Bitesize Research:
ENTRAPMENT SYNDROMES

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PAPER 1:

Clinical characteristics and surgical outcomes in thoracic outlet syndrome: a comparative study of cases with and without cervical rib

Paper reference:

Ali, A.N., ElSobky, H., Abou El-Magd, ES. et al. Clinical characteristics and surgical outcomes in thoracic outlet syndrome: a comparative study of cases with and without cervical rib. Egypt J Neurosurg 40, 19 (2025). https://doi.org/10.1186/s41984-025-00381-1

SUMMARY:

Thoracic outlet syndrome (TOS) is a complex neurovascular condition caused by the compression of structures within the thoracic outlet. The presence of an extra cervical rib adds an additional layer of complexity, influencing the clinical presentation, progression and outcomes. The syndromes of compression can lead to a spectrum of symptoms ranging from mild discomfort to significant neurological and vascular impairment. The diagnostic process for TOS remains contentious, primarily due to the complexity of the syndrome and the variability in patient presentations. Additionally, there is an absence of a universally accepted gold standard test. Physical examination and the use of provocative manoeuvres are crucial for the initial clinical examination. Imaging techniques such as duplex ultrasound are required for a definitive diagnosis. Management can be conservative or surgical depending on severity of symptoms. The presence of a cervical rib can impact onset, duration and pathophysiology of TOS.

PROS:

The study found that in patients with a cervical rib, TOS presented at a younger age and often exhibited bilateral symptoms. Furthermore, cervical rib patients presented with more severe manifestations and more rapid progression of disease. These finding suggest the cervical rib serves as a crucial anatomical factor. The greater severity of symptoms highlights the need to early identification and prompt intervention. This paper suggests the need for a combined diagnostic approach such as X-ray alongside duplex to determine whether TOS is arterial, venous or both, and whether there is presence of cervical rib. Clinical examination plays a key role in the diagnostic pathway with this complex group. The study showed that surgical management offers superior outcomes, emphasising the need for early diagnosis and timely intervention.

CONS:

Small study size consisting of 19 patients. A further study is needed involving larger patient cohorts and longer follow-up periods to validate the findings of the current study.

IMPACT ON PRACTISE:

By enhancing our understanding of the impact of anatomical variations, like the cervical rib, we can contribute to the broader effort to optimize management strategies and outcomes for all patients suffering with TOS. In terms of vascular ultrasound departments, scientists could learn clinical examination techniques to perform alongside duplex investigations to provide a more holistic diagnostic process. We could also try and co-ordinate visits with dual imaging techniques to enhance the patient experience.

PAPER 2:

Doppler US and CT Diagnosis of Nutcracker Syndrome

Paper reference:

Kim SH (2019) Doppler US and CT diagnosis of Nutcracker Syndrome. Korean J Radiol. 4;20(12): 1627-1637. Doi: 10.3348/kjr.2019.0084

SUMMARY:

Nutcracker syndrome (NCS) is a syndrome caused by compression of the left renal vein (LRV), between the abdominal aorta and the superior mesenteric artery, resulting in hypertension of the LRV and hematuria. Doppler ultrasonography (US) has been

commonly used for the diagnosis of NCS. However, several technical issues, such as Doppler angle and sample volume, need to be considered to obtain satisfactory results. In addition, morphologic changes of the LRV and a jetting phenomenon across the aorto-mesenteric portion of the LRV on contrast-enhanced computed tomography (CECT) are diagnostic clues of NCS. With proper Doppler US and CECT, NCS can be diagnosed non-invasively.

PROS:

Because Doppler US may be the easiest way to measure blood flow velocity in the body, it can be used for the diagnosis of NCS. Duplex ultrasound is non-ionizing, relatively cheap to perform and does not require contrast. We can measure the peak velocity difference of the LRV at the hilum and aorto-mesenteric segment. A difference of greater than 5 times suggest NCS.

CONS:

Technically challenging scan. Not all vascular centres scan renal arteries or veins therefore this may be unfamiliar. Training would be required and then managing ongoing competency with low patient numbers. Angle dependant for accurate US diagnosis. An accurate measurement of the peak velocity of the LRV at the hilar and Aorto-mesenteric portion is an integral part of Doppler US-based diagnosis of NCS. It is easy to obtain a satisfactory Doppler spectrum at the hilar portion of the LRV, because the Doppler angle is usually within an optimal range between 30° and 60°, However, obtaining an optimal Doppler spectrum at the Aorto-mesenteric portion of the LRV is sometimes difficult and angle exceeds 90° and spectrum measurements become impossible (see image below).

IMPACT ON PRACTICE:

Although a relatively rare compression syndrome, we as vascular scientist need to be aware of our role in the diagnosis of said conditions. Doppler ultrasound is a useful and safe way of diagnosing NCS. The LRV should be carefully examined to measure peak velocity at hilum and Aorto-mesenteric segment. Doppler ultrasound can be used to correlate with findings of CT and vice versa. Invasive venography, for the measurement of the pressure gradient between the LRV and IVC, may not be necessary for the diagnosis of NCS if we utilize Doppler US and CECT properly in patients who are suspected to have NCS.

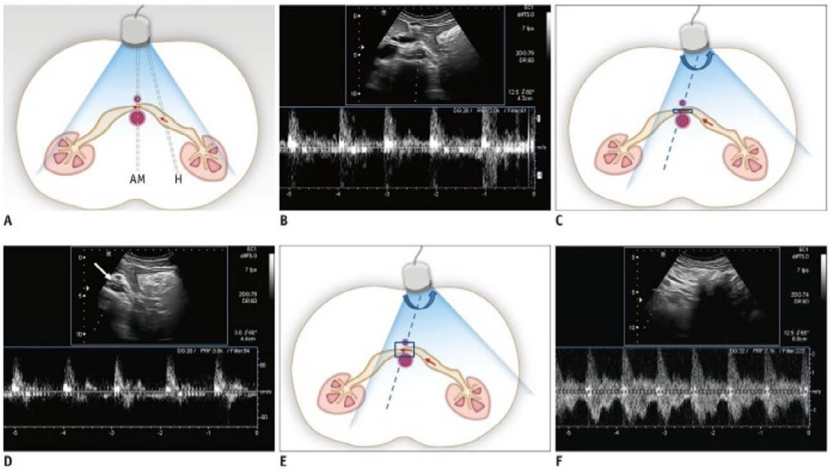


Image shows the best scanning orientation to achieve optimal angle and clear spectral trace.

PAPER 3:

Median arcuate ligament syndrome.

Paper reference:

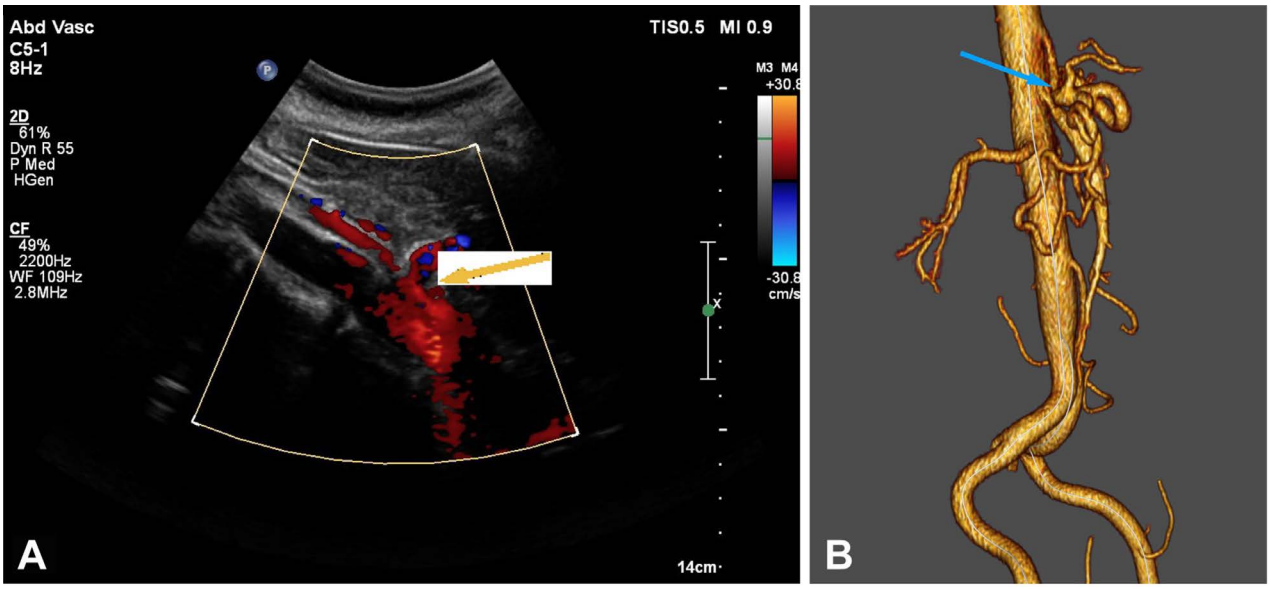
Goodall, Richard et al (2020) Median arcuate ligament syndrome. .Journal of Vascular Surgery, Volume 71, Issue 6, 2170 - 2176

SUMMARY:

Median arcuate ligament syndrome (MALS) describes the clinical presentation associated with direct compression of the celiac artery by the median arcuate ligament. The poorly understood pathophysiologic mechanism, variable symptom severity, and unpredictable response to treatment make MALS a controversial diagnosis. The degree of celiac artery compression is subject to respirational variation. Chronic compression by the MAL can lead to hyperplastic intimal changes of the celiac artery. Frequently reported symptoms include epigastric pain, nausea, vomiting, weight loss, and postprandial or exercise-induced abdominal pain. Diagnosis of MALS typically depends on exclusion of alternative causes of abdominal pain. When clinical suspicion of chronic mesenteric ischemia arises, duplex ultrasound (DUS) is the first-line recommended investigation

PROS:

DUS is advantageous as an initial investigation compared with angiography as it is cheaper and non-invasive, and it does not expose patients to high doses of radiation. A combination of a deflection angle >50 degrees and an expiratory PSV of >350 cm/s confers 83% sensitivity, 100% specificity, and 100% positive predictive value for a diagnosis of MALS.



Diagnostic imaging. A, Duplex ultrasound (DUS) image (in expiration) of the abdominal aorta revealing steep angulation of the celiac axis (arrow). Orientation: cranial end to the right of the image. B, Sagittal three-dimensional volume-rendered image of the abdominal aorta demonstrating narrowing and angulation of proximal celiac artery (arrow).optimal angle and clear spectral trace.

CONS:

Although Doppler is a valid tool it is usually used in conjunction with other modalities for comprehensive evaluation. Relatively low patient cases which means low scan numbers. External training may be required. Requires patient effort to accurately diagnose (inspirational and expiration), poor patient effort could impact diagnosis. May also be useful to scan supine and erect. This could be a limiting factor if the patient is less mobile. Poor views due to bowel gas may be a limiting factor in diagnosis.

IMPACT ON PRACTISE:

With increased understanding of MALS, it underscores the importance of early recognition and intervention in patients with MALS to prevent serious downstream complications, including aneurysm formation and potentially life-threatening hepatic or mesenteric ischemia. Doppler ultrasound plays a vital role in timely diagnosis due to its non-invasive nature and being cheap and quick to perform. An angle of >50 degrees of the coeliac axis should be visible with ultrasound however this may be missed on inspiration. With mesenteric ischemia patients it is important to consider MALS.

PAPER 4:

Sonography's Role in the Diagnosis of May–Thurner Syndrome

Paper reference:

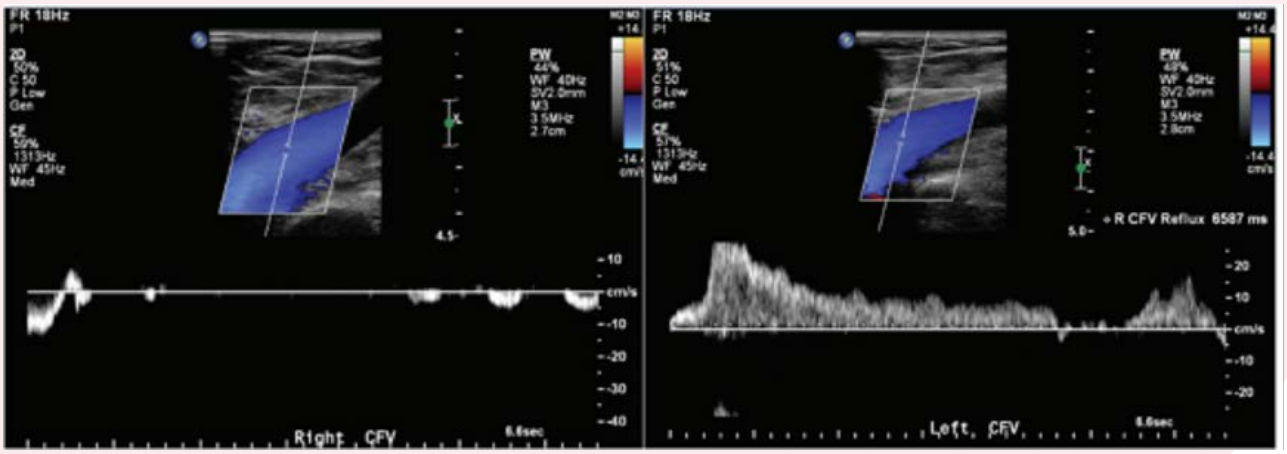
Barry A (2018) Sonography's Role in the Diagnosis of May–Thurner Syndrome. Journal of Diagnostic Medical Sonography, Vol. 34(1) 65–70.

SUMMARY:

May–Thurner syndrome (MTS), also known as Cockett syndrome or iliac vein compression syndrome, is a condition in which patients develop swelling, deep vein thrombosis (DVT), venous insufficiency, and other symptoms of the left lower extremity due to an anatomic variant in which the right common iliac artery overlies and compresses the left common iliac vein against the lumbar spine. Although it is an uncommonly diagnosed condition, it is estimated to compose up to half of cases of left lower extremity venous disease. With proper technique and proficiency, transabdominal sonography can be used as a valuable diagnostic tool in the discovery and to facilitate treatment of May–Thurner syndrome. Diagnostic ultrasound also can monitor the development of recurring DVT and identify symptoms of post-thrombotic syndrome

PROS:

Although the gold standard is venogram, ultrasound has its role in the diagnosis of MTS. Despite sonography having its limitations, such as overlying bowel gas and a large body habitus, it can also be used as a valuable tool in diagnosing MTS. Most publications state that sonography is useful in detecting a DVT but may be limited in detecting iliac vein compression or spurs. Experienced vascular sonographers who use a proper technique can provide high-quality diagnostic evidence of this syndrome. A



lack of respiratory variations and absence of response to Valsalva manoeuvre in the common femoral vein is a sign of proximal compression or obstruction and should be investigated proximally. Furthermore, it is important to measure the LCIV at the exact site of RCIA compression. This is done best in transverse to the abdomen at the bifurcation of the common iliac arteries. Due to the anatomic layout of the abdominal vasculature, even when transverse, the LCIV can be seen longitudinally, traversing underneath the RCIA. Three things are identified sonographically when MTS is present: (1) the LCIV has a small calibre; (2) the LCIV has thickened echogenic walls; and (3) the LCIV has continuous flow.

The right common femoral vein (CFV) does not have venous reflux, whereas the left CFV has severe reflux (6587 m/s) caused by hemodynamic changes in venous pressure due to extrinsic compression of the left common iliac vein by the right common iliac artery

CONS:

Body habitus and bowel gas can limit views of the iliac system and can be operator dependant.

IMPACT ON PRACTISE:

In patients presenting acute DVT or severe leg swelling, pain and heaviness we should consider MTS. US is a useful tool for diagnosis MTS however due to iliac scanning it may be operator dependant.

PAPER 5:

Improving duplex ultrasound methods for diagnosing functional popliteal artery entrapment syndrome.

Paper reference:

Barrett DW, Carreira J, Bowling FL, Wolowczyk L, Rogers S (2024). Improving duplex ultrasound methods for diagnosing functional popliteal artery entrapment syndrome. Scandinavian Journal of Medicine & Science in Sports. 34(3); e14592

SUMMARY:

Popliteal artery entrapment syndrome (PAES) is a rare condition where musculoskeletal structures compress the popliteal artery (POPA) leading to vascular compromise. This study investigates the effect of dynamic plantar- and dorsi-flexion loading on POPA hemodynamic parameters to develop a robust diagnostic ultrasound-based protocol for diagnosing functional PAES. A combination of vascular imaging modalities is routinely used for functional PAES diagnosis. Initial investigations utilize readily available ankle-brachial pressure indices (ABPIs) and triplex ultrasound, which combines 2D greyscale imaging, color Doppler, and spectral (pulse wave) Doppler to evaluate blood flow direction, velocity, and flow turbulence. These investigations are often followed by computed tomography (CT) angiography and magnetic resonance imaging (MRI). Due to its high sensitivity, MRI is considered the "gold standard" in the identification of aberrant popliteal fossa myofascial anatomy pertaining to PAES Types I–V. Diagnostically, ultrasound imaging must be combined with confirmatory cross-sectional imaging such as magnetic resonance to rule out anatomical PAES and plan for surgical intervention in suspected functional PAES patients

PROS:

Duplex ultrasound has been at the forefront of recent developments in a diagnostic protocol that includes provocative manoeuvres due to its non-invasive nature, low cost, and real-time assessment capabilities. The use of triplex ultrasound and ABPIs is often the first-line investigation in suspected functional PAES. Whilst some

studies suggest an ABPI drop of >30% following plantar- or dorsi-flexion manoeuvres is indicative of positive POPA entrapment, difficulties arise from obtaining accurate measurements during exercise. Especially in athletes with high levels of fitness. As entrapment occurs on exertion, measurements obtained after exercise could also result in false negative reading as the occlusion may resolve quickly. Plantar-flexion elicited a reduction in vessel diameter localized to the distal region across all three groups and in both prone and erect positions. This further supports the importance of utilizing the plantar-flexion manoeuvre when assessing the level of popliteal compression; however, dorsi-flexion provocation is still needed as an additional manoeuvre following a negative test on plantar-flexion.

CONS:

This study highlights a lack of ABPI utility in functional PAES diagnosis with no change noted in the control, recreational athlete, and patient group following a vigorous 5-minute calf-raise exercise test despite symptom onset. Small sample size. Due to the small sample size of the study, it is, therefore, challenging to inflate findings to a wider PAES group and the general population. The proposed future PAES diagnostic criteria would need further validation from larger cohort studies with additional confirmatory imaging to assess ultrasound-based diagnostic specificity and sensitivity, in addition to analysis of surgical and treatment outcomes.

IMPACT ON PRACTISE:

This study shows that the ABPI has no use in the diagnosis of Popliteal artery entrapment syndrome. This provides an opportunity to review current protocols and amend accordingly. The present study indicates the importance of assessing the distal POPA with no significant observations identified in the proximal vessel to further aid diagnosis of PAES. elicited a reduction in vessel diameter localized to the distal region across all three groups and in both prone and erect positions. Therefore highlighting the importance of including this position in our scanning routine.

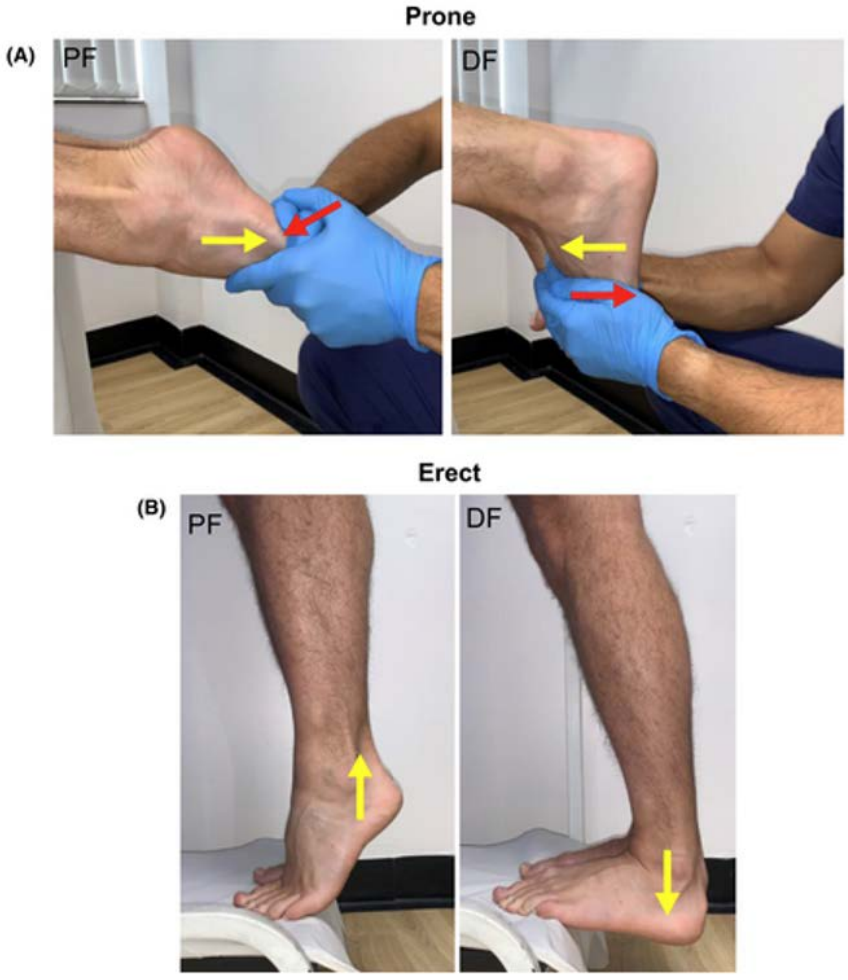


Image showing provocation manoeuvres.