

How to use ultrasound for....

Vascular access

FAST scan

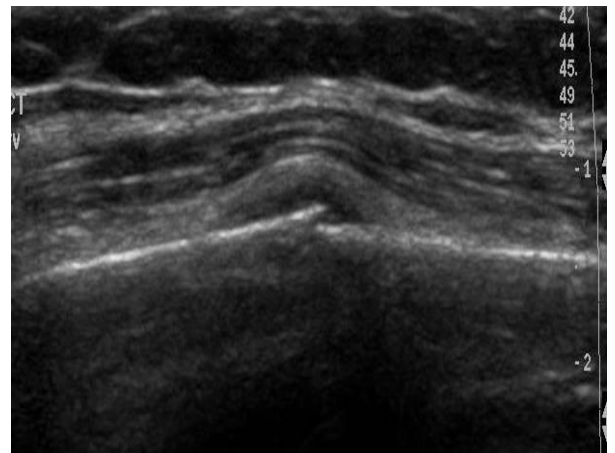
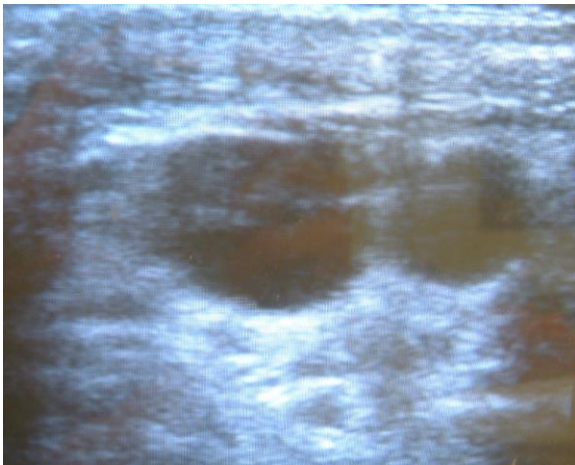
Abdominal aortic screening

Chest exam

Bone fracture diagnosis

Abdominal paracentesis

Drain insertion



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HOW TO USE ULTRASOUND FOR VASCULAR ACCESS



NICE
National Institute for Health and Care Excellence

Guidance on the use of ultrasound locating devices for placing central venous catheters

•The national institute for clinical excellence (NICE) have published guidelines for the use of ultrasound and vascular access via an internal jugular approach (ref. 1). Ultrasound guidance for vascular access has been shown to be advantageous to blind cannulation (land mark technique). (ref. 1, 2).

This presentation is a pictorial review of how to use ultrasound for vascular access.

Equipment

Ultrasound platform

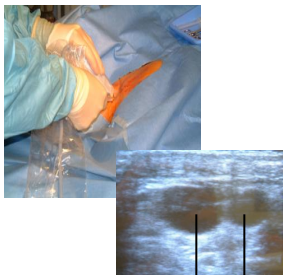


Linear high frequency probe 7.5mhz



Technique

Image the neck vessels with the ultrasound probe in transverse with relation to the neck vessels



Internal jugular vein
Common carotid artery

- The internal jugular vein is generally of a larger diameter than the common carotid artery
- The walls of the internal jugular vein are less muscular and therefore thinner than the common carotid artery.
- The internal jugular vein is easier to compress than the artery.
- The wave form of the internal jugular using Doppler is monophasic as compared to pulsatile arterial wave form of the common carotid artery
- The internal jugular vein is anatomically lateral to the common carotid artery.

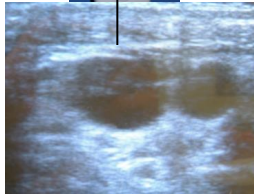
Ultrasound examination allows anatomical demonstration of the neck vessels.

- The patency and presence of the internal jugular vein can be examined with colour flow.
- Thrombus in the internal jugular vein is seen as a filling defect.
- Thrombus prevents the vein from being compressed.
- The size of the internal jugular vein can be assessed
- Asymmetry between right and left internal jugular veins is common. Internal jugular veins can be atretic.

The secret to vascular access using ultrasound is the needle probe image orientation



Needle, probe
Anatomical
orientation



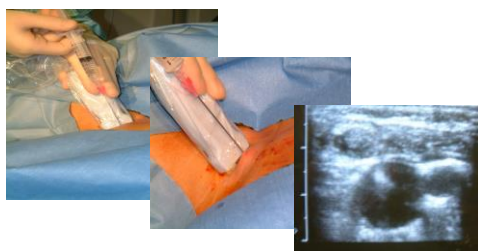
- Orientate the probe with the internal jugular vein in the middle of the image on the screen.
- The centre of the probe is now directly over the centre of the internal jugular vein.



Infiltrate with local anaesthetic.

Needle insertion options;

1. Mark under the centre of the probe, nick the skin and insert the vascular needle without using ultrasound.
2. Guide the needle into the internal jugular directly using ultrasound as below



Insert the needle into the internal jugular vein and aspirate.

Aspiration of blood confirms cannulation of the vessel.



Introduce the guide wire through the needle into the vessel.



Advantages of using ultrasound guidance for Vascular access.

- Direct visualisation of the vessel for size, patency and position (especially advantageous in patients with large short necks.)
- Allows direct visualisation of the needle entering into the vessel
- reducing the number of passes.
- Direct visualisation with ultrasound reduces possible complications of vascular access.

The possible disadvantages of using ultrasound for vascular access are;

- The short learning curve required for optimal operation.
- Ultrasound may not be readily available for use in an emergency setting

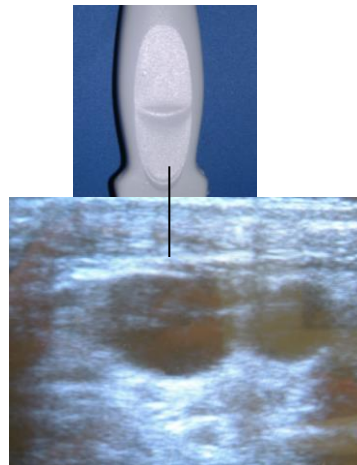
Conclusion

In our experience and the use of ultrasound for vascular access confers great advantage over blind cannulation.

references.

- 1.NICE: Guidance on the use of ultrasonic locating devices for placing central venous catheters. Sept. 2002.
- 2.Hind D et al. Ultrasonic locating devices for central venous cannulation: Meta-analysis. BMJ vol. 327 16 Aug 2003

The secret to vascular access using ultrasound is the needle probe image orientation



Needle,probe
Anatomical
orientation

- Orientate the probe with the internal jugular vein in the middle of the image on the screen.
- The centre of the probe is now directly over the centre of the image/ internal jugular vein.

Focused assessment with sonography for trauma (FAST) scanning

INTRODUCTION

The Fast scan is a rapid bedside test used by emergency physicians and surgeons to identify fluid in 4 areas:

1) PERICARDIUM 2) PERISPLENIC 3) PELVUS 4) PERIHEPATIC & HEPATORENAL SPACE

FAST scanning is used in parallel with clinical examination providing anatomic, functional, and physiologic information in the acutely unwell patients.

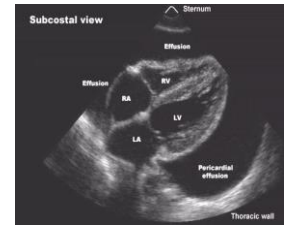
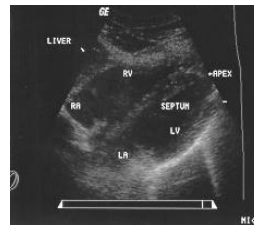
TECHNIQUE

A curvilinear 3.5MHz probe is appropriate to penetrate deep structures.



1) Pericardial Scanning

- Place the probe in the subxiphoid space, just left of the xiphisternum pointing at an angle towards the left shoulder.
- A four chamber view of the heart and diaphragm will be visualised.

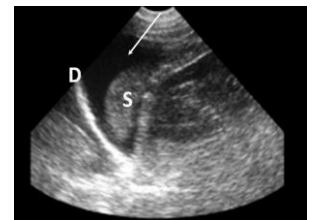


2) Perisplenic Scanning

- Place the probe in the left flank region between the left posterior axillary line and the 9th and 11th ribs.
- Slide the probe inferiorly and superiorly to detect fluid along the spleen tip and above the spleen.

Far right picture:

- Arrow – blood/ S – spleen/ D – diaphragm

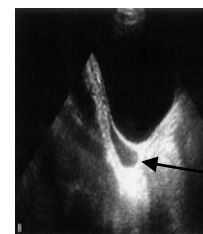
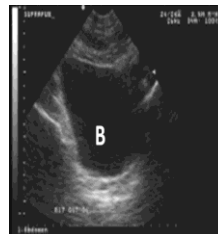


3) Pelvic Scanning

- The probe is placed above the symphysis pubis in the midline.
- When directed inferiorly, it allows visualisation of the rectovesical pouch (males) or the Pouch of Douglas.

Middle picture:

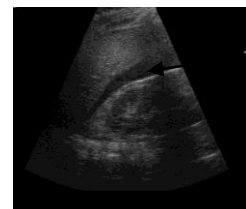
- B – bladder filled with urine



- Small amount of free fluid in pouch of Douglas

4) Peri-hepatic Scanning

- Place the probe in the right upper quadrant between the mid and posterior-axillary line of the 9th and 12th ribs.
- Pointing the probe toward the right posterior axilla allows the diaphragm, liver & Morrison's pouch (hepatorenal space) to be seen.



REFERENCES

www.trauma.org.uk/trauma/sonology/FASTscan.htm

<http://www.acep.org/sonography/FAST-02-10>

<http://www.sonoguide.com/FAST.html>

Imaging the abdominal aorta in hypotensive, collapsed patient

5) Ultrasound scanning of the aorta

- After an aneurysm ruptures, mortality rates reaches 90%.
- Starting in the transverse plane, directing the probe to the "9 o'clock" position, high in the epigastrium.
- Scan from the xiphoid process down the mid line to the iliac bifurcation (near the umbilicus)
- **The aorta** on the patient's left, and the IVC on the right.
- The common iliac arteries should be visualised, which arises around the level of the umbilicus
- Longitudinal views are obtained to identify the vessel's widest diameter by scanning laterally.
- AAA is identified when the diameter > 3cm from outer wall to outer wall, measured anteriorly to posteriorly



Normal longitudinal image of the abdominal aorta



- AAA with an intraluminal thrombus
- Transverse image: ~ 6 cm AAA

Ultrasound of the chest in ITU patients

Introduction

- The lung bases of ITU patients can be difficult to assess clinically and with chest x-ray.
- The position of the supine immobile patient on a ventilator does not often allow adequate clinical examination to determine between normal aerated lung, consolidation and pleural fluid.
- The chest x-ray can be unhelpful, opacification at the lung base on chest x-ray may be due to either consolidation or pleural fluid.
- The supine CXR can be insensitive to the presence of pleural fluid and consolidation.

We routinely use ultrasound of the chest to determine the difference between aerated lung, consolidated lung and pleural fluid.

Ultrasound of the chest has a short learning curve, has high diagnostic capabilities and can allow direction of intervention such as the draining of pleural fluid.

Technique

Required ultrasound platform and a 3.5mhz ultrasound probe.

The ultrasound window to the chest are the intercostal spaces as bone effects ultrasound and degrades diagnostic images.

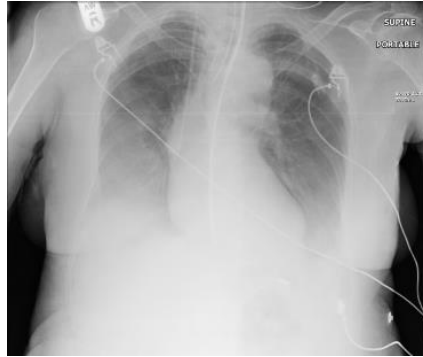
The chest can be examined with ultrasound in a similar fashion to using the stethoscope

Anteriorly: the upper lobes,

Mid axillary line; right the middle lobes and left the lingula

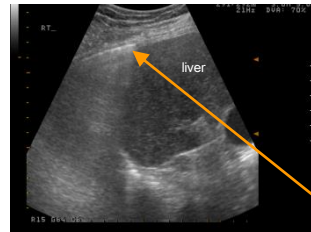
Posteriorly the lower lobes.

Identify the liver and spleen and hemidiaphragms via an intercostal approach and move up the intercostal spaces to visualise the lung bases.

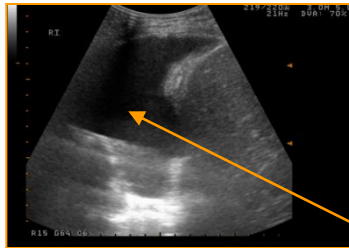


Spine CXR demonstrating loss of clarity of both hemidiaphragms which may be due to consolidation or fluid.

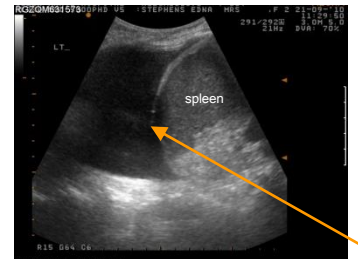
Here are possible ultrasound findings at the lung bases



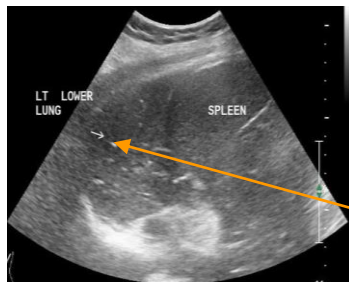
Normal aerated lung in the right lower lobe the air reflects ultrasound. Arrow



A significant right pleural effusion ultrasound is transmitted through the pleural fluid leading to an echo-poor area, Arrow



Left pleural effusion, the dome of the diaphragm and spleen can be clearly seen, Arrow.

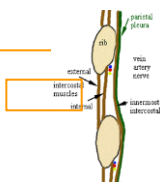


The left lower lobe is solid and consolidated, the bright lines (Arrow) demonstrate air in the bronchi (an air bronchogram).

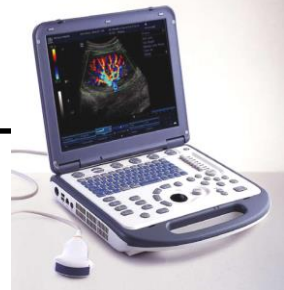
The effusions demonstrated above fill the whole US screen and are thus large and would be drainable.

Conclusion

Ultrasound can clearly demonstrate abnormalities at the lung bases, we have a weekly ITU Ultrasound ward round which is timetabled and of importance to the patient care on ITU.



How to use ultrasound to guide abdominal paracentesis



Introduction

Ascites is defined as the accumulation of fluid in the peritoneal cavity, causing abdominal swelling.

Causes of transudative ascites:

-Portal hypertension, Heart failure

Exudative causes

• Malignancy, Infection

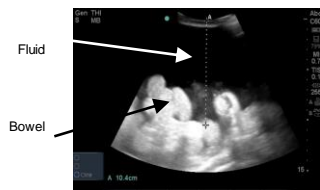
Abdominal paracentesis results in drainage of ascites through a puncture of the peritoneal cavity. The major cause of ascites is caused by liver disease and it is important to ensure there are no clotting abnormalities prior to procedure.

INDICATIONS:

1) Diagnostic tap → new onset ascites (to elicit aetiology) 2) Therapeutic tap → respiratory compromise/ Abdominal pain secondary to ascites accumulation

Scanning technique

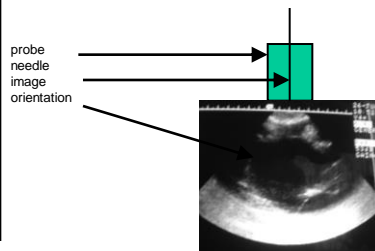
- Ultrasound (US) is used to localise intra-abdominal fluid & to guide fluid aspiration.
- Complications such as puncturing bladder/bowel/epigastric vessels are reduced with the use of US guided drainage.
- The patient should be in supine position if there are severe ascites or if mild in the lateral decubitus position as bowel loops tend to ascend secondary to the presence of air (fig.1).
- A curvilinear 3.5MHz probe is appropriate, positioned in sagittal orientation.
- The needle/ultrasound image/ probe/ orientation is important, the middle of the image equates to the middle of the probe. See fig 1 and 2
- Fluid is echo poor on ultrasound i.e black no image.
- Bowel is white.



Seldinger technique

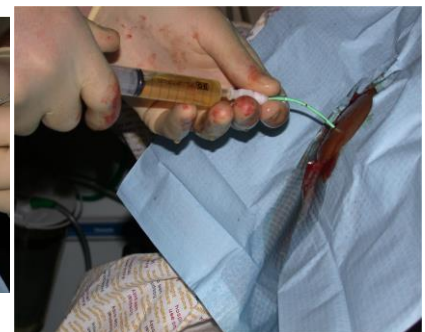
The bladder should be empty prior to procedure.

- Prepare the skin with antiseptic solution, and drape a sheet to create a sterile field.
- Orientate the needle probe image as seen in diag.
- Insert a cutting 18 g needle
- Aspirate fluid
- Insert an 035 stiff wire through the needle
- Dilate up the tract to a 10 f
- Insert a 10 french drain over the wire.



• Fig. 1

Fig. 2



- Insert a cutting 18 g needle

- Insert an 035 stiff wire through the needle

- Dilate up the tract to a 10 f

- Insert a 10 french drain over the wire.

Conclusion:

- In our experience seldinger method of paracentesis using ultrasound guidance confers great safety advantage for patients

- Preventing collateral visceral damage.

REFERENCES

- 1) Del Cura JL, Zabala R & Corta I. US-guided interventional procedures: what a radiologist needs to know. *Radiologia*. 2010; 52(3): 198-207.
- 2) http://en.wikipedia.org/wiki/Seldinger_technique
- 3) <http://www.sonoguide.com/paracentesis.html>
- 4) <http://emedicine.medscape.com/article/80944-overview#a01>

Ultrasound Screening for non displaced hip fractures

What type of fractures are not visible on X-ray ?

Answer; Non displaced fractures



3 day interval



A 70 year old lady fell onto her right hip , the AP pelvic xray was thought to be normal

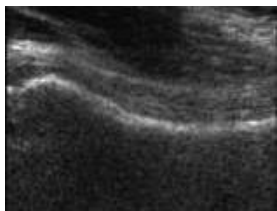
The patient failed to mobilise on the ward a repeat xray was performed and a right fractured neck of femur was demonstrated

- Examples of non displaced fractures; rib, hip, sternum, tibia and scaphoid;
- Non displaced hip fractures.
- between 7 -10 % of hip fractures are non displaced.
- Non displaced hip fractures are a cause diagnostic difficulty in hospitals across the country.

Can point of care ultrasound help ?

- All fractures bleed.
- The presence of a hip effusion in a traumatised hip is an intra articular fracture until proved otherwise, ultrasound can select out patients for MRI examination. (ref. 1) this would be in keeping with the NICE guidelines.

Technique of hip ultrasound screening:



High frequency 7.5 mHz probe imaging anterior to the hip joint



An image of the neck of the femur with the capsule closely applied to neck of femur, no evidence of a hip effusion : non intra articular bone injury

A hip effusion with the capsule lifted from the anterior neck of femur; an intra articular fracture should be considered, refer for MRI in keeping with NICE guidelines.

Is this new ?

Elbow effusions and lipoheamathrosis of the Knee are used to diagnose intra articular fractures on plain x-ray.



Ultrasound is demonstrating the anterior fat pad sign of the hip to indicate intra articular fracture.

Conclusion:

Ultrasound can used to screen for non displaced hip fractures, high quality ultrasound is available is most a/e departments. Unlike diagnostic ultrasound, there is a short learning curve to become proficient in the ultrasound hip examination. Positive ultrasounds of the hip can be referred for MRI in keeping with the NICE guidelines.

- Evidence/ reference 1
- Sonography as a screening test for Occult hip fractures.
- Ori Safran MD et al
- Orthopaedic and Radiology Hadassah Hebrew University Medical Centre Jerusalem Israel
- Journal ultrasound med 2009;28:1447-1452
- 30 patients ultrasound of both hips compared with MRI.
- 100% sensitive 65% specific.
- Concluded, a negative ultrasound can exclude intra articular trauma.

How to diagnose fractures of bone with ultrasound

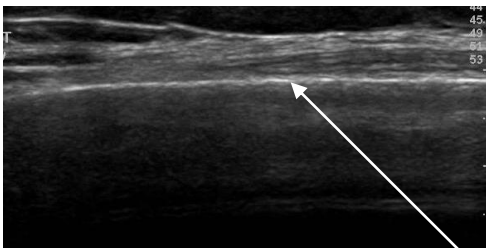
What is the big question in A/E in patients with minor trauma ?

Answer; is the injury a bone fracture or is the injury a soft tissue injury.

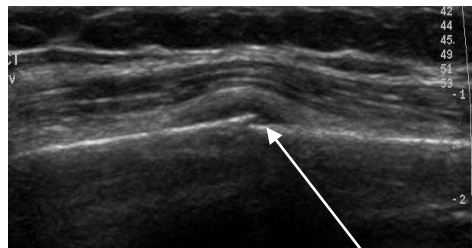
Can ultrasound be of use ?

Traditionally ultrasound was thought to be of no use in the examination of bone due to its density and being highly reflective , however when a bone is fractured , it bleeds and this is fluid, the periosteal fluid can easily be seen with ultrasound .

The use of ultrasound to diagnose diaphyseal fractures



Example the cortex is seen as a highly reflective white line



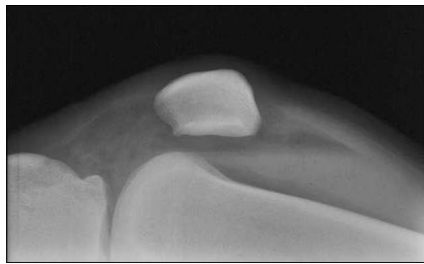
There is a fracture of the cortex with a subperiosteal haematoma

The use of ultrasound to diagnose intra articular fractures



An anterior and posterior fat pad sign of the elbow indicating an intra articular fracture.

Intra articular fluid can be seen with ultrasound.



A horizontal beam lateral showing a lipoheamarthrosis of the knee indicating an intra articular fracture.

Intra articular fluid can be seen with ultrasound



A hip effusion in the presence of trauma would indicate an intra articular fracture of the hip 'anterior fat pad sign of the hip', refer for further imaging MRI

According to the world health organisation WHO what percentage of the world's population Have access to Xray ?

Answer **25 %** : thus 6 billion people have no access to xrays , in remote areas of Canada and Australia where modern medicine is practised in remote locations doctors are using ultrasound to determine between soft tissue injury and bone injury.

Conclusion ;

- Ultrasound can differentiate between soft tissue injury and bone injury, this of use in remote location with no access to xrays , but also in A/E to increase diagnostic accuracy especially in non displaced fractures which are not visible on xray such as rib, sternum , hip and children's tibia .
- Note we are not looking for the fracture just the presence or absence of fluid.
- Studies have demonstrated ultrasound to be 100% sensitive for the diagnosis of bone fracture.
- A verbal audit of fracture clinic currently in our hospital 1 in 3 patients referred to fracture clinic have a bone fracture.

See pointofcareultrasoundinfo.com for further information.

The Use of Ultrasound to Diagnose Rib Fractures

Why diagnose rib fractures?

- Blunt injury to the trunk is a common presentation to secondary care and can be an area of diagnostic difficulty.
- Patients present to secondary care after blunt trauma to the chest wanting to know if they have fractured their ribs.
- The chest x-ray can be insensitive to non displaced rib fractures and reserved for patient who have suspected complication of rib fracture such as haemothorax and pneumothorax
- Clinical examination cannot often distinguish between soft tissue injury and rib fracture.
- The current agreed policy to manage rib fractures and soft tissue injury equally and give the patient an information sheet.
- The differentiation between rib fracture and soft tissue injury is important, rib fracture take approximately 6 weeks to heal while soft tissue injury takes 2 weeks.
- Patients with rib fractures have a higher incidence of chest infections. Rib fractures have a 20% mortality in the elderly.
- Direct examination and imaging with ultrasound has been reported to be able to distinguish between rib fracture and soft tissue injury (ref 1).
- We have introduced a referral pathway from our minor injury unit to ultrasound for suspected rib injury.
- Early results confirm the ribs can be easily imaged with high frequency ultrasound and the cortex of the bone can be seen directly. Minor bone displacement, periosteal haematomas and fractures can be demonstrated.

Technique

With high frequency probe align the probe at 90 degrees to the long axis of the rib in the region of acute tenderness (left image) and image the rib and intercostal spaces in cross section.

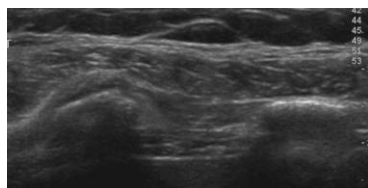
Then rotate the probe by 90 degrees to examine the long axis of the rib (right image) to see the smooth longitudinal image of the cortex.



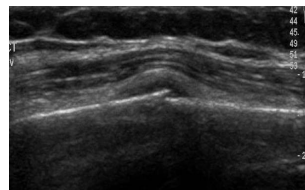
Rib cortex

Case study

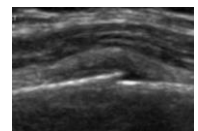
A 47 year old electrician presented to the minor injury unit with severe trunk pain after a fall. On examination there was point tenderness along the 9th rib on the right anteriorly. Under normal circumstances the patient would have been given an information sheet and told that the injury could be soft tissue or a rib fracture. The patient was referred to Ultrasound for direct imaging



There is a periosteal haematoma of the rib on the left.



There is loss of continuity of the cortex of the rib with a periosteal haematoma and rib fracture.



Conclusion

- In our early experience ultrasound is a quick simple direct imaging method to distinguish between soft tissue injury and rib fracture in blunt trauma to the trunk. This allows the correct diagnosis to be made and therefore the correct treatment, prognosis and recovery time to be offered to the patient and employer
- This technique has proven popular with referrers and patients.

Reference

1. Sonography compared with radiography in revealing acute rib fracture. AJR 1999 Dec;173 (6): 1603-9.
2. Sonography: a simple way to visualize rib fractures. AJR 1994 Nov;163(5):1268.

ULTRASOUND GUIDED DRAIN INSERTION USING A SELDINGER METHOD

INTRODUCTION

•Image guided percutaneous drainage of abnormal fluid collections is a well established interventional procedure (ref 1).

•Curative drainage is achieved in more than 80% of patients (ref 2).

•Modified Seldinger technique is an accepted method of chest tube placement (ref 3).

•At our institution we recently introduced the Seldinger technique for drain insertion in preference to the trocar method.

•We present the Seldinger method of drain insertion pictorially.

Advantages of Seldinger vs Trocar method of drain insertion

•Ultrasound guidance of an atraumatic needle in to the collection allows safe and accurate placement of a drain.

•Aspirating fluid through the atraumatic needle confirms the needle tip is in the collection.

•Dilating a tract and delivering the drain over a wire allows safe atraumatic drain placement.

•Blunt dissecting the tract with the drain on the trocar has been associated with collateral damage of surrounding viscera.

•Delivery of drains via the Seldinger method in our experience increases operator confidence.

Materials

•The materials are readily available in the interventional suite:

- 18G cutting needle
- 0.035" wire
- dilators
- drain

•Alternatively commercial Seldinger drainage packs are available e.g Portex chest drain kit.



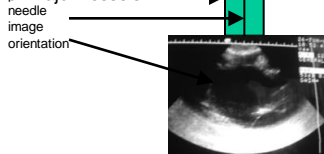
Seldinger drainage technique

•Having gained informed consent, clotting parameters checked and under aseptic conditions.

•The collection is imaged and marked using ultrasound.

•Centre of the probe equates to the centre of the image.

•A suitable site is chosen which does not traverse bowel or major vessels.

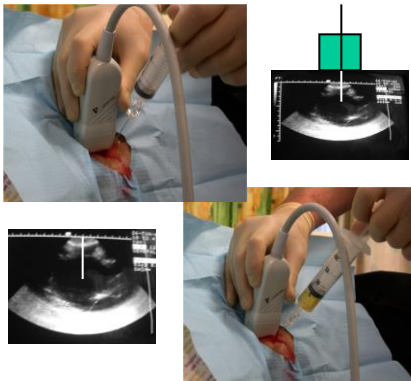


Seldinger drainage technique

•Insert atraumatic needle; aspirating as advancing under real time ultrasound guidance.

•Alternatively if the collection is large enough a simple skin mark is made for drain insertion without ultrasound guidance.

•Aspiration of fluid confirms the needle tip is in the collection.



The probe is cleaned with chlorhexadine and sterile jelly is used for aseptic conditions.

Seldinger drainage technique

•Insert a good length of wire through the correctly sited needle.



Seldinger drainage technique

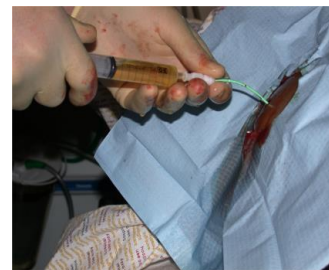
•Dilate tract over wire

•A vascular sheath can be used to dilate the tract, this has the advantage of a short wire and a side arm for aspiration of fluid.



Seldinger drainage technique

•Insert Drain over the wire.



Seldinger drainage technique

•Stitch the drain to the skin and connect to the drainage bag.



Follow-up

•Imaging follow-up is recommended to confirm the drain is functioning and to give an end point to the drainage procedure.

Conclusions

•The Seldinger drainage technique is an effective and safe method for drain delivery.

•The use of an ultrasound guided atraumatic needle means that even difficult to access collections can be drained safely and with confidence.

References

1 Gerzof SG, Robbins Ah, Birkett DH, Pugatch RD, Vincent MB. Percutaneous catheter drainage of abdominal abscesses guided by ultrasound and computed tomography. Am J Roentgenol 1979 Jul;133(1):1-8

2 Lee MJ. Non-traumatic abdominal emergencies: imaging and intervention in sepsis. Eur Radiol (2002) 12:2172-2179

3 Altman E, Ben-Nun A, Curtis W Jr, Best LA. Modified seldinger technique for the insertion of standard chest tubes. Am J Surg 2001 Apr; 181(4):354-5