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Drop of Ankle Brachial Index Predicting Outcome in Treatment of Popliteal Artery Entrapment Syndrome

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ABSTRACT

***Background:** Intermittent claudication is not a common presentation in young people as they are rarely suffering from chronic lower limb ischemia. Popliteal artery entrapment syndrome (PAES) is one of the main known causes of intermittent claudication and should be considered among this young age group. Most of the reported cases are males and usually present before the age of 45. Different anatomical variations found to explain the abnormal compression on the artery in the popliteal fossa. These include variant medial head of gastrocnemius muscle, muscular slip, popliteus muscle or plantaris muscle as a constricting agent. It can be bilateral up to 30% of cases. Repeated trauma may damage the popliteal artery and lead to stenosis, thrombotic occlusion or post stenotic aneurysmal dilatation. Lack of awareness could lead to delay in diagnosis and complications.*

***Aim of the Study:** This study aims to highlight the role of ABI to properly diagnose and subsequently successfully treat PAES.*

***Methodology:** The data of this study has been retrospectively collected with review of patients undergoing operative treatment of popliteal artery entrapment syndrome (PAES). Eight patients (11 limbs) presented, diagnosed and surgically treated. All of them were males. Six limbs had PAES on the left limb. The age ranged from 21 to 47 years with median age of 31 years. Only one patient was diabetic and two were smokers. Out of the 11 limbs included in our study, three patients had bilateral PAE syndrome withunilateral symptoms. The mean duration of symptoms was 12 months and ranged between 3 and 24 months.*

***Conclusion:** ABI drop during muscular stress is a good predictor to identify PAES' patients who benefit from surgical decompression and save others from inadequate outcome.*

INTRODUCTION

Intermittent claudication is not a common presentation in young people as they are rarely suffering from chronic lower limb ischemia. Popliteal artery entrapment syndrome (PAES) is one of the main known causes of intermittent claudication and should be considered among this young age group .[1-3] Most of the reported cases are males and usually present before the age of 45.[3,4] Different anatomical variations found to explain the abnormal compression on the artery in the popliteal fossa. The seinclude variant medial head of gastrocnemius muscle, muscular slip, popliteus muscle or plantaris muscle as a constricting agent.[5] It can be bilateral up to 34% of cases.[1,6] Repeated trauma may damage the popliteal artery and lead to stenosis, thrombotic occlusion or post stenotic aneurysmal dilatation. Lack of awareness could lead to delay in diagnosis and complications secondary to distal embolization to tibial and digital arteries.[3] Surgical management of symptomatic PAES includes popliteal artery decompression with/without arterial reconstruction in complicated cases are the current practice for patients among.[6] On the other hand, surgical decompression on asymptomatic side is debatable. The aim of this study is to present our clinical experience of PAES and to highlight the role of ankle brachial pressure index (ABI) in clinical approach and surgical outcome.

PATIENTS AND METHODS

The data of this study has been retrospectively collected with review of patients undergoing operative treatment of popliteal artery entrapment syndrome (PAES) during 18-year period. Institutional Review Board approval was not approached for approval and no patient informed consent was obtained to be included in

this study. Eight patients (11 limbs) presented, diagnosed and surgically treated. All of them were males. Six limbs had PAES on the left side. The age ranged from 21 to 47 years with median age of 31 years. Only one patient was diabetic and two were smokers. Out of the 8 patients included in our study, 3patientshad bilateral PAES with unilateral symptoms. The mean duration of symptoms was 12 months and ranged between 3 and 24 months. Seven patients (10 limbs) presented with calf claudication and the 11th limb had rest pain with presentation of acute on top of chronic leg ischemia. These ten limbs showed disappearance of palpable pedal pulses on stress (active planter flexion or knee flexion against resistance).Ankle brachial pressure index (ABI) was measured in both limbs in seven patients pre and post exercise (Table 1).In one patient (two limbs), ABI was not measured, and Doppler examination was not recorded. Duplex, catheter angiogram, plain CT/MRI scanning were done for diagnosing and pre-operative planning of PAES.

Table1. *Patients and clinical presentations*

No.	Age y	side	Risk Factors	Symptoms Duration	Symptoms	ABI pre exercise	ABI post
1	26	right	Smoker	18 mon.	claudication	0.8	0.45-0
		left		-	-	1.02	0.65
2	32	Left		9 mon.	claudication	1.02	0.7
3	24	right		3 mon.	claudication	1.0	0.65
4	47	left	Diabetic	21 mon,	claudication + rest pain	0.55	0.55
		right			--	0.9	0.65
5	34	left		6 mon.	claudication	1	0.75
6	29	right	Smoker	8 mon.	claudication	0.95	0.7
7	21	right		7 mon.	claudication	0.95	0.6
8	36	right		24 mon.	claudication	-	-
		Left		-	--	-	-

RESULTS

Loss of the normal triphasic doppler signals during stress is the main factor in considering the case as PAES and was demonstrated in all cases in our series. ABI measurement during rest showed median of 0.98. Eight limbs demonstrated normal triphasic Doppler signals and had significant drop in ankle pressure and ABI post exercise (more than 20 mmHg difference). Duplex scan was able to demonstrate the compression of patent popliteal artery during stress in all cases. Both catheter arteriogram and plain CT were done in 4 patients (6 limbs) and the compression of the popliteal artery was also clearly demonstrated in all of catheter arteriogram during stress (early in this study, CT angiogram was not available yet. Three unilateral cases underwent CT with contrast (angio) and MRI scanning. Two patients (3 limbs) had combined catheter angiogram and CT angio. (Table2).

Table2. Summary of the diagnostic tests

Case no.	Doppler test	Duplex	Catheter Arteriogram	CT	MRI
1	Y	Y	Y	Y	-
2	Y	Y	Y	Y	-
3	Y	Y	Y	Y	-
4	Y	Y	Y	Y	-
5	Y	Y	Y	Y	-
6	Y	Y	Y	Y	-
7	Y	Y	-	CT angio	Y
8	Y	Y	-	CT angio	Y
9	Y	Y	-	CT angio	Y
10	Y	Y	Y	CT angio	-
11	y	y	y	CT angio	-

Table3. *Surgical management*

Case no.	Type	decompression	Aneurysm	occlusion	Bypass	Symptom relief	follow up months
1	II	Y	-	Y	Y	Y	30
2	II	Y	Y	-	-	Y	29
3	I	Y	-	-	-	Y	14
4	I	Y	-	-	-	Y	22

5	I	Y	-	-	-	Y	24
6	IV	Y	-	Y	Y	Y	16
7	I	Y	-	-	-	Y	18
8	III	Y	-	-	-	No	21
9	I	Y	-	-	-	Y	10
10	I	Y	-	-	-	No	6
11	I	-	-	-	-	No	6

Surgical management data are shown in table 3. Ten cases underwent surgical treatment through posterior approach. Decompression was done in all operated cases and included lysis of medial head of gastrocnemius muscle and associated fibrous bands to restore non-compression anatomy. Out of the 11 limbs; seven had type I, two had type II and one limb in each of the types III and IV. The popliteal artery found to be occluded in two of the limbs and revascularisation was done successfully using reversed vein graft interposition with end-to-end anastomosis. Post stenotic aneurysmal dilatation was found in one case with patent popliteal artery and only decompression and division of fibrous band extending from the medial head of gastrocnemius and encircling the artery was performed. Follow up varied from 6 to 30 months with mean of 18 months. Symptoms was relieved in nine limbs (7 patients) and showed no more drop of ABI post exercise. One patient, his claudication distance improved but continue to experience degree of aching pain despite of restoration of normal ABI post exercise. The other patient, (bilateralPAES), his ABI measurements were not available as this protocol was not proposed yet for PAES cases. The surgery was based on CT/MRI and not ABI assessment. He continued to be symptomatic aftersurgical decompression and declined surgical treatment for the asymptomatic contra lateral side.

DISCUSSION

PAES was firstly reported by TP Anderson Stuart, a Scottish medical student in 1879 but named as ''popliteal artery entrapment syndrome'' by Love and Whelan in 1965.[6] Interestingly, Stuart documented a popliteal artery abnormally passing medially to the medial head of gastrocnemius muscle during dissection of an amputated gangrenous leg.[7] PAES has been anatomically classified into five groups.[7] In most of cases, the popliteal artery is abnormally passing medial to normally placed medial head of the gastrocnemius muscle (Type I),which affected the majority of our cases in this series (7 limbs). Less frequently, in type II (about 25%), there is abnormal origin of the medial head of gastrocnemius lateral to the popliteal artery. In Type III, muscle slips originating from medial head of the gastrocnemius muscle compresses the popliteal artery. In Type IV, there is fibrous bands on the popliteal muscle is making compression over the popliteal artery. TypeV was also added when the popliteal vein is involved with the artery in the entrapment by any of the previously mentioned mechanisms.[7] Iatrogenic PAES has been described when bypass procedure using autogenous reversed vein graft wrongly tunnelled through gastrocnemius head.[8,9]

High suspicious is a main drive for picking up symptomatic PAES patients. Such diagnosis should be considered for any patient below 30 years old presenting with calf claudication especially those male athletics.[4]In our series, seven patients (10 limbs) had intermitted claudication. Complicated case presented with popliteal artery lesions such stenosis, thrombosis or aneurysmal dilatation are readily diagnosed with the available images. However, there may be a dilemma to get a certain diagnosis if the compression is over a healthy popliteal artery. In such condition, compression of the artery can be demonstrated during muscular stress. Some authors suggested that compression of popliteal artery by ankle dorsiflexion against resistance.[9]In our series, we found as others did[10]that active planter flexion or knee flexion against resistance is better to detect disappearance of palpable pedal pulses. Therefore, Clinic consultations with vascular laboratory facilities are the key to confirming the clinical suspicion. Thorough history taking is mandatory to confirm the diagnosis of claudication. Pedal pulses were palpable during rest in all except one limb with occluded popliteal artery. The pulses disappear during active contractions of gastrocnemius muscle. Furthermore, the normal triphasic doppler signals changes abruptly to abnormal signals on flexion of the knee against resistance. ABI measurement drops significantly after

exercise.[9]Itindirectly reflects the decrease in blood flow during stress position which is essential to confirm the effect of compression on the blood flow to the extent to be symptomatic. This drop of ABI is the only dynamic quantitative diagnostic test. Other diagnostic imaging either spot the abnormal anatomy or the arterial compression without confirming concurrent diminution of blood blow. In our series, only one patient didn't have measurement of the ABI. Duplex scan of the popliteal artery can spot the compression during muscular stress with understanding of high false positive especially in athelets.[10-12] Again, arterial compression can be compensated from collaterals and there is other cause of pain rather than PAES.

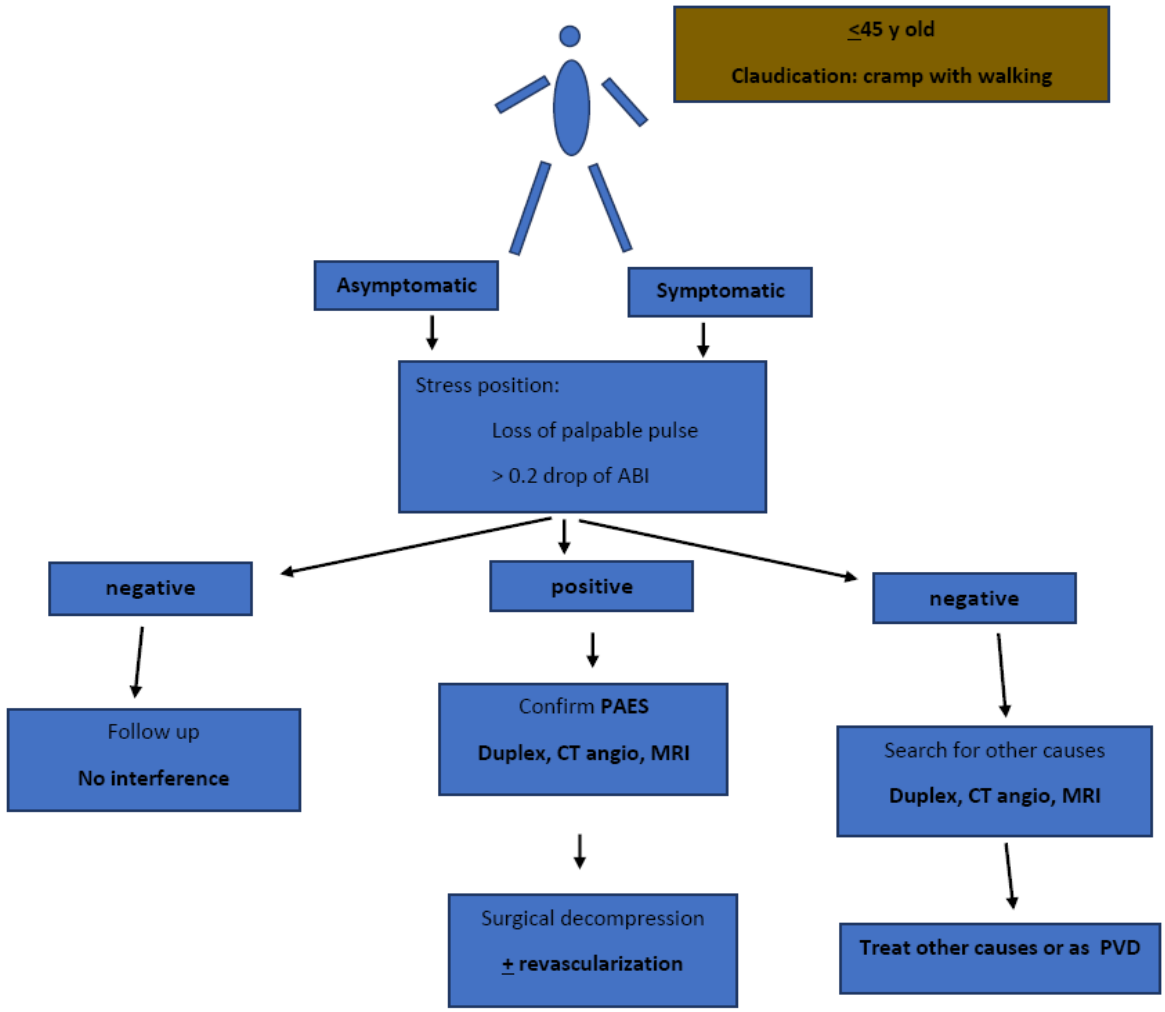

Figure1. *Algorithm demonstrates protocol of PAES management*

In this series, the PAES protocol to diagnose either symptomatic or asymptomatic limb includes that failure to elicit: pulse disappearance, ABI drop post exercise and Duplex scan imaging of the popliteal artery compression, eliminate PAES diagnosis and surgical decompression consideration (Figure 1). Although it may look like a strict policy for diagnosing PAES, it matches the understanding of the anatomical and blood flow abnormalities in PAES. We strongly believe that surgical intervention is not justified in case of failure to fulfil these criteria and other causes of similar symptoms should be explored. High threshold needs to be maintained to consider surgical decompression of PAES. In this series, there was no relieve of symptoms in one patient for which this protocol was not adopted. Another patient (case no. 8 in table 1) had significant drop of ABI from 0.9 to 0.7 during stress position and popliteal artery compression was confirmed by duplex and CT angio. After surgical decompression, he showed no drop of ABI and had clear improvement in claudication distance. This highlight the role of ABI in the assessment of the outcome[13]. Persistence of aching pain can be attributed to other muscular or compartment pathology.

Catheter arteriogram used to be routine imaging modality to confirm artery changes during muscles stress and can precisely outline the arterial wall pathological changes and possible subsequent distal occlusions.[14]Early In our series, we used catheter arteriogram in six cases. However, it is an invasive diagnostic test associated with potential risks and complications and replaced recently by CT angio. which is less invasive and became widely used. Role of MRA in diagnosing PAES at rest has been highlighted. MRA it is less likely to demonstrate popliteal artery compression as it is lengthy procedure and difficult for the patient to maintain stress position. However, MRA can be helpful for surgical planning or exclusion of other causes of differential diagnosis such as central canal stenosis or mass lesions in the popliteal fossa.[15]

Surgical management is indicated for all symptomatic PAES.[16] It includes decompression with/without arterial reconstruction. Decompression can be achieved by division of medial head of gastrocnemius, lysis of abnormal fibrous or fibromuscular bands.[16]Reconstruction of the popliteal artery includes thrombectomy, patching and/or vein graft interposition. Posterior approach to the popliteal artery while patient in prone position is the approach of choice for most surgeons dealing with PAES cases.[17]We used posterior approach in all our procedures because we believe that popliteal vessels and abnormal compressing pathology or anatomy can be better dealt with via posterior approach. This approach allows arterial reconstruction to be performed with direct exposure as compared with medial approach. In cases of popliteal artery occlusions in which bypass is decided for arterial reconstruction, medial approach has been preferred by others[9,17]However, in medial approach, the surgeon may fail to identify abnormal anatomical variations in relation to popliteal artery and PAES can be missed.

We operated on three of our patients on their asymptomatic limbs. It is postulated that in PAES, sensory nerves at the popliteal artery adventitia are exposed to repetitive trauma. Subsequently, leading to sympathetic excitation, affecting the vascular bed and contributing to the raised outflow resistance.[18] This theory supports the surgical management of the asymptomatic contra lateral limb which can complicate on late presentation.[19-21] Also, operating on asymptomatic limbs avoids dealing with complicated cases in which distal embolization to small arteries may raise the outflow resistance and leading to short term patency. We believe as others do that early surgical treatment of PAES including the asymptomatic contra lateral limb is indicated if popliteal artery compression is clearly identified during muscular stress despite lack of symptoms.[18-22]

We conclude that diagnosing PAES is highly suggested based on clinical assessment with support of other imaging techniques[23-25]. ABI drop during muscular stress is potentially a good predictor to identify patients more likely to benefit from surgical decompression. Keeping high threshold to offer surgery for PAES saves patients from inadequate outcome.

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