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Cardiovascular Risk Reduction is Important for Improving Patient and Graft Survival After Ligation and Bypass Surgery for Popliteal Artery Aneurysm

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Abstract

Objectives:

To report outcomes following ligation and bypass (LGB) surgery for popliteal artery aneurysm (PAA) and study factors influencing patient and graft survival.

Materials and Methods:

A retrospective review of patients undergoing LGB surgery for PAA between September 1999 and August 2012 at a tertiary referral vascular unit was performed. Primary graft patency (PGP), primary-assisted graft patency (PAGP), and secondary graft patency (SGP) rates were calculated using survival analyses. Patient, graft aneurysm-free survival (GAFS), aneurysm reperfusion-free survival (ARFS), and amputation-free survival (AFS) rates were also calculated. Log-rank testing and Cox proportional hazards modeling were used to perform univariate and multivariate analysis of influencing factors, respectively.

Results:

Eighty-four LGB repairs in 69 patients (mean age 71.3 years, 68 males) were available for study. The 5-year PGP, PAGP, SGP, and patient survival rates were 58.1%, 84.4%, 85.2%, and 81.1%, respectively. On multivariate analysis, the principal determinants of PGP were urgency of operation ($P = .009$) and smoking status ($P = .019$). The principal determinants of PAGP were hyperlipidemia status ($P = .048$) and of SGP were hyperlipidemia ($P = .042$) and cerebrovascular disease (CVD) status ($P = .045$). The principal determinants of patient survival were previous myocardial infarction ($P = .004$) and CVD ($P = .001$). The 5-year GAFS, ARFS, and AFS rates were 87.9%, 91.6%, and 96.1%, respectively.

Conclusion:

This study has shown that traditional cardiovascular risk factors, such as a smoking and ischemic heart disease, are the most important predictors of early graft failure and patient death following LGB surgery for PAA.

Introduction

Popliteal artery aneurysm (PAA), defined as an increase in popliteal artery diameter >50% of normal, is the most common form of peripheral artery aneurysm affecting approximately 1% of males aged 65 to 80 years.1,2 Most PAAs are asymptomatic at diagnosis; however, aneurysm thrombosis with or without distal embolization can cause acute limb ischemia which is associated with an amputation rate as high as 30%.3 The optimum management strategy is to repair PAAs before complications arise.

Endovascular repair is increasingly being used to treat PAA4,5 with many authors reporting noninferior outcomes6-9; however, open surgical repair remains the gold-standard treatment.10 The most common operative technique is aneurysm ligation and bypass (LGB) using autologous vein through a medial approach as first described by Edwards in 1969.11-13 The use of an interposition graft through a posterior approach has also been described14 which may reduce the risk of aneurysm reperfusion15; however, this operation is less commonly used. The PAA repair has been performed at our center almost exclusively using the LGB technique. The aim of this study was (a) to describe our experience using this technique and (b) to determine factors influencing graft and patient survival.

Materials and Methods

A retrospective review of all patients undergoing PAA repair at the Leicester Royal Infirmary between September 1999 and August 2012 was performed, looking for patients treated by LGB surgery. Patients were identified through interrogation of a prospectively maintained vascular studies unit database. Following case note review, the following data were collected: patient demographics, medical comorbidity status (myocardial infarction [MI], angina, hypertension, left ventricular failure, diabetes, cerebrovascular disease [CVD], hyperlipidemia, renal failure), the presence of other aneurysms, smoking status, medication history (statin, antiplatelet, antihypertensive, oral hypoglycemic, and insulin), indication for surgery (symptomatic or size), urgency of surgery (elective or emergency), native inflow and outflow vessel, type of conduit used (great saphenous/basilic/cephalic vein, composite, and prosthetic), postoperative intensive care unit (ICU) stay, duration of admission, early (<30 days) or late (>30 days) complications, and need for reintervention (graft angioplasty, graft thrombectomy, redo operation, and limb amputation). Mortality data were obtained through interrogation of the hospital electronic patient record.

Size thresholds for operating on asymptomatic PAAs at our center vary slightly between individual surgeons according to the presence or absence of thrombus; however, all symptomatic PAAs are offered repair regardless of size. Following PAA repair, patients are invited to attend for duplex ultrasonography (DUS) graft surveillance at 6 weeks, 3, 6, 9, and 12 months postoperatively and 6 monthly thereafter for the first 5 years. Beyond 5 years, where performed, surveillance is annual. The DUS is performed by experienced vascular scientists who document the following variables: graft patency, graft stenosis, graft/anastomotic aneurysm formation, and aneurysm sac reperfusion. Patency data were extracted from surveillance reports to allow calculation of primary graft patency

(PGP), primary-assisted graft patency (PAGP), and secondary graft patency (SGP) rates using the Kaplan-Meier method. The PGP, PAGP, and SGP were calculated according to the reporting standards defined by Rutherford et al on behalf of The Society for Vascular Surgery. Patient, graft aneurysm-free survival (GAFS), aneurysm reperfusion-free survival (ARFS), and amputation-free survival (AFS) rates were also calculated using Kaplan-Meier analyses. Kaplan-Meier curves were truncated at 7 years for patient survival and 5 years for graft survivals. Survival estimates were deemed in accurate for time points where less than 30% of the original cohort was available for analysis. Log-rank (Mantel-Cox) testing was used to compare survival measures between the groups. Cox proportion hazards regression was used for multivariate analyses and included variables with a P value of <.1 on univariate testing. All statistical analyses were performed using SPSS software version 22 (IBM, Armonk, New York) and a P value of <.05 was used to determine statistical significance.

Results

Eighty-four LGB repairs performed in 69 patients (68 males, mean [range] age 71.3 [51.8-90.3] years) during the study period were available for analysis. Detailed patient characteristics are shown in Table 1. For comparison, during the same time period our center performed 3 endovascular and 2 open interposition graft PAA repairs.

The majority of LGBs were performed electively (n = 59, 70.2%) using autologous vein (n = 76, 90.5%) for symptomatic PAA (n = 55, 65.4%) of the right leg (n = 47, 56%). The mean PAA diameter at the time of surgery was 3.6 cm (range 1.2-12.0 cm). Only 3 LGBs were performed for PAAs <2 cm in diameter; however, in all 3 cases the PAA had thrombosed and was associated with acute or critical limb ischemia. Great saphenous vein was the most common conduit used (n = 59, 70.2%: reversed, n = 47; in situ, n = 12) and superficial femoral artery to below-knee popliteal artery was the most common bypass (n = 62, 73.8%). A prosthetic graft was used in 4 (4.7%) LGBs. The median (range) postoperative length of stay was 7 (0-43) days.

There were 27 deaths that occurred at a median (range) postoperative time of 53 (0.1-156) months. There were 2 deaths in the perioperative period: patient 1 was an 82-year-old patient with preexisting ischemia-induced left ventricular failure who died 3 days postoperatively secondary to cardiac complications; patient 2 was a 78-year-old type 2 diabetic patient who died 10 days postoperatively on the ICU after repair of a large 6.2 cm thrombosed PAA. Both patients had presented with symptoms of acute limb ischemia and were operated on as an emergency.

The actuarial 1, 3-, and 5-year patient survival rates were 97.6%, 86.0%, and 81.1%, respectively. Patient survival rates were not influenced by urgency of operation (P = .419) but were significantly worse in patients with a previous MI (median survival 67.9 vs 150.1 months; P = .031) or history of CVD (38.1 vs 156.3 months; P < .001; see Figure 1A and B) on univariate analysis and trended toward being worse for patients with renal failure (P = .086). Previous MI and CVD status remained significant predictors of patient survival after Cox proportional regression analyses (see Table 2).

A total of 886 duplex ultrasound reports were reviewed. The 1, 3-, and 5-year PGP rates were 72.1%, 60.3%, and 58.1%, respectively. The PGP was significantly worse for nonelective repairs (20.3 vs 94.5 months; P = .001) and in those with any history of smoking (71.3 vs 110.3 months; P = .027) on univariate analysis (see Figure 2A and B) and trended toward being worse for symptomatic PAA (P = .074). Subdividing smokers into current and past revealed worse PGP rates in current smokers (38.9 vs 73.4 months). A comparison of autologous versus synthetic grafts did not reveal any significant differences in PGP in our cohort (P = .576). Urgency of operation and smoking history remained significant predictors of PGP after Cox proportional regression analyses (see Table 3).

The 1, 3-, and 5-year PAGP rates were 90.3%, 84.4%, and 84.4%, respectively. The PAGP did not vary according to urgency of operation but was significantly worse in those with a diagnosis of hyperlipidemia (100.1 vs 128.8 months; P = .006) or CVD (68.1 vs 117.0 months; P = .025; see Figure 3A and B) and trended toward being worse in those with diabetes (P = .054), renal failure (P = .092), or hypertension (P = .092) on univariate analysis. Only hyperlipidemia remained a significant predictor of PAGP after Cox proportional regression analyses (see Table 4).

The SGP over the same time intervals were 92.7%, 85.2%, and 85.2%, respectively. The SGP rates were significantly worse for those with diabetes (119.3 vs 76.2 months; P = .029), hyperlipidemia (128.8 vs 102.6 months; P = .01), or CVD (118.6 vs 68.1 months; P = .01; see Figure 4A to C). Hyperlipidemia and CVD status remained significant predictors of SGP after Cox proportional regression analyses (see Table 5).

Three patients required a major amputation (above knee, n = 2; below knee, n = 1) occurring at 4, 9, and 10 weeks postoperatively; AFS rates at 1, 3, and 5-years were 96.1%. Neoaneurysms within the graft or at the site of anastomosis were detected in 7 repairs during surveillance translating into 1-, 3-, and 5-year GAFS rates of 100%, 92.3%, and 87.9%, respectively. The GAFS rates did not vary according to the presence or absence of multianeurysmal disease (ie, the presence of aneurysms in other arterial beds; P = .326). Aneurysm reperfusion was detected in 5 (6%) cases; aneurysm recanalization in 2 cases at 36 and 42 months, respectively, and aneurysm sac reperfusion via a feeding vessel (most commonly genicular) in 3 cases at 12, 21, and 72 months, respectively. This translates into 1, 3-, 5-, and 7-year ARFS rates of 98.5%, 94.4%, 91.6%, and 87.3%, respectively. At latest follow-up, neither case of aneurysm recanalization had undergone intervention, and there had been no significant aneurysm sac enlargement. However, 2 of the 3 reperfusion via feeding vessel cases necessitated treatment using coil embolization because of significant sac enlargement. In one of these cases, there remained persistent sac enlargement, despite coil embolization, and the patient ultimately underwent surgical reexploration oof popliteal fossa to oversew the feeding vessels.

Discussion

The principal finding from the current study is that cardiovascular risk factors such as history of MI or CVD (stroke or transient ischemic attack) are the most important predictors of early patient death after LGB surgery for PAA. Furthermore, cardiovascular risk factors such as history of smoking, CVD, or hyperlipidemia predict early graft failure. Although these findings may seem intuitive to clinicians, this study has quantified the impact of these risk factors.

Following LGB surgery, patient survival rates at our center were >80% at 5 years which are on par with other published series worldwide. The 2 largest single-center series published in the English literature are those from Minnesota (United States) and Mainz (Germany) reporting 5-year patient survival rates following open PAA repair of 75%3 and 63.5%,16 respectively, although in the latter study one-third of the repairs used an interposition graft. Our series, reporting exclusively following LGB repair, found the best results were achieved in patients without significant cardiovascular disease, where patient survival was up to 4-fold better than for patients with established cardiovascular disease (history of MI or CVD). Whether LGB surgery should be avoided in preference of an endovascular solution in patients with established cardiovascular disease is unclear; however, this study provides good evidence for offering patients with newly detected PAAs aggressive cardiovascular risk reduction strategies (tight glycemic and blood pressure control, exercise, dietary and smoking cessation advice, antiplatelet, and/or 3-hydroxymethylglutaryl coenzyme A reductase inhibitor pharmacotherapy), similar to those offered to patients with peripheral vascular disease to reduce the incidence of future myocardial and cerebrovascular events.17 This is important to emphasize because aneurysmal disease is often not regarded in the same way as occlusive disease with respect to cardiovascular risk. In fact, a recent multicenter audit by our group has found that patients with aortic aneurysmal disease are frequently underprescribed best medical therapy and are not offered smoking cessation advice (>1000 patients; <40% on best medical therapy and not smoking; unpublished).

Our series was unable to detect a lower PGP rate using nonautologous bypass grafts as has been described by others,3 but this is likely to be due to a type 2 error since only a small number of prosthetic conduits were utilized (n = 4). Our results do however confirm the poorer PGP rates seen following emergency repair and highlight smoking as an important significant adverse predictor. A recent meta-analysis examining the impact of smoking on lower limb extremity bypass graft patency found the negative impact to be proportional to the degree of smoking (heavy vs moderate smokers) and that smoking cessation, even if commenced postoperatively, improves graft patency toward that of “never smokers.”18 Our results confirm the benefits of stopping smoking on graft patency; ex-smokers experienced PGP rates nearly double those of current smokers. Clinicians managing patients with PAA, especially those being worked up for LGB repair, must be trained to offer good quality smoking cessation advice or refer patients to an appropriate smoking cessation service.

Although a handful of series have reported better PGP rates than in the current series,16,19,20 our center has always adopted an aggressive approach toward performing graft angioplasty. This is reflected by our PAGP rates, which are significantly improved and on par with other large case series published worldwide. We found that the presence or absence of hyperlipidemia was the most important factor determining PAGP; its absence improving graft patency by more than 28 months. A diagnosis of hyperlipidemia was also the most important factor influencing SGP. Reduced graft patency in patients with hyperlipidemia is almost certainly related to its effect on atherosclerosis.21 Indeed, the detrimental impact of high cholesterol and triglyceride levels on early and late saphenous vein graft patency in patients undergoing coronary artery bypass grafting is well described,[22-24] and lipid-lowering medication has been shown to improve graft patency following both coronary artery and infrainguinal bypass grafting.[25,26]

The influence of atherosclerotic risk factors on graft patency following bypass surgery for occlusive disease is described previously; however, this is the first time, to the authors' knowledge, that such risk factors have been quantified as the most important predictors of early graft failure following LGB surgery for aneurysmal disease. Despite the altered remodeling that takes place in vein bypass grafts for aneurysmal versus occlusive disease,[27] careful patient selection and ongoing modification of cardiovascular risk factors are essential for prolonging graft survival in patients treated with LGB for PAA. The benefit of more stringent graft surveillance in patients with certain cardiovascular risk factors also warrants further study.

The current study has focused exclusively on PAAs repaired using the LGB technique. This differentiates it from most of the other series reporting on PAA repairs in the literature, as multivariate analyses to identify predictors of patient and/or graft survival are not confounded by the type of open repair. However, this study does have a number of limitations, predominantly related to its retrospective nature. Only information recorded in the hospital medical notes could be collected. This meant that certain factors (such as serum cholesterol levels at the time of operation or at various postoperatively time points, both of which are usually monitored by the patient's general practitioner) could not be studied which may have provided useful further insights into some of the findings from this study (such as the effect of a hyperlipidemia on graft patency).

Conclusion

The current series confirms that the LGB technique for PAA repair is associated with good patient- and graft-related outcomes at 5 years. However, careful patient selection and aggressive cardiovascular risk reduction strategies are essential for improving patient and graft survival following the use of this technique.

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