Endovascular and Open Approaches to Non-thrombosed Popliteal Aneurysm Repair: A Meta-analysis

R.E. Lovegrove, M. Javid, T.R. Magee, R.B. Galland*

Department of General Surgery, Royal Berkshire Hospital, Reading, UK

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Abstract  Objective: Endovascular repair of popliteal artery aneurysms is a relatively new technique that is still undergoing evaluation. The aim of this study was to compare outcomes following open and endovascular approaches.

Methods: All published studies comparing outcomes following open and endovascular popliteal aneurysm were included. Endpoints included operative duration, length of stay, and postoperative complications including short-term patency rates. Outcomes were combined using a random-effects meta-analytical technique and differences assessed using odds ratios (OR), weighted mean difference (WMD) and log hazards ratio (HR).

Results: Three studies comprising 141 patients (37 endovascular; 104 open) were included. No significant differences in patient characteristics were seen. Operative duration was significantly longer for endovascular repair (WMD 120 minutes, \( p < 0.001 \)). Thirty day graft thrombosis (OR 5.05, \( p = 0.06 \)) and reintervention (OR 18.80, \( p = 0.03 \)) were more likely following endovascular repairs. Postoperative length of stay was shorter in the endovascular group (WMD \(-3.9\) days, \( p < 0.001 \)). There was no significant difference in long-term primary patency rates (HR 1.70, \( p = 0.53 \)).

Conclusions: Endovascular repair of popliteal artery aneurysms offers similar medium-term benefits as an open repair. However, short-term graft thrombosis and reintervention rates are significantly greater. With the current technology it is difficult to justify endovascular treatment of popliteal aneurysms.

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* Corresponding author. Mr. R. B. Galland, Consultant Vascular Surgeon, Royal Berkshire Hospital, London Road, Reading, Berkshire, RG1 5AN. Tel.: +118 322 7419; fax: +118 322 7881.
E-mail address: robert.galland@royalberkshire.nhs.uk (R.B. Galland).
Non-thrombosed Popliteal Aneurysm Repair

Introduction

Management of popliteal aneurysms (PA) has evolved from inducing thrombosis by compression or ligation; obliteration of the aneurysm, with or without sympathectomy; to preserving circulation whilst excluding the aneurysm. The commonest procedure carried out today is ligation, combined with bypass by a medial approach. The conduit of choice is autologous vein. This technique has recently been challenged. Some reports have suggested that the popliteal aneurysm can develop or retain flow following ligation in up to one third of cases. Significant symptoms have been described in up to one fifth of cases. These findings have not been confirmed by others. An open posterior approach, whereby the aneurysm is opened and an interposition graft inserted, is an alternative which overcomes these problems.

Endovascular repair of abdominal aortic aneurysms is gradually gaining acceptance and produces good short and medium-term results compared with a conventional open repair. There is much less evidence to support the use of endovascular stenting for peripheral artery aneurysms. The first report of popliteal artery stenting was in 1994. Palmaz stents covered with a polytetrafluoroethylene (PTFE) graft were used. Since then there have been reports suggesting that in selected cases endovascular repair can produce equivalent results to open repair. The aim of this paper is to compare endovascular with open repair of non-thrombosed popliteal aneurysms based on current evidence.

Methods

Study selection

The literature was searched using PubMed and Medline databases for published studies comparing outcomes between open and endovascular approaches to the treatment of popliteal aneurysms. The following MeSH search terms were used: “popliteal artery”, “aneurysm”, “vascular surgical procedures”, “stents”, “blood vessel prosthetic implantation” and “randomized controlled trials”. In addition the following keywords were used: “endovascular”, and “comparative”. These terms were used in various combinations together with use of the “related articles” function in order to maximise the search. No restrictions on language of publication were made and references from obtained articles were hand searched. The date of the last search was 31 July 2007.

Inclusion criteria

Included studies had to compare outcomes between open and endovascular approaches to popliteal aneurysm repair and report on at least one of the outcome measures described below. Studies assessing outcome following open or endovascular approaches to thrombosed popliteal artery aneurysms were not excluded from the literature search.

Exclusion criteria

Studies were excluded from further analysis if they did not report outcomes in a comparable fashion or data were unable to be extracted from the published report. Outcomes where there were no events for either the open or endovascular group were excluded from the meta-analysis of that outcome, but were taken into account when considering the overall sample size for the outcome.

Outcomes of interest

Outcomes of interest were considered in two areas:

Operative parameters: These consisted of operative time recorded in minutes, recorded blood loss in millilitres (ml), and postoperative length of stay recorded in days.

Complications: These consisted of all complications occurring within 30 days of operation, or in the case of graft surveillance, during recorded follow up. Primary patency rates were defined as the time from surgery to graft or stent occlusion, and were derived from published Kaplan-Meier plots. Reintervention rates were also recorded.

Statistical analysis

Meta-analysis was performed in line with recommendations from the Cochrane Collaboration the Quality of Reporting of Meta-analyses (QUORUM) guidelines. The effect measures estimated were odds ratio (OR) for dichotomous data and weighted mean difference (WMD) for continuous data, both reported with 95% confidence intervals (CI). The analysis was undertaken by comparing endovascular with open surgery with an odds ratio of more than 1 denoting that an event was more common following endovascular surgery. Studies that contained a zero in one cell for the number of events of interest in one of the two groups resulted in problems with the computation of ratio measurement. To overcome this problem the Haldane correction was applied, whereby a value of 0.5 was added in both groups from that particular study. Long-term graft patency rates were extracted from published hazards ratios (HR) and Kaplan-Meier survival curves using the techniques described by Parmar et al.

For categoric variables the odds ratios were combined with the Mantel–Haenszel Chi-squared method using a “random effect” meta-analytical technique. In a random effect model it is assumed that there is variation between studies and the calculated odds ratio thus has a more conservative value. In surgical research, meta-analysis using the random effect model is preferable particularly because patients that are operated on in different centres have varying risk profiles and selection criteria for

<table>
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<tr>
<th>Study</th>
<th>Cases</th>
<th>Dates of Study</th>
<th>Matching Criteria</th>
</tr>
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<tbody>
<tr>
<td>Antonello</td>
<td>15 15</td>
<td>1999–2003</td>
<td>1,2,3,5,6,7,8</td>
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<tr>
<td>Curi</td>
<td>15 41</td>
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<td>1,5,6,7,8</td>
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<tr>
<td>Stone</td>
<td>7 48</td>
<td>1995–2004</td>
<td>4</td>
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Matching criteria: 1 = Gender, 2 = Age, 3 = Aneurysm diameter, 4 = Symptomatic presentation, 5 = Smoking status, 6 = Diabetes, 7 = Hypertension, 8 = Bilateral popliteal aneurysms.
each surgical technique. For studies that presented continuous data as mean and range values, the standard deviation (SD) was calculated using statistical algorithms and checked using “bootstrap” resampling techniques. Thus all continuous data were standardized for the analysis.

Heterogeneity was quantitatively assessed by calculation of Chi square statistic for a given outcome and graphical exploration with funnel plots was used to evaluate publication bias.13,19

Analysis was conducted using Review Manager Version 4.3 (The Cochrane Collaboration /C0, Software Update, Oxford, UK).

Results

Studies selected

The literature search identified eight studies for potential inclusion in the analysis.2,20–26 five of these were subsequently excluded as there were no extractable comparative results between the open and endovascular approaches.2,22–25 The remaining three20,21,26 studies, comprising 141 patients (37 endovascular and 104 open), were included in the analysis. One study used the Hemobahn graft,20 one Viabahn endografts,21 and the third used the Wall graft in five patients and Viabahn in two patients.26 There were no studies assessing outcome of thrombosed popliteal artery aneurysms that met the inclusion criteria.

Patient characteristics

There were 133 (94.3%) men with no significant differences between the open and endovascular groups (Tables 1 and 2). Mean age at intervention and mean aneurysm diameter did not differ significantly between the two groups. Hypertension was noted in 66%, cardiac disease in 46%, pulmonary disease in 17% and diabetes in 20% with no statistically significant differences between the two groups. A smoking history was noted in 66% of patients. In one study,21 bilateral popliteal aneurysms were recorded

<table>
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<th>Table 2</th>
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<tr>
<td>Characteristic</td>
<td>No. Studies</td>
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<tr>
<td>Mean age</td>
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<td>Male gender</td>
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<td>Hypertension</td>
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<td>Cardiac disease</td>
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<td>Pulmonary disease</td>
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<td>Smoking</td>
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<tr>
<td>Aneurysm diameter (mm)</td>
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</table>

OR — Odds ratio.
WMD — Weighted mean difference.
CI — Confidence interval.
HG — Heterogeneity.
P values in bold denote statistical significance at the 5% level.
* Outcomes given as WMD.

<table>
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<tr>
<th>Table 3</th>
<th>Operative details and postoperative complications following endovascular and open popliteal artery aneurysm repair</th>
</tr>
</thead>
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<tr>
<td>Outcome</td>
<td>No. Studies</td>
</tr>
<tr>
<td>Operative time (mins)</td>
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<tr>
<td>Length of stay (days)</td>
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<tr>
<td>30 Day graft thrombosis</td>
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<tr>
<td>30 Day reintervention</td>
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</tr>
<tr>
<td>Long-term graft patency</td>
<td>2</td>
</tr>
</tbody>
</table>

OR — Odds ratio.
WMD — Weighted mean difference.
HR — Hazard ratio.
CI — Confidence interval.
HG — Heterogeneity.
P values in bold denote statistical significance at the 5% level.
* Outcomes given as WMD.
+ Outcomes given as HR.
in 42 (63.6%) of 66 patients. One study\textsuperscript{21} provided details of distal run-off in the open and endovascular groups, with patients having 1, 2 or 3 vessel run-off in approximately 33% of cases in both groups.

Outcomes following open or endovascular popliteal aneurysm repair

Duration of the interventional procedure was significantly longer for endovascular interventions than for open repair [WMD 119.9 minutes (95% CI 102.1–137.7), \( p < 0.001 \)] (Table 3). Postoperative length of stay was significantly shorter following endovascular procedures when compared with open [WMD \(-3.9\) days (95% CI \(-4.3\) to \(-3.5\)), \( p < 0.001 \)].

The incidence of 30 day graft thrombosis and reintervention rates were significantly greater following endovascular repair of popliteal aneurysms. However, medium-term graft patency did not differ significantly between the two groups (Fig. 1).

Discussion

This meta-analysis has shown no difference in medium-term patency comparing open with endovascular treatment of popliteal aneurysms. Patency following ligation and bypass is 70%—94% at five years.\textsuperscript{27} Similar results are obtained when an open posterior approach is used.\textsuperscript{28} In a series of 57 PA undergoing endovascular repair from 1998—2004 a two year primary patency of 77% was achieved.\textsuperscript{29} Medium-term patency of the 112 PA in our study was 1.70 times greater following open surgery when compared with endovascular approaches.

Approximately 30% to 50% of popliteal artery aneurysms are asymptomatic at the time of presentation,\textsuperscript{1,30} although this can be as high as 80% in some series.\textsuperscript{31} The avoidance of complications is therefore paramount. Complications following elective open repair of popliteal aneurysms are uncommon. Thirty day mortality is less than 1%, and limb loss less than 2%.\textsuperscript{27} The commonest postoperative problems involve the surgical wound, occurring in about 5% of cases.\textsuperscript{32} Both local and systemic complications are greater in patients undergoing open repair of popliteal aneurysms for acute ischaemia.\textsuperscript{27,32} Early graft failure is uncommon. By contrast, in this study we found that 30 day graft thrombosis was significantly higher in patients undergoing endovascular repair. Similarly, 30 day reintervention was also greater in this group of patients. There were 13 early and late stent-related complications in nine patients from a group of 67 popliteal artery aneurysms.\textsuperscript{29} These included migration, with or without endoleaks, stenosis and stent disruption. Endoleak has been described in 20% of endovascular popliteal artery aneurysm repairs at a mean follow up of 16 months.\textsuperscript{21}

It is possible that the included studies may represent pilot studies assessing the feasibility of endovascular repair of popliteal aneurysm. This may go some way to explaining the significantly longer operative time seen in the endovascular group, although this outcome was discussed in only one study. In the absence of further studies from centres with established endovascular practices being available the effect of endovascular repair on operative time needs to be interpreted with some caution.

The only advantage which we have demonstrated for endovascular repair is a shorter length of stay in hospital. This needs to be balanced against the greater number of complications seen in these patients. With the technology currently available it is difficult to justify endovascular repair for patent popliteal aneurysms. Future advances in technology and the overcoming of any learning curves may lead to improvements in outcome following endovascular repair of popliteal artery aneurysms and these would need to be reassessed at the appropriate time.

References


