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Thoracic outlet study ultrasound		Dec 2021	1.2

### Scope & purpose

The thoracic outlet is the space between your clavicle and your first rib. Thoracic outlet syndrome is the congenital or acquired narrowing of this space, which leads to compression of blood vessels or nerves or both. This compression is often dynamically induced. A duplex ultrasound study can be performed as part of the work-up to aid with the diagnosis of thoracic outlet syndrome caused by arterial or venous compression (ref 1, 2 and 3).

Common indications for testing (ref 4):

- General upper limb symptoms include: pain, numbness, tingling, weakness
- Arterial TOS symptoms may include: intermittent weakness, coldness and pain in the upper limb, subclavian artery thrombosis +/- with peripheral embolisation
- Venous TOS symptoms may include: intermittent swelling and cyanosis of the extremity with pain, a feeling of heaviness in the upper limb, venous distention of the upper arm and shoulder region, subclavian-axillary vein thrombosis (Paget-Schroetter syndrome or effort thrombosis)

### Personnel

Clinical vascular scientists (CVS), including trainees.

### Principles / performance characteristics

The thoracic outlet study is a dynamic study which uses duplex ultrasound to assess the subclavian artery and vein at the level of the clavicle during several manoeuvres. The aim of the study is to identify any significant compression of the subclavian artery or vein beneath the clavicle.

### Service users & background

The most common age range for this syndrome is 20–40 years, with a female-to-male ratio of 4:1. The symptoms of TOS are typically reproduced or exacerbated by activity requiring elevation or sustained use of the arms, such as reaching for objects overhead or lifting. Three distinct syndromes may be encountered, individually or combined: neurogenic syndrome, arterial syndrome, and venous syndrome. According to the literature, neurogenic TOS is observed in 90%–95% of the cases and vascular TOS in 5%–10%. In many cases, classification as arterial or neurologic compression remains difficult. Symptoms can be vague and nonspecific and clinical diagnosis is often difficult, requiring the use of imaging methods and electrophysiologic criteria, such as electromyography or somatosensory evoked potentials. This information is very important because treatment for thoracic outlet symptoms is aimed at alleviating or reducing the compression inside the narrowed space (ref 1).

Contraindications for a TOS duplex include:

- An acute upper limb deep vein thrombosis (minimum of 6 weeks, in conjunction with clinical judgement)
- An acute upper limb arterial thrombosis

Limitations may include the following:

- Obesity
- Dressings, open wounds, staples, haematoma etc.
- Severe oedema/swelling

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- IV or catheters that limit visualisation of vessels
- Acoustic shadowing
- Patients who are unable to cooperate due to reduced cognitive functions e.g. Alzheimer's or dementia and through involuntary movements
- Examinations undertaken at the patient's bedside may be limited due to equipment and room dimensions
- Patient discomfort
- Bone; A short segment of the Subclavian vein/artery cannot be examined as it moves under the clavicle
- Chronic thrombus

### Facilities, equipment & special supplies

Duplex ultrasound machine with both linear and curvilinear transducers available. There should be a selection of transducers delivering a wide range of frequencies (high and low).

The examination couch should be height adjustable and ideally the head rest should be able to go up and down. The CVS's chair should provide good lumbar support, be height adjustable and allow for the CVS to move close to the examination couch.

Ultrasound gel to provide a couplant between transducer and patient.

Cleaning materials should be available in line with local and manufacturer's guidelines. These are available either in each procedure room or located in the laboratory store room.

### Calibration

Across all sites annual calibration and safety checks of the ultrasound equipment are performed by Clinical Engineering (Trust contract with GE Healthcare).

### Quality control

Second opinions from vascular scientist colleagues are requested routinely if clarification is sought.

Trainee vascular scientists have all thoracic outlet scans checked until they are signed off by a senior colleague for competency.

### Environmental & safety controls

Infection control procedures followed in accordance with Trust infection control and risk assessment policies – Please see 'Personal Protective Equipment (PPE) for infection prevention and control' policy, 'Hand Hygiene' policy and 'Staff Risk Assessments' which are all available through the Trust Intranet.

Tristel wipes are for cleaning the ultrasound machines and probes after patient use. Universal Clinell wipes are for cleaning all other equipment. Where high risk infection presents or post-op wounds are present use probe covers with sterile gel or Tegaderm dressings, in addition to routine cleaning.

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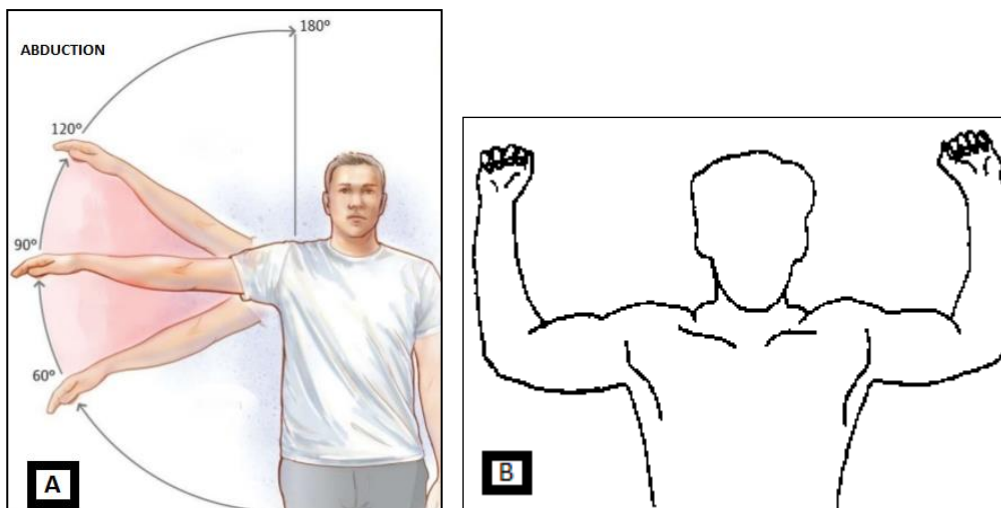
## Thoracic outlet study procedure

	<b>Preceding document:</b> <i>VAS-MP-6 Patient management</i>
1.	The examination is always performed bilaterally. The patient is asked to remove their clothing to expose the neck and shoulder region.
2.	The patient should be sitting on the edge of the bed with feet hanging down and the patient facing the CVS (positions 1-6, see below). The height of the bed should be quite low such that the CVS's arm is angled down from the horizontal if possible. This helps the CVS achieve an ergonomic position for scanning, reducing the chance of future muscle strain.
3.	<p>The scan:</p> <ul style="list-style-type: none"> <li>Image one side at a time during each manoeuvre.</li> <li>Image the subclavian artery in B mode and using colour Doppler from the infra-clavicular window and obtain spectral Doppler signals, documenting the PSV. Record any abnormalities such as tortuosity or aneurysmal dilatations.</li> <li>Image the subclavian vein in colour Doppler, identify the absence/presence of colour flow and use spectral Doppler to confirm the absence of flow.</li> <li>Repeat for the other side.</li> <li>Repeat this in all stated positions. Allow the patient to return to the relaxed position between the imaging of each side and between manoeuvres.</li> <li>Continue to perform each manoeuvre (positions 1-4) even if a positive result is found.</li> </ul> <p>The machine controls should be optimised continually throughout the scan to obtain the best image to aid with diagnosis.</p>
4.	<p>The following manoeuvres are performed and documented for each patient:</p> <p><b>Position 1:</b> Relaxed with the patient's arms hanging down on each side.</p> <p><b>Position 2:</b> Both arms raised to 90° abduction (diagram 1A) and externally rotated with palms facing upwards.</p> <p><b>Position 3:</b> Patient sits with a straight back and holds <b>both</b> arms in a surrender position (diagram 1B), the elbows must be just above the horizontal position. If no entrapment demonstrated, then repeat with the head turned away from the shoulder being imaged, if this additional movement causes entrapment then mention this on the report.</p> <p><b>Position 4:</b> Patient holds arms in surrender position and pushes <b>both</b> arms backwards, simultaneously pushing the chest outwards, again maintaining the elbows above the horizontal position. If no entrapment demonstrated, then repeat with the head turned away from the shoulder being imaged, if this additional movement causes entrapment then mention this on the report.</p> <p>If no entrapment was demonstrated during positions 1-4 then the following manoeuvres may also be used if deemed necessary:</p> <p><b>Position 5:</b> Patient sits with both arms straight out in front of them horizontally.</p>

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Position 6: Patient sits with both arms abducted to 180° (diagram 1A).

Position 7: The patient may position their arms in a position of their choice to aggravate an entrapment.



**Diagram 1.** Manoeuvres for TOS. Diagram A shows abduction (ref 5). Diagram B shows surrender position (ref 6).

### The Result

Complete cessation of flow in the subclavian artery in any of the positions demonstrates the presence of arterial thoracic outlet syndrome. This can be confirmed by asking the patient to move their position slightly to produce the appearance and disappearance of flow.

- If the flow is impeded so that the PSV is significantly raised (>2 times velocity increase) with excessively turbulent flow and the artery appears to be extrinsically compressed on B-mode, then this can possibly indicate mild/moderate entrapment or an equivocal result (clinical judgement to be used) (ref 1).

If no flow can be detected in the subclavian vein in colour or spectral Doppler upon augmentation, and visible extrinsic compression can be identified in B-mode in any of the positions, the presence of venous thoracic entrapment has been demonstrated.

**Subsequent documents:** *VAS-MP-6 Patient management, VAS-MP-1 Results processing*

### Reporting

The report is a record and interpretation of observations made during the thoracic outlet duplex ultrasound examination; it should be written by the CVS undertaking the examination.

The report should include correct patient demographics, date of examination, examination type, the name and status of the CVS and any clinical history deemed relevant.

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The report should include:

- The PSV of the subclavian artery in each position
- The waveform of the subclavian artery in each position
- The presence or absence of flow in the subclavian vein in each position
- Any additional manoeuvres performed that are not included in the template

Any incidental findings should be documented and further imaging recommended when clinically appropriate.

## References

1.	Demondion, X. et al. (2006). 'Imaging assessment of thoracic outlet syndrome', <i>RadioGraphics</i> , 26(6), pp.1735–1750
2.	Shiel, W. (2020). Thoracic Outlet Syndrome (TOS), MedicineNet.
3.	Plewa, M. Delinger, M. (1998). The false-positive rate of thoracic outlet syndrome shoulder maneuvers in healthy subjects. <i>Academic Emergency Medicine</i> . 5(4):337-42.
4.	VAS-ED-5. Vascular Technology Professional Performance Guidelines Arterial Duplex Ultrasound Examination.
5.	Physiopedia (2019). <i>Subacromial pain syndrome</i> .
6.	Hawkes Physiotherapy Blog (2019). <i>Thoracic outlet syndrome</i> .