Arteriosclerotic Popliteal Aneurysms

Diagnosis and Management

By S. M. Greenstone, M.D., T. B. Massell, M.D., and E. Craig Heringman, M.D.

IN THE FIELD of medicine there are few conditions presenting a threat to life and limb that are as readily diagnosable before the occurrence of catastrophe as aneurysms of the popliteal artery. Moreover, this is a pathology condition that has been amenable to surgical attack for 200 years, since John Hunter performed femoral artery ligation in the adductor canal. In spite of the potential ease of diagnosis and the availability of successful therapy, most popliteal aneurysms are allowed to go on to disastrous complications, either unrecognized or untreated.

The high incidence of complications has been shown by Gifford, Hines, and Janes in an analysis of 100 cases of popliteal aneurysms. They described acute thromboses in 20 cases, rupture of the aneurysm in 16, peripheral emboli from the aneurysm in 14, and gangrene of the extremity in 24 cases. In addition they reported a limb loss of 23 per cent following conservative treatment, as compared to 8 per cent following surgical intervention. Linton reported an amputation rate of 77 per cent in untreated cases. In his series of operative cases, sympathectomy followed by aneurysmectomy, there were no amputations. Other reports have indicated equally good results following surgical intervention. Lord advocated endoaneurysmorrhaphy in patients who are poor surgical risks or who have no distal pulses. In good-risk patients and in those with pedal pulses he employed venous autografts. Austin and Thompson and Bahnson have had success with homografts, and Julian et al. reported the restoration or preservation of ankle pulses in seven of nine cases with the use of venous autografts or homografts.

These series indicate the generally successful results that can be obtained by the surgical approach, varied though it may be. The important feature is the early diagnosis and the recognition of the potential seriousness of the untreated condition.

The purpose of this paper is to elucidate the clinical features of arteriosclerotic popliteal aneurysms and to illustrate the various surgical methods of treatment that are available and may be particularly suited to the individual case.

Table 1 summarizes the major features of each patient. Certain of these cases are reported in detail below, followed by comments regarding the salient points of diagnosis and treatment.

Case Reports

Case 1

A 32-year-old white man, previously well, appeared with a 1-week history of pain and swelling behind the right knee. Examination revealed a pulsatile mass in the right popliteal area associated with a bruit. Posterior tibial and dorsalis pedis pulses were present. The serologic test for syphilis was negative. An arteriosclerotic aneurysm of the popliteal artery was resected with restoration of arterial continuity by means of an iliac artery homograft inserted end-to-end. Good pedal pulses were noted postoperatively. Nine months later the pedal pulses had disappeared and the oscillometric readings below the knee were greatly reduced. It is likely that occlusion of the homograft has taken place. His only symptom, however, is mild claudication after walking three or four blocks.

Although the majority of arteriosclerotic aneurysms, popliteal and otherwise, are found in the older age groups, one must still consider their possibility in younger individuals. A pulsatile mass and a bruit are diagnostic at any age. An effort should be made to establish arterial continuity after resection of the aneurysm, if the popliteal branches are patent. This case is also an example of homograft failure, of which many others have been reported in the recent literature. It is probable that the occlusion of the homograft was gradual, allowing sufficient collateral circu-
### Table 1

**Summary of Cases of Popliteal Aneurysms**

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age</th>
<th>Sex</th>
<th>Symptoms</th>
<th>Findings</th>
<th>Pulses Pre-op.</th>
<th>Surgery</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>M</td>
<td>Painful swelling</td>
<td>Arteriosclerotic aneurysm; no thrombosis or leakage</td>
<td>Present</td>
<td>Resection and iliae artery homograft</td>
<td>Pulses maintained; good initial result; absent pulses 9 months later</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>M</td>
<td>Calf pain, blisters, and coldness</td>
<td>Compression of popliteal veins by aneurysm producing phlebitis</td>
<td>Present</td>
<td>Sympathectomy followed by resection and venous autograft</td>
<td>Excellent pulses present 4 years later</td>
</tr>
<tr>
<td>3</td>
<td>56</td>
<td>M</td>
<td>Pain followed by claudication and numbness</td>
<td>Dissecting aneurysm with recent thrombosis</td>
<td>Absent</td>
<td>Resection and Tefon prosthesis</td>
<td>Excellent restoration of pulses; claudication gone</td>
</tr>
<tr>
<td>4</td>
<td>73</td>
<td>M</td>
<td>Sudden pain and discoloration 4 days</td>
<td>Thrombosed popliteal aneurysm, rapid gangrene</td>
<td>Absent</td>
<td>Thigh amputation</td>
<td>Working with prosthesis 3 1/2 years</td>
</tr>
<tr>
<td></td>
<td>Lt.</td>
<td></td>
<td>Asymptomatic mass in popliteal area</td>
<td>Probable old thrombosed aneurysm; history suggesting arterial insufficiency in the past</td>
<td>Absent</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>M</td>
<td>Pain, coldness and discoloration following recent trauma</td>
<td>Thrombosed popliteal aneurysm</td>
<td>Absent</td>
<td>Exploration popliteal artery; thrombosis involved branches of artery; could not restore circulation</td>
<td>Below-knee amputation</td>
</tr>
<tr>
<td></td>
<td>Lt.</td>
<td></td>
<td>Asymptomatic</td>
<td>Arteriosclerotic aneurysm without thrombosis or leakage; major branches aneurysmal</td>
<td>Present</td>
<td>Sympathectomy followed by ligation of popliteal artery</td>
<td>Good results; no symptoms</td>
</tr>
<tr>
<td>6</td>
<td>75</td>
<td>M</td>
<td>Pain and enlarging mass</td>
<td>Aneurysm with evidence of old and recent leakage</td>
<td>Absent</td>
<td>Ligature in adductor canal</td>
<td>Can walk 8 to 10 blocks without pain</td>
</tr>
<tr>
<td>7</td>
<td>62</td>
<td>M</td>
<td>Pain and coldness</td>
<td>Multiple aneurysms of femoral and popliteal arteries with recent thrombosis; amputation of opposite leg 4 years previously</td>
<td>Absent</td>
<td>Exploration of artery; circulation could not be restored; lumbar sympathectomy</td>
<td>Amputation below knee</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>M</td>
<td>Pain, coldness, and numbness</td>
<td>Recent thrombosis involving popliteal aneurysms and extending proximally into femoral artery and distally into all branches</td>
<td>Absent</td>
<td>Exploration of artery; unable to restore circulation; lumbar sympathectomy</td>
<td>Above-knee amputation</td>
</tr>
<tr>
<td></td>
<td>Lt.</td>
<td></td>
<td>Asymptomatic</td>
<td>Pulsating aneurysm</td>
<td>Present</td>
<td>Awaiting excision and graft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rt.</td>
<td></td>
<td>Asymptomatic</td>
<td>Pulsating aneurysm involving popliteal artery and all three branches</td>
<td>Present</td>
<td>Lumbar sympathectomy followed by excision of aneurysm 2 weeks later; no graft</td>
<td>Good result; no claudication; 4 years later pedal pulses noted due to excellent collateral circulation</td>
</tr>
<tr>
<td>9</td>
<td>44</td>
<td>M</td>
<td>Pain and tightness in popliteal space; recent injury to knee</td>
<td>Pulsating aneurysm involving popliteal artery and all three branches</td>
<td>Present</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ARTERIOSCLEROTIC POPLITEAL ANEURYSMS

lation to develop so that the ensuing symptoms were minimal.

Case 2

A 62-year-old white man developed pain in the left calf, becoming progressively worse and associated with cyanotic blotching or mottling of the skin and coldness of the foot. There was no history of trauma. Examination revealed tenderness of the left calf, cyanosis of the skin, and a positive Homans' sign. A pulsating aneurysm of the left popliteal space was also felt; the pedal pulses were present. A diagnosis of deep thrombophlebitis was made, and it was thought that this condition was secondary to compression of the popliteal vein by the aneurysm.

The patient was treated with anticoagulant drugs and showed improvement in his symptoms and disappearance of the discoloration. A left lumbar sympathectomy was then performed. Two weeks later the popliteal aneurysm was excised and arterial continuity was re-established with a venous autograft taken from the ipsilateral great saphenous vein. His postoperative course was uneventful, and 4 years later excellent pedal pulses were noted in the operated leg. He had no residual symptoms except for minimal swelling, which was probably secondary to his previous phlebitis and varicosities.

Compression of the popliteal vein is one of the complications of popliteal aneurysm. In view of the close proximity of the artery and vein in the relatively closed space, one wonders why this complication is not more often noted. The increasing obstruction to the popliteal vein may result first in edema and eventually in thrombosis, as illustrated in this case. The enlarging aneurysm may also press on the tibial and peroneal nerves causing considerable pain in the areas of their distribution. The end result with the venous autograft in this case is consistent with that reported in Lord's series.

Case 3

A 56-year-old white man noted the sudden onset of cramping pain in the right calf followed by numbness in the foot. Popliteal and pedal pulses were absent on the right and normal on the left. A popliteal mass was not discernible. A percutaneous femoral arteriogram disclosed occlusion of the popliteal artery, but the diagnosis of aneurysm was not established. Operation revealed a long, fusiform aneurysm of the popliteal artery, which was resected, and the blood flow was re-established with a 3/8-inch woven Teflon prosthesis. The specimen measured 6.2 cm. in length and 0.8 to 1.0 cm. in diameter. When the aneurysm was opened, it was found to be a dissecting aneurysm, the dissection occurring between the inner two thirds and outer one third of the media. There was fresh thrombus in the false lumen, compressing but not completely occluding the true lumen. Postoperatively the patient did well with complete relief of his symptoms and restoration of both pedal pulses.

Although one usually associates arterial dissection with the aorta, especially the arch and thoracic portions, it can occur in other vessels that are arteriosclerotic, and should be considered in the differential diagnosis of acute arterial occlusions.

Case 4

A 73-year-old man was admitted with a history of sudden pain and discoloration of the right leg 4 days in duration. Examination revealed a cold, pulseless, mottled lower leg. Gangrene and toxicity rapidly developed, necessitating a low-thigh amputation. Examination of the specimen showed a typical arteriosclerotic aneurysm well localized to the popliteal artery and containing old and fresh thrombus. Postoperatively he did well and has been fitted with a prosthesis. He has been completely rehabilitated. Examination of the opposite leg in this patient revealed a thrombosed aneurysm of the popliteal artery with pulsation in the femoral artery down to the aneurysm but no pulsations distally. He had minimal symptoms of arterial insufficiency in this leg and described an episode suggestive of acute occlusion in the past.

The development of an arteriosclerotic popliteal aneurysm ordinarily does not in itself produce significant collateral circulation in the extremity, such as is usually noted in gradually obliterator arteriosclerosis. When acute occlusion due to thrombosis does occur, collateral circulation is inadequate, and the outcome is usually gangrene.

Case 5

A 65-year-old white man was admitted to the hospital with pain, coldness, and discoloration of the left leg following trauma. Examination disclosed evidence of a thrombosed popliteal aneurysm with no distal pulses. At operation the thrombotic process extended into the major branches of the popliteal artery. It was impossible to remove the thrombus completely. Gangrene developed, necessitating amputation below the knee.

The diagnosis of a popliteal aneurysm of the opposite leg was made during the same admission. This aneurysm was pulsatile and pedal pulses were present. A right lumbar sympathectomy was performed followed by exploration of the popliteal artery 1 week later. A large, pulsating aneurysm was present, involving the popliteal trifurcation so that grafting was not feasible. The arterial branches were ligated close to the aneurysm, and the popliteal artery was divided im-

Circulation, Volume XXIV, July 1941
mediately proximal to the aneurysm without disturbing collateral circulation. Postoperatively he did well and had no symptoms in that leg.

**Case 6**

A 75-year-old man complained of progressive pain in the left thigh and popliteal area associated with an enlarging mass in this region. Examination revealed a large pulsatile mass in the popliteal area with considerable tenderness, induration of the overlying tissues, and ecchymotic discoloration. There were no distal pulses. On exploration a large arteriosclerotic aneurysm of the popliteal artery was found. This was surrounded by marked inflammatory reaction, almost of a granulomatous type, the result of previous episodes of leakage from the aneurysm. There was also evidence of recent leakage but no massive hemorrhage. Smaller aneurysms were present along the course of the femoral artery associated with considerable atherosclerotic changes.

Owing to the marked inflammatory reaction surrounding the aneurysm, the involvement of the major branches of the popliteal artery, the extensive atherosclerotic changes, and the patient's poor general condition, it was not considered advisable to resect the aneurysm or to try to maintain arterial patency. The superficial femoral artery was ligated in Hunter's canal as close as possible to the aneurysm to preserve proximal collateral vessels. This procedure was very similar to that described by John Hunter in the eighteenth century. Postoperatively the foot remained warm and of good color, with no evidence of ischemia. The postoperative course was complicated by deep thrombophlebitis that was treated with anti-coagulant drugs. Ten months later the patient was able to walk 8 to 10 blocks without stopping with no symptoms referable to the operated leg other than residual edema well controlled with an elastic stocking.

Rupture of a popliteal aneurysm is not an uncommon complication. If untreated, death may result from continued loss of blood and toxic absorption. If grafting is not feasible, then obliteration endoaneurysmorrhaphy or a simple ligation of the popliteal artery above the aneurysm will suffice to prevent further leakage or frank hemorrhage.

**Case 7**

A 62-year-old white man developed sudden pain and coldness of his left leg. He was mildly diabetic, and 4 years previously had had mid-thigh amputation of the right leg for arteriosclerotic gangrene. The left leg was noted to be cold and mottled below the knee. Popliteal and pedal pulses could not be felt but at surgery small pulsatile aneurysms were found along the entire course of the femoral artery. Calcification in these aneurysms was readily demonstrated by x-ray.

A left lumbar sympathectomy was performed followed by immediate exploration of the popliteal artery. This was found to be aneurysmal also and completely occluded by a thrombus that extended into all the distal branches. A thrombectomy was performed but retrograde blood flow could not be obtained. He subsequently developed gangrene of the lower third of the left leg. After a below-knee amputation this patient had an uneventful recovery. He is ambulatory with bilateral prostheses.

**Case 8**

A 50-year-old white man was seen approximately 8 hours following the sudden onset of pain, coldness, and numbness of the left leg. The leg was cold and pale from the mid-thigh downward, with no pulses below the femoral artery in the groin. He could not move his toes or foot.

A lumbar sympathectomy was performed immediately, followed by exploration of the femoral-popliteal artery. This revealed extensive atherosclerosis of the femoral artery with a popliteal aneurysm. Both the artery and aneurysm were completely occluded by a recent thrombus that involved all the major branches and collateral blood vessels. Blood flow could not be re-established. He rapidly developed gangrene. This necessitated an above-knee amputation, which healed satisfactorily.

Examination of the opposite leg revealed a pulsating popliteal aneurysm with pedal pulses. He is now awaiting operation on the right leg.

**Case 9**

A 44-year-old man noted pain and tightness in the right popliteal area shortly following an injury to that region. Examination revealed a pulsatile aneurysm of the right popliteal artery with good pedal pulses. A lumbar sympathectomy was performed, followed by exploration of the aneurysm in 2 weeks. The aneurysm was found to involve the entire popliteal artery and the trifurcation, so that the insertion of a graft was not feasible. The aneurysm was excised without an attempt to restore arterial continuity. Immediately following operation there were no pulses in the foot, but it was warm, of good color, and showed no arterial insufficiency. When last seen, 4 years later, he had excellent pedal pulses on the right leg and the oscillometric readings at the right ankle were almost as good as those on the left. He had no claudication.

The reappearance of the pedal pulses was due to the combined effects of the lumbar sympathectomy and the preservation of all collateral circulation during the excision of the aneurysm.

*Circulation, Volume XXIV, July 1961*
Results

Nine patients with a total of 12 popliteal aneurysms are reported.

Three extremities were treated with resection of the aneurysm and restoration of blood flow by a homograft, venous autograft, or plastic prosthesis. The initial results in all three cases were good, with maintenance or restoration of the pedal pulses in each case. Good results were maintained in two of the extremities to the present time. In one case pulses disappeared 9 months after operation owing to failure of the homograft.

Three extremities were treated by ligation of the popliteal artery or excision of the aneurysm with or without lumbar sympathectomy. In all three cases viability of the extremity was assured, and the patients were asymptomatic at follow-up.

In four extremities acute thrombosis of the aneurysm was the presenting feature and gangrene of the extremity resulted in all. Direct surgical attack on the aneurysm resulted in all cases. In one case pulses were palpable but did not assure survival of the limb. These results indicate the serious nature of thrombosis of a popliteal aneurysm in regard to survival of the limb and speak for earlier diagnosis before this complication occurs.

Discussion

The diagnosis of popliteal aneurysm will be missed in most cases unless careful palpation of the popliteal area is part of every physical examination. Except for the occasional occurrence of symptoms due to pressure on the popliteal vein or the adjacent nerves, popliteal aneurysms are generally silent. Symptoms sufficient to call attention to the aneurysm are manifestations of catastrophic complications such as thrombosis or rupture.

Because of the absence of a significant history, it may be difficult to distinguish an aneurysm from a popliteal cyst or tumor. In such cases femoral arteriography by percutaneous injection may be helpful. A popliteal aneurysm will rarely be demonstrated as a saccular structure filled with opaque medium, but rather will give the appearance of an arterial occlusion, even when there is no evidence of diminished blood flow distal to the aneurysm. On the other hand a popliteal cyst or tumor will not disturb the normal arterial contour, unless it is causing so much extrinsic pressure that reflex vasospasm will cause a clinical picture of complete arterial occlusion.

As the reported series has demonstrated, various forms of treatment may be employed. Resection of the diseased artery and restoration of arterial continuity is the procedure of choice. On the basis of our experience with various types of grafts in other areas we believe that a venous autograft is best for popliteal artery replacement, because a relatively short segment of vessel of small lumen is needed. If a venous autograft is not suitable, due to technical reasons, then arterial continuity can be restored with a plastic prosthesis such as Teflon. It is not always feasible, however, to do a grafting operation, especially if the aneurysm extends beyond the popliteal trifurcation or when there are extensive and diffuse degenerative changes of most of the femoral artery. The danger of thrombosis of a very long graft or one of very small caliber is so great that we believe one of the older procedures such as endoaneurysmorrhaphy or Hunterian ligation is less likely to produce dangerous ischemia, especially if reinforced by lumbar sympathectomy. In our experience all the types of operation used gave uniformly satisfactory results in uncomplicated popliteal aneurysms.

On the other hand, once thrombosis occurred, no form of treatment seemed capable of saving the overwhelming majority of the involved limbs. If the patient with the dissecting aneurysm is omitted, since his thrombosis involved only the false lumen, it will be seen that only one patient escaped amputation after his aneurysm thrombosed. Treatment by sympathectomy may lower the level of amputation but restoration of blood flow is generally impossible.

Summary and Conclusion

1. Arteriosclerotic popliteal aneurysms are usually asymptomatic until complications oc-
These complications are nerve pressure, popliteal thrombophlebitis, hemorrhage from the aneurysm, and acute thrombosis of the aneurysm. 2. Diagnosis is relatively easy and can be accomplished usually by simple palpation of the popliteal space. 3. Femoral arteriography differentiates aneurysms from extra-vascular popliteal masses. 4. Various forms of surgical treatment have been shown to be satisfactory in the uncomplicated cases. 5. Of the complications described, leakage is consistent with salvage of the limb but thrombosis is more frequent and usually necessitates amputation. Early diagnosis and treatment are obviously desirable.

References

Leopold Auenbrugufer
1722—1809

Many doctors paid absolutely no attention to Auenbrugufer's discovery. Others declared that it was not a discovery at all, that there was nothing new in what he wrote, since it was to be found in the Hippocratic writings. Yet others regarded percussion as a needless molestation of the sick. Much more distressing to Auenbrugufer was de Haen's cold and stubborn silence, for the Dutchman was antagonistic to innovations, took no notice of them, contumptiously ignored them. Nevertheless if there was any place where the new method might have proved fruitful, it was at the Viennese clinic.

Still the book was widely read, so that in two years a new edition was called for. Many of its readers recognized its importance. Haller declared that percussion was 'worthy of close attention, and, it would seem, an entirely new discovery. It is true that proposals of this kind must not be unhesitatingly accepted, but they deserve our respectful attention.'—Henry E. Sigerist, M.D. The Great Doctors. New York, W. W. Norton & Co., Inc., 1933, p. 241.