Popliteal vein entrapment: A benign venographic feature or a pathologic entity?

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Purpose: Asymptomatic morphologic popliteal vein entrapment is frequently found in the healthy population (27%). In our institution, popliteal vein compression on plantar flexion was observed in 42% of all ascending venograms. Some authorities consider the lesion benign, without pathologic significance. This study examines the pathophysiologic importance in select patients, describes treatment with surgery, and suggests a diagnostic tool.

Method: Thirty severely symptomatic patients with venographic evidence of popliteal entrapment were selected to have popliteal vein release after a process of elimination (ie, other causes of chronic venous insufficiency [CVI] were ruled out by means of comprehensive hemodynamic and morphologic studies). In the last nine limbs, popliteal vein pressure was also measured by means of the introduction of a 2F transducer tip catheter. Patients were clinically and hemodynamically assessed before and after surgery, and anatomical anomalies encountered during surgery were recorded.

Results: Popliteal vein release was performed without mortality or serious morbidity. Anomalies of the medial head of the gastrocnemius muscle caused entrapment in 60% of the patients; anatomic course venous anomalies were infrequent (7% of the patients). Significant relief of pain and swelling occurred in the patients who had surgery. Stasis ulceration / dermatitis resolved in 82% of patients. Popliteal venous pressures had normalized in the six patients who were studied postoperatively.

Conclusion: Popliteal vein entrapment should be included in the differential diagnosis of CVI in patients in whom other, more common etiologies have been excluded on the basis of comprehensive investigations. Popliteal vein compression can be demonstrated venographically in a large proportion of patients with CVI, but the lesion is likely pathological only in a small fraction of these patients. A technique for popliteal venous pressure measurement is described; it shows promise as a test for functional assessment of entrapment. Immediate results of popliteal vein release surgery are encouraging; long-term follow-up is necessary to judge the efficacy of surgical lysis of entrapment in symptomatic patients who fail to improve with conservative treatment measures. (J Vasc Surg 2000;31:631-41.)

Popliteal vein compression is frequently interpreted as a benign radiologic finding, without functional or pathological significance, similar to subclavian vein stenosis that is produced by shoulder girdle maneuvers or barium reflux into the esophagus that is induced with abdominal compression.[1] In our institution, constriction of the popliteal vein with active or passive ankle flexion is observed as an incidental finding in approximately 42% of limbs undergoing ascending venography for a variety of indications. Among the limbs showing venographic entrapment, 22% have bilateral involvement. Some narrowing of the popliteal vein can often be seen in venograms, even without ankle maneuvers. In healthy adults, a 27% incidence of popliteal vein compression found by means of duplex Doppler ultrasound has been reported.[2] Thus, one can probably correctly assume that popliteal vein narrowing on foot movement does not contribute to the pathophysiology in most patients with chronic venous insufficiency (CVI). It may, however, be of importance in a small subset of patients with radiological features of popliteal entrapment who have clinical features of CVI and in whom no other

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Table I. Prevalence of clinical features in 30 patients undergoing popliteal entrapment release

Symptom	*Prevalence*
Swelling	87%
Pain	83%
Hyperpigmentation	47%
Hyperpigmentation extending to the middle or upper calf	27%
Discoloration / dusky / cyanosis	23%
Stasis ulceration	30%*
Stasis dermatitis	7%*
Recurrent cellulitis	13%

*Among 11 limbs with stasis skin changes, isolated popliteal reflux was present in eight. In the remaining three limbs, outflow obstruction from entrapment was the only identifiable pathology.

satisfactory explanation can be found for their symptoms, even after extensive investigations. In approximately 4% of patients in our practice, a conventional basis for CVI is not revealed, despite exhaustive routine testing. When venographic features of popliteal entrapment are present in this subset of patients, the question whether the lesion is a benign incidental finding or the causative pathology arises.

This study examines the importance of popliteal vein entrapment in select patients, describes treatment with popliteal release and the abnormalities encountered during surgery, and suggests the measurement of popliteal vein pressures as a diagnostic tool.

MATERIAL AND METHODS

From August 1996 to December 1998, 30 consecutive patients underwent release of popliteal vein entrapment. This cohort represented 6% of all patients undergoing surgery for CVI, including procedures for relief of obstruction or reflux, during the same period at our institution (men / women, 14 / 16; median age, 49 years [range, 27 to 73 years]; left / right limb, 1 / 1.1). The primary indications for surgery were swelling of the limbs (30%), pain (33%), stasis dermatitis (7%), and frank stasis ulceration (30%). The prevalence of presenting clinical features is shown in Table I.

The patients were selected for surgery after a process of elimination (ie, more common causes of CVI were ruled out before popliteal entrapment observed on venography was considered to be the causative factor). Only patients with severe disabling symptoms after failed compression treatment were considered for surgery. Certain symptoms or clinical features were considered more suggestive of popliteal vein entrapment: leg swelling below the knee, which did not extend proximally into the thigh; circumferential hyperpigmentation that extended proximally beyond the gaiter area into the middle and upper calf; and pain that became *worse* with walking rather than better, as is the case in most other forms of refluxive CVI. Popliteal release was performed as a "last-resort" procedure in these severely symptomatic limbs with exhausted options.

Before surgery, all patients underwent a detailed clinical examination and a comprehensive set of venous laboratory studies, including arm / foot venous pressure differential, ambulatory venous pressure measurement, air plethysmography, and duplex examination in the erect position with measurement of valve closure times. Ascending venography was performed with active plantar flexion and passive dorsal flexion (Fig 1), and popliteal venous constriction with plantar flexion was present in all limbs on which surgery was performed. The site of popliteal venous constriction was classified as high, middle, or low from the venograms. For this classification, the middle popliteal segment was defined as a 5-cm length of popliteal vein centered on the joint line, and the higher and lower segments were designated accordingly. Toe plethysmography (PPG) was performed with the same foot movements to indicate popliteal artery entrapment. Findings of subnormal ejection fraction (less than 40%) on air plethysmography, concomitant arterial entrapment on toe plethysmography, and increased popliteal vein velocity in the erect position (more than 13 cm/s) were considered to suggest narrowing of the vein, but were not always present.

Popliteal vein pressure. Popliteal vein pressure measurement of the symptomatic leg was performed in the last nine patients in this study. The posterior tibial vein near the ankle was cannulated initially (four cases) through a small cutdown with local anesthesia and later (five cases) by means of percutaneous venipuncture with an 18-gauge angiocatheter with ultrasound scanning guidance. A 2F catheter with a tip-mounted pressure transducer approved for cardiovascular use (Millar Instruments, Houston, Texas) was passed through the angiocatheter and positioned in the popliteal vein at the level of the joint line with fluoroscopic control. The patient was then asked to stand and perform 10 toe-stand exercises while the popliteal vein pressure was recorded. Simultaneously, a needle in the dorsal vein of the foot allowed traditional ambulatory venous pressure measurement during the exercises. Postexercise pressure, percentage drop, and recovery time for both the popliteal vein and the dorsal vein were sep-

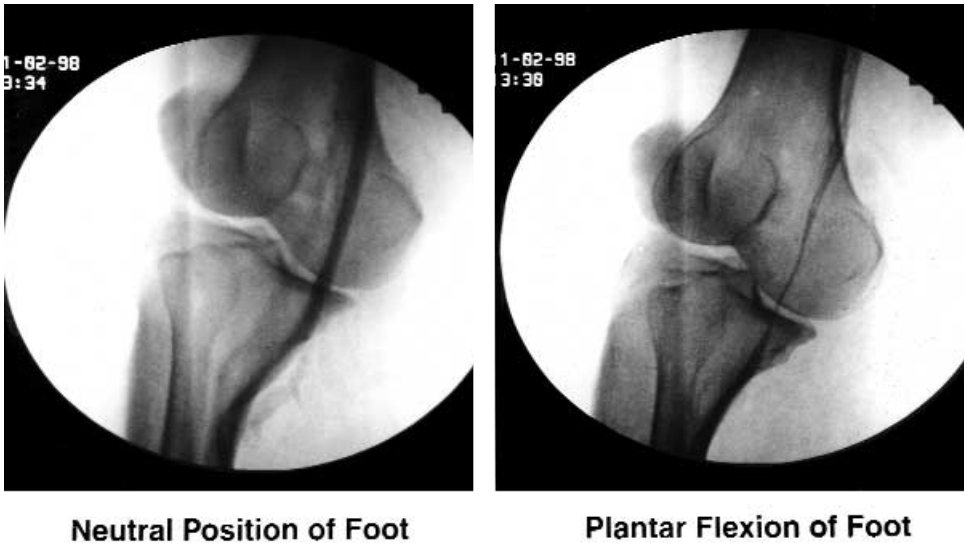

Fig 1. Popliteal entrapment seen on routine ascending phlebography with plantar flexion of the foot.

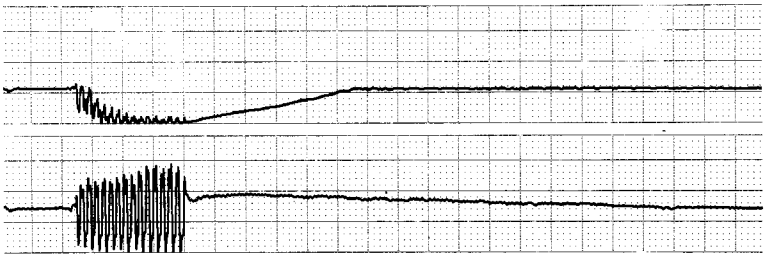

Fig 2. Simultaneous pressure tracings in the dorsal foot vein (*top*) and popliteal vein (*bottom*) with calf exercise. Note the elevation in popliteal pressure and decrease in foot venous pressure after exercise. Popliteal pressure elevation persists for 100 seconds after cessation of exercise before slowly declining to baseline.

arately recorded on a strip chart (Fig 2). A popliteal pressure increase to any degree or a decrease of less than 15% with exercise was considered to be supportive of significant outflow obstruction. These pressure criteria were derived from an analysis of exercise popliteal pressure in 48 limbs with a variety of obstructive and nonobstructive pathologies.

Surgical procedure. The popliteal vein was approached through an 8- to 10-cm medial incision centered on the joint line. The medial tendons were divided as necessary to gain adequate exposure. The medial head of the gastrocnemius was hooked and divided close to the bone. At this stage, any anomalies of the muscle became apparent, because the popliteal vein was skeletonized. Such anomalies were recorded. All muscular and fibrous compression bands were meticulously divided, and the popliteotibial venous segment was cleared of all branches for a length of approximately 5 to 6 cm (Fig 3). Any abnormalities of the vein were noted. When an anomalous course of the popliteal vein and artery lateral to the lateral head was found (in two cases), the lateral head of the muscle was also detached from its origin. A thick perivenous fascia[3] was found to contribute to entrapment in several cases and was carefully dissected away to free the vein. The short saphenous and the gastrocnemius veins can contribute to entrapment by angulating the popliteal vein at their entry point during calf contraction.[3] These tributaries were carefully identified and divided. A popliteal valve frequently comes into view during the process of clearing the popliteal vein of branches and may prove incompetent by means of the strip test. Eleven such incompetent valves were

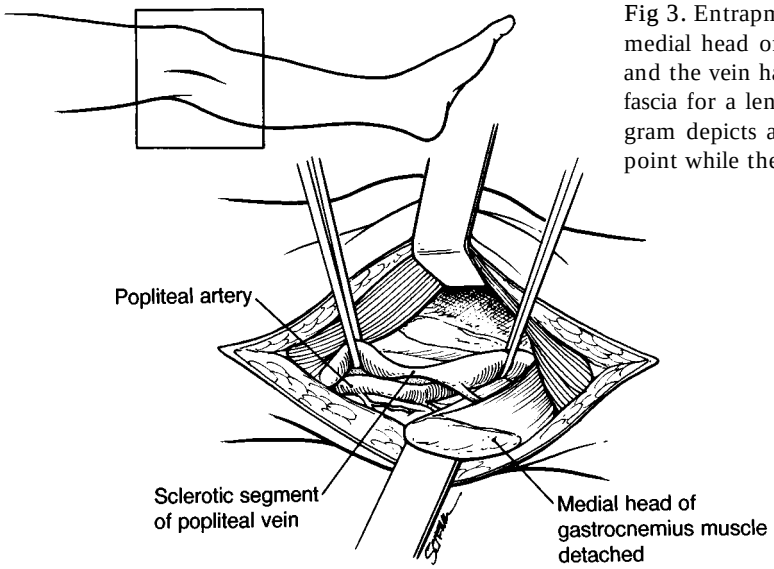

Fig 3. Entrapment lysis through the medial approach. The medial head of the gastrocnemius has been taken down, and the vein has been cleared of branches and perivenous fascia for a length of approximately 5 to 7 cm. The diagram depicts a sclerotic vein segment at the entrapment point while the vein below is dilated.

Table II. Venous laboratory data

Test	*n*	*Preoperative*	*n*	*Postoperative*	P *value*
Ambulatory venous pressure % drop	30	58 ± 16	11	68 ± 15	< .05
Ambulatory venous pressure venous filling time	30	40 ± 42	11	40 ± 25	NS
Air plethysmography					
Venous filling index (VFI_{90})	29	2.6 ± 2.8	13	2.4 ± 1.7	NS
Venous volume (VV)	29	106 ± 57	13	103 ± 54	NS
Ejection volume (EV)	29	66 ± 33	13	59 ± 31	NS
Ejection fraction (EF)	29	65 ± 18	13	61 ± 21	NS
Residual volume fraction (RVF)	29	42 ± 20	13	45 ± 23	NS
Outflow fraction	26	51 ± 12	9	60 ± 11	< .02

NS, Not significant.

encountered at the time of surgery, one more than indicated by means of preoperative duplex Doppler ultrasound scanning. These incompetent valves were repaired. Seven valves had transcommissural valvuloplasty, and four valves were repaired by means of axillary vein transfer. After completion of entrapment lysis, the subcutaneous tissue and the skin were closed over a suction drain.

The patients were clinically assessed before and after surgery. Clinical assessment of pain was performed by using a visual analogue scale from 0 to 10, in which 10 indicated the most severe pain. Swelling was classified as follows: grade 1, nonobvious edema, but pitting on palpation; grade 2, visible ankle edema; and grade 3, gross edema involving the leg below the knee. Outcome was considered excellent when the patient became completely asymptomatic postoperatively; outcome was considered improved when there was substantial objective and subjective improvement with some residual complaints that were easily tolerable to the patient; and outcome was considered unchanged when there was no substantial change in the condition of the patient. Stasis dermatitis or an ulcer that did not heal completely were included in the last category.

The patients were observed clinically postoperatively; venous hemodynamic studies and measurement of exercise popliteal pressure were repeated 2 to 3 months after surgery.

Statistics. The Student paired *t* test was used as a means of evaluating differences of groups. A *P* value of less than .05 was considered significant.

RESULTS

Popliteal vein release was performed without mortality or serious morbidity. Postoperative throm-

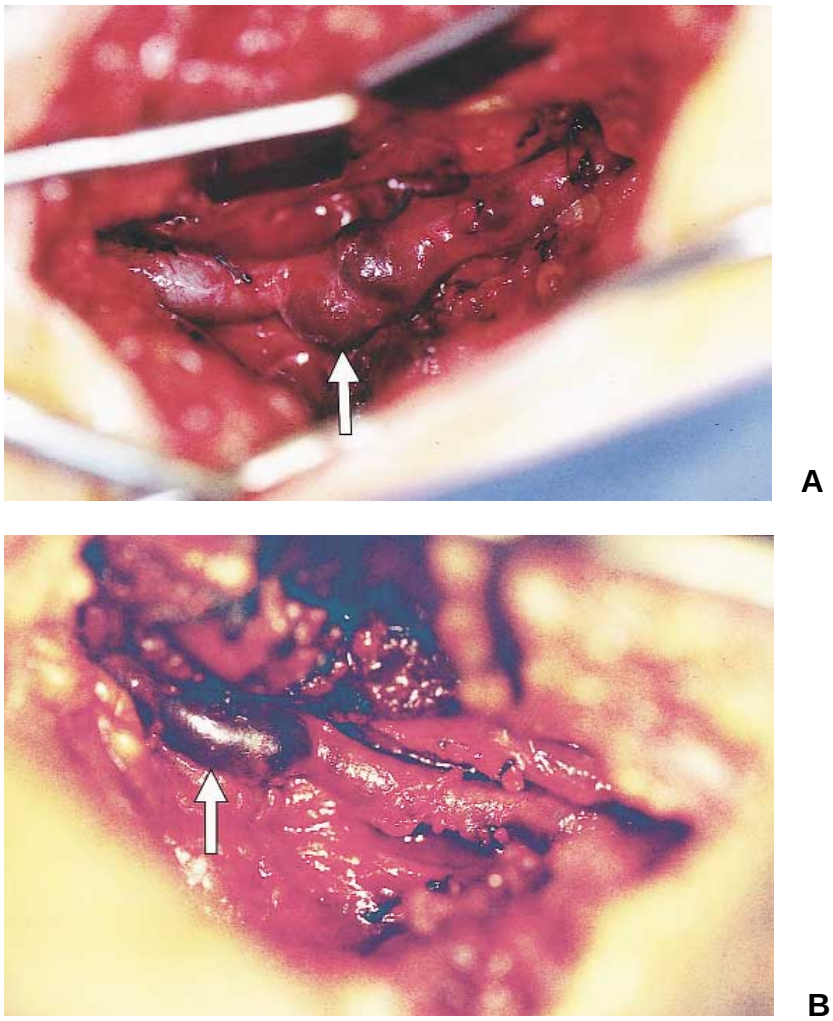

Fig 4. Examples of prestenotic and poststenotic dilatation of the popliteal vein adjacent to the compression point. **A,** The poststenotic dilatation is saccular. **B,** The prestenotic dilatation is tubular and is seen as a second bulge impinging the dilated valve station immediately adjacent.

bosis of the popliteal vein occurred in one patient at 3 weeks. Treatment with catheter-directed thrombolysis resulted in only partial response. In this patient, the vein was sclerotic because it pursued an anomalous course, along with the artery lateral to the lateral head of the gastrocnemius muscle, which was divided at surgery.

The major entrapment elements encountered and the pathological changes seen in the popliteal vein during surgery are listed in Table II. Anomaly of the medial gastrocnemius head was defined as an extension of the origin of the muscle beyond the medial femoral condyle and adjacent medial shaft more laterally toward the area above the intercondylar fossa or even the lateral condyle and shaft. This anomaly was the most common and was often seen in combination with an atrophic lateral head. The extensive insertion was also seen as a distinct additional slip ("third head") arising from the medial head and extending to the intertrochanteric fossa compressing the vein. A prestenotic or poststenotic dilatation of the vein, sometimes approaching aneurysmal proportions (larger than 2 cm), was seen in five limbs (Fig 4, *A* and *B*), but the most frequent finding was a sclerosis of the vein wall (Fig 5). This sclerosis was localized to the vein segment at the pressure point and situated above the valves that were incompetent. The sclerotic segment exhibited

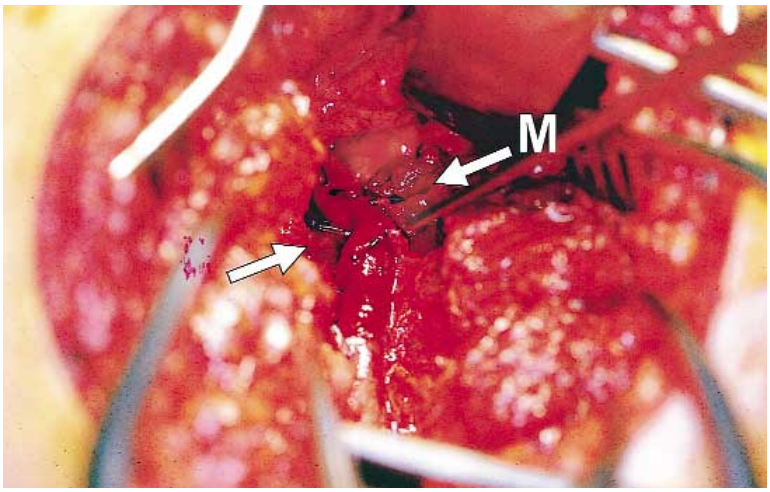

Fig 5. Sclerotic vein segment (*arrow*) at the compression point. It overlies the medial head of the gastrocnemius muscle (*M*) that has been released. The view is slightly angled toward the foot.

Table III. Pathological features in 30 cases undergoing entrapment release

Compressive entrapment mechanism	*Number*
Gastrocnemius medial head anomalous origin	18*
Additional "3rd" head of gastrocnemius	1
Gastrocnemius lateral head origin from medial condyle	5
Soleus sling	3
Thick perivenous fascia	13†
Abnormal course of vascular bundle lateral to the lateral head	2
Unknown	1
Pathological changes in the popliteal vein	
Sclerosis	13
Prestenotic dilatation	1
Poststenotic dilatation	4‡
Post-thrombotic changes	2

*One case associated with atrophic lateral head.
†Associated with other entrapment mechanisms.
‡Two saccular aneurysms.

a noticeably thickened wall compared with the adjacent venous segments and tended to contract more readily into spasm with surgical manipulation. In 13 of the 30 limbs, a thick perivenous "fascia" was found, often appearing to have a close connection with the muscle fascia.

Hemodynamic tests. The preoperative and postoperative hemodynamic results are shown in Table III. No superficial or deep axial reflux or any obstruction in these limbs was indicated before surgery by means of these investigations, but 10 limbs had isolated popliteal vein reflux. There was a statistically significant increased dorsal vein pressure drop (% drop) and outflow fraction after surgery, indicating successful entrapment lysis, although these changes occurred within the reference range for these tests.

Venography. As a selection criterion, all limbs had vein compression on active plantar flexion, but a venous constriction was also noted with passive dorsal flexion in 14% of limbs. In 34% of patients, bilateral entrapment was present. Venographic features of popliteal vein entrapment varied from a localized hourglass appearance (Fig 6, *middle*) to a more diffuse form of compression (Fig 1). The site of compression was the high popliteal in 11% of patients, the midpopliteal in 39% of patients, and the low popliteal in 18% of patients, and in 32% of patients, the site was diffuse, with entrapment of high and middle popliteal segments in 7% of patients, middle and low segments in 4% of patients, and all three in 21% of patients. Representative venographic examples are shown in Fig 6. Associated arterial entrapment was indicated in 57% of patients (8 of 14 patients) by means of toe photoplethysmography with ankle maneuvers.

The popliteal vein pressure changes with calf exercise preoperatively and postoperatively with corresponding dorsal foot vein pressures measured simultaneously are shown in Fig 7. Preoperatively, the popliteal vein pressure increased with exercise in

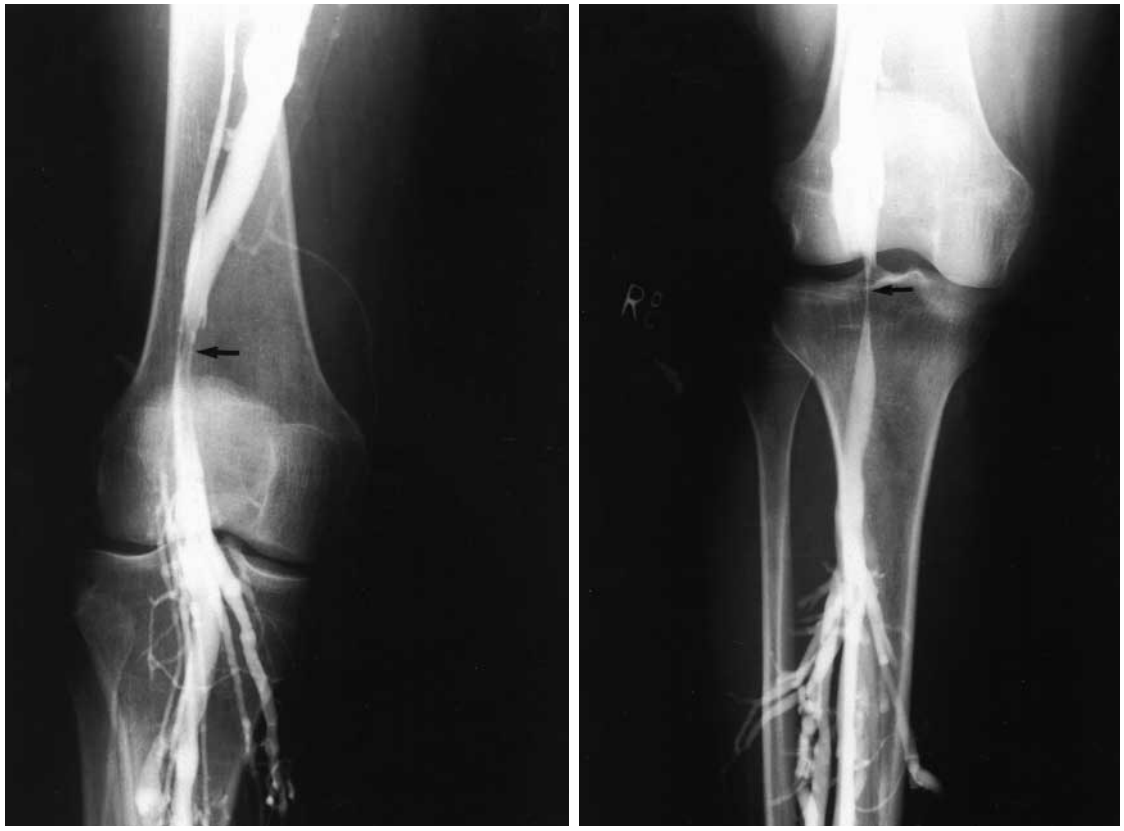

Fig 6. Examples of high, middle, and low popliteal venous constriction with ankle movements. Vein compression may be localized or diffuse. An example of diffuse compression is depicted in Fig 1.

five limbs, although the dorsal foot vein pressure measured concurrently decreased substantially. The pressure increase persisted for some time in several limbs after the cessation of calf exercise (Fig 2). The time for the elevated pressure to return to baseline after cessation of calf exercise was 5, 24, 25, 30, and 100 seconds in these five limbs. In four limbs, the popliteal pressure decreased, but the decrease was greater than 15% in only one limb.

Postoperatively, no increase in popliteal venous pressure was observed in any of the six patients who were studied. All patients had a greater drop in popliteal vein pressure after entrapment lysis, indicating less outflow obstruction.

Clinical follow-up was available in 29 of the 30 patients. The median follow-up period was 14 months (range, 2 to 36 months). The resolution of primary symptoms after surgery is shown in Table IV. A highly significant improvement of pain inten-

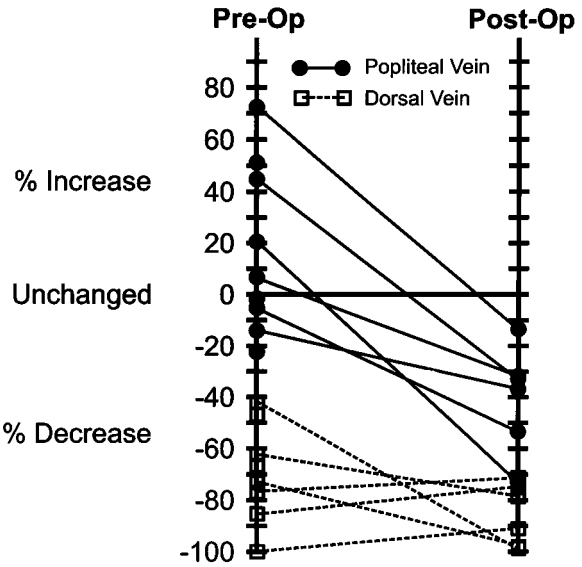

Fig 7. Change of popliteal vein and simultaneously measured dorsal foot vein pressures in limbs preoperatively (9) and postoperatively (6).

sity and degree of swelling occurred postoperatively. After surgery, pain improved or disappeared in 76% of patients (19 of 25), was unchanged in 16% of patients (4 of 25), and became worse in 8% of patients (2 of 25). Fourteen of 29 patients (48%) had complete relief of pain.

After surgery, swelling improved in 63% of patients (17 of 27), was unchanged in 26% of patients (7 of 27), and was worse in 11% of patients (3 of 27). Complete relief of swelling was noticed in 12 of 29 patients (41%).

The clinical outcome was considered excellent in 41% of patients (12 of 29), improved in 38% of patients (11 of 29), unchanged in 17% of patients (5 of 29), and worse in 3% of patients (1 of 29). Clinical follow-up was available in eight of the nine patients in the subset of patients who underwent popliteal vein pressure measurements. The outcome was considered excellent or improved in all seven patients in this subset who had a popliteal vein pressure drop of less than 15% or a pressure increase preoperatively. The remaining patient in this group (1 of 8) had a 22% pressure drop preoperatively and no clinical improvement after surgery.

DISCUSSION

Popliteal vein entrapment as a pathological entity is well recognized in the literature. Rich and Hughes, in 1967, were the first to report a case of vein entrapment although arterial entrapment has been known since the last century.[4] In this case, these authors documented both prestenotic and poststenotic saccular dilatation of the popliteal vein, below and above the entrapment point, respectively. Similar observations were found in our study. Now, several case reports and a few series describing vein entrapment, some in combination with popliteal artery entrapment, exist.[4-10] It is estimated that 10% to 15% of patients with arterial entrapment also have coexisting vein entrapment.[3] Contrary to suggestions in the literature,[3] the pathology occurred in all age groups in this series and was not particularly confined to young patients.

Morphologic popliteal compression can be readily confirmed by means of duplex scanning or venography with appropriate ankle maneuvers. The magnetic resonance technique described by Nelson and colleagues may be informative for muscular anomalies and extrinsic compression, such as from Baker's cyst.[6] Although popliteal compression is often considered functionally benign, outflow embarrassment has been demonstrated with air plethysmography.[2] It is possible that this entity is pathological in selected patients. The difficulty lies in the identification of these particular limbs, because the incidence of morphologic entrapment is so high. A process of elimination is unsatisfactory, and an accurate test must be found. The clinical outcome jumped from 59% excellent and improved limbs in the first 21 patients selected on clinical criteria in this study to 100% of patients (7 of 7) with the addition of popliteal pressure measurement (a drop less than 15% or an increase). This finding, in combination with the observed larger drop in popliteal vein pressure after surgery, may indicate that deep pressure measurement is a useful functional test. Exercise popliteal pressures in healthy adults are not available. From the physiology of the calf venous pump as currently understood, earlier studies, and a recent personal series of popliteal venous pressure measurements performed in 48 symptomatic limbs with and without venographic popliteal entrapment, it is clear that any increase in popliteal pressure with exercise is abnormal and indicates outflow obstruction.[11,12] From an analysis of the exercise pressure drop in the latter group of 48 limbs, 12 of which had neither reflux nor obstruction, it appears that, at a minimum, a pressure drop greater than 15% to 20% is to be expected in healthy limbs, because many of the symptomatic limbs met or exceeded this threshold. Although the test is invasive, it can be performed percutaneously. There were

Table IV. Clinical results

Symptom	*n*	*Preoperative*	*Postoperative*	P *value*
Swelling (mean grade*)	29	1.8 ± 0.9	0.9 ± 1.1	< .01
Pain (mean grade†)	29	4.4 ± 3.0	1.5 ± 2.5	< .001
Stasis ulcer / dermatitis	11	Present	9 healed‡	—

*Grade 1, pitting edema, not gross; grade 2, ankle edema; grade 3, gross edema of entire leg.
†Visual analogue scale 0 to 10.
‡Two limbs without associated popliteal reflux (see Table I) healed their skin lesions after entrapment lysis.

no complications related to the percutaneous procedure. Popliteal pressure measurement is a dynamic functional test and appears superior to static tests, such as outflow fraction measurement performed in the recumbent patient. The latter has been suggested as a diagnostic tool for popliteal vein entrapment.[2] Outflow fraction results were normal (more than 40%) preoperatively in the group of patients who underwent surgery. Thus, the test had no diagnostic value in this series. A statistically significant increase in outflow fraction was noted after surgery; the postoperative values remained within the reference range also. Although this is not of clinical significance, it may, nonetheless, indicate that outflow obstruction was less after surgery. Similar comments apply to the noticed increase in dorsal foot vein exercise pressure drop after surgery.

A reliable test would not only be important in limbs with isolated popliteal entrapment, but also in limbs with mixed pathology. It is likely that the presence of popliteal entrapment in combination with reflux or post-thrombotic obstruction will further decompensate the calf muscle pump. Incomplete relief of symptoms after reflux correction may be caused by a remaining popliteal vein entrapment. It has been speculated that popliteal entrapment may lead to perforator incompetence or even deep vein thrombosis.[2,3,9] Although plausible, such sequelae from entrapment remain conjectural at this point.

In a recent series of 28 patients (personal material) with significant venographic entrapment, popliteal venous pressure measurements were positive for entrapment in only 16 limbs and were negative in the remaining 12 limbs. PPG evidence of associated arterial entrapment was positive in 36% and negative in 64% in the former group of pressure-positive patients. However, PPG for arterial entrapment was also positive in 25% of the latter group of 12 patients with normal popliteal pressure results. Thus, it appears that evidence of arterial entrapment is not a reliable sensitive or specific indicator of functionally significant popliteal vein entrapment.

Isolated popliteal reflux combined with entrapment occurred in 11 (37%) of 30 patients in this study. The significance of this observation is unclear. From the described morphological observation during surgery, it may be postulated that the incompetence is caused by dilatation of the popliteal vein or high pressure in the valve segment below the point of obstruction. Another observation probably further supports this theory. When two valves were encountered in the refluxive segment, the first valve below the entrapment was always incompetent, and the second valve was sometimes competent. The reverse situation was never encountered. This would indicate an axial breakdown of the valves distally, incriminating the proximal compression. Popliteal vein entrapment might account for otherwise unexplained isolated popliteal reflux. Isolated popliteal reflux, when it occurs in other settings, seldom produces severe symptoms, unlike the cohort in this study.[13] It appears that the presence of outflow obstruction and reflux near the calf pump is a particularly bad combination, because reflux is amplified from the supranormal popliteal pressures generated in the entrapped popliteal segment (Fig 2). This may explain why isolated popliteal reflux, a relatively benign condition in other settings, leads to increased severity of clinical presentation in the presence of entrapment. It is suggested that popliteal entrapment be considered as an underlying pathology when isolated popliteal reflux presents with symptoms. The patients in this series were severely symptomatic, having exhausted other therapeutic options, and surgery was being carried out on a “last-resort” basis. In these circumstances, a comprehensive correction of all encountered pathologies at surgery, including popliteal reflux, was considered to offer the best chance for symptom relief. A rather aggressive approach to popliteal valve reconstruction, particularly in the four cases of axillary vein transfer in this series, has to be viewed in this context, and the results appear

to justify this approach. Furthermore, the best chance for valve reconstruction is during the initial surgery. If the opportunity is lost, later or delayed reconstructions may be difficult or even impossible because of cicatrix from the initial surgery. Because skeletonization of the popliteal vein, a necessary first step in valve reconstruction, is an inherent part of entrapment lysis, concurrent valve reconstruction expends relatively less additional time. Venous stasis dermatitis / ulceration occurred in 11 limbs in this series, eight limbs with associated popliteal reflux and three limbs without popliteal or other reflux. Vein entrapment was the only abnormality found in the latter three limbs, and entrapment lysis resulted in healing of the skin lesions in two of the three limbs. In other mixed obstruction / reflux pathologies such as post-thrombotic syndrome, skin changes are generally attributed to the reflux component. However, the interplay between obstruction and reflux in the genesis of skin ulceration is yet to be fully elucidated. It is not known to what extent, if any, the cell mediated microvascular damage that has been described in the presence of reflux also occurs with outflow obstruction. Balloon dilatation and stenting of iliac vein stenosis alone can heal skin ulceration in a fraction of post-thrombotic cases in which combined obstruction and reflux are present.[14]

The most frequently implicated compressive mechanism in vein entrapment reported in the literature is lateral extension of the origin of the medial head of the gastrocnemius muscle beyond the medial femoral condyle and adjoining femoral shaft, or a "third" head or slip contributing additional bulk to the muscle.[5,7-10] The medial head normally arises from a tendinous origin from the medial side of the medial femoral condyle and as a muscular attachment to the medial side of the femoral shaft immediately above the condyle.[15] In the fetus, the medial head arises wholly from the condyle, and the muscular extension to the shaft is a postnatal development.[15] Anomalous migration of the muscular origin more laterally, therefore, seems to occur after birth. Abnormalities of the lateral head of the gastrocnemius muscle appear to occur much less frequently.[3,6] In five cases in this study, the lateral head of the gastrocnemius was entirely absent, and the entire muscle arose from the medial condyle and intercondylar fossa. To our knowledge, this abnormality has not been described before. The popliteal vein appears to follow a normal anatomic course in most cases, whereas the muscle abnormality is responsible for the vein entrapment. This finding is contrary to the experience with arterial entrapment, in which anatomic course anomalies of the artery are more frequently present. In two cases in this series, both the artery and vein coursed laterally to the lateral head of the gastrocnemius, which appears to be a very rare anomaly. In both of these cases, clinical manifestations were related to the venous entrapment, and arterial symptoms were absent. Although gastrocnemius muscle anomalies at its origin are thought to be mainly responsible for entrapment, the actual mechanism of compression is obscure. In this series, high popliteal vein compression some distance from the muscle origin was noted venographically in several cases, and the compressed vein segment was quite long and diffuse in other cases. Traction and stretching of the vein by the attachment of the perivenous fascia to the contracting muscle may be responsible for these variations. The persistence of elevated popliteal pressure for nearly half a minute or more in several cases after cessation of calf exercise is a curious finding and suggests a complex mechanism, involving persistent contraction by the band of compressing muscle, spasm of the vein induced by compression, or both. Exercise-induced hyperemia may also play a role.

Most authors have recommended a posterior approach to release the vein entrapment.[3-5,7,8] This recommendation is based on experience with the management of an abnormal course of the vessel in arterial entrapment. Because muscle abnormalities are more common with vein entrapment, the medial approach for release was satisfactory; the exposure was adequate; and the anatomic course variations were rare and quite manageable when they occurred. The compressing muscle with the medial head was simply detached from the bone. Sato et al have recommended a more definitive excision of the medial head of the gastrocnemius muscle to create a greater space in the popliteal fossa for the vein.[5] This may be a worthwhile approach in instances in which extensive muscle bulk is present and in cases of recurrence.

Popliteal vein entrapment may be considered of causative importance in select patients with significant signs and symptoms of CVI with venographic evidence of entrapment and no other pathology identified on comprehensive investigations. Although popliteal vein entrapment is a frequent morphological finding, this study suggests that it may be a pathologic entity in some cases. This is supported by several observations:

1. The clinical improvement of pain, swelling, and ulcer healing after surgical release. The complete relief of pain in 48% of patients and complete relief of swelling in 41% of patients are noteworthy, because these are recalcitrant symptoms and seldom resolve completely or rapidly unless the specific underlying pathology is corrected. The rapid resolution of pain and massive swelling in several instances has been dramatic and impressive. The visual analogue scale of measuring pain used in this study is considered reliable.[16]
2. Identified muscle abnormalities combined with secondary popliteal vein changes, particularly the prestenotic and poststenotic dilatation, which imply a real impediment to venous flow.
3. The increased popliteal vein pressure during exercise, indicating deep venous obstruction, and the reversion to "normal" after entrapment lysis.
4. The improvement in dorsal foot vein pressure drop and outflow fraction after surgery, indicating improved outflow.
5. The lack of other identifiable pathology as a basis for the severe symptoms in this group of patients.

The last observation is perhaps the weakest argument in trying to validate popliteal entrapment as a real pathological and clinical entity. Certainly, negative selection of patients by a process of elimination is not a satisfactory approach if an alternative positive selection method was available. Further progress in understanding the disease can occur only if an objective test is developed to separate functional from morphological entrapment. Exercise popliteal venous pressure measurement may prove to be a discriminating test, but further studies are necessary. Although the immediate results are encouraging, the short follow-up period in this study mandates a longer observation period to prove the durability of popliteal vein release.

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