Focused Acute Medicine UltraSound (FAMUS)

HANDBOOK

Vascular Modules

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FOCUSED ACUTE MEDICINE ULTRASOUND

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THE SOCIETY FOR ACUTE MEDICINE

V1.1

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1) Introduction to FAMUS

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1) Introduction to FAMUS:

In many parts of the world ultrasound is learnt as part of the undergraduate medical curriculum, but within the United Kingdom it has traditionally been practised under the auspices of radiology departments. With the increasing availability of ultrasound machines that are portable and relatively cheap, there has been much interest in the use of Point of Care Ultrasound (POCUS). There is significant potential for POCUS to both facilitate clinical decision making and increase patient safety, particularly during invasive procedures. It is now considered mandatory for chest drains for pleural effusion to be undertaken with ultrasound guidance, and central line insertion has long been facilitated by the use of ultrasound. Specialties have started to develop their own training and governance standards; Emergency Medicine has incorporated the Focused Assessment with Sonography in Trauma (FAST) protocol within their curriculum, and Intensive Care Medicine has recently published Core Ultrasound Intensive Care (CUSIC). The Royal College of Radiologists have issued standards relating to individual system examinations, and there is good evidence for the utility of protocolised chest ultrasonography (the 'BLUE protocol') in the adult patient presenting with acute respiratory failure. There has not previously been an ultrasound curriculum designed to aid the management of the unwell adult medical patient outside of Critical Care.

Within Acute Medicine, a recent trainee survey conducted by this group, highlighted enthusiasm among trainees for some form of ultrasound training to be a core part of the Acute Internal Medicine (AIM) curriculum. In addition, clinicians on the Acute Medical Unit (AMU) support the use of ultrasound on the AMU and the development of specific guidelines for AMU clinicians.

We present here the Focused Acute Medicine Ultrasound (FAMUS) Handbook developed specifically for physicians on the AMU to aid in the management of the breadth of patients who present to Acute Medicine.

2) Vascular Module:

I. Deep Vein Thrombosis

Venous thromboembolisim (VTE) accounts for a sizable workload within the National Health Service. It is an important cause of death in hospital patients and its non-fatal events carry a considerable cost to the health service.
VTE most commonly originates from the deep veins of the legs, hence called deep vein thrombosis (DVT).

The 2012 NICE guidance on VTE recommends proximal leg vein ultrasound scanning as the diagnostic endpoint in DVT investigations. This requires a formal, complete proximal vein assessment with ultrasound. In-other-words, a rule-out scan.
As part of the assessment of the sick or suspected VTE patient, early indication of a significant clot burden is important for the tailoring of management and overall care of the patient. There is now mounting evidence that is supportive of rule-in scans that help answer this critical question. In FAMUS, we have adopted a systematic rule-in scanning protocol that aids management (identifies significant clot load) at that critical time point in the patients care. This however is not a rule-out departmental scan.

Equipment

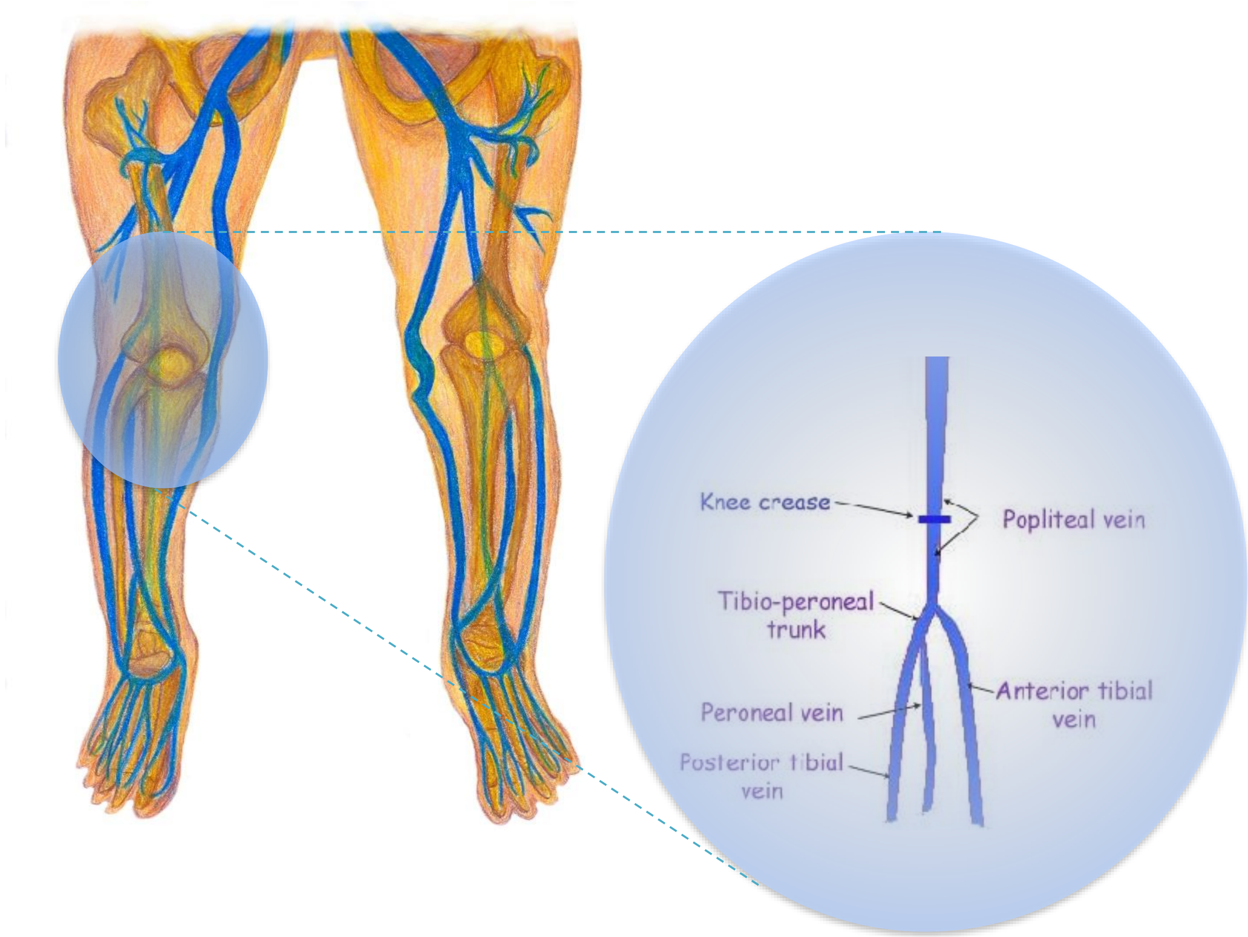
For the assessment of DVT, a Brightness (B) mode ultrasound machine is needed. There are a variety of shapes and sizes of ultrasound machines which are perfectly acceptable, as long as regular safety checks and services are carried out to maintain adequate function.
The probes needed for good vascular assessment need to be high in frequency. High frequency probes however have lower penetration, so in general, probes of over 3MHz would suffice. The vascular probe with a linear transducer has high frequency and are useful for high resolution assessment of small legs were low depths are anticipated. For legs requiring higher depths, the curvilinear transducer which has lower frequency is more appropriate.

Anatomy

The anatomy of interest is the area from the common femoral vein (CFV) down to the distal popliteal vein (tri-fication).

During the FAMUS scanning process, the common femoral vein, femoral vein, profunda vein and the popliteal vein are visualised.

Figure 1. Schematic representation of lower limb vessels from the CFV to the proximal calf veins



Scanning process

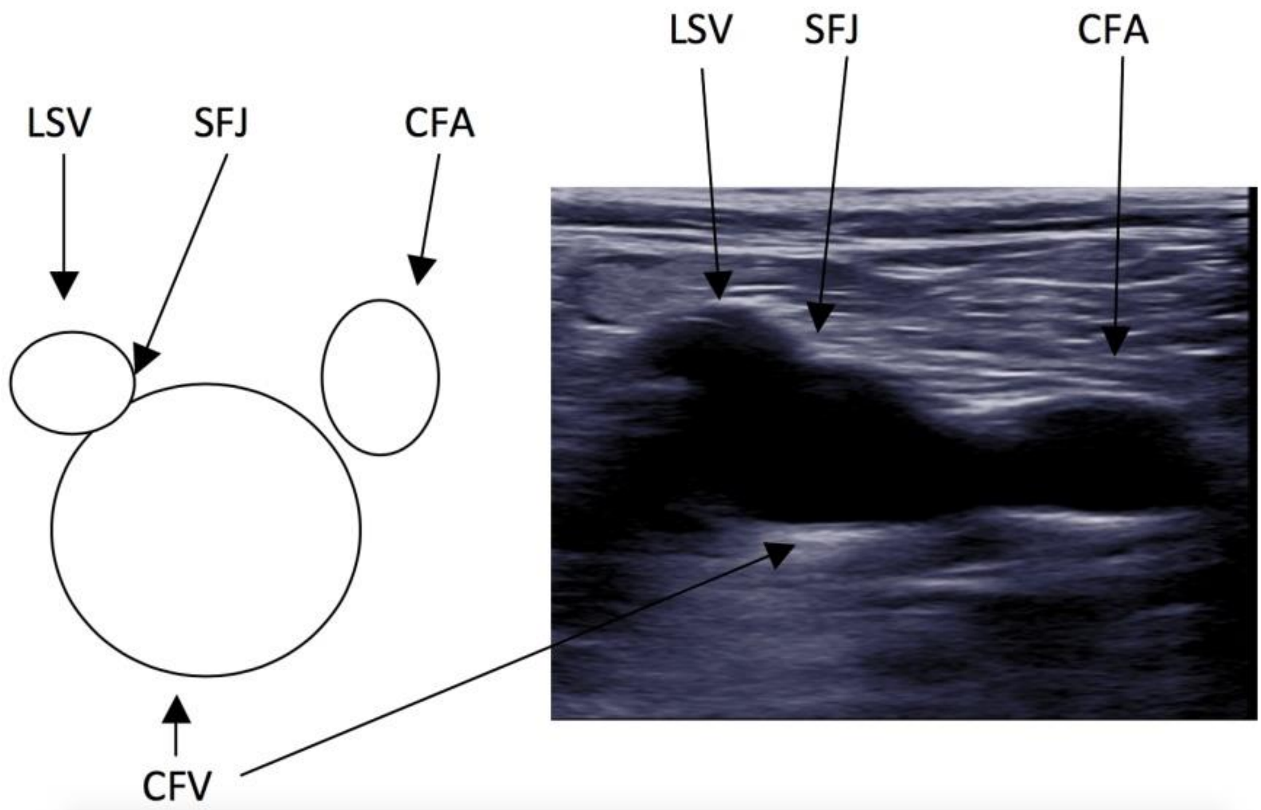
As with other medical processes, this should begin with an introduction by the person scanning, where possible. The machine should be set up with the patient's details and explanation of the process to the patient, where possible, is also a recommended starting point.

Verbal consent and patient cooperation is necessary before exposure of the exam area (groin to below knee). Patient positioning is a critical step to ensure comfort for the patient and the person scanning as well as helping to optimise image acquisition. Positioning is best supine with head tilt, hip externally rotated and with the knee slightly flexed.

Once the above is set, prepare the probe with gel and find the 'Mickey Mouse Sign'.

The Mickey Mouse sign represents the level (in transverse plane) at which the common femoral vein and the sapheno-femoral junction are visible. The face of Mickey Mouse represents the common femoral vein (CFV), while the ears represent the common femoral artery (CFA) and the long saphenous vein (LSV). The orientation of the 'ear' vessels depends on which leg is being scanned. The sapheno-femoral junction is therefore the attachment point of the corresponding ear, to the face of Mickey Mouse.

Figure 2. Schematic of the Mickey Mouse sign – Left Leg



After identifying the Mickey Mouse sign, apply a little downward pressure on the probe to ensure that the common femoral vein (CFV) compresses. Complete wall-to-wall compression signifies a patent vessel. Partial compression signifies non-occlusive thrombus and no compression signifies an occlusive thrombus (Figure 25 – ultrasonic differentiation of veins and arteries).

Figure 3. Ultrasonic differentiation of veins and arteries.

	Vein	Artery
Wall	Thin	Thicker (Brighter)
Pulse	Non-pulsatile	Pulsatile
Compression with minimal pressure	Compressible	Much less compressible
Spectral Doppler	Low velocity	Higher velocity

This represents the first point in the 3-point minimum dataset for a FAMUS DVT scan. After gentle compression, the probe should then be moved medially down the thigh, while keeping focus of the femoral vein in the middle of the screen. Compressing down the length of the femoral vein will increase the sensitivity of the scanning process. Once at the mid-thigh region, compression of the femoral vein should be attempted. This represents the second point in the minimum dataset.

After completion of above, continue to scan distally. Compress as you go along, until the femoral vein becomes difficult to visualise medially, as it continues on its course behind the knee. Lift the probe and place it in the popliteal fossa to visualise the popliteal vein. After attaining an acceptable image, compress. Assess for wall to wall vein compression, which signifies patency. This is the third point on the minimum dataset.

For good clinical governance, we recommend saving representative images of the scanning process which should match at least, the minimum dataset and should be representative of the final report generated.

We recommend the use of the rule-in FAMUS DVT scan reporting sheet below.

Figure 4. FAMUS DVT Minimum dataset

Minimum Dataset

Standard 3-Point Lower Limb Deep Vein Thrombosis 'RULE-IN' FAMUS Scan

From the Society of Acute Medicine Ultrasound Working Group

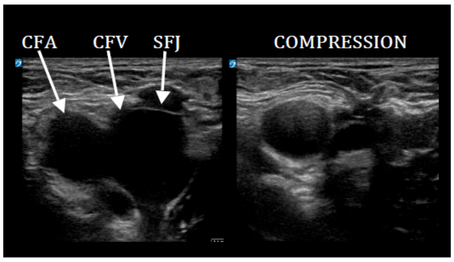
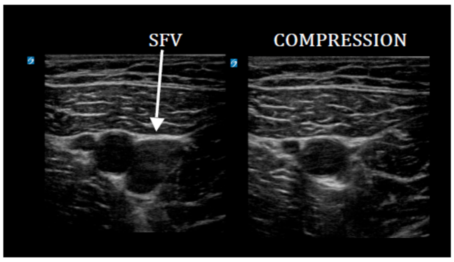
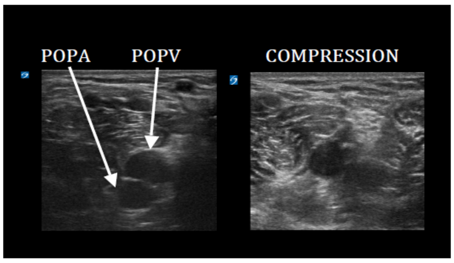
Patient Position	Probe Position	Modality	Ultrasound Image	Explanatory Notes
	Transverse	2D		Patient: Supine with slight external rotation of leg Probe: Transverse & positioned in groin crease Anatomy: Locate CFA, CFV & SFJ Study: Compress the vein for complete wall to wall apposition Note: Compression at valve level may be difficult
	Transverse	2D		Patient: Supine with slight external rotation of leg Probe: Transverse & positioned at mid thigh level Anatomy: Locate SFV Study: Compress the vein for complete wall to wall apposition Note: Anatomical variants like two SFV's are possible
	Transverse	2D		Patient: Supine with slight external rotation of leg Probe: Transverse & positioned at knee crease Anatomy: Locate POPA & POPV Study: Compress the vein for complete wall to wall apposition Note: Sitting patient on bed side dilates the vein, improving visualisation

Figure 5. FAMUS DVT reporting sheet

Focused Acute Medicine Ultrasound (FAMUS)

Reporting sheet – 'rule in' DVT

Trainee name: Date:

Patient identifier:

Image quality: Good Adequate Poor

LEFT LEG			RIGHT LEG		
Examined?	Yes □	No □	**Examined?**	Yes □	No □
'Mickey Mouse' sign (CFA, CFV, SFJ) visualised?	Yes □	No □	**'Mickey Mouse' sign (CFA, CFV, SFJ) visualised?**	Yes □	No □
Common Femoral Vein (CFV) Compressible?	Yes □	No □	**Common Femoral Vein (CFV)** Compressible?	Yes □	No □
Superficial Femoral Vein (SFV) Compressible?	Yes □	No □	**Superficial Femoral Vein (SFV)** Compressible?	Yes □	No □
Popliteal vein trifurcation visualised?	Yes □	No □	**Popliteal vein trifurcation visualised?**	Yes □	No □
Popliteal Vein (PV) Compressible?	Yes □	No □	**Popliteal Vein (PV)** Compressible?	Yes □	No □
Deep vein thrombosis confirmed? Yes ☐ No ☐					
Comments/further details and conclusion of the scan: e.g. site of DVT if confirmed need for formal imaging					
Trainee reflection on scan (optional) e.g how did the scan affect management					
Mentor/Supervisor comments:					

Signed (trainee):

Signed to confirm above findings (mentor/supervisor):

Initial to confirm trainee suitable to commence mentored practice (only required once):
(minimum 5 supervised scans)

Is a Departmental scan required? Yes □ No □ Requested? Yes □ No □

Once completed trainee must maintain logbook of countersigned report sheets. Please remember not to remove patient confidential information from Trust property

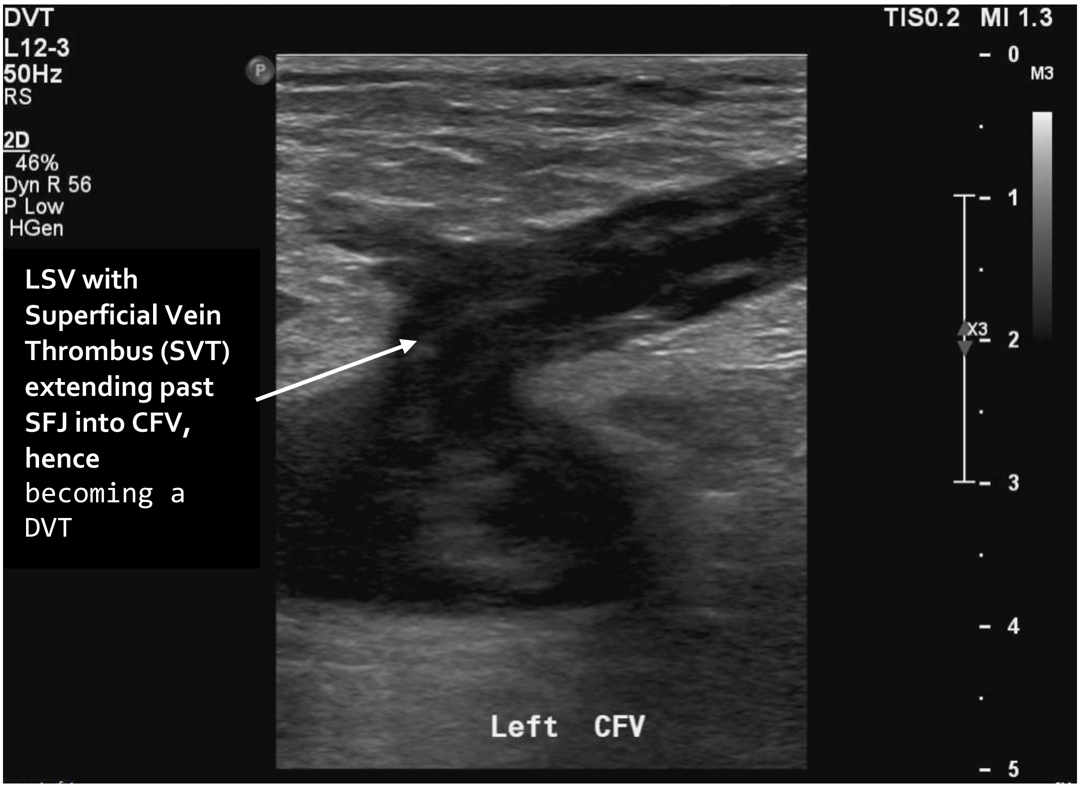
What's 'normal' or not

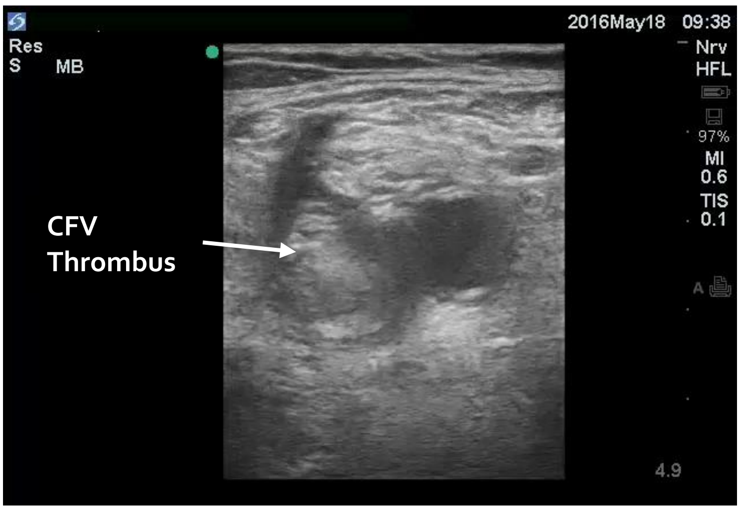
A 'normal' scan in this context does not mean the exclusion of a DVT, as this is a rule-in process alone.

Clear identification of the common femoral vein, down to the distal femoral vein and popliteal vein, with normal wall-to-wall compression is 'normal' in this context.

A positive scan in this context identifies the presence of thrombotic material within the examined vessel. This identification occurs visually, or in the absence of wall-to-wall compression. The vessel could be identified as completely occluded (with obvious thrombus seen within ± no compression) or partially occluded (with obvious thrombus seen within part of the lumen ± partial compression). See FAMUS website for movie of normal FAMUS DVT Rule-in Scanning Process and examples of clinical findings

Figure 6. Ultrasound images with confirmed lower limb thrombus





FOCUSED ACUTE MEDICINE ULTRASOUND

II. Vascular Access

Point of care ultrasound for vascular access is increasing in its availability and use. In the right hands, ultrasound guided vascular access can improve successful cannulation rates, reduce iatrogenic injury and the number of attempts at cannulation. Broadly, the use of ultrasound improves safety and success in vascular access procedures.
For access problems, ultrasound can be used to aid in central or peripheral venous procedures, as well as arterial access where needed. The main limiting factor for ultrasound use, where a machine is available, is an appropriately qualified individual. As a result, in the right hands, there are no absolute contraindications to using ultrasound as an adjunct in the vascular access processes.

Vascular access sites

Choice of site is largely based on the reason generating that access need. One should also consider the calibre of the vessel to be accessed, the depth and course of the vessel, as well as superficial (like overlying cellulitis) and surrounding structures.
Central sites of use are predominantly internal jugular vein, femoral vein and possibly subclavian vein. Peripheral sites may include cubital, cephalic or basilica veins in the upper limb.

Pre-procedure set up

The clinician performing the procedure should be fully aware of the clear indication for the access need, the site and potential site complications, and the systemic risks that could complicate the procedure (like coagulopathy). Familiarity with the equipment (ultrasound machine, lines or needles), full explanation to the patient (where possible), obtaining consent, and having a clear understanding of the on-going care are also important.
Once there is clarity on the indication, site and consent, then preparation regarding the ultrasound equipment and site should begin. Patient positioning is of great importance and will influence the chances of a successful procedure. Ideally also, the ultrasound machine should be positioned opposite the clinician therefore making it possible to visualise the site of access and the screen of the machine simultaneously. Preparation of the machine, probe, sterile sheath, gel, local anaesthetic and venous access equipment should then occur. Strict sterile barrier precautions are necessary for central access and much less so, for peripheral venous access.
The skin over the site should be prepared in a sterile manner and barrier precautions should be set up. The ultrasound probe also should have a sterile sheath (the probe is dropped into the sheath, which is then extended up the cord of the probe to maintain sterility) and sterile gel (which is applied to the base of the sheath before the probe is

dropped in). For good function of the probe, the sterile gel must be applied on both sides of the sheath (inside and outside) adjacent to the probe face.

Once the equipment is organised and barrier precautions set up, the local infiltration of the site with anaesthetic is a logical next step. This helps patients become more comfortable during the process and is likely to reduce the possibility of unexpected movements due to pain. First visualisation of the structures using ultrasound would normally occur before local anaesthetic application.

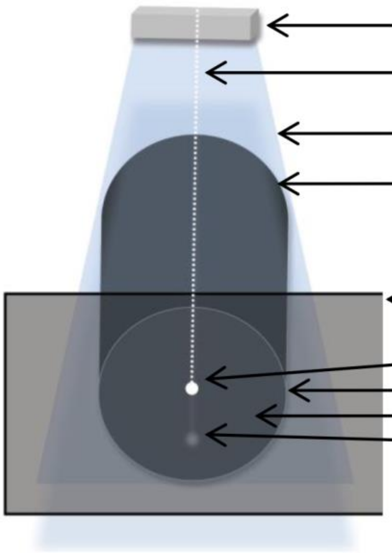
The Process

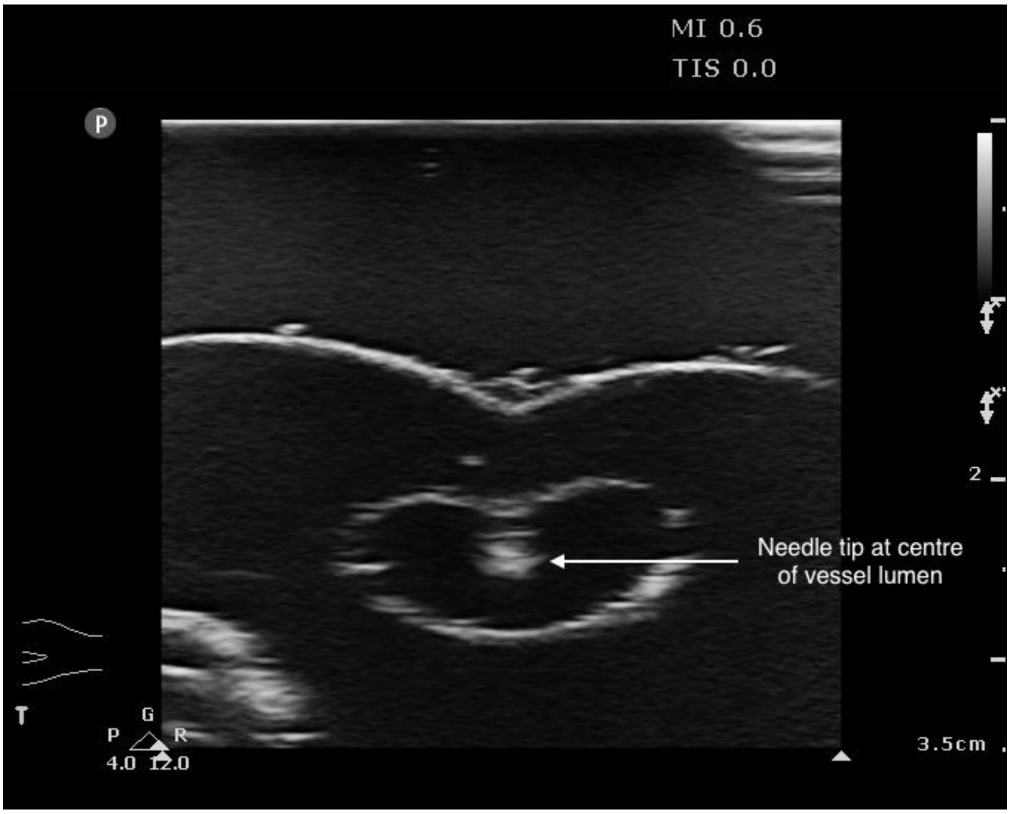
In FAMUS, we promote the use of real time visualisation of the needle tip during the vascular access process. This dynamic approach is in favour of a more static approach, where the ultrasound is used to identify the structures of importance, site marking then occurs before performing the invasive procedure. Although the static approach is not completely landmark based, the lack of visualisation of the needle tip suggests that this approach is not superior to the dynamic approach.

Another procedural consideration would be in the decision to use an out-of-plane (short-axis) or in-plane (long-axis) visualisation technique.

Using the short-axis view, the vessel lies (and the needle appears) perpendicular to the image plane. This gives the view of an oval shaped vessel (echoic/bright wall (better seen in arteries) with an anechoic/dark lumen) passing into the screen, with the needle appearing as a hyper-echoic/ very bright point (in cross-section; out-of-plane) within that image (Figure 29).

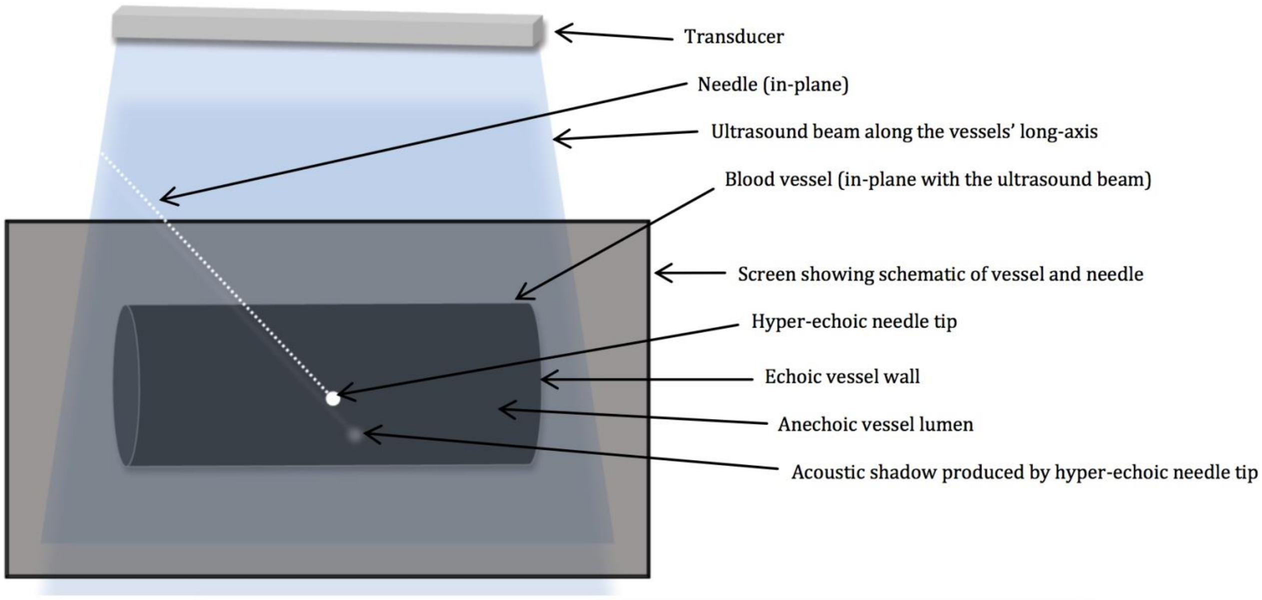
Figure 7. Out-of-plane approach

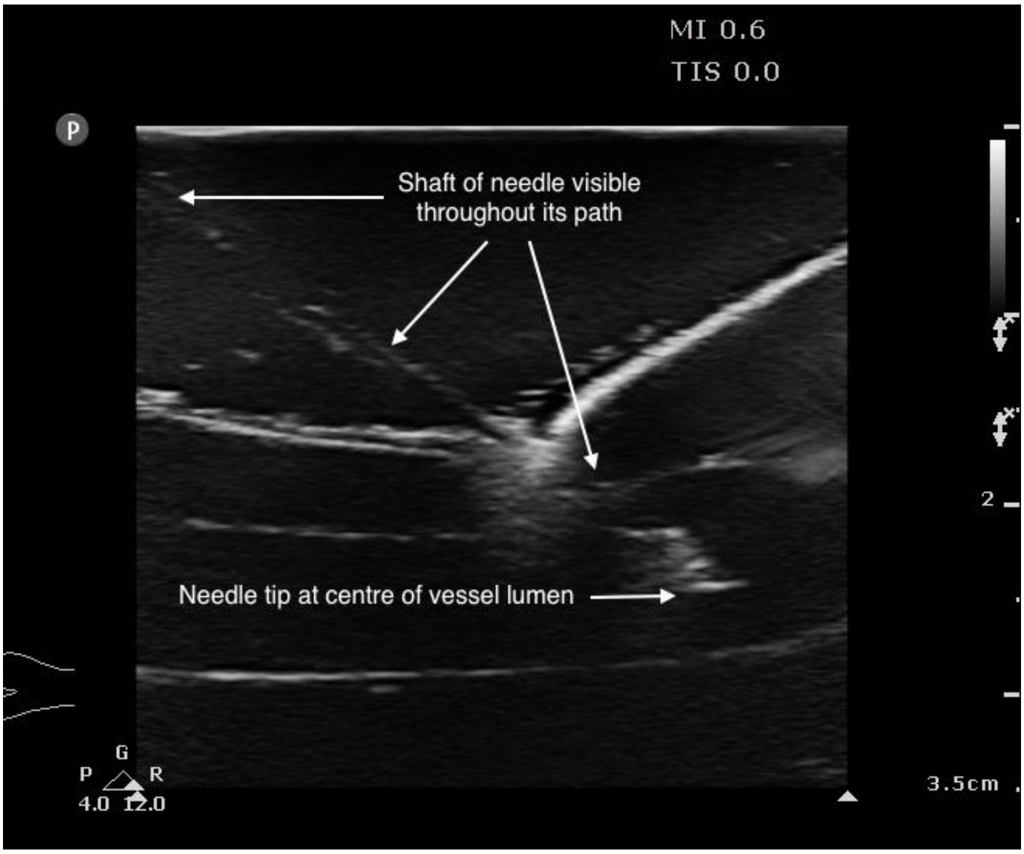




In the long-axis view, the ultrasound beam runs parallel to the vessel path and gives the opportunity for full visualisation of the needle tip and shaft (as it advances) which is in-plane (Figure 30). Bearing in mind that the ultrasound beam is only a few millimetres thick, care should be taken to ensure that the needle and vessel remain in-plane with that beam. So careful positioning, ensuring adequate space to allow for the probe footprint and the needle, and steady hands are required. The obvious benefit of this technique is the visualisation of the needle shaft and tip all the way as it advances to the target point.

Figure 8. In-plane approach





After the above considerations have been resolved, an awareness of the ultrasound depth from skin to the target (vessel centre) is important. This distance is useful in the short-axis approach, as inserting the needle at a 45-degree angle, at that equivalent distance from the probe will ensure that the needle tip will roughly be at the target point (vessel centre). (Figure 31)

It is worth pointing out however, that with either the short-axis or long-axis approach, needle tip visualisation and the maintenance of sterile technique (especially in central line placement) is paramount.

When using the short-axis method, insert the needle as described above and in Figure 31, at a 45-degree angle with the insertion site being at approximately the same distance from the probe, as the depth to the target (skin to vessel centre). Slow introduction of the needle is advised at intervals. One approach is to tilt the probe towards the skin until the needle tip is seen at the entry point more superficially, then by tilting the probe deeper and then advancing the needle point deeper (small depths at a time) until visualised on the screen and then repeat the process in increments until the target is reached. As long as the initial setup (vessel in the middle of the probe with the needle inserted in alignment of this) is maintained in the short-axis, a flashback of blood into the needle or cannulae will be seen as well as the needle tip visualisation within the lumen indicating successful cannulation, when the critical depth is reached.

Problems that one may encounter include advancing the needle off-plane in short axis (resolved by stopping and rocking the probe to find the needle tip. If not found, then withdraw the needle to a point just deep to the skin, and start again); and advancing the needle beyond the posterior wall of the vessel (resolved by withdrawing the needle until the needle tip is seen again within the lumen, target sign). The operator should be mindful of this.

Another approach is of course to keep the probe steady, visualising the vessel, inserting the needle at an equivalent distance from the probe and at 45 degrees and with small, gentle incremental depths, the target will be met by the needle.

In the long axis, once there is good visualisation of the vessel and the probe is held steady, insert the needle adjacent to the probe and in plane with the beam. The tip of the needle should first be seen and then with gradual advancements, then shaft is seen. Both the needle tip and shaft can then be followed as it slowly advances towards the vessel, indents the vessel wall and then penetrates into the lumen producing a blood flashback in the needle or cannulae. The obvious problem here is to ensure that the vessel and needle remain in plane of the narrow ultrasound beam.

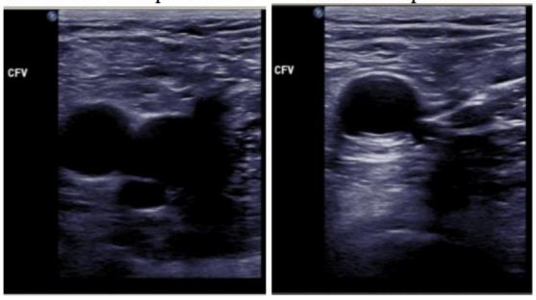
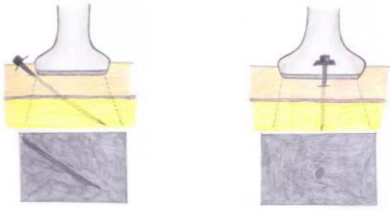
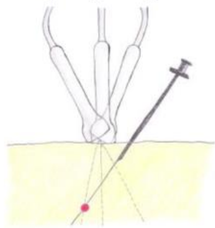
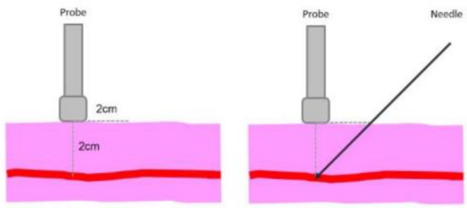
Once flashback is achieved (using any above method), advance a little further to be clear of the vessel wall. Then use the ultrasound to confirm the position (within the central lumen of the vessel of choice). After this, then simple cannulation, placement of the guide-wire then dilator then line can proceed.

Figure 9. FAMUS Vascular access minimum dataset

Minimum Dataset

Vascular Access - FAMUS Scan

From the Society of Acute Medicine Ultrasound Working Group

Steps	Image	Explanatory Notes
Set up, prepare all your equipment and position USS device in line with limb		• Tegaterm Dressing for USS probe • Use **longer cannula** (at least 4 cm long) • Chloroprep • Consider device on opposite side of patient • You should be able to see Ultrasound screen and cannula at the same time
Look for appropriate Blood Vessel	Without Compression With Compression 	• Linear Transducer • Veins are more oval and easily compressible • In elderly patients or low output states arteries might be compressible as well hence compress slowly, arteries will be more pulsatile • Follow the vein with your ultrasound to understand course of vein for later insertion
Decide on in plane / out of plane technique	In Plane Out of Plane 	• In plane technique is better if vein and artery on top of each other, however vein need to be straight enough • Out of plane technique better when vein and artery next to each other
Use either: • Follow the needle approach	1 2 3 	• Move transducer first, then follow with needle until needle tip appears on the ultrasound screen (always keep the ultrasound ahead of the needle to avoid needle tip injuring deeper structures Repeat these steps (1, 2 &3) until blood vessel is reached
• 45-degree angle		• Depth of vessel (2cm here) and insertion distance from ultrasound transducer (2cm here) should be equal. • If an angle of 45 degrees is used, then a needle inserted at that point and advanced through should hit target
The final steps are similar to normal cannula insertion		