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RESEARCH LETTER

The Importance of Patient Position When Defining Normal Versus Pathological Functionality in the Diagnosis of Popliteal Artery Entrapment Syndrome with Duplex Ultrasound

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Popliteal artery entrapment syndrome (PAES) is a rare condition where musculoskeletal structures compress the popliteal artery (POPA) leading to vascular or neurogenic symptoms. Rapid detection and treatment can prevent progressive arterial damage, with early detection associated with favourable long term outcomes.[1,2] Early intervention for those diagnosed with functional PAES, caused by gastrocnemius muscle hypertrophy, has proven that 78% of athletes can return to competitive sport.[3,4]

This study aimed to optimise ultrasound based protocols to better diagnose functional PAES. The importance of patient position was also investigated. Triplex ultrasound on the effect of dynamic forced dorsiflexion and plantarflexion loading in asymptomatic healthy controls (do not exercise), asymptomatic elite athletes (run >30 km or cycle >250 km weekly), and symptomatic patients with functional PAES (anatomical PAES excluded by the multidisciplinary team and magnetic resonance imaging) was investigated. Twenty healthy individuals, 20 elite athletes, and 20 patients with PAES consented to take part in this study (ethics approval no.: 18/NW/0635). Triplex ultrasound imaging of both lower limb arterial trees was performed in 120 limbs. Vascular scientists (limited to three) who performed the scans were qualified and experienced in PAES ultrasound. Proximal (above knee) and distal (below knee) POPA Doppler waveform shape, peak systolic velocities (PSV, cm/second), and vessel diameter (anteroposterior, cm) were measured. Measurements were taken at rest and during loaded plantarflexion and dorsiflexion, respectively, with the patient in prone and erect positions (Fig. 1). On full contraction of the calf muscles with dorsiflexion and plantarflexion, significant manual resistance was applied by a second vascular scientist (Fig. 1A, B). In the erect position, dorsiflexion under load was elicited by dropping patients' heel off the edge of the examination stool (Fig. 1D), with plantarflexion performed by gastrocnemius contraction while patients self raised onto their toes (Fig. 1C). Following normality testing, statistical analysis was performed using descriptive statistics and independent *t* testing in Microsoft Excel.

Ultrasound excluded underlying atherosclerosis in all 120 limbs. Mean ankle brachial pressure index (ABPI) ratios at rest in the control (1.14), elite athlete (1.14), or patient groups (1.07) showed no change post-exercise (1.21, 1.22, and 1.05, respectively). Complete distal vessel occlusion was noted following plantarflexion in the prone position for control (50%), athlete (70%), and patient groups (65%). POPA occlusion was only noted in the proximal vessel within the patient group (15.8%). When prone, 50% of control (40 limbs), 70% of athletes (40 limbs), and 65% of patients (40 limbs) had distal POPA occlusion during plantarflexion. When prone, elite athletes (5%) and PAES patients (12.5%) had distal POPA compression under dorsiflexion. Dorsiflexion did not elicit POPA occlusion in the control group. POPA occlusions with the patient in erect position were only noted in the symptomatic patient group under both dorsiflexion (15.8%) and plantarflexion (23.7%).

Compared with resting positions, no change in POPA diameter was noted during dorsiflexion for all patients. There was no change in proximal POPA diameter during plantarflexion, whereas the distal POPA diameter reduced by −81.4%, from 0.43 $\pm$ 0.04 cm to 0.079 $\pm$ 0.03 cm ($p <$ .001). Across all groups, the overall percentage change in POPA diameter following flexion manoeuvres was −4.3% proximally and −33.7% distally. Proximally, prone plantarflexion resulted in a large overall negative PSV percentage change in the control (−82.8%), elite athlete (−127%), and patient (−144.9%) groups ($p =$ .035, $p =$ .002, and $p =$ .013, respectively), with no change noted during erect plantarflexion in the control (+8.8%), elite athlete (+4.1%), and patient (−3.3%) groups. Similarly, in the distal vessel in the elite athlete group there was an overall negative percentage change in PSV following prone plantarflexion (−59%; $p =$ .004), with no significant change noted in the control (−24.8%) or patient (−33.8%) groups. No change

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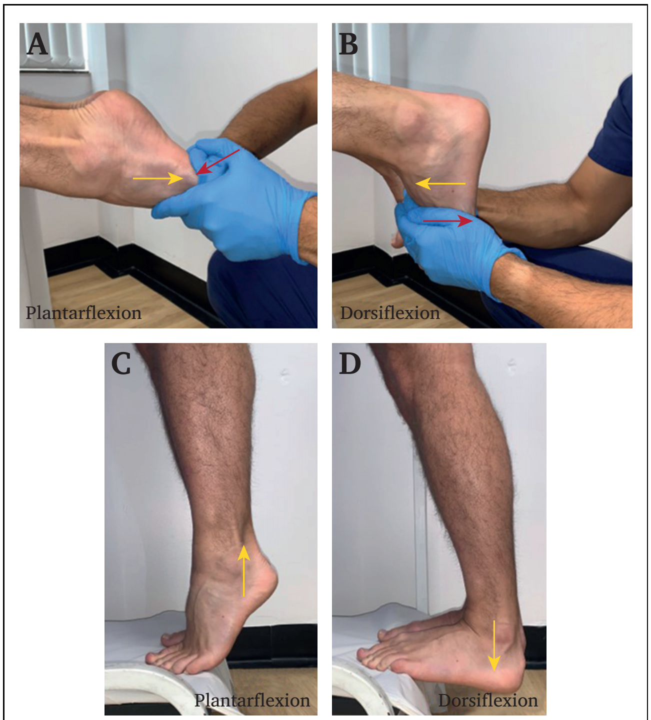

Figure 1. Dynamic flexion manoeuvres performed during popliteal artery assessment. Patients performed manoeuvres in the (A, B) prone position including (A) dorsiflexion and (B) plantarflexion, with a second vascular scientist applying resistance, and in the (C, D) erect position under their own weight, during (C) dorsiflexion and (D) plantarflexion. Yellow arrows indicate direction of patient movement and red arrows indicate the direction of loading resistance applied.

was noted following erect plantarflexion in the control (+4.7%), elite athlete (+3.8%), and patient (+7.9%) groups.

This study highlights the importance of patient positioning and forced loading manoeuvres when evaluating PAES, to avoid a false positive diagnosis. A significant occlusion rate was observed, with significant changes in diameter and PSV localised to the distal vessel, especially following plantarflexion. POPA occlusion was only identified in symptomatic patients positioned in the erect position, and not in the control or elite athlete groups.

It has been shown that POPA occlusion may occur in the same patient following both plantarflexion and dorsiflexion manoeuvres, albeit at a higher rate following plantarflexion. Following a negative plantarflexion manoeuvre, occlusion under dorsiflexion only occurred in one case in the elite athlete group, with the vessel occluding distally in a prone position. This further supports the importance of using the plantarflexion manoeuvre when assessing the level of popliteal compression; however, dorsiflexion provocation is still needed as an additional manoeuvre following a negative test on plantarflexion. Surprisingly, and probably due to a small sample size, in patients with full popliteal artery occlusion on flexion, this was noted bilaterally in all cases. Previous studies have shown a high percentage of bilateral positive popliteal impingement (74 − 83%); however, the incidence of partial compression to full occlusion was previously unknown.[5,6]

Therefore, to reduce false positive rates (from asymptomatic compression) and scanning time, the recommended ultrasound protocol assesses potential PAES candidates only in the erect position (i.e., scanning supine may not be required), paying particular attention to changes (diameter, PSV, waveform, and occlusions) on plantarflexion (but still assesses dorsiflexion), in the distal below knee POPA. There is no need to complete ABPI testing, but exercise is important. A larger prospective study is now needed to validate the proposed protocol and should assess intra- and interobserver variability, comparing it with other imaging modalities. Separate research should investigate which patients benefit from surgical intervention.

CONFLICTS OF INTEREST

None.

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