Long-term Results of Surgical Repair of Popliteal Artery Aneurysm

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Objective. To determine the long-term outcome of surgical repair of popliteal artery aneurysms (PAA).

Methods. A retrospective review of consecutive patients who underwent surgical PAA repair in two vascular surgery units between 1988 and 2006 was performed. Primary and secondary graft patency, limb salvage and patient survival rates were determined using Kaplan-Meier methods.

Results. 48 patients underwent repair of 63 PAAs (ligation and bypass = 45, interposition grafting = 18). The 5-year primary graft patency, secondary graft patency, limb salvage and patient survival rates were 75%, 95%, 98% and 81%, respectively. The 10-year primary graft patency rates were significantly lower for emergency cases (59%) compared with elective cases (66%) (p = 0.0023). Thirteen patients (16 PAAs) required a total of 20 late re-interventions.

Duplex ultrasound was available in 33 of 45 PAAs treated by ligation and bypass. Five (15%) PAAs demonstrated perfusion of the aneurysm sac at median (range) follow up of 75 (1–246) months after primary repair and two of these required emergency re-operation.

Conclusions. These data demonstrate that surgical PAA repair is associated with excellent long-term durability and provide an important benchmark with which to compare results of endovascular PAA repair. Patients treated using the ligation and bypass technique should be enrolled in an aneurysm sac surveillance program.

Keywords: Aneurysm; Popliteal artery.

Introduction

The majority of popliteal artery aneurysms (PAAs) are asymptomatic at the time of presentation but the 5-year complication rate associated with non-operative management is high.1–4 As emergency repair is associated with significantly inferior graft patency and limb salvage rates compared with elective repair it is generally agreed that all symptomatic PAAs should undergo elective repair.1,5,6 However the management of asymptomatic aneurysms remains controversial. We have previously reported significantly inferior patency and limb salvage rates following elective repair of symptomatic compared to asymptomatic aneurysms.7 A review by Galland et al. reported the average annual risk of an asymptomatic PAA becoming symptomatic as 14% (range 5–24%), and Lowell et al. have previously demonstrated PAA size >2 cm as an independent risk factor for the development of symptoms.8,9 As a result many centres advocate elective repair of all PAAs >2 cm, irrespective of symptomatology. In contrast, with the use of a Markov decision analysis, Galland and Michaels proposed conservative management of asymptomatic PAAs was appropriate unless sac diameter is >3 cm or distortion is >45°.9,10

The most widely utilised surgical technique for repair of PAA is proximal and distal aneurysm ligation combined with long saphenous vein bypass through a medial approach.11 Failure of aneurysm exclusion has been demonstrated in up to one-third of PAAs treated by ligation and bypass and this may lead to continued aneurysm perfusion, expansion and subsequent pressure symptoms or rupture.3,12,13 A posterior approach to the PAA with interposition graft reconstruction and oversewing of the geniculate arteries should prevent aneurysm perfusion, although
this technique is not generally suitable for PAAs extending proximal to the adductor hiatus. More recently, endovascular PAA repair has been advocated as a minimally invasive alternative to surgical repair in both fit and unfit patients but long term durability data are lacking.1,14,15

We have previously reported the short-term outcome of surgical PAA repair in a single-centre cohort.7 The aim of the present study was to assess the long-term outcome of surgical PAA repair performed in two institutions, with particular emphasis on late re-intervention and continued aneurysm sac perfusion.

Methods

A retrospective review of consecutive patients who underwent primary surgical repair of an atherosclerotic popliteal artery aneurysm (PAA) in the Vascular Surgery Units at the University Hospital Birmingham NHS Foundation Trust and Heart of England NHS Foundation Trust between 1988 and 2006 was performed. Patients were identified through vascular registries, individual and hospital operative logbooks and radiological records. Operative treatment was recommended if the PAA measured ≥2 cm in diameter or was symptomatic with at least one vessel runoff onto the foot.

Case notes were reviewed and the following clinico-pathological data retrieved: patient demographics; indication for intervention; operative technique including surgical approach, donor and recipient artery and conduit (synthetic vs. autologous); and early (within 30 days of index procedure) and late (greater than 30 days of index procedure) outcome.

Data were collected on follow-up imaging of the popliteal artery and surgical reconstruction. All PAAs treated by ligation and bypass were invited to attend for clinical and ultrasound review. Duplex ultrasound examination was performed by an experienced vascular technician who recorded the following: graft patency, graft stenosis, graft or anastomotic aneurysm, aneurysm sac perfusion and aneurysm sac diameter.

Primary and secondary graft patency, limb salvage and patient survival rates were calculated using the Kaplan-Meier method and were compared with the non-parametric Cox-Mantel test. A probability value of less than 0.05 was considered statistically significant.

Results

Fifty-seven patients underwent 72 primary surgical PAA repairs during the study period. Nine patients who had undergone nine PAA repairs were excluded from analysis because they had either been lost to follow up (n = 5), or incomplete operative records were available (n = 4). Thus, 48 patients (45 men; median age 69, range 46–88, years) who underwent 63 surgical PAA repairs were studied.

Ligation and bypass was performed for 45 PAAs (12 emergency and 33 elective cases) and interposition grafting in 18 PAAs (all elective). A total of 11 of 12 emergency procedures were performed for acute limb ischaemia, and one was performed for ruptured aneurysm. Autologous vein grafts were used in all cases (Long saphenous vein (LSV) in situ = 22, LSV reversed = 28, Short saphenous vein reversed = 12, Basilic vein reversed = 1).

One patient died in the peri-operative period secondary to cardiac complications: post-procedure mortality rate, 1.6%. There was no peri-operative limb loss and no patients required early re-intervention. During a median (range) follow-up of 78 (1–246) months, 13 patients with 16 PAAs (25%) required a total of 20 re-interventions secondary to graft thrombosis (n = 12), graft stenosis (n = 5), symptomatic aneurysm perfusion including one case of rupture (n = 2) and graft aneurysmal change (n = 1) (Table 1). The median time to first re-intervention was 31 (range, 0–165) months. The 5- and 10-year survival rates free from re-intervention were 65% and 51%, respectively (Fig. 1).

The 5- and 10-year patient survival rates were 81% and 64%, respectively, and there was no significant difference depending on the type of reconstruction (p = 0.48). (Fig. 2) The 5- and 10-year primary graft patency rates were 75% and 63%, respectively, and there was no significant difference depending on the type of reconstruction (p = 0.6). (Fig. 3) In elective cases, there was no significant difference in primary patency rates for ligation and bypass or interposition grafting (p = 0.088). However, the 10-year primary graft patency rates were significantly lower for emergency (59%) compared with elective ligation and bypass (66%) (p = 0.0023) with a hazard ratio for elective versus emergency repair of 0.157 (95% confidence intervals, 0.034–0.73).

The 5- and 10-year secondary graft patency rates were 95% and there was no significant difference depending on the type of reconstruction (p = 0.35). The 5- and 10-year limb salvage rates were also 95%. Two patients underwent major limb amputation secondary to graft occlusion at 4 and 12 months following ligation and bypass. There was no significant difference in limb salvage rates depending on the type of reconstruction (p = 0.37).

Post-operative duplex ultrasound imaging was performed in 33 of 45 PAAs treated by ligation and bypass. Five (15%) PAAs demonstrated aneurysm...
perfusion at mean (range) follow up of 75.3 (0–246) months after primary PAA repair. One patient presented with a contained PAA rupture and underwent ligation and bypass some 112 months after initial surgery. One patient with a tender recurrent PAA underwent re-exploration and oversewing of geniculate collaterals via a posterior approach 41 months after initial surgery: 26 months after this revisional surgery, the patient remains asymptomatic but there is evidence of recurrent aneurysm perfusion. There is no evidence of aneurysm expansion in the remaining three patients who are currently undergoing regular duplex ultrasound surveillance.

### Discussion

In our experience, surgical repair of PAA with autologous vein was associated with 10-year primary graft patency, secondary graft patency and limb salvage rates of 63%, 95% and 95%, respectively. These outcomes are comparable to reports from North America and Europe.1,5,12,16,17

Risk factors predicting loss of primary graft patency are widely described. Huang et al. found symptomatic presentation, vessel runoff status, distal anastomosis and synthetic graft material were positive predictors risk factors of early graft failure in 358 legs.18 Similar findings were reported in a literature review by Dawson et al. of 2445 PAAs.19 Pulli et al. found no difference in primary patency rate depending on graft material used (autologous vein vs.

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### Table 1. Summary of re-interventions

<table>
<thead>
<tr>
<th>Patient</th>
<th>Original Operation</th>
<th>Reason for Re-intervention</th>
<th>Type of Re-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>LGB</td>
<td>Proximal Anastomosis</td>
<td>redo bypass AK pop TP trunk</td>
</tr>
<tr>
<td>1*</td>
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<td>Proximal Anastomosis</td>
<td>redo bypass SFA AT1</td>
</tr>
<tr>
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<td>IGR</td>
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<td>Bypass CFA BK pop</td>
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<tr>
<td>3</td>
<td>IGR</td>
<td>Proximal Anastomosis</td>
<td>Graft thrombectomy AK pop BK pop</td>
</tr>
<tr>
<td>4</td>
<td>IGR</td>
<td>Proximal Anastomosis</td>
<td>Bypass SFA BK pop</td>
</tr>
<tr>
<td>5</td>
<td>IGR</td>
<td>Proximal Anastomosis</td>
<td>Thrombectomy and anastomosis refashioning AK pop BK pop</td>
</tr>
<tr>
<td>6</td>
<td>LGB</td>
<td>Proximal Anastomosis</td>
<td>Bypass SFA BK pop</td>
</tr>
<tr>
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<td>LGB</td>
<td>Proximal Anastomosis</td>
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<td>8</td>
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<tr>
<td>9</td>
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<tr>
<td>16</td>
<td>LGB</td>
<td>Proximal Anastomosis</td>
<td>Branch ligation N/a N/a</td>
</tr>
</tbody>
</table>

* = Same Patient, LGB = Ligation and Bypass, IGR = Interposition Graft Reconstruction, AK = Above Knee, BK = Below Knee, CFA = Common Femoral Artery, SFA = Superficial Femoral Artery, Pop = Popliteal Artery, Trif = Trifurcation, TP = Tibial-peroneal, AKA = Above Knee Amputation, BKA = Below Knee Amputation, PTFE = Polytetrafluoroethylene, N/a = not applicable.

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**Fig. 1.** Kaplan-Meier plot of patient survival free from re-intervention.
Polytetrafluoroethylene). In our experience acute clinical presentation influenced primary patency on univariate analysis. However, the authors recognise that the relatively poor results for emergency surgery may be explained by vessel run-off status and that this represents the major limitation of this study.

No patients required early re-intervention but late re-intervention for graft-related complications was required after 25% of PAA repairs at a median of 31 (range, 0–165) months after the index procedure. The 10-year survival rate free from re-intervention was 51%. Surgical intervention was the procedure of choice for graft thrombosis, graft aneurysm formation and symptomatic aneurysm perfusion while graft stenosis was managed by angioplasty. Aneurysm perfusion after ligation and bypass may occur due to failed proximal or distal ligation or, more commonly, patent geniculate collaterals (similar in endovascular terms to a type II collateral endoleak) which impart increased arterial pressure within the excluded sac causing expansion, neurovascular compression, pain or aneurysm rupture. Four previous studies have reported this late complication: Kirkpatrick et al. reported persistent aneurysm perfusion in 12 of 36 (33%) legs at a median follow-up of 48 months with symptomatic PAA enlargement in 50% of these patients; Mehta et al. reported persistent perfusion in 10 of 26 (38%) legs at a mean follow-up of 38 months with subsequent rupture occurring in 3 (12%) PAAs; Ebaugh et al. reported aneurysm sac enlargement in 8 of 25 (32%) legs at a median follow-up of 48 months; and Huang et al. reported PAA recurrence requiring re-intervention in 7 of 216 (0.03%) legs at a mean follow-up of 50 months. In the present study, 15% of PAA repairs treated by ligation and bypass demonstrated sac perfusion at a median of 75 months after the index procedure. Ebaugh et al. have previously recommended resection or endoaneurysmorraphy of all PAA as a means of preventing sac reperfusion. Huang et al. reported no PAA recurrence in 115 legs treated by ligation and bypass in combination with endoaneurysmorraphy.

Some authors advocate a posterior approach with interposition grafting in the presence of compressive features or focal PAAs that do not extend proximal to the adductor hiatus. In our experience, there was a trend toward better primary patency with this approach compared to ligation and bypass ($p = 0.088$). Unlike ligation and bypass, this technique allows overseeing of all the geniculate collaterals from within the aneurysm sac.

Endovascular PAA repair has gained popularity in a small number of specialist centres although, to date, only one randomised controlled trial and three case series with more than 10 PAAs have been reported in the literature. Type II endoleak from geniculate collaterals appears to be relatively uncommon although follow-up in published series is considerably shorter than in surgical series reporting aneurysm perfusion after ligation and bypass. With longer follow-up, there may be more instances of late aneurysm expansion due to previously undetected type II endoleak.
Conclusion

The excellent primary and secondary patency, and limb salvage rates demonstrated in the present study support the assertion that open surgical repair of PAA with autologous vein continues to be the evidence-based standard treatment. We recommend all PAA treated by ligation and bypass without sac excision or endoaneurysmorraphy should be enrolled into a lifelong aneurysm surveillance programme.

References


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