Popliteal Arterial Aneurysms

A REVIEW AND ANALYSIS OF 55 CASES

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SUMMARY

Fifty-five popliteal aneurysms in 43 patients seen over a 15-year period, are presented. The commonest cause was atherosclerosis, with a male incidence of 98%. Bilateral popliteal aneurysms were found in 29% of this group, and extrapopliteal in 11% of patients.

Sixty-seven per cent of the patients had complications when they were first seen, and the commonest complication was acute arterial occlusion caused by thrombo-embolism. The reasons for the high incidence of thrombo-embolism are discussed. Rupture was uncommon.

Small aneurysms are not immune to complications and in the absence of contra-indicating factors such as short life expectancy, or poor surgical risk, all popliteal aneurysms should be considered for reconstructive vascular procedures.

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The popliteal aneurysm is the commonest aneurysm affecting the limb arteries, and of all aneurysms is second in frequency only to the abdominal aortic aneurysm. Unlike abdominal aneurysms where the usual complication is rupture with a threat to life, popliteal aneurysms are prone to thrombo-embolic complications threatening the limb. Gifford, Hines and Janes[1] reported that 23% of 80 conservatively-treated popliteal aneurysms eventually resulted in amputation, and Linton[2] reported a limb loss of 77% in 22 conservatively treated aneurysms.

The surgical treatment of popliteal aneurysm has undergone considerable changes over the centuries, varying from different ligating procedures, aneurysmorrhaphy, excision, sympathectomy, and intraluminal wiring, to present-day vascular reconstructive grafting. It would seem that the popliteal aneurysm has been a testing ground for the evolving surgical procedures for aneurysm, and that the experience so gained has been applied to the treatment of aneurysms elsewhere. The aetiology of popliteal aneurysms has also changed. Whereas in the past syphilis and the trauma from extension and flexion in cavalrymen and postboys were always seriously considered, atherosclerosis is by far the commonest cause today. Syphilis as a cause has been almost entirely eliminated.

During a 15-year period ending in April 1972, 55 popliteal

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aneurysms were encountered in 43 patients. This report is an analysis and review of these patients.

CLINICAL MATERIAL

Of the 43 patients, all except 1 were male. Their ages ranged from 33 to 79 years, with a mean age of 62 years. Most patients were over the age of 50 years. The aetiology of the aneurysms varied and is shown in Table I.

TABLE I. AETIOLOGY, AND NUMBER OF PATIENTS WITH ANEURYSMS

Aetiology	Patients	No.
Atherosclerosis	38	49
Popliteal entrapment	3	4
False aneurysm	2	2
	—	—
Total	43	55

Atherosclerosis

The commonest cause was atherosclerosis, which was responsible for 49 aneurysms in 38 patients. In 11 patients (29%) the aneurysms were bilateral; 28 affected the right leg and 21 the left leg. In 9 patients (24%) there were extrapopliteal aneurysms, 5 involving the abdominal aorta and 4 the common femoral artery. Of the 38 patients, all except 1 were male. The age distribution of this group by decades is 2 between 30 - 39 years; 6 between 40 - 49 years; 9 between 50 - 59 years; 16 between 60 - 69 years, and 5 between 70 - 79 years. As was to be expected, concomitant disease in the atherosclerotic group was common and is shown in Table II. Cardiorespiratory disease was present in 21, cerebrovascular insufficiency in 2, and hypertension in 14 patients. Diabetes mellitus was encountered twice, and 4 patients had polycythaemia. Seven patients had no concomitant disease, and some had 2 or more diseases. Most of the patients were smokers.

TABLE II. CONCOMITANT DISEASE IN 38 PATIENTS

Disease	No.
Cardiorespiratory disease	21
Cerebrovascular disease	2
Hypertension	14
Polycythaemia	4
Diabetes	2
None	7

Popliteal Artery Entrapment

The popliteal artery entrapment syndrome with post-stenotic aneurysmal formation was encountered in 3 patients. One patient had the condition bilaterally. The ages of patients in this group were 43, 47 and 49 years.

False Aneurysms

Two false aneurysms were encountered, both were at the distal anastomoses of femoropopliteal bypass grafts, in which the grafts were prostheses.

SIZE AND LOCATION

The aneurysms varied in size, shape, and location. In diameter they varied from 1,5 to 9 cm and in length from 2 to 20 cm. They were all single, although some were bilobate. The smaller aneurysms were usually located opposite the knee joint and were unilocular, whereas the more proximal aneurysms tended to be larger and bilocular. The latter were more often associated with ectasia of the superficial femoral artery in Hunter's canal.

DIAGNOSIS

The diagnosis of popliteal aneurysm was usually made on the finding of an expansile, pulsating, tender or non-tender swelling in the popliteal fossa. Those that had thrombosed presented simply as a non-tender mass.

In 10 limbs the aneurysm was not diagnosed clinically. The patients in this group of 10 presented with arterial occlusion, and the diagnosis of a thrombosed aneurysm was established only at operation, when either a bypass graft or an amputation was done. Straight X-ray films of the knee region, especially the lateral view, occasionally showed calcification in the wall of the aneurysm (Fig. 1).
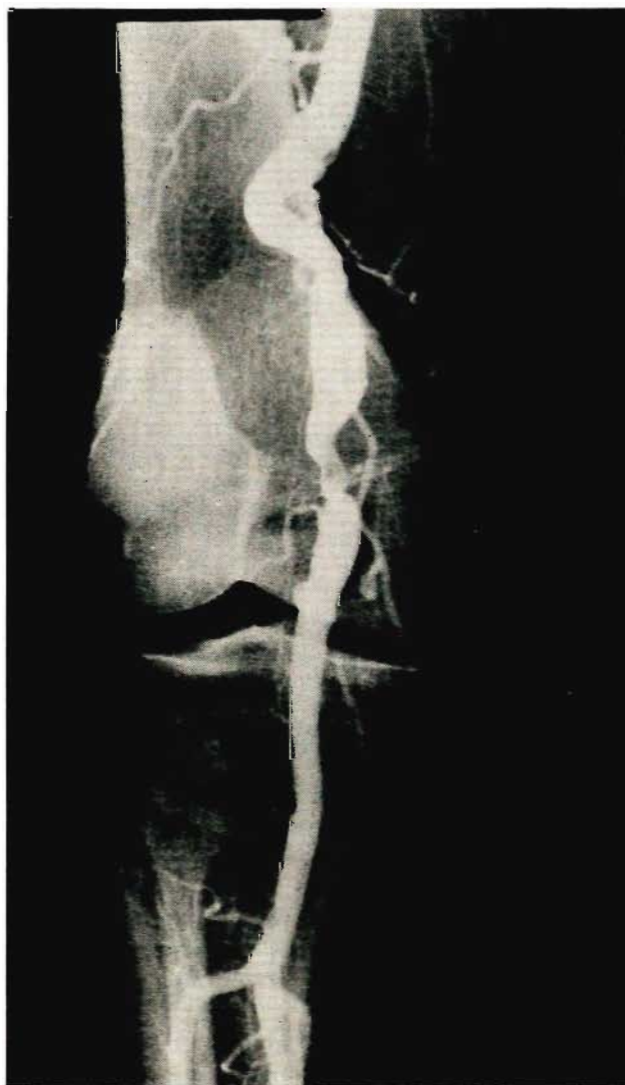

Fig. 1. Lateral view of knee joint to show calcification in a thrombosed popliteal aneurysm.

Fig. 2. Arteriogram of a partially thrombosed popliteal aneurysm. Most of the true lumen has been obliterated by intrasaccular thrombus. At operation the diameter of the aneurysm was about 4 cm.

Arteriography was not always helpful in the diagnosis because of intrasaccular thrombosis which reduced or obliterated the true lumen (Fig. 2). However, it was always done to determine the outflow tract.

PRESENTATION

Table III shows the method of presentation. In 26 limbs the presenting features were acute arterial occlusion of either minor or major extent. Where the ischaemia affected the distal part of the foot, small-vessel occlusion was usually the cause, presumably from embolism. In many of these limbs one or both pulses at the ankle were absent and small areas of scattered cutaneous petechiae were often seen. In massive ischaemia the cause was usually thrombosis of the aneurysm, which was usually large. In many of these patients there was a history of chronic ischaemia, such as claudication. Two patients who presented with a massive ischaemia had ruptures of their aneurysms.

TABLE III. PRESENTING CLINICAL FEATURES OF 55 ANEURYSMS

Presentation	No.
Acute arterial occlusion	26
Chronic arterial occlusion	11
Local pain and swelling	4
Asymptomatic	14
	—
Total aneurysms	55

In 11 limbs the major symptom was claudication and in 4 patients the aneurysm produced local pain in the popliteal fossa, with or without a swelling. In 14 extremities the aneurysms were asymptomatic and usually found on routine examination.

TABLE IV. PRESENTING COMPLICATIONS

Complication	No.
Thrombosis	28
Embolism	7
Rupture	2
	—
Total	37

The complications which correlated well with the clinical features are listed in Table IV. In 28 limbs the aneurysm was occluded by a thrombus, which was confirmed by arteriography and at operation. In 7 aneurysms embolism was presumed from distal ischaemia caused by small-vessel occlusion of the tibial or plantar arteries, and by the finding, in some patients, of petechiae of the skin. There were 2 ruptured popliteal aneurysms which presented with diffuse swelling and ecchymosis of the thigh and calf and impending gangrene. Rupture was confirmed at operation.

TREATMENT AND RESULTS

Of the 55 aneurysms, the diagnosis of aneurysm was not made initially in 10 patients. The patients in this group presented with either severe ischaemia or intermittent claudication, and provisional diagnosis of atherosclerosis obliterans of the femoropopliteal segment was made. The true nature of the occlusion, thrombosis of a popliteal aneurysm, became evident only at surgery. In 7 patients, amputation was done for established gangrene in 4 limbs, and severe rest pain in 3 limbs. The latter were not amenable to reconstructive vascular surgery because of an absent or inadequate 'run-off' at exploration. The fact that these aneurysms were not diagnosed pre-operatively, is presumptive evidence of their small size. Three of these patients were successfully treated by grafting. There was 1 death in this group.

In 45 limbs in which the diagnosis of popliteal aneurysm was made initially, 27 patients were submitted to surgery. In this surgically-treated group, 4 of the limbs were amputated at the outset for established gangrene or severe ischaemia, which, on arteriography or exploration, precluded reconstructive vascular surgery. The 2 ruptured popliteal aneurysms were in this group: 23 limbs were grafted.

The remaining 18 limbs with aneurysms were not submitted to surgery at first because the aneurysms were too small and asymptomatic, the general condition of the patient poor, the patient refused surgery, there was established thrombosis with minimal claudication, or there was extremely poor 'run-off' on arteriography. Of these 18 patients, 14 were available for follow-up, 1 of whom has since died. Six aneurysms have since thrombosed and 2 have lost their limbs. Three patients developed claudication and 1 patient in this group was grafted. Two patients, who at first refused surgery, subsequently consented because of an increase in the size of the aneurysm, and of pain. The remaining 3 patients are in statu quo after periods of observation of 3 months to 4 years.

TABLE V. RECONSTRUCTIVE VASCULAR PROCEDURES

Procedure	No.	Result
Excision grafting	9	1 amputation
Autogenous vein 5		
Prosthesis 4		
Bypass grafting	20	1 amputation
Autogenous vein 19		
Prosthesis 1		

Vascular reconstructions were done in 29 limbs (Table V). In 9 limbs the aneurysms were resected and continuity restored by an autogenous vein graft in 5, and a Dacron prosthesis in 4. In 20 limbs the aneurysm was treated by the exclusion bypass procedure, ligating the afferent and efferent vessel, or simply bypassing the aneurysm if it had thrombosed. Of the 29 patients who had grafts, 2 limbs were amputated after surgery, but in both the grafts proved to be patent. Amputation was required for irreversible ischaemic changes which were

not evident before grafting. An above-knee amputation was done on 1 patient and on another a conservative transmetatarsal amputation. The early-patency rate in the grafted limbs was ±93%. In the resected non-complicated popliteal aneurysm the early-patency rate was 100%. Of the 27 patients who were discharged with functioning grafts, 2 of the Dacron grafts occluded within 1 year and 1 vein graft occluded at the end of 2 years. One of these patients required an amputation, 1 developed claudication, but in the third the circulation was restored by regrafting with a saphenous vein. Of the 15 grafts, 5 have been lost to follow-up, the others have remained patent for periods from 3 months to 8 years.

DISCUSSION

The result of this study shows that by far the most common cause of popliteal aneurysm is atherosclerosis. This is in accord with other reports.[1,3,4-6,7] An unusual, but increasingly recognised cause is the popliteal artery entrapment syndrome, of which 4 cases were encountered.[8,9] The 2 false aneurysms in this series occurred at the distal ends of femoropopliteal arterial anastomoses, in which the grafts were prostheses (Fig. 3). Most false aneurysms, occurring after femoropopliteal grafting with a prosthesis, usually appear in the groin. Both patients in this series lost their limbs.

A striking feature of the atherosclerotic group is the unusually high incidence of males. Arteriosclerotic aneurysms of the abdominal aorta are about 10 times more frequent in men than women,[10] but in this series of popliteal aneurysms, the sex incidence was ±98% male. Crichlow and Roberts[4] did not encounter any females in their series. The higher sex incidence of the male might be explained by the greater susceptibility of the male to trauma. The age incidence corresponds, not unexpectedly, with that of atherosclerosis in general. The youngest patient was aged 33 years and the diagnosis was proved histologically.

Bilateral popliteal aneurysms occurred in almost 30% of the patients and extrapopliteal aneurysms were found in 24%. Wychulis et al.[7] found in their series that 59% had bilateral popliteal aneurysms and 45% had aneurysms elsewhere. This association should always lead to a diligent examination of the major arterial trunks in patients suffering from popliteal aneurysms. One patient, aged 68 years, ruptured an abdominal aortic aneurysm a week after an above-knee amputation for a thrombosed popliteal aneurysm. The abdominal aneurysm was successfully resected, but the patient died 3 weeks later from massive pulmonary embolism. Dent et al.[11] found that among 36 patients with a popliteal aneurysm, 78% had a second aneurysm, 64% had an aorto-iliac aneurysm, and 47% had bilateral popliteal aneurysms. They suggest the greater use of arteriography to show up aneurysms not clinically apparent.

Complications are frequent in popliteal aneurysms. Sixty-seven per cent of the patients in this series had complications when they were first seen. By far the commonest complication was acute arterial occlusion, caused mainly by thrombosis or embolism, and this occurred in

Fig. 3. Arteriogram to show a false aneurysm at the distal anastomosis of a femoropopliteal bypass graft, in which a prosthesis was used.

47% of the patients. The incidence of limb loss was 20%. Most of the patients in this group were not amenable to reconstructive vascular surgery, for gangrene was established, or the distally occluded arteries could not be cleared of thrombus.

The small aneurysms were not immune to thromboembolic complications. In 18% of the limbs the aneurysms often presented as an acute arterial thrombosis and, in some cases, were not suspected, the diagnosis being made at operation (Fig. 4). Boyd et al.[12] drew attention to this finding in their experience.

Of the 18 patients whose aneurysms were not submitted to surgery in the first instance, 6 thrombosed subsequently with the loss of a limb in 2 patients. The amputation rate was, therefore, about 27%. In patients whose aneurysms were grafted, the limb salvage rate was 93% and, in cases without complications, the early-patency rate was 100%.
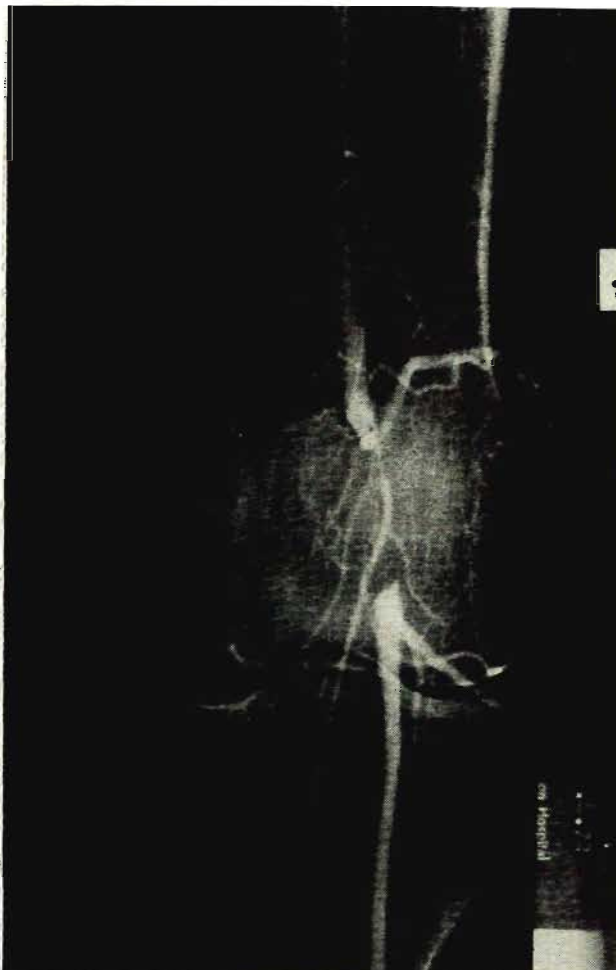
Fig. 4. Arteriogram to show a popliteal artery occlusion in a man aged 33 years, who presented with acute claudication. An aneurysm 1,5 cm in diameter was found at operation, which was not clinically palpable.

Fig. 5. Arteriogram of man aged 52 years, to show the course of the popliteal artery with the knee joint extended.

The predilection of popliteal aneurysms more than any other aneurysm for thrombo-embolic complications can probably be accounted for on the basis of the anatomy of the popliteal artery. The popliteal artery is about 15 to 20 cm in length and is relatively fixed at its origin, where it enters the popliteal fossa through the adductor hiatus, and at its termination at the lower border of the popliteus muscle where the anterior tibial artery perforates the interosseous membrane. The geniculate and muscular branches of the artery tend to restrict mobility of the artery.

With the knee joint extended, the popliteal artery runs parallel to the long axis of the femur and the tibia (Fig. 5). With the knee joint flexed, the popliteal artery becomes lengthened relative to the posterior surface of the femur and tibia, and for it to conform with the shorter course in the popliteal fossa, the artery either becomes foreshortened, or the redundant artery assumes a tortuous course. With advancing age, arteries, especially the atherosclerotic artery, lose their elasticity and cannot shorten.

A series of kinks, therefore, may form and may obstruct or narrow the lumen (Fig. 6). It is quite easy to understand how thrombosis in a popliteal aneurysm may occur, and especially after prolonged sitting or squatting.

The concept of post-stenotic dilatation being a factor in the pathogenesis of popliteal aneurysms, has support. Stenosis of the femoral artery at the adductor hiatus, caused by atheroma, is often found, and may be a factor precipitating proximal aneurysms. With regard to distal popliteal aneurysms, the arcuate popliteal ligament which becomes sharp and prominent when the leg is fully extended, has been involved.[13] Boyd et al.[12] incriminated a fibrous tunnel derived from fascia on the deep surface of the gastrocnemius muscle just above the level of the knee joint. In the cases of the 4 limbs affected by the popliteal entrapment syndromes presented here, the cause was clearly post-stenotic dilatation. In all the limbs the pop-

Fig. 6. Arteriogram to show that with the knee joint flexed, and the popliteal artery relatively lengthened, a series of kinks and undulations develops.

liteal artery took an abnormal course around or through the medial head of the gastrocnemius muscle, and thrombosed aneurysms were found in the 4 limbs.

Rupture of a popliteal aneurysm was unusual in this series and encountered only twice. This contrasts the high incidence of rupture of aortic aneurysms. The difference can be accounted for by the greater diameter of an abdominal aortic aneurysm and the correspondingly greater increase in wall tension (law of La Place). The high incidence of limb loss when popliteal aneurysms rupture, is understandable, having regard to the severe ischaemia which is produced by pressure, not only on the venous return, but also on collaterals. Although both limbs were amputated in this series, this should not preclude successful repair.

With regard to treatment, the results of vascular reconstructive surgery were found to be excellent if it was done before the development of complications. Consideration should, therefore, be given to the surgical extirpation of all aneurysms, irrespective of size, unless life expectancy is short, or the general condition of the patient precludes this. The need to treat a thrombosed aneurysm presenting with claudication only, will obviously depend on the degree of disability.

The view[14] that the natural history of the moderate or small aneurysm usually shows it to be harmless, cannot be supported by this experience, and the follow-up of patients with untreated aneurysms shows that the limbs are often lost.[15] Furthermore, reconstructive surgery of the uncomplicated aneurysm gives outstanding results, and the operation is exceedingly well tolerated even by the elderly patient. Thrombosis in small aneurysms is likely to produce claudication only, but in larger aneurysms thrombosis is more likely to produce gangrene because of the greater involvement of collaterals.

With regard to diagnosis, arteriography should always be done, not so much to establish the diagnosis, as to determine the outflow tract and for assistance in siting the distal anastomosis. For diagnostic purposes, arteriography can be extremely misleading in the popliteal aneurysm, in much the same way as it is in the abdominal aneurysm. Intrasaccular thrombosis is almost invariably present, which reduces the size of the true lumen and leaves a channel, regular or irregular, which may be erroneously construed as made by the true arterial wall (Fig. 2). Even where arteriography failed to show an outflow tract, this did not influence the decision to operate, especially with acute thrombosis. In many limbs the occluded outflow tract was caused by recent thrombus or embolus which could be cleared with a Fogarty catheter, to produce satisfactory backflow with successful grafting.

The type of surgical procedure employed was modified with experience. Early in this series an attempt was made to remove the aneurysm. This involved unnecessary dissection, and, on occasions, damage to the popliteal vein which lengthened the operation. Subsequently, the aneurysms were left *in situ* and bypassed after the proximal and distal ends of the aneurysm had been ligated. If the aneurysm was thrombosed, the latter part of the procedure was omitted. The preferred replacement was always autogenous saphenous vein and the type of anastomosis usually a proximal end-to-side, and a distal end-to-side, anastomosis. Occasionally the distal anastomosis was end-to-end, the distal popliteal artery having been divided. With a very small mobile aneurysm, the aneurysm was excised and the defect repaired with a vein graft, whenever possible. In 1 patient, suffering from the popliteal entrapment syndrome, where the aneurysm was saccular, aneurysmorrhaphy, using a vein patch-graft, was done.

Although either a posterior or medial approach can be used for the popliteal artery, the medial approach was preferred in most of the patients in this series. This approach allows adequate exposure of the entire length of the popliteal artery and easy access to the saphenous vein. Occasionally the saphenous vein on the medial side of the knee is of insufficient diameter, but a vein of adequate calibre can usually be obtained from the upper thigh region. With the patient prone, access to the groin region is not possible, and therefore, if required, the vein

must be removed before the patient is turned. Lumbar sympathectomy was also done on some patients who had poor arterial outflow.

Excision of the aneurysm only, with the sympathectomy,[2] probably has little place in the modern treatment of popliteal aneurysms. The degree of residual ischaemia after such procedures is unpredictable. Even when the popliteal artery is thrombosed beyond the popliteal bifurcation, a search for a distal patent tibial vessel should be made. A femoral distal tibial bypass graft was done for 1 patient, with success.

Proximal ligation of the femoral artery, the Hunterian ligation, originally described for the treatment of popliteal aneurysms, but seldom practised today for fear of distal ischaemia, is still occasionally indicated. In the elderly poor risk patient with an expanding or painful aneurysm and impending rupture, ligation of the superficial femoral artery in Hunter's canal can be done under local anaesthesia, and is a relatively simple procedure.[14]

With regard to vascular replacement, autogenous vein of good calibre is probably the best, but Dacron grafts,[17] when suitable veins are not available and when the afferent and efferent arteries are wide, which is often the case, can be a satisfactory alternative. Autogenous external iliac artery, or reconstituting the iliac artery by a Dacron prosthesis, seems an unnecessarily complicated replacement.[18]

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