Surgical Management of Popliteal Aneurysms

By L. Henry Edmunds, Jr., M.D., R. Clement Darling, M.D.,
and Robert R. Linton, M.D.

POPLITEAL ANEURYSMS if untreated have a high incidence of limb-threatening and occasionally life-endangering complications. Gifford, Hines, and Janes, reporting on 100 aneurysms treated between 1913 and 1951, observed that 23 per cent of 80 conservatively managed popliteal aneurysms eventually resulted in amputation. Of 45 patients with asymptomatic aneurysms, followed for an average of 46 months, 29 per cent developed complications and 11 per cent required amputations. Linton reported a 77-per cent limb loss and a 27-per cent mortality in 22 conservatively treated aneurysms occurring in 15 patients.

In the last two decades the surgical management of popliteal aneurysms has evolved from sympathectomy, alone or combined with excision of the aneurysm, to direct arterial reconstruction utilizing arterial homografts, various prosthetic tubes, or autogenous vein grafts. This report is an analysis of 98 popliteal aneurysms in 82 patients treated by surgery at the Massachusetts General Hospital in the 16 years from 1948 to 1963. Patients treated by both the resident and visiting staffs are included. This study does not include patients requiring primary amputation when first seen.

Clinical Features

The 98 aneurysms occurred in 82 patients, all except one of whom were male. The age distribution is presented in figure 1. All except two aneurysms (one traumatic and one mycotic) were thought to be due to arteriosclerosis, although one patient had concomitant syphilis. The right leg was affected in 25, the left in 31, and both legs in 26. Sixteen of the

![AGE DISTRIBUTION - 82 patients](image)

**Figure 1**

Age distributions in 82 patients with popliteal aneurysms. (Massachusetts General Hospital 1948-1963).

bilateral group had both aneurysms operated on at this hospital.

The coexisting diseases in these 82 patients are summarized in table 1. The low incidence of diabetes and the high incidence of hypertension are noteworthy. Nineteen patients had no clinical manifestation of arteriosclerosis other than their popliteal aneurysms.

The usual complications of popliteal aneurysms are embolism or thrombosis with or without gangrene, pressure on the popliteal vein or posterior tibial nerve, and infrequent-

<table>
<thead>
<tr>
<th>Coexisting Diseases in 82 Patients with Popliteal Aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
</tr>
<tr>
<td>Valvular heart disease</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Previous myocardial infarct or angina</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
</tr>
<tr>
<td>Aneurysms other than popliteal</td>
</tr>
<tr>
<td>Arteriosclerotic occlusive disease</td>
</tr>
<tr>
<td>Recent cardiac arrhythmia (1 month)</td>
</tr>
<tr>
<td>Polycythemia vera</td>
</tr>
<tr>
<td>Syphilis</td>
</tr>
<tr>
<td>None</td>
</tr>
</tbody>
</table>

From the Department of Surgery, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts.

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ly rupture. In addition, patients may complain of local pain or may become aware of an otherwise asymptomatic aneurysm during self or professional examination.

Acute Ischemia
In 23 instances (23.5 per cent) the presenting signs and symptoms related to acute arterial occlusion resulting from thrombosis of the popliteal aneurysm. The duration of symptoms was from 2 to 48 hours. In 18 of the 23 limbs (82 per cent) the acute occlusion was the first symptom of the popliteal aneurysm. The circulation in 13 extremities (57 per cent) was considered not adequate for limb survival and these limbs showed evidence of nonviability at the time of admission, that is, evidence of both sensory and motor loss at the ankle, lack of capillary filling, and early muscle swelling. In the remaining 10 patients, though obviously ischemic, the extremity was considered clinically to be viable at the time of admission.

Chronic Ischemia
In 36 patients (36.7 per cent) the major presenting complaint was intermittent claudication, commonly of a severe nature. These limbs had survived one or more episodes of acute embolization to the distal tibial outflow vessels. Commonly, the popliteal aneurysm was still pulsatile but in all instances one and usually both pedal pulses were absent. Five patients, in addition, had overt tissue necrosis distally as well as ischemic pain at rest.

Expanding Mass
Many of the 59 patients with occlusive symptoms also had local pain from the aneurysmal mass in the popliteal space, at least five patients presenting with typical calf thrombophlebitis as a result of compression of the popliteal vein. The typical radiation of posterior tibial nerve compression with pain in the heel was elicited in a single patient. Twelve patients, who did not have occlusive symptoms, complained only of local pain in the popliteal space. Four additional patients had aneurysms that had hemorrhaged into the popliteal space. Three of these were atherosclerotic and one was mycotic in origin. Two patients had had a previous popliteal exploration elsewhere because of a suspected Baker's cyst.

Asymptomatic Aneurysms
The fourth group of 23 limbs was essentially asymptomatic. In many instances the aneurysm was detected at the time of admission for complications of a contralateral popliteal aneurysm.

Pathology
Of the 98 aneurysms, pathologic data were available in 90 (table 2): 74 were single aneurysms, 16 were multiple; usually these were dumbbell-shaped, but in one patient four discrete aneurysmal masses were present. All except two aneurysms were atherosclerotic in origin; one was mycotic and the other traumatic in origin. The length of the excised specimens varied from between 2.5 to 18 cm.; 63 per cent were over 5 cm. Sixty-one per cent of 87 specimens had a diameter of less than 4 cm. when measured after excision. In reports noting patency of the aneurysmal lumen, 40 were patent; 27 were not. The size of the aneurysm did not correlate with the development of thrombi or emboli. Large aneurysms, however, were responsible for symptoms due to local pain and pressure symptoms in the popliteal space.

Treatment
All 98 limbs underwent surgery designed

Table 2
Pathologic Findings in 90 Popliteal Aneurysms (Measurements made following excision)

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single aneurysm</td>
<td>74</td>
</tr>
<tr>
<td>Multiple</td>
<td>16</td>
</tr>
</tbody>
</table>
| Length of aneurysm
  less than 3 cm.         | 3     |
  3-5 cm.                  | 23    |
  5-8 cm.                  | 31    |
  more than 8 cm.          | 31    |
| Diameter
  less than 3 cm.         | 18    |
  3-4 cm.                  | 22    |
  4-5 cm.                  | 20    |
  5-8 cm.                  | 24    |
  more than 8 cm.          | 3     |

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either (a) to save the limb, (b) to relieve the ischemic or pressure symptoms, or (c) to prevent future complications of the aneurysm. These operative procedures were carried out over a 16-year period and are divided into three groups according to treatment in vogue at the time. The first group includes nine sympathectomies, five ligations or excisions, and 13 sympathectomies followed by excision of the aneurysm usually within 10 to 14 days after sympathectomy. The second group includes 21 arterial homografts, three direct end-to-end anastomoses, 10 Dacron, and three Nylon prosthetic grafts. The patients with autogenous vein grafts comprise the third group. There were 29 saphenous vein autografts, three popliteal vein autografts, and two aneurysmorraphies with saphenous vein patch grafts. The number of operations done each year for each therapeutic group is present in figure 2. Since 1955 only an occasional aneurysm has been treated by sympathectomy with excision. Arterial homografts were used exclusively between 1953 and 1957; since 1957 no arterial homografts have been used. Popliteal vein grafts were used in the first three cases (1950 to 1953); saphenous vein autografts have been used subsequently. Most of the venous autografts have been used since 1959. The age distribution, symptomatology, and incidence of coexistent disease within each therapeutic group are similar except that the autogenous vein group has a greater number (14) of asymptomatic limbs undergoing surgery.

Results

The early results were assessed according to the type of presenting symptoms and whether either (a) sympathectomy with or without aneurysmectomy or (b) aneurysmectomy and direct arterial reconstruction were performed. These results are presented in tables 3 and 4, respectively.

Sympathectomy

Of 27 extremities that were treated by sympathectomy with or without aneurysmectomy, there was one operative death. Of three limbs that showed evidence of nonviability prior to operation, none was salvaged by sympathectomy. Of 20 patients in whom the operative procedure was carried out for relief of symptoms, only five (25 per cent) left the hospital without symptoms. Of the entire group, in only nine instances (33 per cent) was the limb free from pain at the time of discharge. Four of these were asymptomatic preoperatively and three had symptoms referable to the local aneurysmal mass only. Of the 24 patients who entered with a viable extremity, one patient with a mycotic aneurysm came to subsequent amputation. There were two additional patients who had sympathectomy followed by excision of a popliteal aneurysm who subsequently developed limb-endangering ischemia and required arterial reconstruction.

While this mode of treatment did not relieve intermittent claudication in the majority of cases and in our experience saved no limbs which would have otherwise been lost, the avoidance of late complications and maintenance of limb survival was remarkably good. Except for a single instance in which sympathectomy had been carried out without excision of a pulsatile popliteal aneurysm, which subsequently occluded 2 years later, no late amputations have resulted. Of 17 patients available for follow-up examination at
Table 3

Early Results of Sympathectomy, Excision, or Both in the Treatment of 27 Popliteal Aneurysms (Massachusetts General Hospital 1948-1963)

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Asymptomatic</th>
<th>Symptomatic</th>
<th>Amputation</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viable limb</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonviable limb</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viable limb</td>
<td>10</td>
<td>1</td>
<td>8</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Nonviable limb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locally symptomatic</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>27</td>
<td>9</td>
<td>13</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4

Early Results of Arterial Reconstruction (All Types) in the Treatment of 71 Popliteal Aneurysms (Massachusetts General Hospital 1948-1963)

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Asymptomatic</th>
<th>Symptomatic</th>
<th>Amputation</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viable limb</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonviable limb</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Chronic occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Viable limb</td>
<td>21</td>
<td>18</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonviable limb</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locally symptomatic</td>
<td>9</td>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>19</td>
<td>17</td>
<td>8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>71</td>
<td>53</td>
<td>8</td>
<td>9</td>
<td>1</td>
</tr>
</tbody>
</table>

3 years, the limb was considered well nourished in all, and in seven of these patients no significant disability was noted. Ten of these patients had prominent intermittent claudication. Of 12 patients followed for more than 5 years, four were asymptomatic while eight showed ischemic symptoms with exercise.

Arterial Reconstruction

Reconstructive arterial surgery was carried out in 71 patients. In contrast to the late follow-up, it appeared that early success was not related to whether arterial homograft, prosthetic tubes, or autogenous vein substitutes were used, but appeared to be more directly related to the technical excellence and experience of the surgeon (table 4). Of 15 patients who entered with evidence of known nonviability of the involved extremity, eight (53 per cent) were salvaged by direct arterial surgery. Of perhaps more importance, however, of 28 patients who entered with ischemic but viable extremities, 24 left the hospital with complete relief of their ischemic symptoms. There were nine amputations, seven of these occurred as a result of graft failure in patients who had extensive distal clot in limbs that preoperatively had shown evidence of nonviability. Of the other two amputations, one was a direct result of sepsis, while the other followed a technical error in graft placement. There was one operative death. Of the 61 patients who left the hospital with a viable extremity following arterial reconstruction, all but eight (87 per cent) were asymptomatic. These eight patients had residual intermittent claudication; four, however, had had nonviable extremities prior to the grafting procedure.

While the late results of reconstructive surgery are considerably better than the preceding group as far as rehabilitation of the limb is concerned, it should be pointed out...
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that if late complications of the grafting procedure itself are to be avoided, the proper choice of graft material must be made initially.

Homograft Replacement

Because of the tendency for aneurysmal dilatation, atheromatous degeneration, and calcification, arterial homografts are no longer used. Of 21 homografts inserted in the popliteal region, there were five acute failures. Of 16 patients eligible for 5-year follow-up, four patients are either dead or lost to follow-up. Nine patients are living and well and show no evidence of significant aneurysmal dilatation. Three patients have developed large aneurysms in their homografts, two of these being reoperated on successfully. There have been no late occlusions of the arterial homografts in this region, nor have there been any late amputations.

Prosthetic Replacement

The 13 patients with prosthetic replacement of popliteal artery had operation since 1959. There was one postoperative death. Three Nylon prostheses occluded acutely postoperatively resulting in amputation in each instance. In nine cases, a knitted Dacron tube was successfully implanted initially. Six of these remain functioning well in asymptomatic patients at 2, 2, 3, 5, 5, and 6 years postoperatively. Of the three remaining, one patient died during the first postoperative year. Another patient required amputation in spite of an open graft for persistent ischemic foot ulceration. There was one late occlusion, which did not result in the loss of the limb.

Autogenous Replacement

Optimally, we believe that arterial reconstruction should be carried out with autogenous tissue. In three patients in whom direct arterial anastomoses could be carried out following excision of the aneurysm, the late follow-up has been excellent. In most instances, however, this is either technically impossible or undesirable because of the extent of the aneurysm. In three additional patients a graft of the adjacent popliteal vein was used. This procedure has subsequently been discarded because of the known tendency of this large structure to dilate under arterial pressure. Of 31 autogenous saphenous vein grafts carried out, four could not be made to function because of distal propagating clot in patients with preoperative nonviable extremities. There has been one late closure in the remaining 27 patients, this being the result of anastomotic stricture resulting in recurrence of claudication. There have been no late amputations. Twelve patients have been followed for 3 years or more, and in this group no late occlusions have occurred. These figures are in accord with other studies suggesting that long-term patency can be expected of autogenous saphenous vein grafts, even when led across a flexion crease. In addition, angiography from 3 to 10 years postoperatively has failed to show evidence of graft deterioration or aneurysmal dilatation.

Discussion

Popliteal aneurysms may present as a painful mass behind the knee, as an occlusion of the popliteal vein, or with compression of the posterior tibial nerve. Few rupture, and when they do rupture, the hemorrhage is confined to the popliteal space. Such complications do not preclude a good result from excision of the aneurysm and arterial reconstruction with an autogenous saphenous vein graft. Unfortunately, the usual complications are the ones that threaten limb survival, principally because of thrombosis of the aneurysm or embolization from it to the distal tibial vessels. As the literature well documents, the incidence of limb loss in such instances is high. Chronic disability almost always results in the limb that survives the acute episode. Reconstructive surgery prior to the development of complications offers protection not only against loss of limb but also against the high incidence of morbidity.

The diagnosis of popliteal aneurysm is made by palpation. In some instances local or referred pain, unexplained deep phlebitis, or sudden loss of distal pulses may prompt careful palpation of the popliteal space, but in most instances the diagnosis can be made before complications develop. Oscillometric ex-
amination almost always reveals two to three times normal values over the lower thigh. When calcium is present in the wall of the aneurysm, a lateral roentgenogram of the knee often reveals the extent of the aneurysm (fig. 3). Arteriography is remarkably inaccurate in denoting a popliteal aneurysm (fig. 4). It is of value, however, in assessing the outflow tract distal to the aneurysm prior to reconstructive surgery.

Surgical management of popliteal aneurysms, in our opinion, is best carried out by the medial exposure of the popliteal artery with insertion of an autogenous graft, preferably saphenous vein. In many instances this can be obtained through the medial incision at the knee, or, if of insufficient caliber at this level, a separate incision in the groin will generally reveal a saphenous vein of sufficient size. In some instances, a paneled graft of adequate caliber can be fashioned by the longitudinal suture of two sections of saphenous vein. Our experience with Dacron tubes is too small to determine whether the long-term patency rate will equal that of autogenous vein grafts.

Lumbar sympathectomy, we believe, should be reserved for the patient with a stable and viable extremity who has survived acute occlusion of the popliteal aneurysm. Although we can find no evidence that such a procedure ever saves an extremity showing nonviability, or even improves intermittent claudication, there seems to be little question that an adequate lumbar sympathectomy will make an ischemic limb more tolerable and, by improving skin nutrition, prevent the digital lesions that lead to late amputation.

Summary

Ninety-eight popliteal aneurysms are reported that occurred in 82 patients who were treated surgically during a 16-year period from 1948 to 1963. The presence of acute or chronic arterial occlusive symptoms prior to operation significantly influenced the results of surgical management. Arterial reconstruction salvaged more than one half of the limbs presenting with limb-threatening ischemia, but early and late results recommend excision and grafting of all asymptomatic popliteal aneurysms before such complications develop. In our opinion saphenous vein autografts are preferable to prosthetic replacement in the surgical management of popliteal aneurysms.

References

7. Greenstone, S. M., Massell, T. B., and Hering-

Figure 3

Lateral film of the knee. The extent of the popliteal aneurysm is well outlined by the calcium in the vessel wall.


The Esthetics of Science

It is the great beauty of our science, that advancement in it, whether in a degree great and small, instead of exhausting the subject of research, opens the doors to further and more abundant knowledge, overflowing with beauty and utility.—M. Faraday.

Circulation, Volume XXXII, October 1965
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Circulation. 1965;32:517-523
doi: 10.1161/01.CIR.32.4.517

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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