial effusion (arrowed), subxiphoid view



2. Right upper quadrant view (RUQ): Morison's Pouch and Right Lung Base

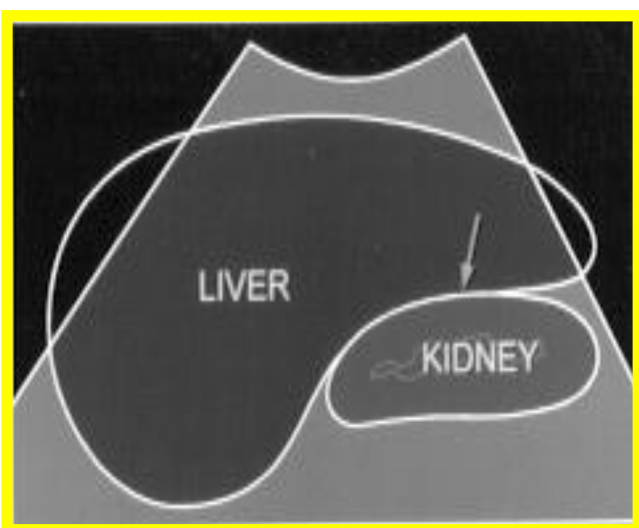
Probe parallel and between the ribs where the costal margin meets the mid-axillary line on the right of the patient (see image below). The view obtained utilizes the liver as an acoustic window and should demonstrate right kidney, liver, diaphragm (highly echogenic) and right lung base for pneumo/haemothorax. Sweep the probe anteroposteriorly and alter the probe angle until you obtain a clear view of Morison's pouch.

FF will appear as a black stripe in Morison's pouch. Ask the patient to take a deep breath if possible, particularly if rib shadows obscure the area of interest: a clearer view of the liver and Morison's pouch is often obtained with this method.

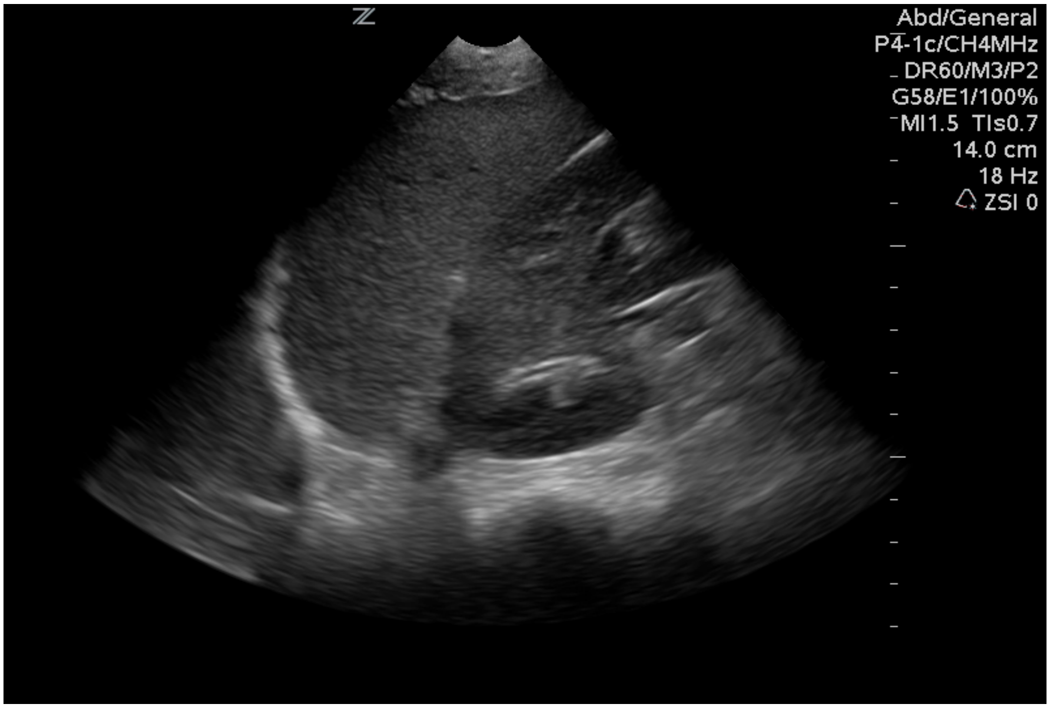
Remember to slide the probe up to the thorax for EFAST view (see next section, *EFAST*).

Probe position for RUQ view

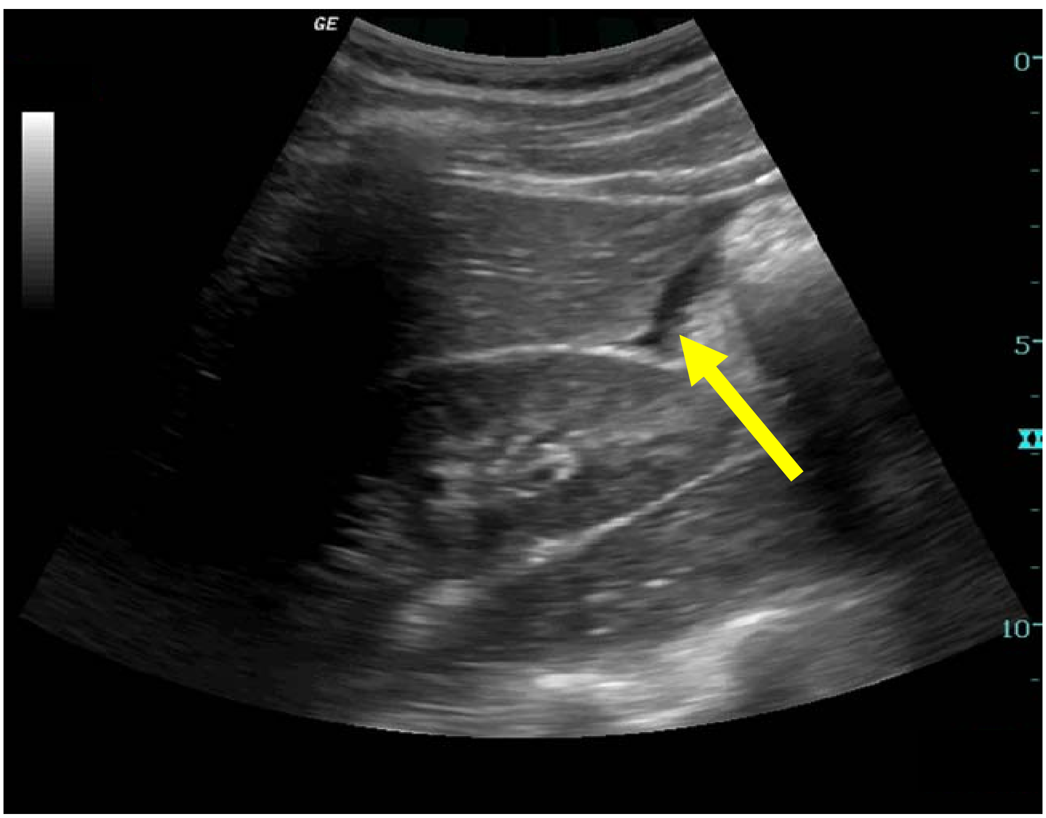
Schematic: RUQ view



Morison's pouch: no free fluid



Morison's pouch: free fluid (arrowed)

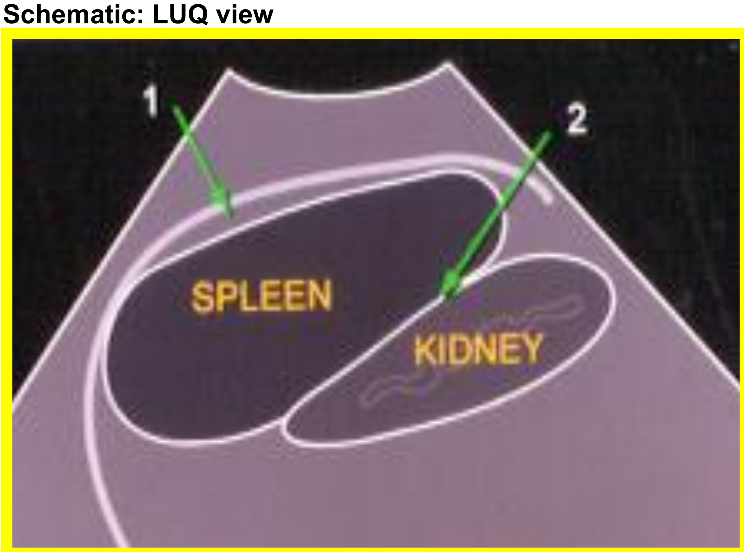


3. LUQ: Lienorenal interface and Left Lung Base

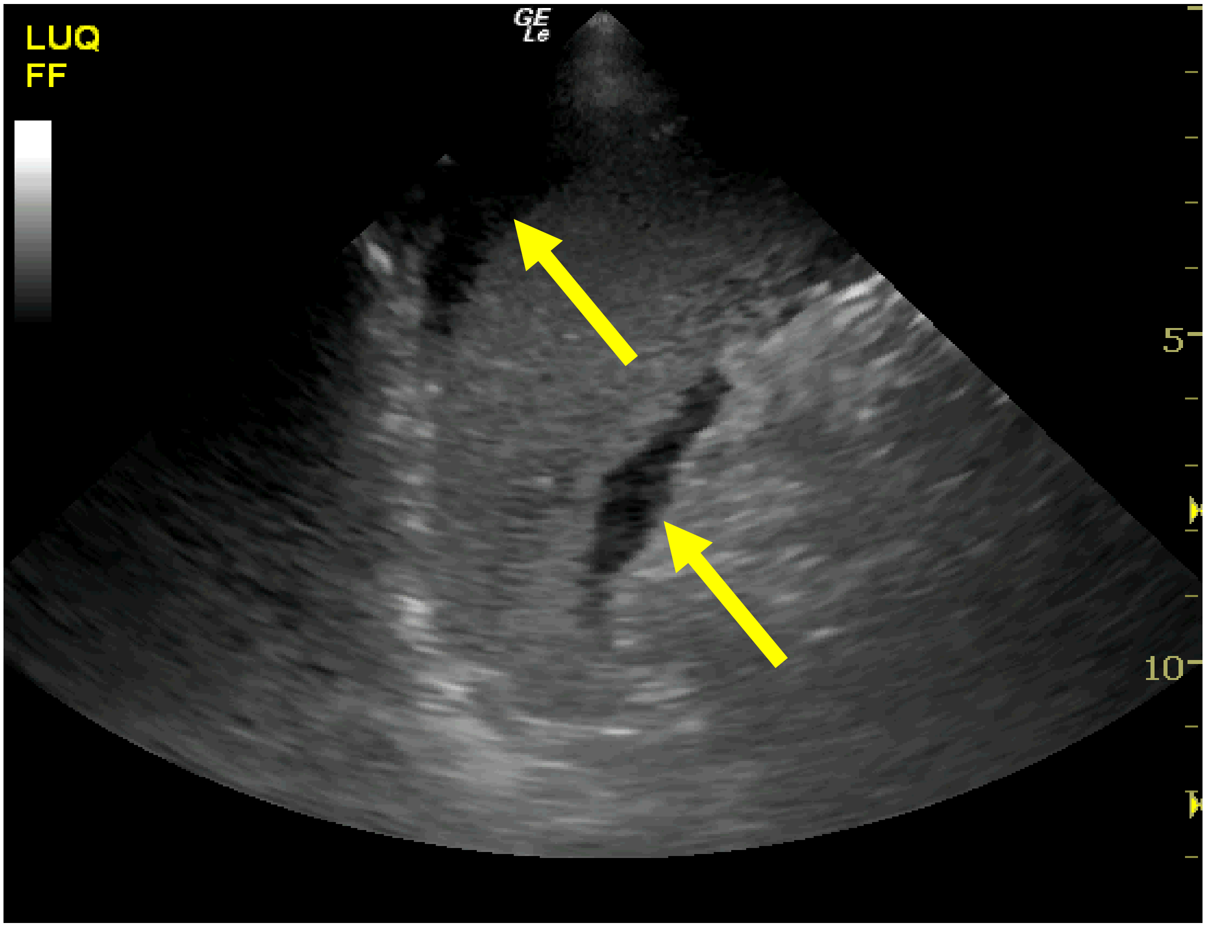
Probe is angled on the left side as if looking for Morison's pouch but higher (ribs 9-11) and more posteriorly, in the posterior axillary line. The spleen may be higher than expected and is more difficult to visualize than the liver. In a cooperative patient, a deep breath may help. Sweep the probe and alter its angle as above, until you obtain a clear view of left kidney, spleen, diaphragm and left lung base. FF will appear as a black stripe in the lienorenal interface or between the spleen and the diaphragm (subphrenic FF).

Probe position for LUQ view

Schematic: LUQ view



LUQ: free fluid (arrowed)



4. Pelvis: sagittal & transverse

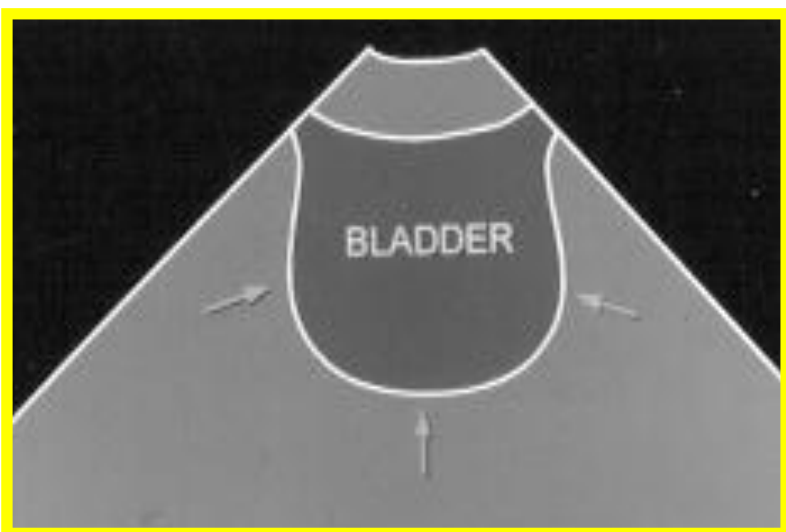
For both pelvic views the fluid filled bladder is utilized as an acoustic window. It is therefore important that the patient have a full bladder during this part of the examination. Ideally scan before catheterizing the patient. Otherwise, depending on urgency clamp the indwelling catheter and allow the bladder to fill or fill the bladder with normal saline via the catheter.

To obtain the sagittal view, place the probe in the midline just above the pubis and angle it caudally at 45 degrees into the pelvis. The view obtained should demonstrate a coronal section of the bladder and pelvic organs. FF will be around the bladder or behind it (Pouch of Douglas).

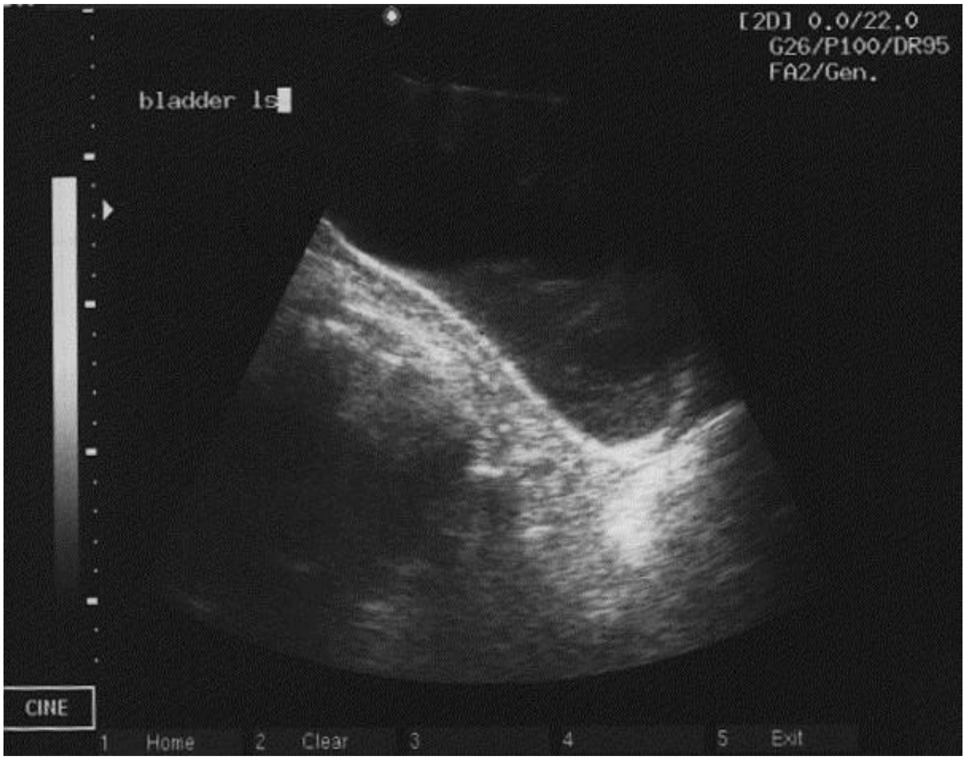
The transverse view is obtained by rotating the probe through 90 degrees from the sagittal position while maintaining contact with the abdominal wall. Angle the probe into the pelvis, identify the bladder in transverse section and sweep the probe to visualise the Pouch of Douglas and pelvic organs as above.

Probe position for transverse pelvic view

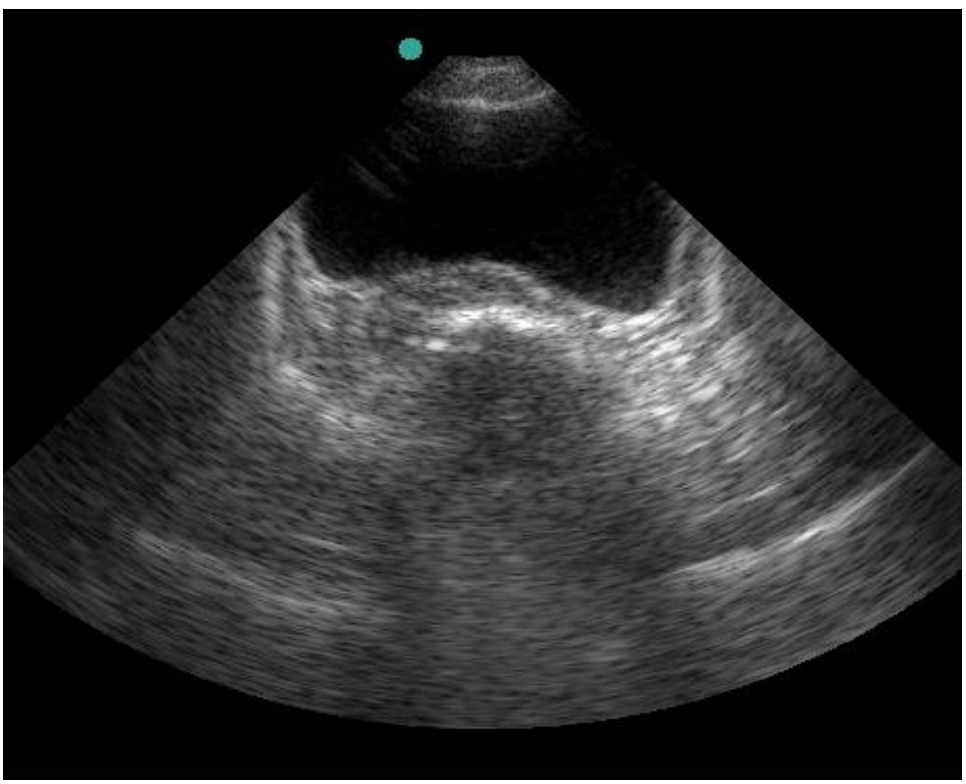
Schematic: transverse pelvic view



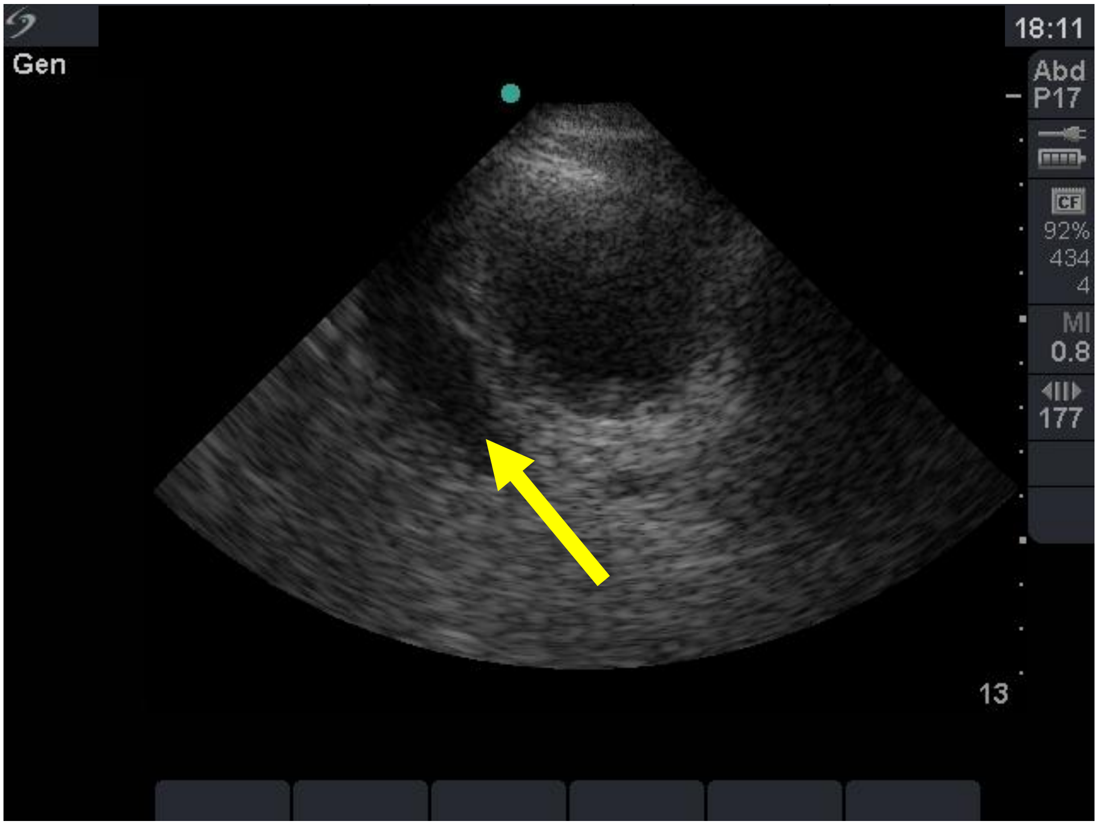
Longitudinal pelvic view: normal



Transverse pelvic view: normal



Transverse pelvic view: positive FF (arrowed)



Extra Views?

Some authors recommend paracolic views. These probably do not add to the sensitivity of FAST and are not routine.

Handy Hints

- Pericardium: consider alternative windows such as parasternal long axis & apical.
- The lienorenal interface is more posterior and more proximal than you think.
- Scan through the respiratory cycle, with probe parallel to ribs, to minimize the effects of rib shadowing.
- If available, use a phased array (cardiac) probe to scan scan between ribs.
- If you still find it difficult to obtain clear views of Morison's pouch or the lienorenal space, slide the probe proximally until you view the highly echogenic diaphragm. Use this as the landmark to identify the adjacent pleural space and liver/spleen.
- Sometimes only subdiaphragmatic FF will be seen (particularly on the left), so scan between the liver/spleen and diaphragm.
- Beware false negative scans. In the presence of small amounts of FF, a single view of Morison's pouch or lienorenal interface may be falsely negative. Hence, scan through a number of planes to rule out FF. if you still suspect FF, consider serial scans or other investigation.
- Similarly, scan any positive findings of FF through a number of planes and observe for peristalsis, pulsation and displacement with respiration. This allows FF to be differentiated from false positives due to fluid filled structures such as inferior vena cava, gallbladder and intraluminal bowel fluid.
- Other causes of false positive scans include:
    - Fat eg. pericardial fat pad
    - Ascites
    - Mirror artifact (see below)
- Fluid in the bladder is required to visualize the pelvis.
- If FF in the pelvis cannot be distinguished from mirror artifact scan the pelvis through a number of planes: only FF should persist. Alternatively, the bladder can be partially emptied. Mirror artifact "shrinks" with the emptying bladder while FF remains constant.
- Repeat the san: particularly if a stable patient becomes unstable.
- If on the first or second view you demonstrate FF in an unstable patient, further views are not needed and waste time.

What FAST Can Tell You

FAST can determine the presence of the following:

- Free intraperitoneal fluid
- Pericardial fluid
- Pleural fluid

What FAST Cannot Tell You

FAST cannot determine the following:

- Source of free fluid
- Nature of free fluid eg. blood versus ascites
- Presence of solid organ or hollow viscus injury
- Presence of retroperitoneal injury.

Now What?

Urgent surgical consultation is mandatory in the unstable trauma patient with suspected intra-abdominal injury.

FAST is not indicated in patients with clear indication for immediate laparotomy eg. penetrating injury in an unstable patient.

SAMPLE ALGORITHM USING FAST

Stable patient: FAST seldom changes management radically. If you suspect significant blunt abdominal trauma (remember this is a clinical decision), a more definitive test (eg CT abdomen) is usually needed.

Unstable patient: this is where FAST is most useful.

- Positive FAST: arrange urgent TF to operating theatre.
- Negative FAST: look elsewhere for source of haemorrhage & keep repeating the scan.
- Indeterminate FAST: this is tricky. Decision to proceed to alterative test (eg CT or diagnostic peritoneal aspiration) or operation depends on individual circumstances.

Summary

- **FAST is useful when assessing the traumatized abdomen.**
- **FAST is indicated only if it will affect patient management.**
- **It does not replace sound clinical judgement.**
- **It must be used in conjunction with ATLS principles.**

EFAST
(Extended FAST)

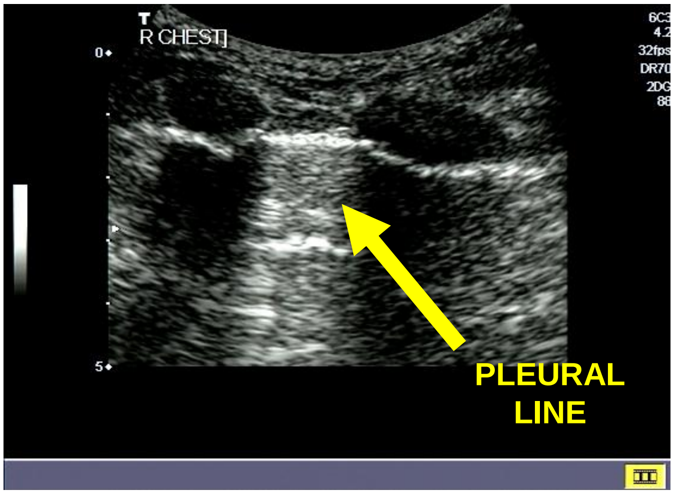
The Question: Is There Haemothorax (HTX) or Pneumothorax (PTX)?
Extended FAST (EFAST) aims to pick up HTX and PTX in the multitrauma patient. For example, small PTX missed by routine trauma CXR can be fatal with IPPV or aeromedical transfer.

Transducer
- Ideally the linear array (5-10 MHz transducer)
- But even the curved probe will work (and it's already connected)

How to scan
Start RUQ as for FAST view, with the probe in long axis of body, marker to head. ID liver and echogenic diaphragm then slide probe up to thorax. Slide probe along 3 lines:
- Anterior (small PTX)
- Mid-axillary line
- Posterior (small HTX)

You will recognise the thorax because:
- you are above the diaphragm
- air in the thorax scatters the sound wave, causing a 'sparkle' effect
- interposing rib shadows interfere with the image. See example below:

Reduce image depth to about 5cm, and focal zone to about 2cm. Keep the probe in the long axis when starting out, as the rib shadows will help to orient the image. Look between & below the ribs for pleural line.



What to look for

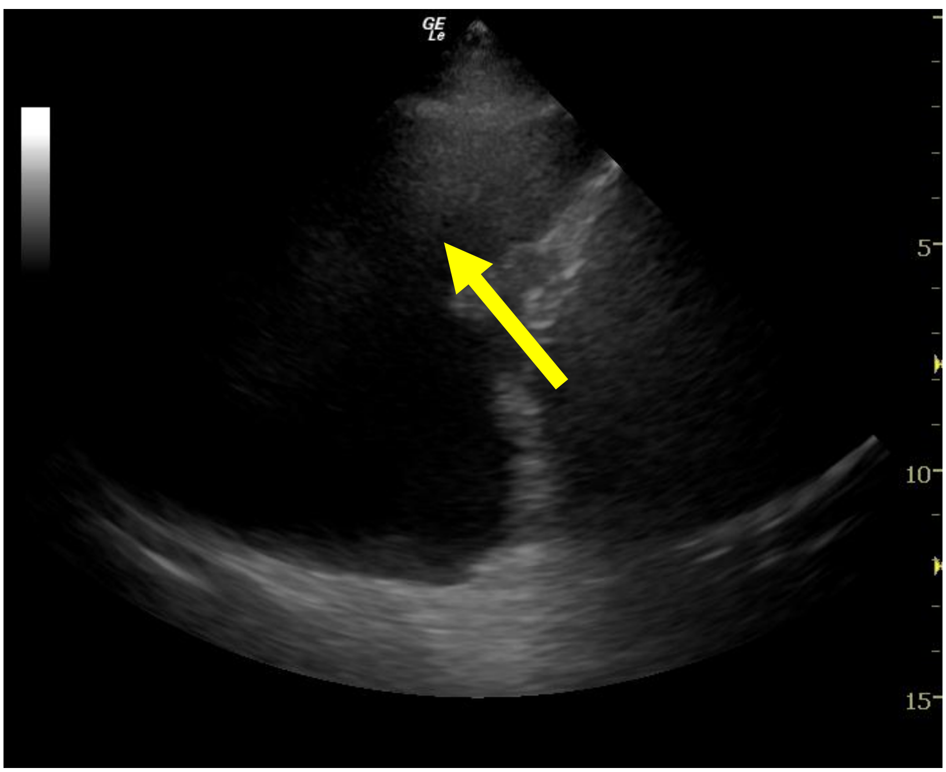
1. Pleural fluid

This collects in the dependent regions of the thorax, analogous to FF collecting in the peritoneum. Like FF in the peritoneum, its appearance vareis with its nature:

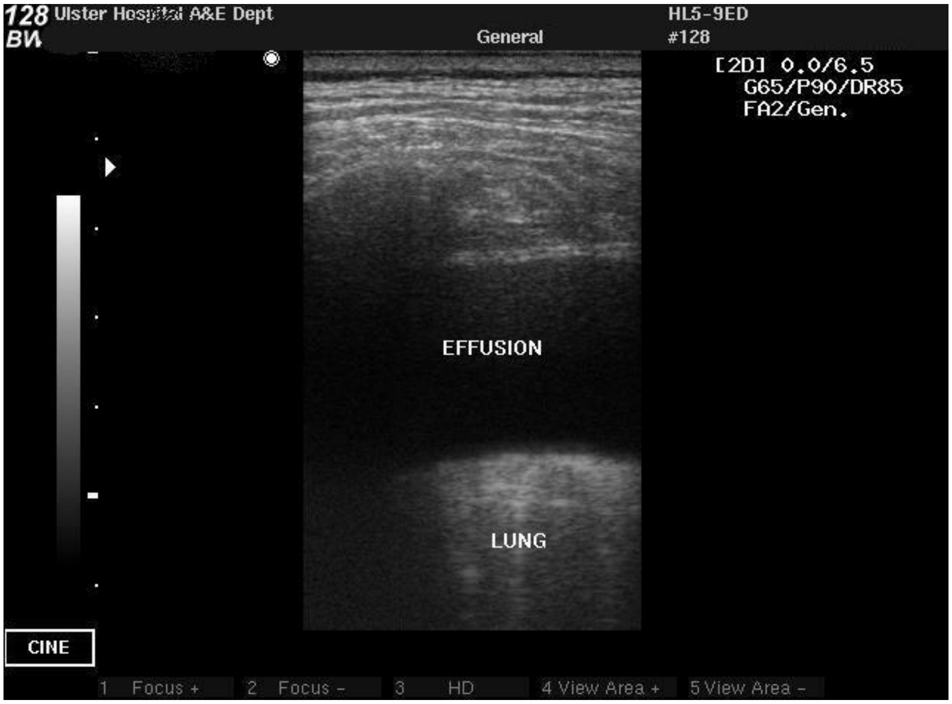
- black = anechoic (fresh blood, transudate/ exudate)
- echogenic = blood, exudate

As little as 100ml can be detected with EFAST, with sensitivity >97%, specificity 99-100% (Sisley et al, J Trauma 1998).

Pleural fluid (ARROWED) in RUQ seen with curved probe



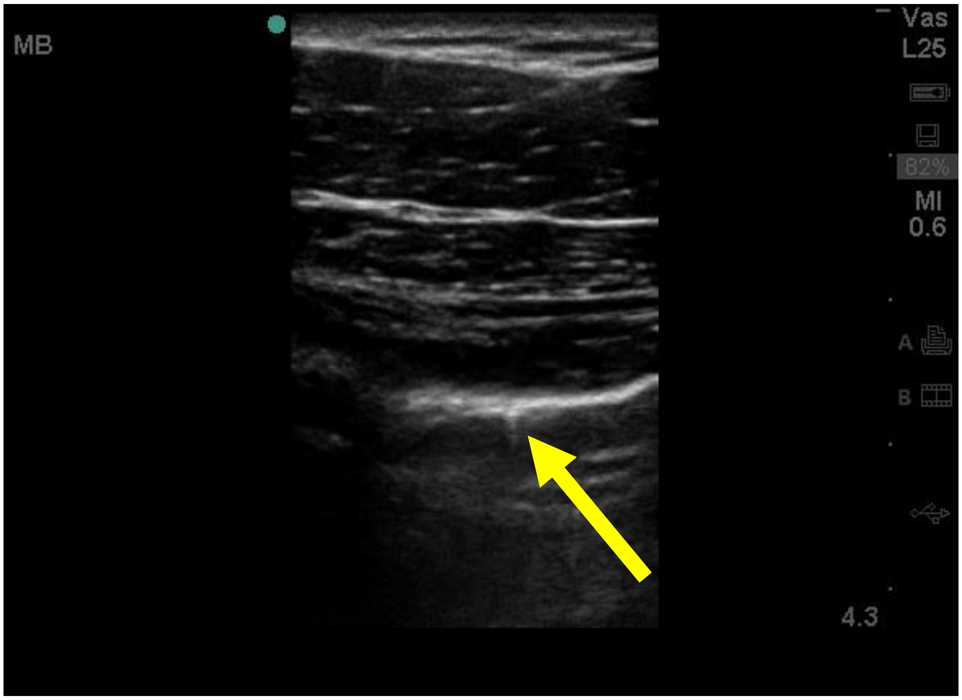
Pleural fluid seen with linear probe



2. Normal lung:

- A lines = reverberation artefact from the pleural line. They are horizontal & static. (See image above.)
- B lines = hyperechoic reverberation effect from air/water interface. They are thick vertical lines which move with respiration, reach to edge of screen & obliterate A lines. They are also known as 'comet tails'. See image below (B line arrowed).

- Z lines = like B lines, these are vertical, fade quickly, and don't move with resps. (See image below.)



3. “Dynamic sliding” at pleural interspace: the normal pleural line resembles a ‘sparkling curtain’ sliding back & forth as the patient breathes. (The sparkle represents scatter from the air in the lung.) This is known as dynamic sliding and its absence is the most reliable ultrasound sign of pneumothorax.

4. Pneumothorax (PTX)

In PTX, the pleural surfaces are separated by air and waves are now reflected at the interface of the parietal pleura with the air of the PTX itself. Therefore movement of the visceral pleura and lung deep to the PTX cannot be seen, leading to loss of the typical appearances outlined above.

Absence of dynamic sliding (see above) is a key feature of PTX on US. However, it can be found in a number of other conditions as well:

- The lung apices
- Chronic airflow limitation (CAL)
- Right main stem intubation (absence of sliding on the left side)
- Pleural tethering (eg due to lung cancer at the periphery) (fig 6)

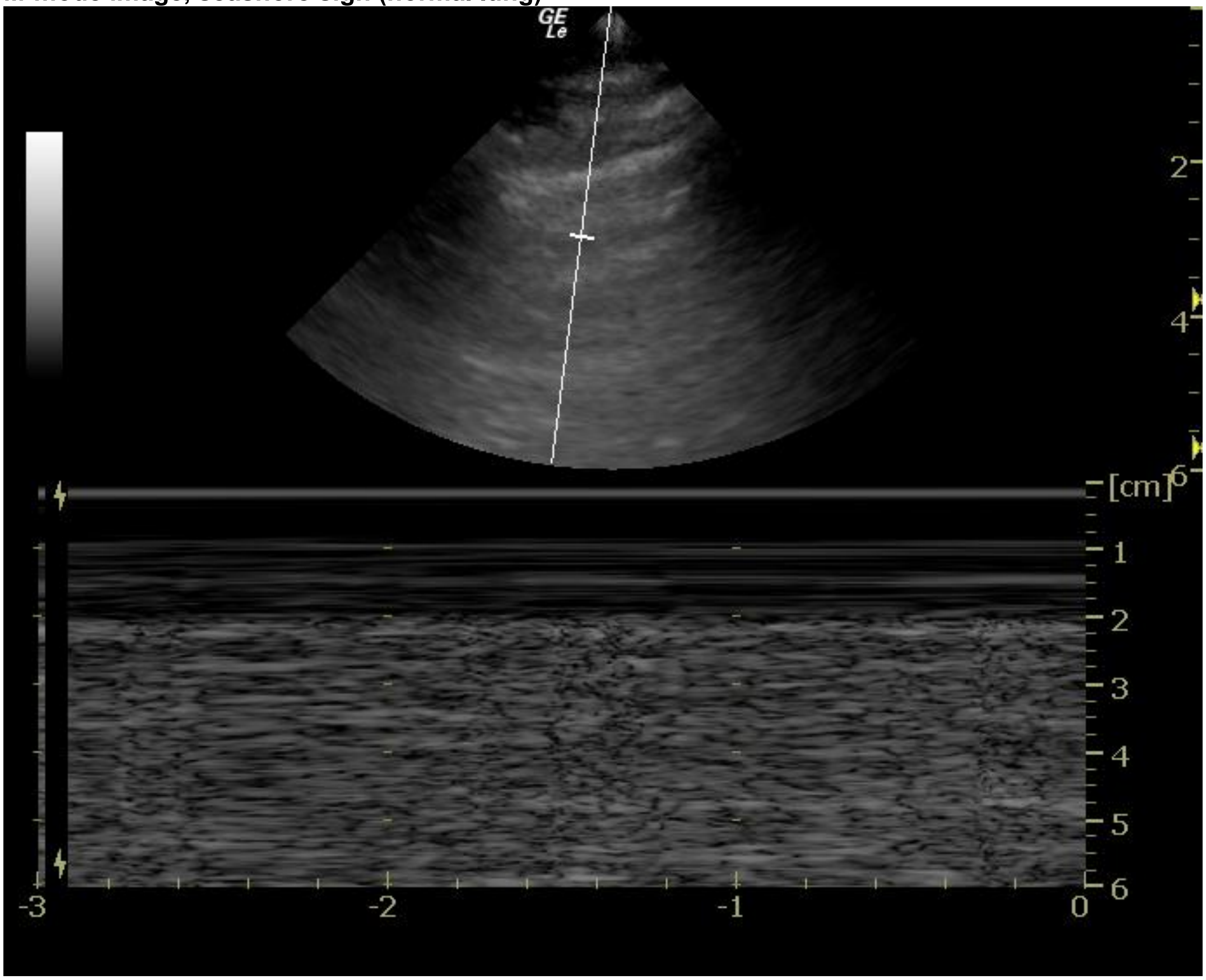
More specific to pneumothorax is the lung point sign. (fig 7) This window represents the site where normal lung gives way to pneumothorax, so that on one side of the image sliding is present, while on the other side it is absent. Some say this is the only truly reliable sign of pneumothorax. However, it can also be seen in cases of pleural tethering.

Key points:

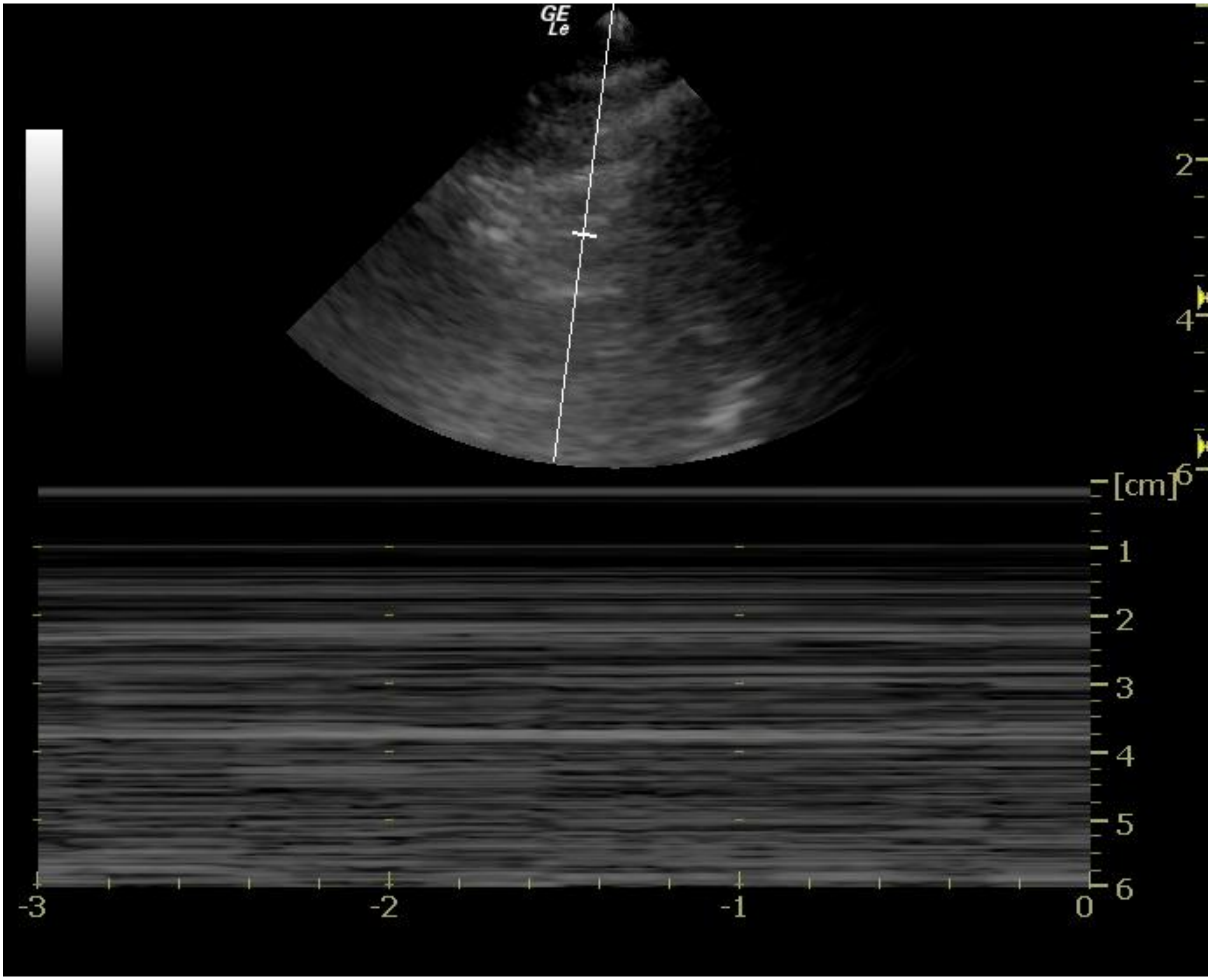
- If you can see dynamic sliding, there is no PTX at that site. (But there may be a PTX elsewhere in the lung field.)
- If you can’t see dynamic sliding, there may be a PTX at that site.
- If you see the lung point sign, there is probably a PTX at that site.

M-mode (Motion mode) is not essential but sometimes helps confirm the presence /absence of dynamic sliding. In M-mode, normal dynamic sliding is described as the seashore sign whereas the absence of normal sliding is described as the stratosphere sign.

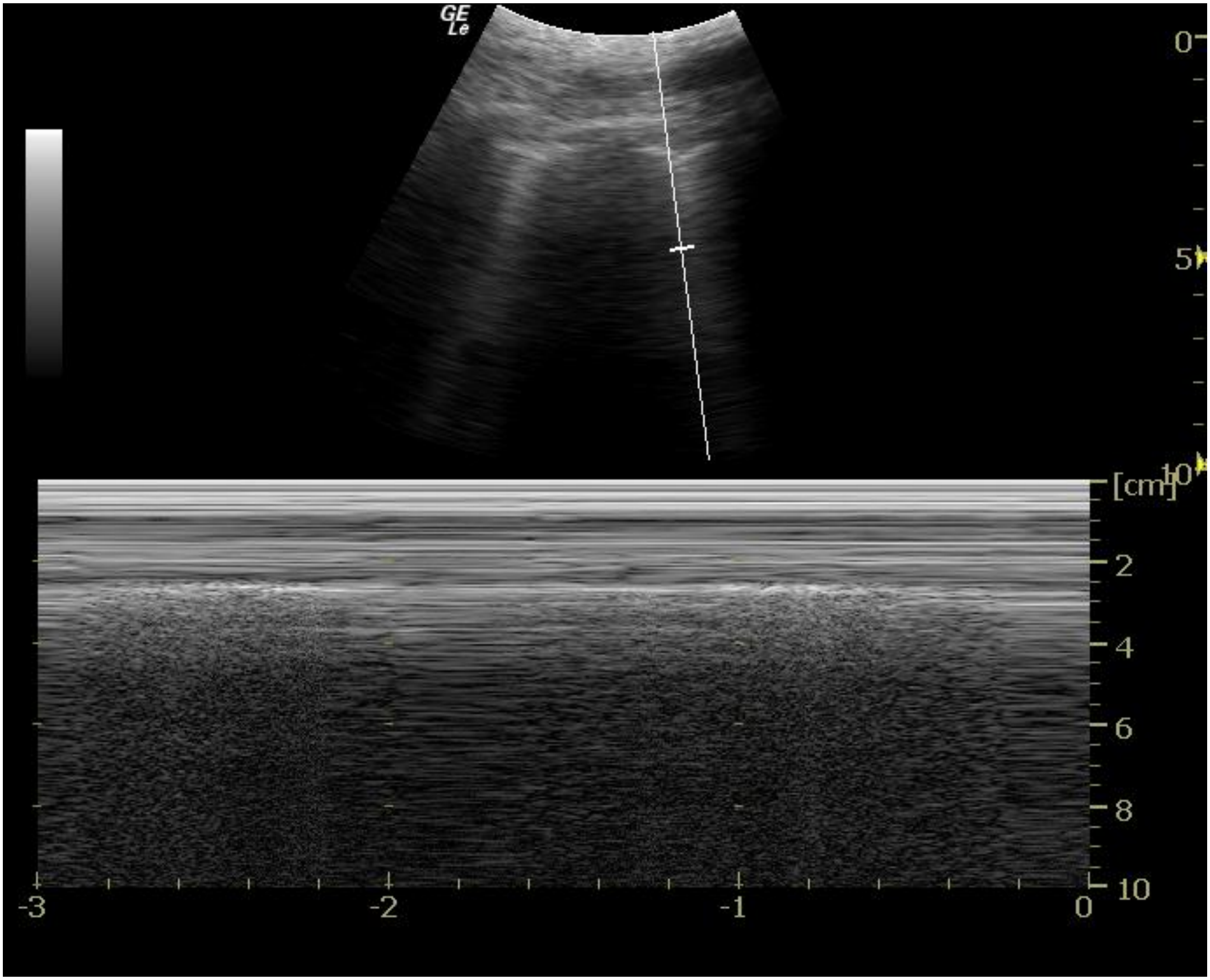
M-mode image, seashore sign (normal lung)



M-mode image, stratosphere sign (pneumothorax)



M-mode image, lung point sign



EFAST: Handy hints and pitfalls

- Start with a low frequency (phased array or curved) probe to help you identify anatomical structures such as the **diaphragm**. Carefully orientate yourself to structures lying above and below the diaphragm.
- Switch to the linear probe to examine the pleura in more detail.
- Hold the probe still – look for pleural sliding for a period of time before moving to the next window.
- Scan as much of the lung fields as possible, or you will miss small PTX and fluid collections.
- Lung sliding can be absent in a number of conditions (see above), but if the lung point is identified, this points towards a diagnosis of pneumothorax. Rarely a lung point will be seen at a point of pleural tethering.
- It can be difficult to differentiate fluid in the left hemithorax from pericardial fluid when scanning the heart. Pericardial fluid passes in front of the descending aorta, while pleural fluid surrounds the descending aorta.
- Similarly, peritoneal fluid can be mistaken for pleural fluid. The key is to carefully identify the diaphragm. Pleural collections are superior to the diaphragm and the lung can be seen 'floating' in large collections.

What EFAST can tell you

- The multitrauma patient: is there a pneumothorax or a haemothorax?

What lung US can't tell you

- You cannot determine the nature of pleural fluid: for example fresh blood versus transudate
- You cannot *rule out* a tiny pneumothorax or effusion

If you want to find all pneumothoraces, perform a CT scan.

Now what?

- Negative CXR but US shows PTX, in a stable patient: consider CT
- Negative CXR but US shows PTX, *unstable* patient: treat PTX
- Negative CXR but US shows PTX, stable patient but rushing to OT/helicopter: consider intercostal catheter (ICC)
- Unstable patient and large pleural fluid: suspect massive haemothorax. Emergency ICC.
- Aspirating a PTX – no further air forthcoming but still *absent* pleural sliding in superior chest – reposition catheter and continue aspiration.
- Aspirating a PTX – no further air forthcoming and pleural sliding *present* in superior chest – aspiration is complete.

AAA

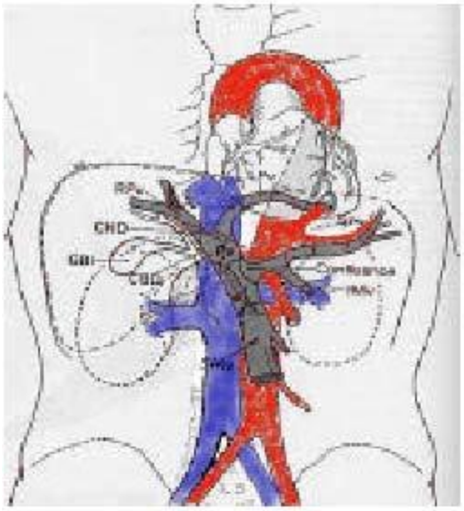
Abdominal Aortic Aneurysms

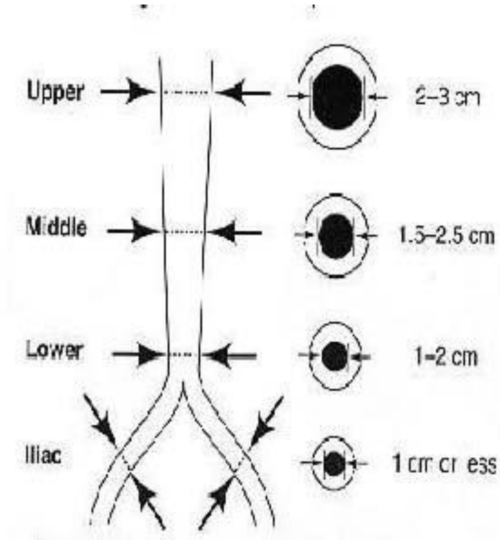
- Approximately 90-95% of abdominal aortic aneurysms (AAA) are confined to the infrarenal aorta.
- AAA are usually not repaired until they exceed 4-5cm in maximum diameter.
- The risk of rupture within 5 years is 25% at 5cm diameter.
- AAA smaller than 5cm have a 3% risk of rupture over 10 years.
- Ultrasound is used to monitor the rate of enlargement of AAA. The average increase is 2mm/year diameter.

Why Do a AAA Scan in the Resuscitation Area?

- Apart from ischaemic heart disease it is a principal diagnosis NOT to be missed in the older patient who presents with:
- Abdominal pain
- Back pain
- First episode of “renal colic”
- Loin pain or
- Collapse.
- Physical exam for AA often unreliable
- Palpation sensitivity 40%.
- Formal US/CT availability:
- Very best 20 minutes, worst ?
- CT 2 flights up and corridors away
- What resuscitation facilities away from OT/Resus?

Aorta- Anatomy

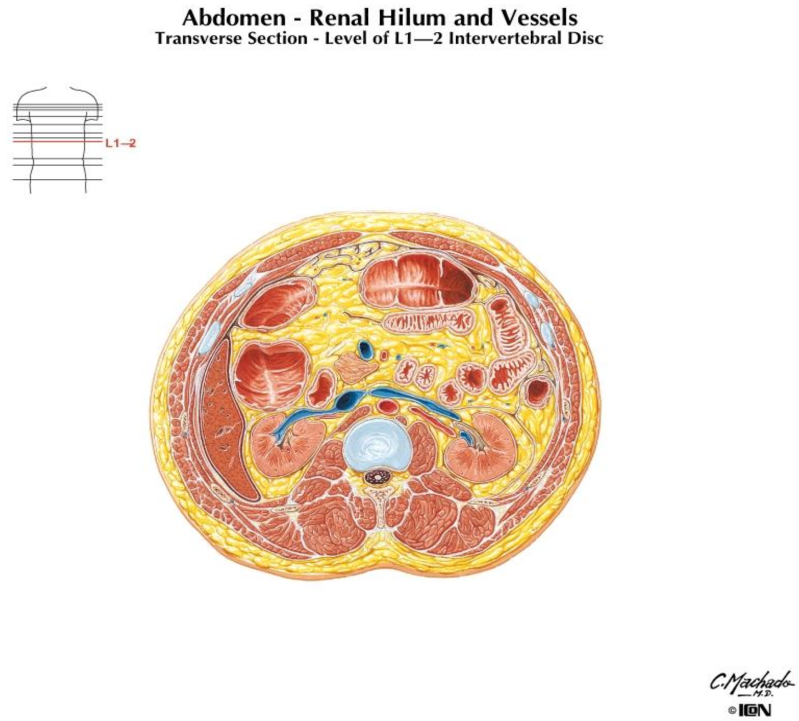




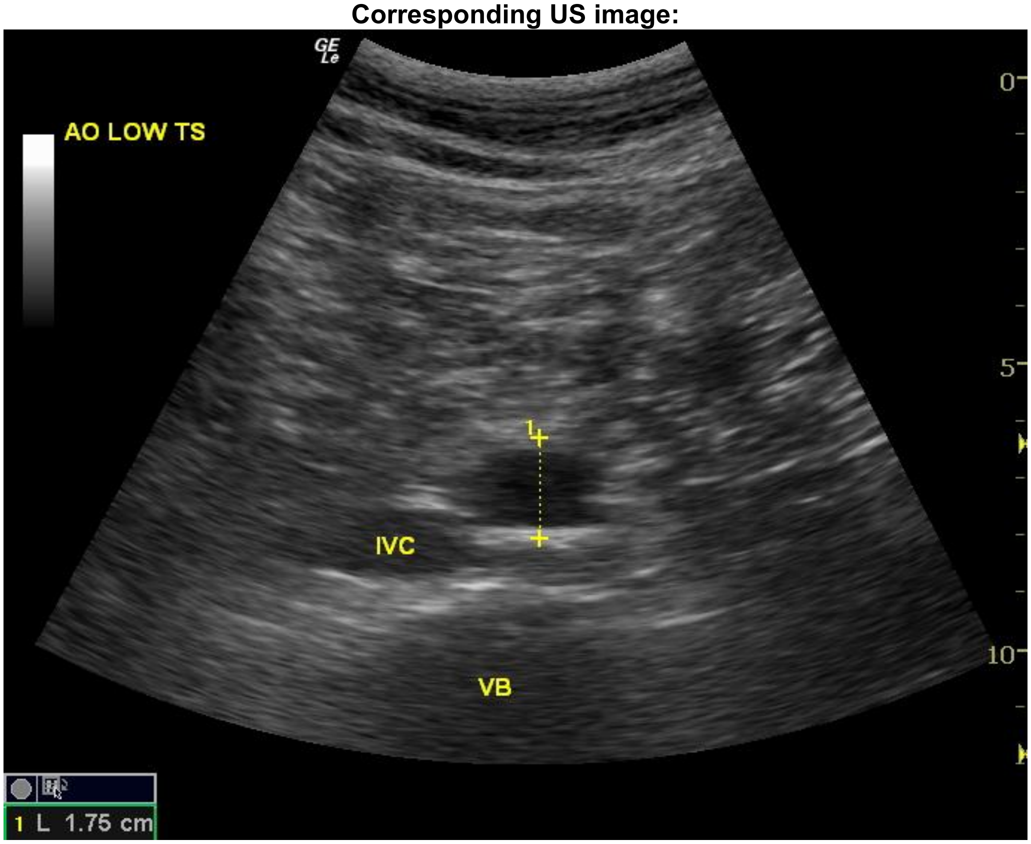
<u>Dimensions</u>

Normal aorta <2cm
Ectatic aorta 2-3cm in diameter
AAA >3cm

Image: cross sectional anatomy of aorta



Corresponding US image:



AAA Study: The Technique and Views

Patient Position

- Dictated by clinical picture
- Supine horizontal is most practical

US Scanner

- Move to bedside and turn on machine
- Curved probe on “general”
- Focus depth approx 10cm

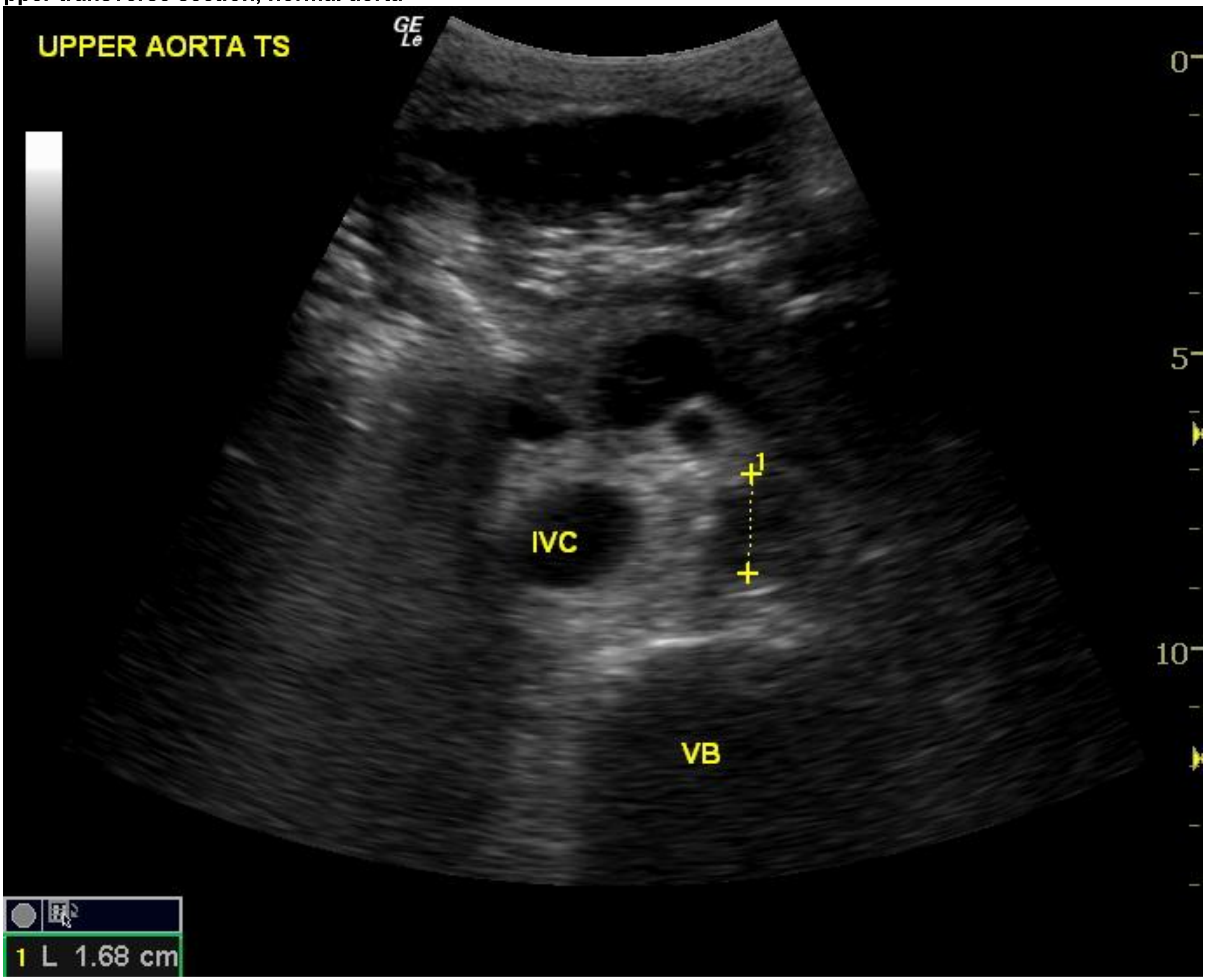
Probe Placement and Landmarks

- Start just below xiphisternum. Transverse position with probe marker to patient’s right.
- Identify landmarks: vertebral body (VB, note bone’s acoustic shadow) directly behind aorta, liver anterior and to the right, bowel
- Identify two vessels: inferior vena cava (IVC) is parallel and to the right (large, thinner walls and more oval cross-section than aorta); aorta to left (smaller unless aneurysmal, rounder, calcified, pulsing). Alter the depth of focus and gain to obtain the best image.
- Measure AP diameter, save and print image.
- Maintain the transverse position and slide distally until bifurcation: measure diameter, save and print image.
- Swing the probe to longitudinal position and scan. Attempt to obtain a view of the aorta with origin of celiac trunk or superior mesenteric artery (SMA).

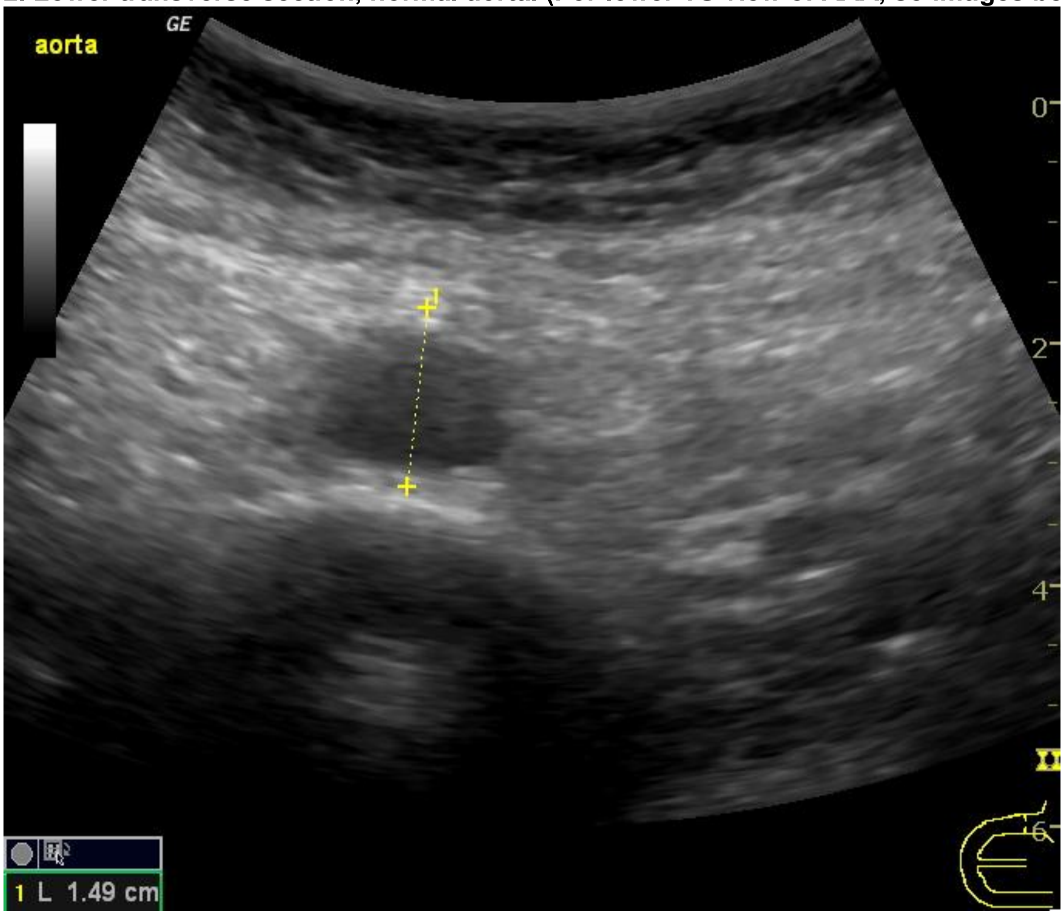
Essential Views

The entire aorta must be imaged or you cannot rule out AAA. For QA & credentialing, a minimum of three views must be saved unless the patient is unstable:

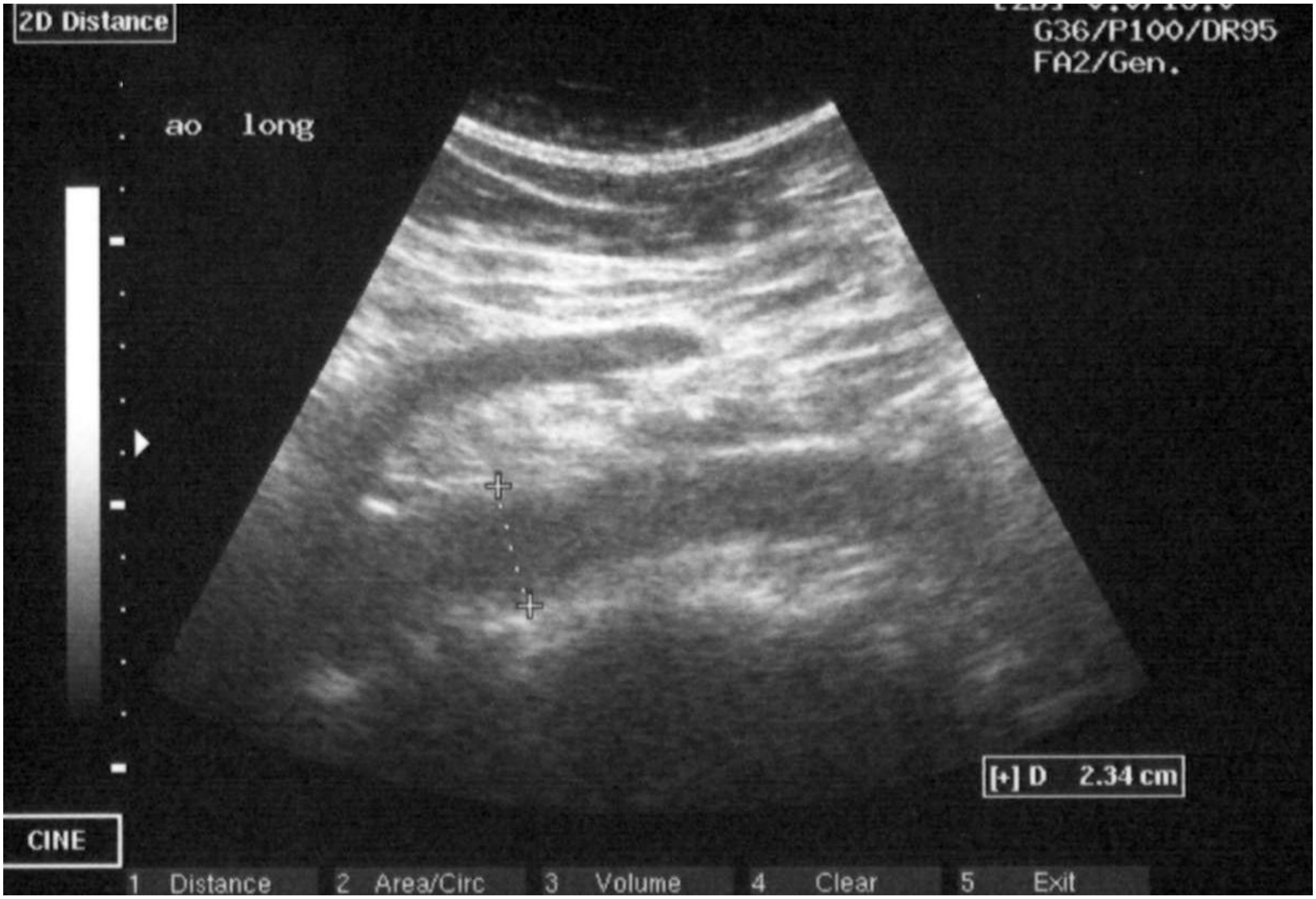
1. Upper transverse section, normal aorta



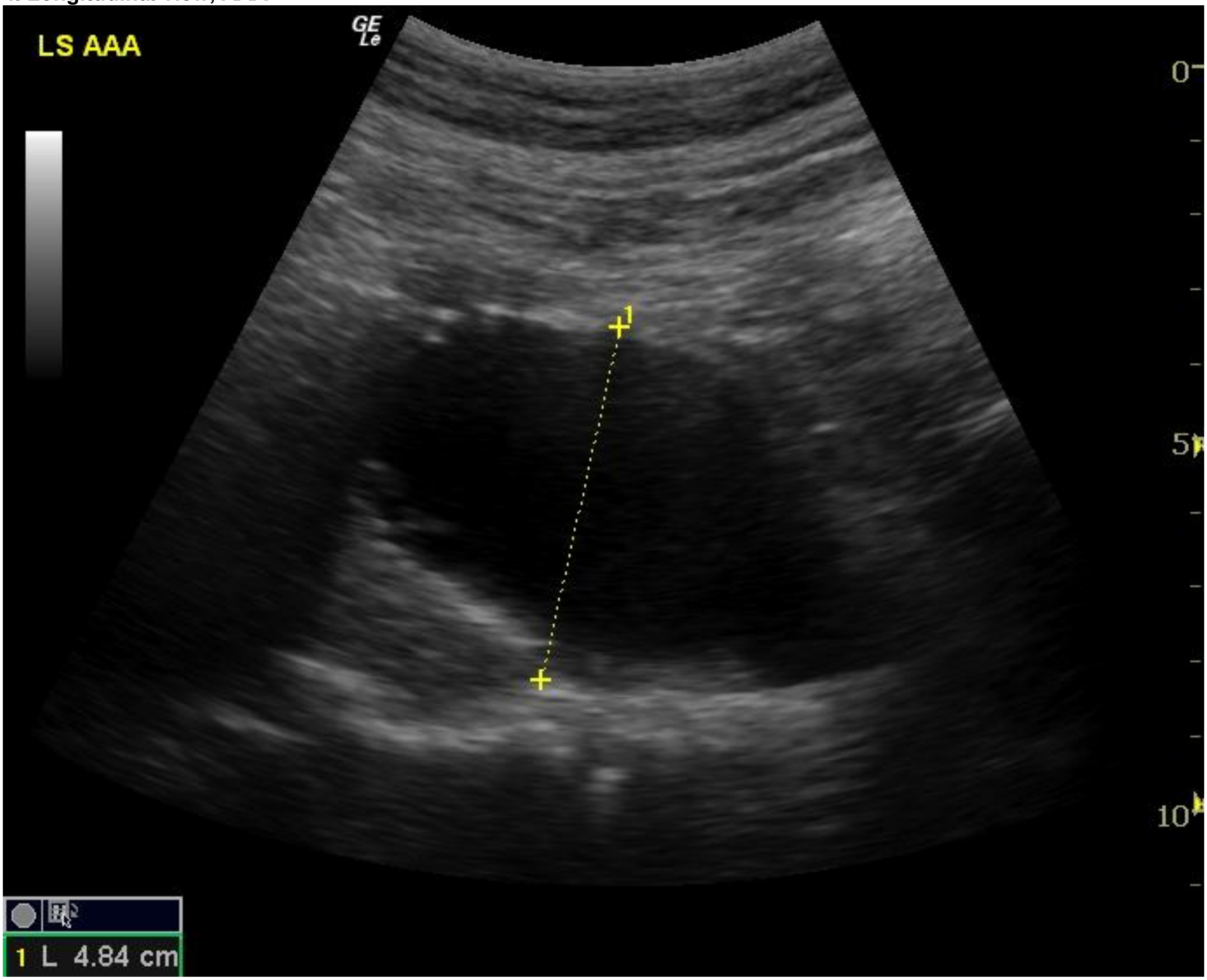
2. Lower transverse section, normal aorta. (For lower TS view of AAA, so images below in *Diameter* section).



3. Longitudinal section, normal aorta (with origin of SMA).



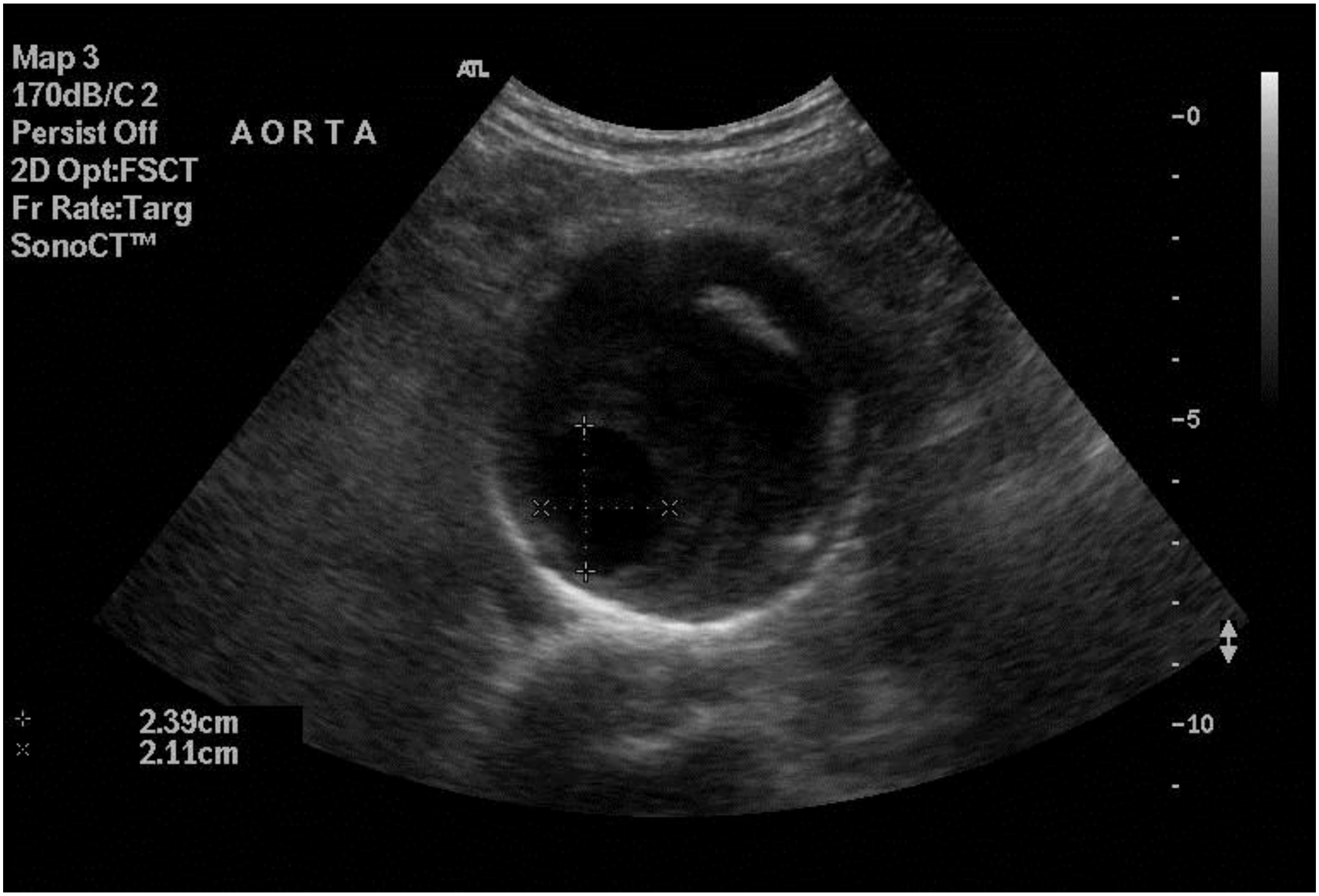
4. Longitudinal view, AAA



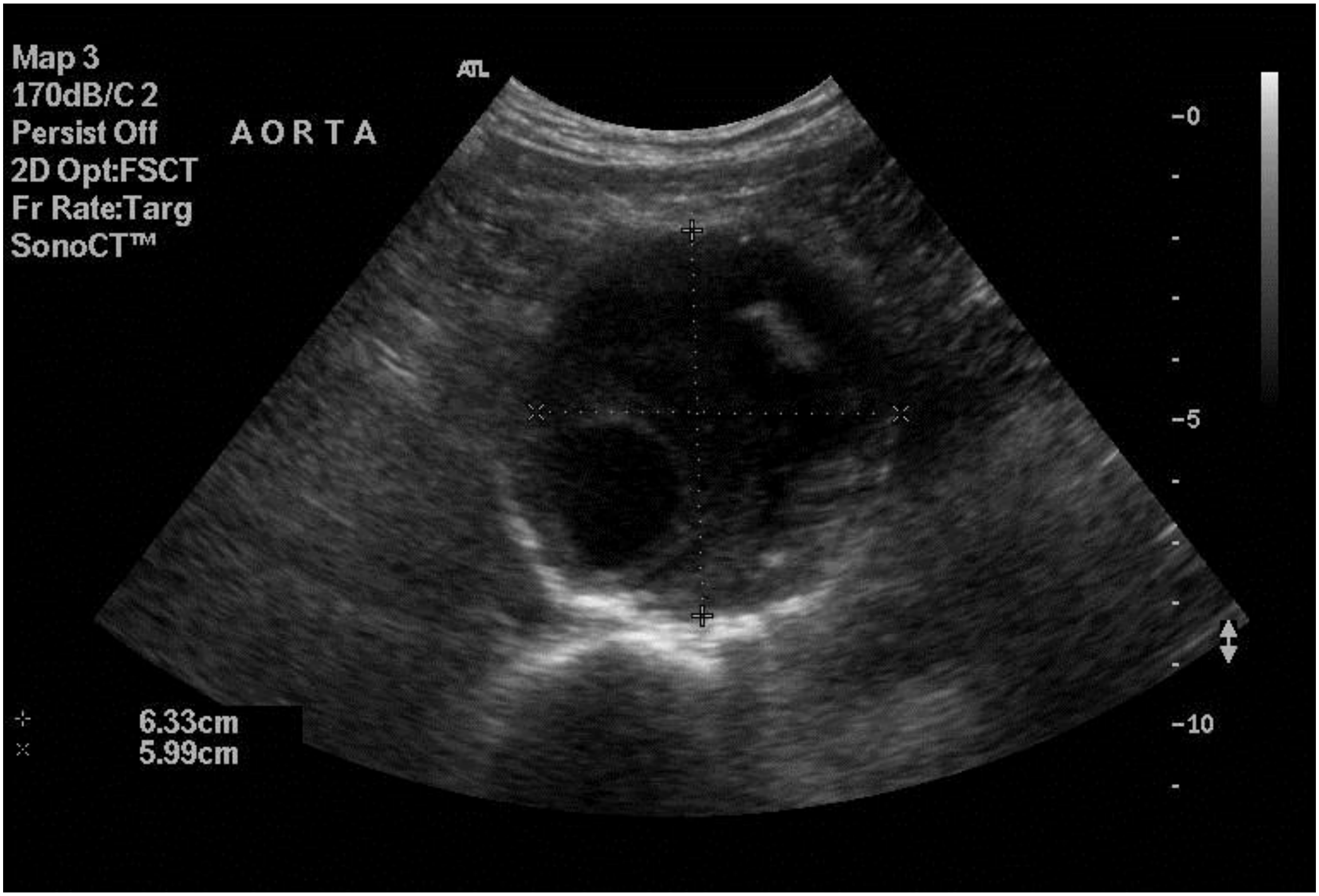
Diameter

All three views must include measurement of **diameter**. Measure diameter from outer to outer wall. On transverse view, diameter may be obtained in either anteroposterior (AP) or horizontal direction, although the latter is probably more accurate.

Be very careful when measuring diameter. The two images below show the same AAA with diameter incorrectly measured (inner-inner wall)...



...and now correctly measured (outer-outer wall).


Map 3
170dB/C 2
Persist Off
2D Opt:FSCT
Fr Rate:Targ
SonoCT™
AORTA
ATL
6.33cm
5.99cm
0
5
10

Handy Hints

- If bowel gas is in the way, continue direct pressure with the probe on the abdominal wall to move the bowel. Stop if this increases pain. Altering the angle of the transducer may also help.
- Obese patients may be very difficult. Increase the image depth and alter the focus.
- Measure diameter between the outer margins of each wall, not inner. This avoids false negatives due to mural thrombus.
- Ecstatic aorta: measurement of diameter difficult. Attempt to measure the diameter perpendicularly: avoid taking a slice at an angle as this will overestimate the diameter.

You have not ruled out AAA unless you can visualise the entire length of the aorta.

What USS Can Tell You
Is there an aneurysm (AAA)?
USS can detect AAA in at least 97% of cases.

What USS Cannot Tell You
Is the aneurysm leaking?
USS is insensitive in detection of retroperitoneal fluid (such as blood). If you detect AAA in a shocked patient, assume it has ruptured or is leaking.

Now What?

- Unstable patient and AAA

  Notify surgical team immediately. The patient must be transferred immediately to OT for AAA repair.
- Unstable patient, unable to rule out AAA

  Ongoing resuscitation, urgent surgical review and decision to proceed to OT (or further imaging such as CT) must be based on clinical likelihood of AAA.
- Unstable patient and no AAA

  Ongoing resuscitation and further assessment to find the cause of the patient's presentation.
- Stable patient and AAA (or unable to rule out AAA)

  Call surgeons. Patient will likely require further imaging (eg. CT) to assess extent, renal artery involvement etc.
- Stable patient, no AAA

  Patient needs further assessment to find the cause of the patient's presentation.

US guided procedures:

- vascular access
- effusions
- suprapubic catheter
- lumbar puncture

Why use US?

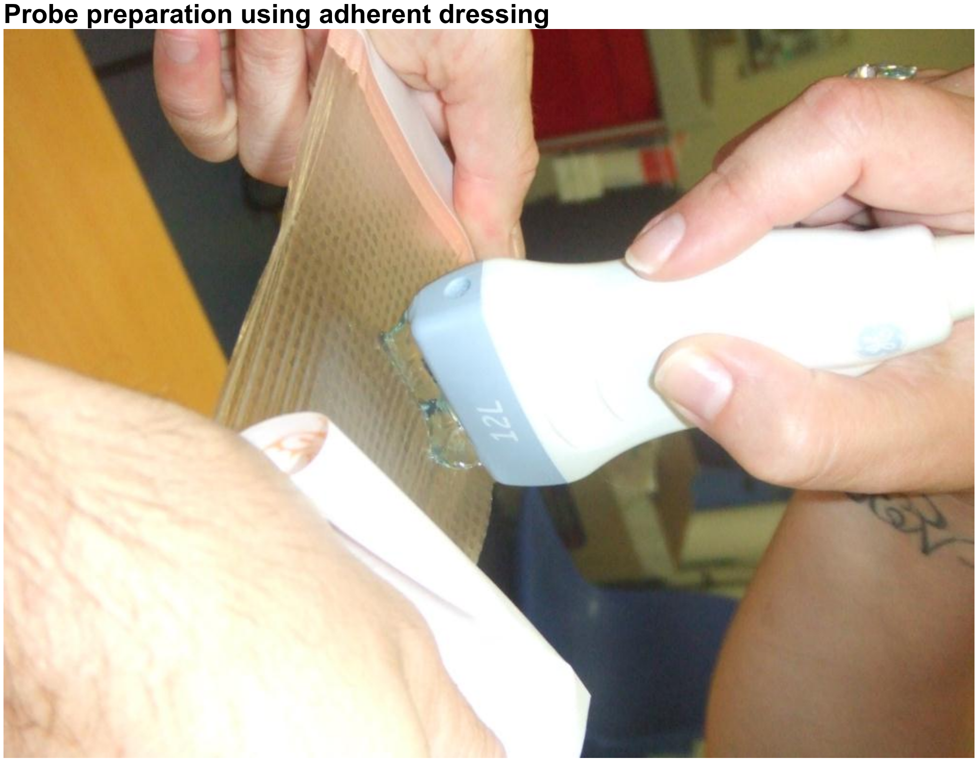
- Even with an expert knowledge of anatomy, blind insertion of needles and drainage catheters can be dangerous and technically difficult for many reasons such as abnormal anatomy and coagulopathy.
- Where available and practical, US-guided needle insertion is best practice. It enables accurate location of the relevant anatomy, identifies local pathology such as thrombosed veins and decreases the risk of complications such as damage to nearby structures.
- Several studies have demonstrated that central venous cannulation using 2D US guidance is safer and more successful than the landmark technique.
- In the UK, current National Institute for Clinical Excellence (NICE) guidelines (www.nice.org.uk) recommend 2D US guidance for emergency and elective CVC cannulation.

Probe sterilization

- Sterilise the probe with the aid of an assistant. One method is to prepare the probe with standard gel, then insert the probe into a sterile US probe sheath or a sterile glove and apply sterile gel over the sheath.

- An alternative method is the ‘gel - free technique’:
    - Cover the probe with a sterile adherent dressing such as Opsite 3000 ® *[figure below].* Ensure that no air bubbles are trapped between the probe and the dressing, or the resulting US image will be affected.
    - Instead of using sterile gel over this, as a scanning medium simply use the antiseptic liquid used to sterilize your field (eg chlorhexidine).
    - The resulting image will be adequate for most procedures, and the technique is less messy.

Probe preparation using adherent dressing



When preparing a sterile probe, it is easy to accidentally contaminate your gloves, so wear a double set.

Central venous cannulation

Anatomy

1. The internal jugular vein (IJV) runs in the carotid sheath, usually lateral to the common carotid artery (CCA) and deep to the sternocleidomastoid muscle (SCM). Its compressibility and relative safety make it a preferred CVC site in the ED. A traditional cannulation site is approximately halfway between the sternal notch and the mastoid process, at the bifurcation of the SCM.
2. As well as compressibility, the femoral vein (FV, also known as Common Femoral Vein) has the advantage of distance from important structures such as the airway and lungs. In the femoral sheath it is usually medial to the pulsation of the femoral artery, which lies approximately halfway between the symphysis pubis and the anterior superior iliac spine (ASIS).

- Subclavian vein cannulation is technically difficult and beyond the scope of this text.
- It is essential to distinguish between veins and arteries on US:
    - Vein larger, oval cross section, thinner walled and compressible (unless thrombus or proximal obstruction eg massive PE)
    - Vein's diameter changes with respiration and Valsalva
    - Arterial pulsation (beware transmitted venous pulsation)
    - Doppler waveform analysis will further differentiate vein from artery. However, Doppler is not essential and not recommended by NICE.

Which technique?
Three techniques are described. A combination of all three is recommended.

'Static' technique
US is used to identify the target vein and mark the optimum site of needle entry prior to sterile preparation of the field. This confirms venous depth, course and compressibility. It is recommended as a 'screening exam' prior to using one of the other techniques below. Used alone, it is less technically demanding and obviates any requirement for sterility. However, it is not as safe as real time US guidance.

Real time in-plane and out-of-plane techniques
Described below, both techniques require a sterile technique. Both are more difficult than the static technique and an assistant is required to 'drive' the ultrasound machine. However, real time US guidance is safer than the static approach

CVC cannulation using real time US: Preparation

- Informed consent unless emergency
- Patient attached to monitors and oxygen. Local anaesthetic and Seldinger technique equipment
- US monitor in your line of sight: it is difficult and potentially hazardous to insert a CVC when craning to look over your shoulder at the screen.
- Choose site and confirm anatomy with static US, then prep and drape site.

Patient position

- Dictated by clinical picture
- IJV cannulation: 10 degrees Trendelenburg tilt will significantly increase IJV diameter and prevent intracranial air embolism
- Femoral cannulation: leg abducted. Hang the leg over the edge of the bed if necessary.

Probe and scanner settings

- High frequency (eg 7.5 MHz) linear array probe. Some probes have a notch in their midline to guide the needle.
- Vascular preset

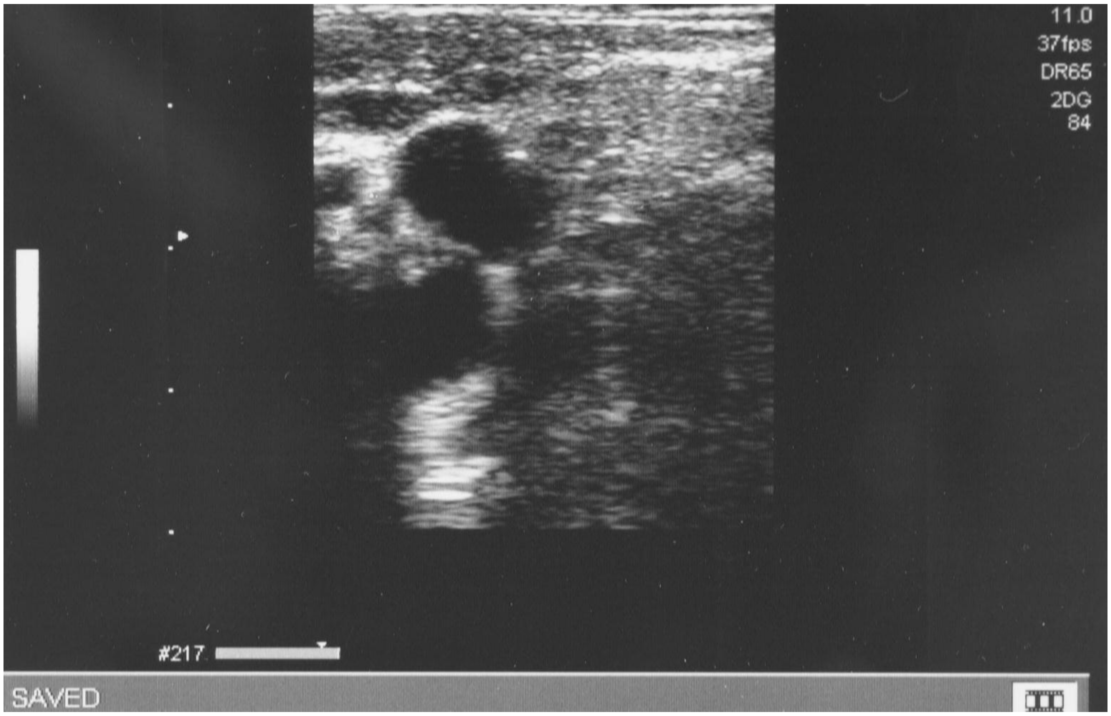
'Out-of-plane' or transverse technique

1. With your non-dominant hand, place probe transversely over the chosen site. Identify vein, artery and nearby structures on screen. Lymph nodes may mimic vessels in cross section but are not compressible or tubular. Use colour Doppler if in doubt.

US image: transverse section, RIJ vein & right CCA

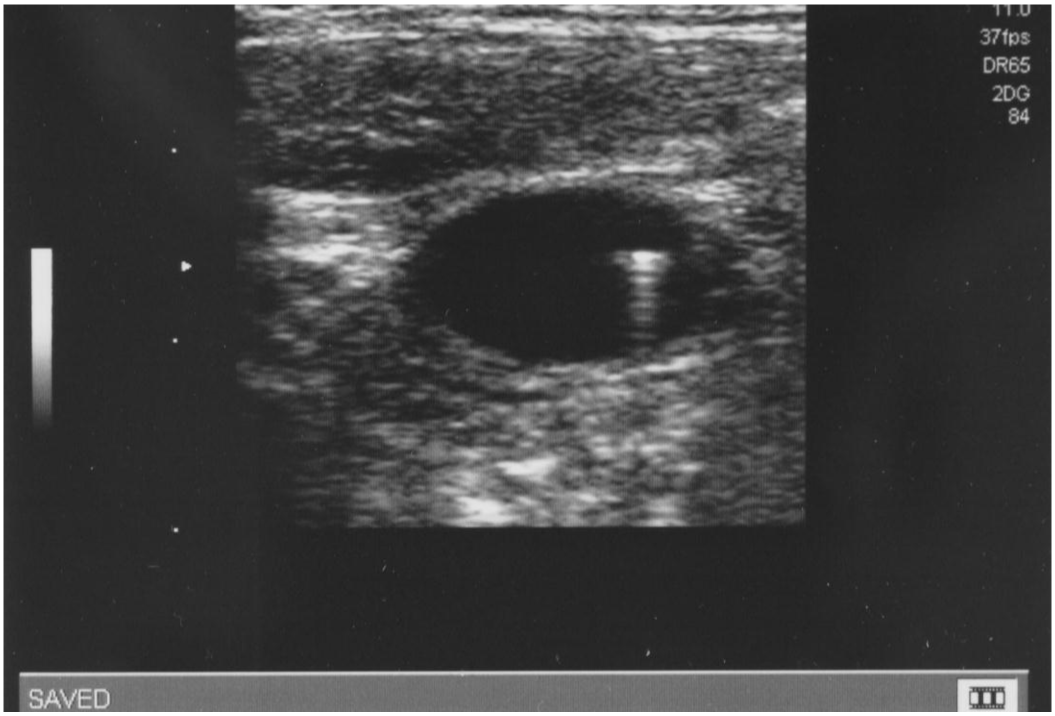
2. Move probe and alter image depth and focus so that vein appears in the centre of the screen. This will serve as a landmark for needle position.
3. Administer local anaesthetic (LA) over the course of the vein at the probe's midway point. When LA has taken effect, a scalpel may be used to nick the skin to ease the subsequent passage of the introducer needle. This step is not essential.
4. With your dominant hand, insert introducer needle (attached to syringe) at the site of LA, at a steeper angle to the skin than that used for blind CVC insertion. Introduce the needle at an angle and position to ensure the needle tip intersects the vein in the plane of the US image and does not overshoot the plane of the US image. Using out-of-plane technique, the image of the needle often is not seen, but its 'ring-down' artefact will confirm its position. If in doubt, change the angle of the probe until the needle is seen.
5. The major risk of such a steep angle is inadvertent 'through and through' venous puncture. Avoid this by the following:
   - Introduce the needle more slowly than when performing blind CVC insertion.
   - Introduce the needle under real time visualisation of the US image.
   - Watch for 'tenting' of the vein's upper wall inwards as the needle approaches the vein.

US image: tenting of RIJ vein by tip of needle



- When the needle enters the vein, this tenting will diminish even if you do not see the needle in the vein. The needle tip (or its artefact) should be visible in the venous lumen but may not be if the US plane does not intersect the needle. You should be able to see the reverberation artefact or ‘ring-down’ as the US beam intersects with the needle, however.

US image: ‘ring down’ artefact



- Confirm position by aspirating venous blood.
- Once the needle has entered the vein, decrease the angle of the needle. Take care to ensure the needle tip remains in the lumen.

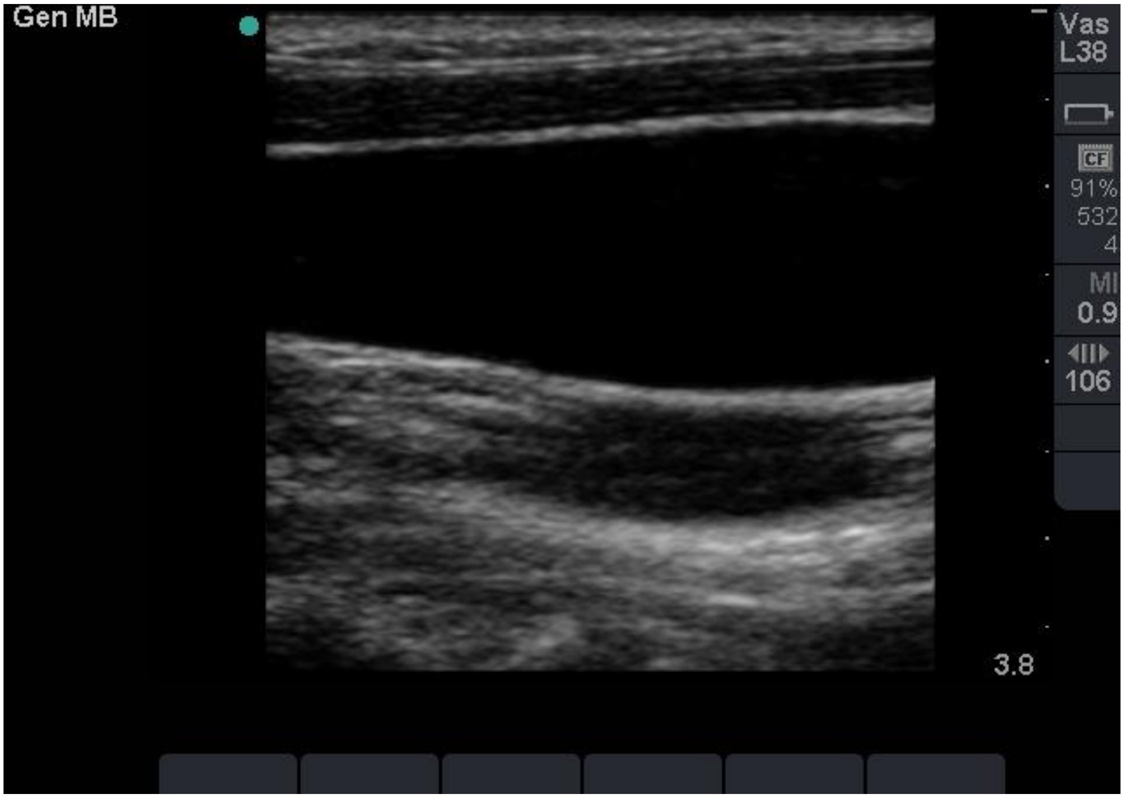
6. Remove the syringe and introduce the guide wire. The guide wire should be visible in the venous lumen. Using transverse and longitudinal scanning, trace the path of the guide wire to ensure it has not kinked back.
7. Remove the probe, complete Seldinger insertion of the CVC and check position with x-ray as per local protocol.

'In-plane' or longitudinal section (LS) technique:

Step 1: as for out-of-plane.

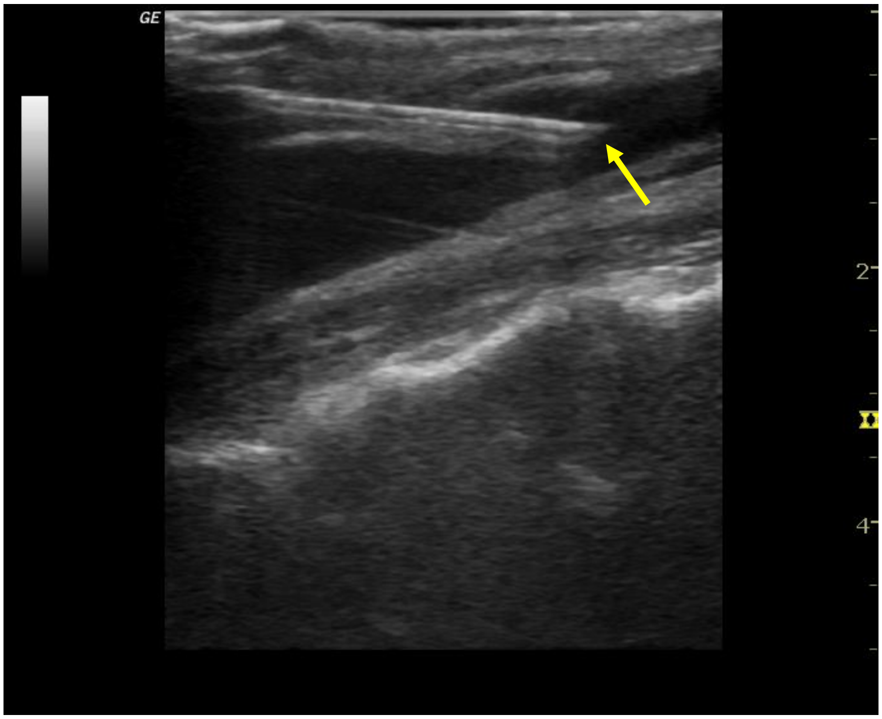
2. Once vein is identified, rotate the probe until the vein appears in LS: confirm the vessel is venous using the checklist above ('Anatomy').

US image: RIJ vein, longitudinal section



3. Administer LA beneath the probe and consider nicking the skin with a scalpel as above.
4. Introduce introducer needle at a shallow angle as for traditional blind cannulation. This allows easier visualisation of the needle on US.

US image: needle tip (arrowed) in RIJ vein, longitudinal section



- The major pitfall of this technique is inadvertently moving the probe so that its plane no longer parallels that of the vein and needle. This may lead to needle overshoot or even arterial cannulation.
- Once the needle has entered the vein, complete steps 6 and 7 as above.

Summary

Out-of-plane technique

- Steep angle needle entry
- Easier and preferred by novice operators
- Difficult to visualise US image of needle: ‘ring down’ artefact used instead
- Risk of overshoot if probe plane does not intersect needle

In-plane technique

- Shallow angle needle entry
- Requires finer control of the probe to ensure that entire needle (especially tip) is on screen, but safer than out-of-plane technique
- Risks if probe’s plane no longer parallels that of the vein or needle: needle overshoot, arterial cannulation.

A combination of a non-sterile screening exam, then a real time technique, is safest.

Handy hints and pitfalls

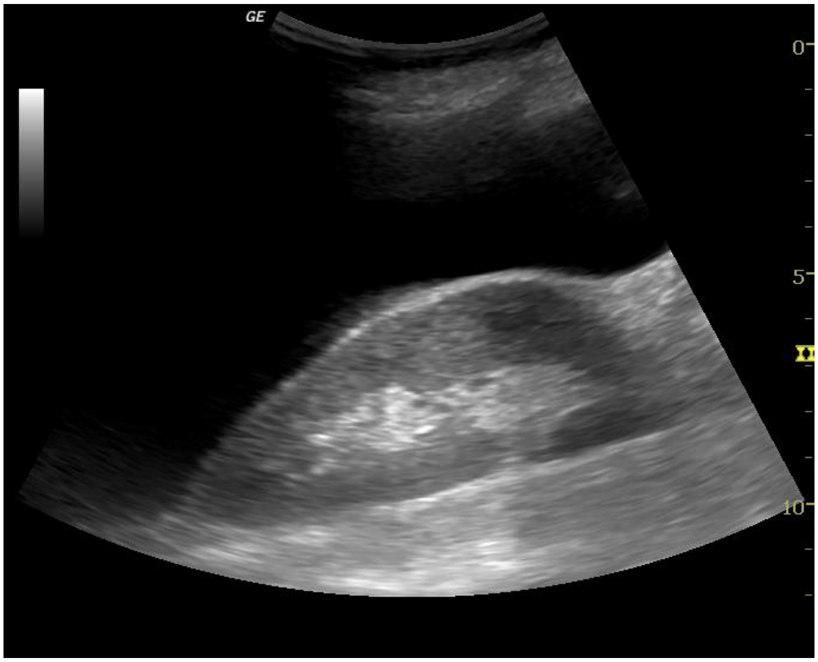
- **Doppler is not required to distinguish veins from arteries**
- Keep the US screen directly in front, in your line of sight
- You will need an assistant to drive the machine
- Needle angle differs between in-plane and out-of-plane techniques
- In-plane technique is safer but can be harder to learn
- Avoid through-and-through venous puncture by:
    - Slow needle insertion
    - Real-time US visualisation
    - Keep the needle tip on screen (if using in-plane approach)
    - Watch for tenting of vein as needle approaches
    - Continuous aspiration of syringe
- US guidance may also be used when cannulating peripheral veins and arteries. *(figs 18)*

Draining effusions: thoracocentesis, pericardiocentesis and paracentesis

Anatomy

- Simple fluid collections (eg transudate, fresh blood) are hypoechoic (dark) on US and demonstrate posterior acoustic enhancement.
- Complex collections (eg pus, clotted blood) can appear complex and even iso- or hyperechoic. They may contain particles (debris) and even linear structures (eg fibrin strands, multi-loculated collections).
- Bowel air and normal lung tissue reflect sound poorly and produce scatter.

Simple fluid: ascites



Complex fluid: subcutaneous abscess

Preparation

- As for CVC cannulation (above)
- Specific equipment depends on indication (eg whether simple aspiration or insertion of a catheter is required) and local practice (eg dedicated pericardiocentesis catheter)
- If sending fluid for analysis: 3-way tap, large syringe, specimen containers

Patient position

- This depends on the circumstances. For example, the easiest position for simple aspiration of pleural fluid is patient seated with arms folded, leaning forward whereas semi-recumbent is preferred for intercostal catheter insertion, and supine for paracentesis (with elevation of the contralateral hip).

Probe and scanner settings

- A curved or even a phased array probe should be used initially to confirm the presence of fluid and nearby anatomical structures. Most operators prefer to switch to a high frequency, linear array probe for a more accurate assessment of depth of the effusion and for real time guidance, but some prefer to use a curved or phased array probe throughout.
- At least one good view of the fluid should be obtained and recorded.

Probe placement and landmarks

For specific sites, please refer to the following sections in the manual:

- for pleural fluid and pneumothorax, see *EFAST*
- for pericardial effusions, see *focused echocardiography*
- for ascites, see *FAST*

<u>Needle placement</u>

Thoracocentesis

- Identify a site where the effusion is deep, and well above the diaphragm in full expiration.
- If draining a pneumothorax, the recommended site is the fifth intercostal space in the anterior axillary line. An alternative site is the second intercostal space in the mid-clavicular line.
- Insert the needle above a rib to avoid the neurovascular bundle.

Pericardiocentesis

- Traditionally, the subxiphoid approach is taught. However, even a cursory view of the subxiphoid window demonstrates that this approach requires passage of the needle through the liver.
- Therefore it is more prudent to approach via the parasternal or apical windows, taking care to avoid the internal thoracic vessels.
- Choose a site where the pericardial effusion is maximal.

Paracentesis

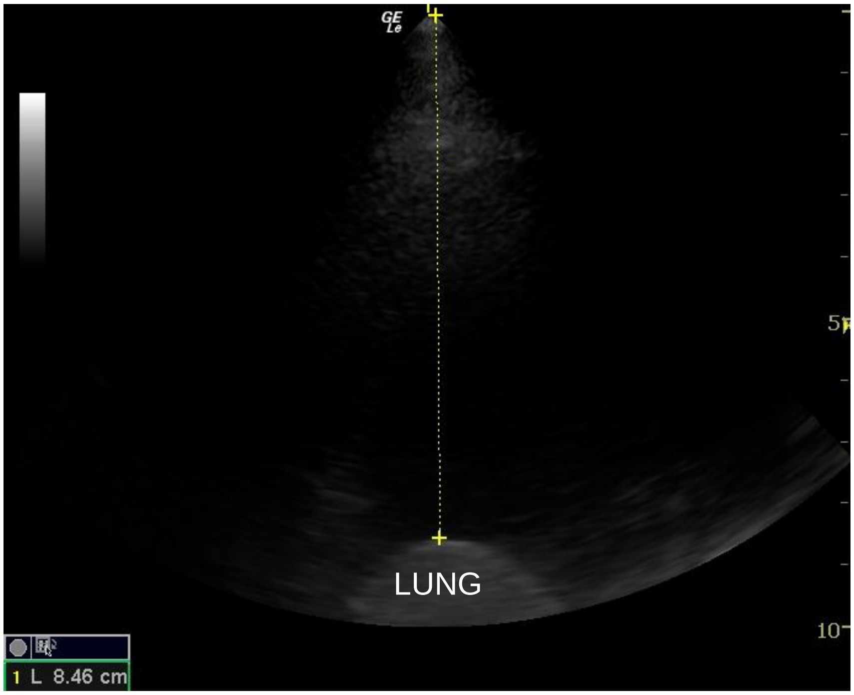
- Traditional teaching has advised needle placement via the left or right iliac fossa, or midline, to avoid the inferior epigastric arteries.
- While US guidance has supplanted this advice to some extent, it is still prudent to ensure that no vessels are inadvertently punctured by the technique. Therefore avoid excess probe pressure when scanning, otherwise vessels in the abdominal wall may not be seen.

Handy hints and pitfalls

- Real-time US guidance of aspiration is safer than merely using US to identify the optimum drainage site for later blind aspiration.
- If you are not using real time US but simply using US to mark a needle site before sterilizing the field, do not allow the patient to change position subsequently (eg sitting up from supine position). This shifts fluid and organs and mandates that you re-scan the area of interest.
- Failure to consider diaphragmatic movement with respiration may make these procedures hazardous. So can organomegaly or unusual body habitus.

- Therefore always scan through respiration and in at least two planes, paying particular attention to nearby structures, before choosing the optimum site for needle insertion.
- Before draining fluid, measure the depth of the fluid. *(see figure below)* This is particularly important, to prevent introducing the aspiration needle/cannula too deeply.

US image: meauring depth of pleural fluid collection



- When no further fluid can be aspirated re-image the collection to assess its size. If fluid is still present, alter the needle or cannula's position to allow further aspiration.
- When removing a cannula from the thoracic cavity, remove it in expiration or during Valsalva manoeuvre to ensure positive intrathoracic pressure.

What US can tell you
- Is there a fluid collection?
- Is it accessible for drainage?
- Is it suitable for drainage? If there is much debris or the collection is multi-loculated it is probably unsuitable for complete drainage

What US can't tell you
- The nature of the fluid: eg haemothorax, empyema, transudate

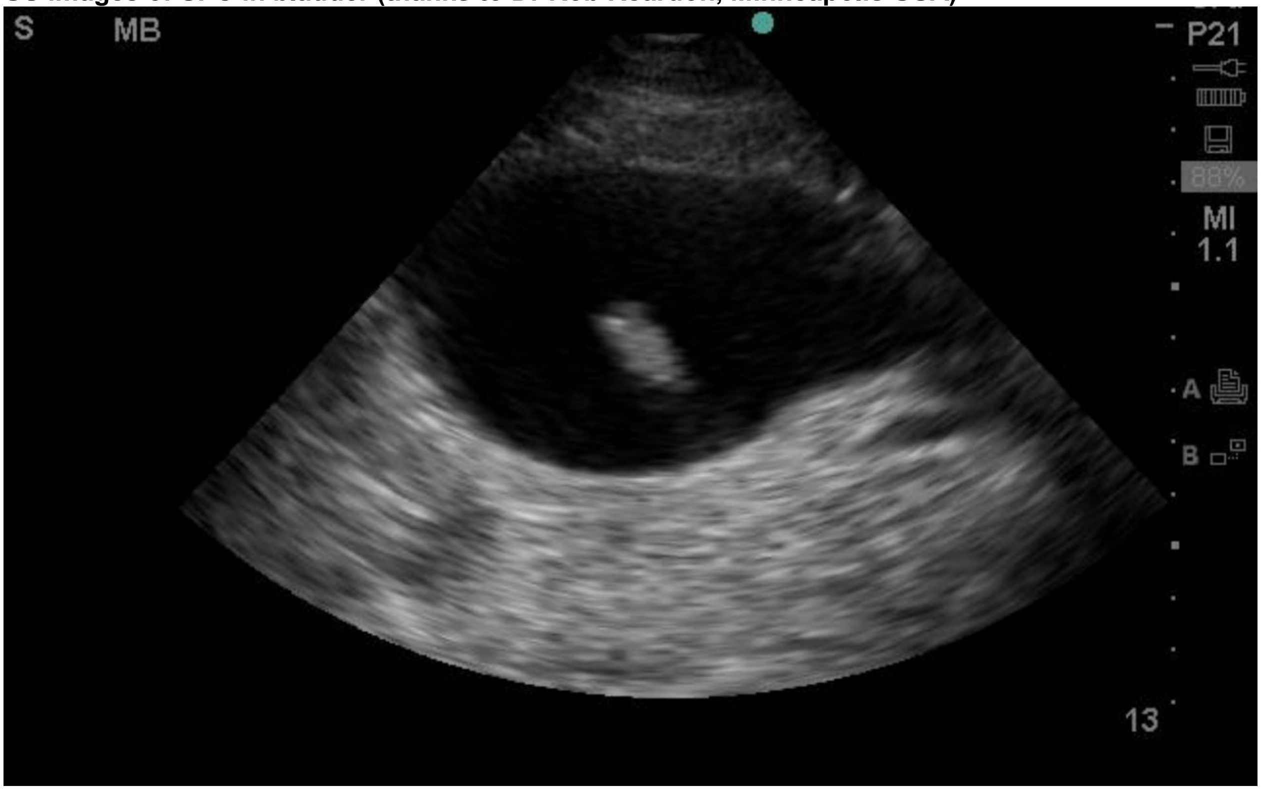
Complications of draining effusions
- Pain
- Pneumothorax
- Infection
- Perforation of nearby organs eg diaphragm, lung, bowel
- Mistaking fluid within structures such as bladder for ascites
- Haemorrhage, due to vascular or organ injuries

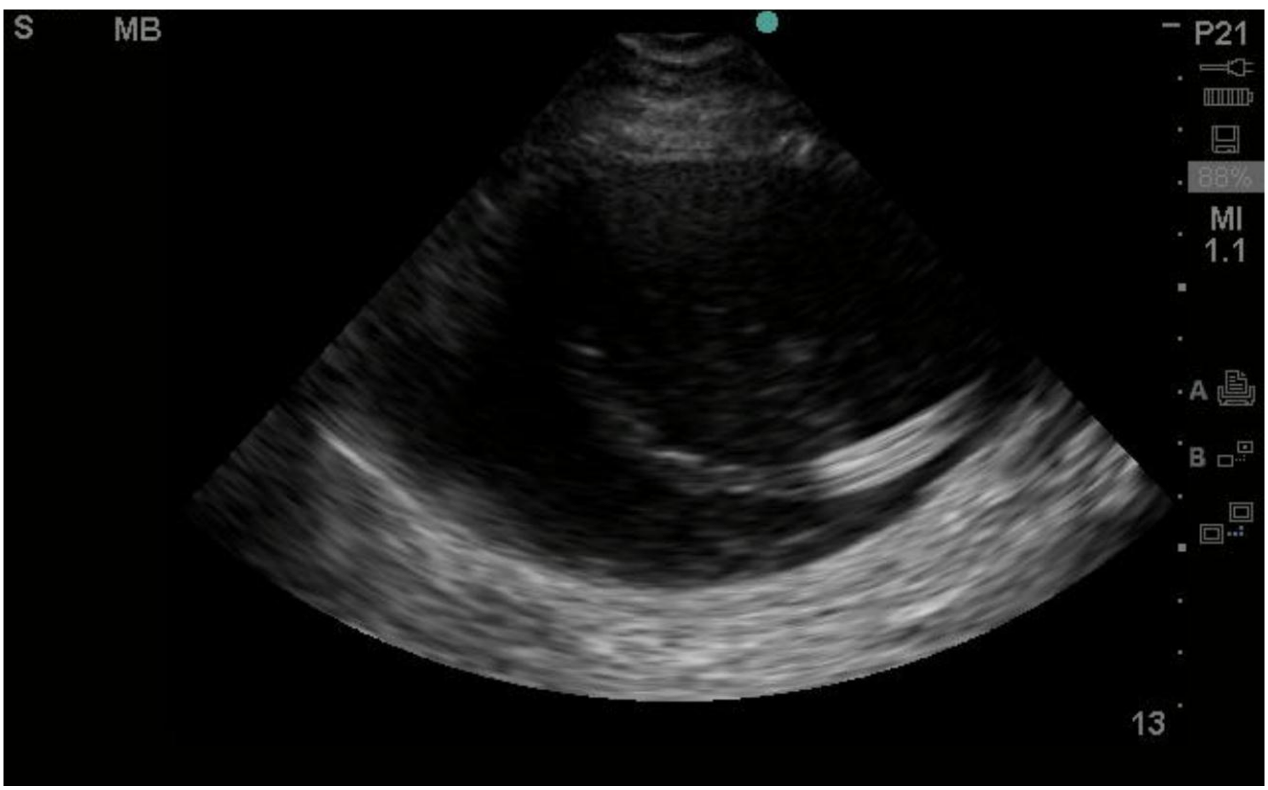
Suprapubic catheterisation

This is used in the patient in acute retention in whom urethral catheterisation is difficult or contraindicated. This may be performed using real-time US guidance (described below) or the site identified using US prior to SPC insertion.

- Informed consent, dedicated suprapubic catheter (SPC), local anaesthetic, sterile equipment and sterile US sheath as per local practice.
- Using a low-frequency probe (curved or microconvex), confirm full bladder as per *FAST* section
- Identify a site in the midline above the symphysis pubis with no structures overlying the bladder. Mark the site and clean the skin using full aseptic technique.
- Administer local anaesthetic. While the anaesthetic is taking effect, sterilise the probe and image the bladder again, confirming the optimal site for SPC insertion. (Note: you may continue using the low frequency probe or change to high frequency linear probe depending on body habitus and operator preference.)
- Incise the skin with a scalpel to aid SPC passage. Introduce the SPC and introducer, monitoring progress into the bladder. *(Figures below)*
- Observe ‘flashback’ of urine, remove introducer and secure SPC following manufacturer’s instructions.

US images of SPC in bladder (thanks to Dr Rob Reardon, Minneapolis USA)





Lumbar puncture

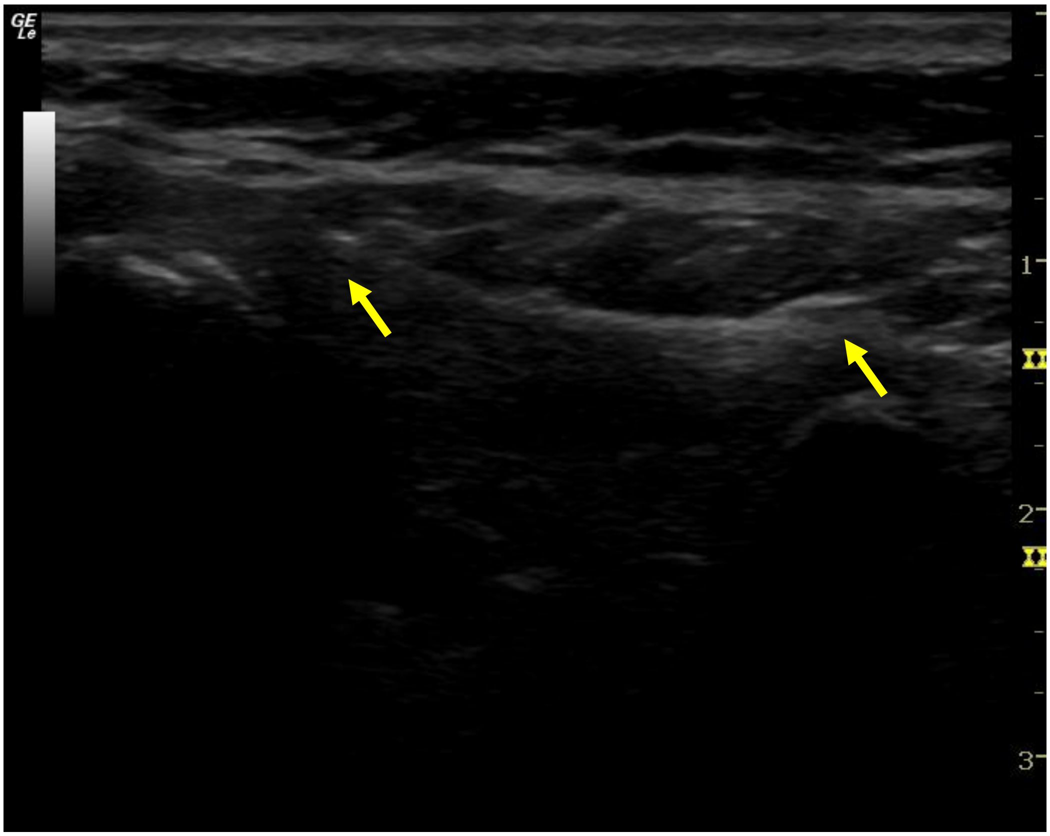
Although US can visualise deep structures such as the ligamentum flavum in some patients, most operators use it simply to identify the spinous processes of the lumbar vertebrae and to map out the interspinous space for needle entry. Compared with the traditional 'landmark' approach, US-guided LP has a significantly lower failure rate and has been shown to improve the ease of the procedure in obese patients.

Technique

Note: this is a static rather than real time technique.

- Informed consent, dedicated lumbar puncture (LP) kit, local anaesthetic, sterile equipment and sterile US sheath as per usual practice. Surgical skin marking pen if available.
- Patient position (either lateral foetal or seated, leaning forward) as per blind 'landmark' technique. Palpate landmarks and attempt to identify the line of the spinous processes as usual.
- Using a linear high frequency probe, scan from right to left with the probe in longitudinal plane until you see the lumbar spinous processes. Like all bony structures, on US they appear bright (echogenic) with posterior acoustic shadows. The midpoint between two such processes is the optimal site for needle placement.

Longitudinal image : interspinous space & spinous processes (processes arrowed)

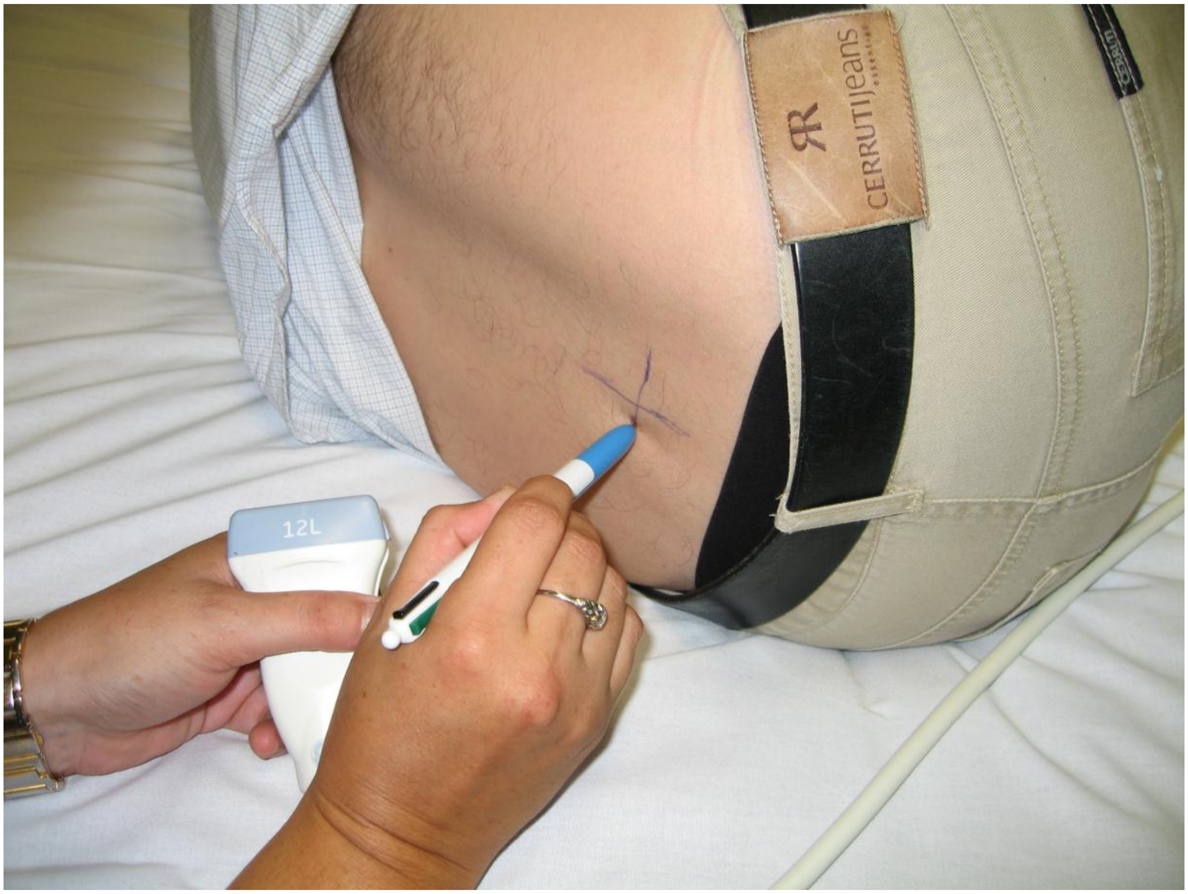


- Centre this point on the US image then mark the skin on both sides of the middle of the probe. Remove the probe then draw a transverse line connecting the two points.

Marking skin either side of probe

- Repeat the process in transverse section, identifying the interspinous space and marking the skin on both sides of the middle of the probe. Remove the probe and draw a longitudinal line connecting the two new points until you have a ‘cross’ or ‘X’ centred over the site for needle insertion.

Marking skin: ‘X marks the spot’



- Prep and drape the site and proceed with local anaesthesia and LP.

Handy hints and pitfalls

- Be very careful to avoid any patient movement between the acts of marking the optimal site and actually inserting the LP needle, otherwise you will need to start again.
- Ironically, US is least useful in those patients who require it most for LP, that is the very obese. This is because adipose tissue renders landmarks impalpable and obscures the US image. However, studies have demonstrated that US can identify the pertinent landmarks in 74% of obese patients.
- In obese patients the spinous processes may appear simply as ill-defined areas of shadowing.
- In the very obese, try an abdominal probe on the lowest frequency available, and alter depth, gain and greyscale to maximise image quality.

Credentialing

Who should perform focused ultrasonography?

- As ultrasound becomes more widespread, conflicts have developed over who should be performing the ultrasonography.
- Radiologists, surgeons, and emergency physicians all want to be credentialed in emergency ultrasound.
- The primary requisites for sonographers are that they are competent, present during the acute phase of resuscitation, and are able to repeat the scan as required.
- Competency in sonography requires a tutored credentialing process. The learning curve for FAST examination is fairly steep, and most are satisfactorily competent after 25 scans (20 negative, 5 positive).
- Some verification programmes require many more scans than this however, and upwards of 300 is necessary in some countries.
- Credentialing should include formal instruction on the principles and physics of ultrasound, skills stations, practice examinations for both negative and positive FASTs (peritoneal dialysis, ascites), and proctored instruction on the use of ultrasound in actual trauma resuscitations.
- Ultrasound should be available 24 hours per day for emergency patients, particularly for those being evaluated for cardiac tamponade, abdominal aortic aneurysm, abdominal trauma, and ectopic pregnancy.
  - A focused or limited bedside Emergency Department ultrasound should be available, performed by technicians, radiologists, or appropriately trained, qualified and experienced Emergency Physicians.

Credentialing Guidelines

American College of Emergency Physicians

ACEP Policy Statement USS Guidelines 2001

Introductory / initial course

- Satisfactory completion of introductory / initial course [1 day for limited applications / areas; 2day for all applications].
- Satisfactory completion of training ultrasound exams.
- Participation in departmental lectures.

Practiced based training

- Practiced based training with confirmatory tests.
- 25 Initial scans followed by a further 25 –50 scans for a specific area e.g. AAA.
- A minimum of 150 scans if general / all applications involved.
- Training as part of a programme in the ED supervised by an ED ultrasound coordinator.
- Credentialed along lines of eligible provider, experience requirements and specific ultrasound privileges.

Australian College of Emergency Medicine

Credentialing for ED Ultrasonography: Trauma Examination and Suspected AAA July 2000

1. Ultrasound Workshop

- . Introductory course. Ability to demonstrate abnormalities at end of course.

2. Logged Exams

- FAST
  - At least 25 accurate, credentialed trauma examinations must be performed for the FAST module.
  - 50% of these exams must be clinically indicated.
  - At least 5 should be positive for intraperitoneal, pleural or pericardial fluid.

- AAA
    - 15 accurate, credentialed scans of the aorta must be performed for the Abdominal Aortic Aneurysm module.
    - 50% of these exams must be clinically indicated.
    - 5 should demonstrate an aneurysm.

3. Credentialing Examination (a real time exam performed on a patient or volunteer in front of the examiner)

- Ability to create adequate ultrasound images.
- Identify any relevant artefacts or pathology present during real time scanning and/or on videotaped scans and/or hard copies of scans. Recognize an inadequate scan.
- Know the indications and limitations of ultrasound examination for the

4. Maintenance of Credentials

- 3 hours of ultrasound training per year
- 25 FAST scans per year.
- 15 AAA scans per year.
- EDs in which bedside ultrasound is performed must conduct bi-monthly audits of the ultrasound examinations as part of the department's quality improvement process.

6. Quality Improvement

- A database of all ED ultrasound scans should be used for continuous quality improvement review, individual and department performance monitoring, and teaching.
- There should be a periodic review of sonograms for both image quality and interpretation.
- Tracking clinical outcomes of patients who were scanned in the ED should also be used to monitor the clinical interpretation of ultrasound studies. This may be in the form of obtaining reports of follow-up imaging procedures or surgical findings. Errors in clinical interpretation or failure to obtain appropriate images can then be identified and reviewed.

Maintaining Skills- CME

- Emergency physicians who perform ultrasound as part of the scope of their clinical practice should continue to obtain continuing medical education in ultrasound after the initial training phase.
- After the initial training phase, continuous use of the ultrasound technology is advised to maintain skills.
- The frequency of ultrasound usage should increase in the years after the initial training.
- The amount of CME (continuing medical education) and the frequency will depend on the number of applications used and the developments in emergency ultrasonography.

Documentation

Emergency ultrasonography is performed to answer very specific questions, i.e. does this patient have an acute life threatening condition?

Medicolegally assume you will be asked to justify the actions you took based on your ultrasound examination.

The results of all ultrasound examinations must be recorded in the patient notes. The documentation should:

- Indicate the necessity for the examination
- include written interpretation of the examination
- be available for review, quality assurance and audit, including recorded images

Incidental findings must be recorded and details of diagnosis and necessary follow up relayed to the patient.

References and Useful Papers

General

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