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Clinical Research

Comparison of Early and Midterm Results of Open and Endovascular Treatment of Popliteal Artery Aneurysms

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Background: Aim of this study was to retrospectively compare perioperative (<30 days) and 2-year results of open and endovascular management of popliteal artery aneurysms (PAAs) in a single-center experience.

Methods: From January 2005 to December 2010, 64 PAAs in 59 consecutive patients were operated on at our institution; in 43 cases, open repair was performed (group 1), whereas the remaining 21 cases had an endovascular procedure (group 2). Data from all the interventions were prospectively collected in a dedicated database, which included main preoperative, intraoperative, and postoperative parameters. Early results in terms of mortality, graft thrombosis, and amputation rates were analyzed and compared by χ^2 text or Fisher exact text. The surveillance program consisted of clinical and ultrasonographic examinations at 1, 6, and 12 months and yearly thereafter. Follow-up results (survival, primary and secondary patency, limb salvage) were analyzed by Kaplan−Meier curves, and differences in the two groups were assessed by log-rank test.

Results: There were no differences between the two groups in terms of sex, age, risk factors for atherosclerosis, and comorbidities; PAAs were symptomatic in 48% of cases in group 1 and in 29% in group 2 ($P = 0.1$). Fifteen patients with mild-to-moderate acute ischemia due to PAA thrombosis underwent preoperative intra-arterial thrombolysis, 13 in group 1 and 2 in group 2. In open surgery group, nine cases were treated with aneurysmectomy and prosthetic graft interposition, and in seven cases, the aneurysm was opened and a prosthetic graft was placed inside the aneurysm. In 27 cases, ligation of the aneurysm with bypass grafting (21 prosthetic grafts and 6 autologous veins) was carried out. In group 2, 20 patients had endoprosthesis placement, whereas in the remaining patient, a multilayer nitinol stent was used. There was one perioperative death in a patient of group 2 who underwent concomitant endovascular aneurysm repair and PAA endografting. Cumulative 30-day death and amputation rate was 4.5% in group 1 and 4.7% in group 2 ($P = 0.9$). Follow-up was available in 61 interventions (96%) with a mean follow-up period of 22.5 months (range: 1−60). Estimated primary patency rates at 24 months were 78.1% in group 1 and 59.4% in group 2 ($P = 0.1$). Freedom from reintervention rates at 24 months were 79% in group 1 and 61.5% in group 2 ($P = 0.2$); estimated 24-month secondary patency rates were 81.6% in group 1 and 78.4% in group 2 ($P = 0.9$), and freedom from amputation rates were 92.7% and 95%, respectively ($P = 0.7$).

Conclusions: Endovascular treatment of PAAs provided, in our initial experience, satisfactory perioperative and 1-year results, not significantly different from those obtained with prosthetic

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open repair in patients with similar clinical and anatomical status. There is, however, a trend toward poorer primary patency rates among patients endovascularly treated, who also seem to require more frequently a reintervention.

INTRODUCTION

Popliteal artery is the second most frequent localization of arterial aneurysms.[1−3] Main complications of popliteal artery aneurysm (PAA) include rupture, distal embolization, and thrombosis, leading to high risk of limb loss.[4,5] For this reason, elective surgical management of asymptomatic aneurysms larger than 20 mm has been advocated by several authors.[6,7]

Results of open repair of PAAs are good, particularly in the elective setting, with high rates of graft patency and freedom from amputation during follow-up.[8−10]

In recent years, in the era of large spreading of endovascular treatment in different vascular fields, PAA exclusion with stent−graft has been emerging as a possible alternative to open surgery, particularly in high-risk patients.[11]

Also in our institution, after the long and large experience in open repair of PAAs,[10] in recent years, we are getting used to performing endovascular approach in selected patients.

The aim of this study was to retrospectively compare perioperative (<30 days) and 2-year results of open and endovascular management of PAAs in our experience.

MATERIALS AND METHODS

From January 2005 to December 2010, 64 PAAs in 59 consecutive patients were operated on at our institution; in 43 cases, a conventional open repair was performed (group 1), whereas the remaining 21 cases had an endovascular procedure (group 2). The temporal trend of interventions is shown in Figure 1. Data from all the interventions were prospectively collected in a dedicated database, which included demographic data, preoperative risk factors, clinical and diagnostic assessment, intraoperative features, and early and follow-up outcomes.

Preoperative Assessment, Indications for the Treatment, and Technical Details

All patients underwent duplex examination and angio-computed tomography scan or digital subtraction angiography before surgery. Our indication for treating asymptomatic aneurysm was a diameter of >20 mm. In symptomatic patients, indication for surgery was unrelated to aneurysms' diameter.

At the beginning of our experience, our indications for endovascular repair were the presence of a focal PAA, limited to popliteal fossa, with diameters of vessels compatible with commercially available stent−grafts, and at least two patent tibial vessels.

In the following years, we adopted more liberal indications, and nowadays, we evaluate for endovascular feasibility of also longer lesions, involving the entire popliteal artery from the adductor tendon to the popliteal bifurcation, provided that a proximal and distal landing zone of at least 2 cm length is present, with the patency of at least one tibial vessel. Endografts were oversized 10% to 15% relative to the landing zones. When more than one endograft was required for exclusion, overlap of at least 2 cm to prevent a type III endoleak from component separation was used. Overlapping endografts differed by no more than 2 mm in diameter. In the presence of incomplete proximal sealing of endograft at completion angiography, adjunctive ballooning and, when necessary, stenting was performed. All endovascular procedures were carried out in the operating room.

Management in Patients With Acute Ischemia

In selected patients with mild-to-moderate ischemia (grade I or IIa according to Rutherford's classification of acute ischemia) due to acute aneurysms' thrombosis, preoperative catheter-directed thrombolysis with urokinase (Urochinasi Crinos; Crinos SPA, Milan, Italy) was performed.

Thrombolytic treatment was administered in a bolus of 100,000 IU, followed by continuous infusion with a delivery rate of 70,000 IU/hr. In all the patients, 1,000 to 1,500 IU/hr of sodium heparin were administered through the same catheter to maintain values of activated partial thromboplastin time two times higher than normal value.

Angiographic controls were performed daily or more, when necessary, and lytic infusion lasted until patency of popliteal and tibial vessels was achieved or for a maximum of 3 days when unsuccessful. Thrombolysis was defined successful in the presence of restored patency of popliteal artery

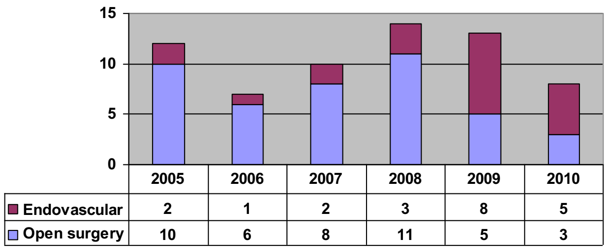

Fig. 1. Temporal trend in open and endovascular popliteal artery aneurysm repair in the present series.

and at least one tibial vessel. Surgical intervention was performed within 24 hours from the cessation of administration of thrombolytic treatment. In the case of unsuccessful thrombolysis, a prompt surgical attempt was performed.

Follow-up

The surveillance program consisted of clinical and ultrasonographic examinations at 1, 6, and 12 months and yearly thereafter. Patency of the graft and status of anastomoses, inflow and outflow vessels, and contralateral femoropopliteal axis were assessed. In patients undergoing endovascular treatment, exclusion of aneurysmal sac from the blood flow was also examined.

All studies were performed using an Acuson Sequoia 512 ultrasound system (Acuson Corporation, Mountain View, CA).

Definition of the Outcomes

Primary patency was defined as uninterrupted patency without procedures performed on or at the margin of the treated segment, whereas secondary patency was defined as restored patency through the original treated segment. Freedom from amputation was defined as the avoidance of above- or below-knee amputation, whereas freedom from reinterventions was defined as the avoidance of any open or endovascular new procedure on the treated artery.

Statistics

Early results in terms of mortality, graft thrombosis, and amputation rates were analyzed and compared by χ^2 text or Fisher exact text. Multivariate analysis (stepwise logistic regression analysis) for 30-day thrombosis was performed for the factors that were significant at univariate analysis.

Follow-up results (survival, primary and secondary patency, freedom from amputation, freedom from reintervention) were analyzed by Kaplan–Meier curves, and differences in the two groups were assessed by log-rank test. Univariate and multivariate analyses (Cox regression) of the factors affecting primary patency in both groups were performed. In Cox regression analysis, the factors with statistical significance at univariate analysis were included. Statistical significance was defined as a P value of <0.05.

Statistical analysis was performed with a dedicated software for Windows (SSPS 18 Inc., Chicago, IL).

RESULTS

Demographic Data, Clinical Status, and Anatomical Status

There were no differences between the two groups in terms of sex, age, risk factors for atherosclerosis, and comorbidities, except for a significantly higher percentage of arterial hypertension in group 2 than in group 1 (Table I).

In 22 cases, contralateral PAA was present (13 in group 1 and 9 in group 2). Other aneurysms were present in 22 cases (34.5%), 14 in group 1 (32.5%) and 8 in group 2 (42%), without significant differences between the two group; in 20 cases (12 in group 1 and 8 in group 2), the aneurysm was located at aortoiliac level, whereas in the remaining two patients, a contralateral common femoral artery aneurysm and a splenic artery were present.

Nine patients (three in group 1 and six in group 2) had been previously operated on for abdominal aortic aneurysm.

Clinical features were similar in the two groups, even in the presence of a trend toward a higher percentage of symptomatic patients in group 1, and are reported in Table I; also, the status of runoff was similar between the two groups, but, again, there was a trend toward a higher percentage of patients with a runoff score of <2 in group 1 (19 cases, 44%) than in group 2 (4 cases, 20%; $P =$ 0.06, odds ratio [OR]: 0.29, 95% confidence interval [CI]: 0.08–1.1). Mean diameter of the treated lesion was 34.7 mm in group 1 and 35.6 mm in group 2 ($P = 0.9$, 95% CI: 7.2/5.5).

Acute Ischemia and Rupture

Fifteen patients with mild-to-moderate acute ischemia due to PAA thrombosis underwent preoperative intra-arterial thrombolysis, 13 in group 1 (30.2%) and 2 in group 2 (9.5%; $P = 0.07$, OR: 0.2, 95% CI: 0.04–1.1; Fig. 2). The mean duration of thrombolytic treatment was significantly longer in group 1 (26.8 hours, SE: 7.8) than in group 2

Table I. Demographic data and clinical presentation in groups 1 and 2

Demographic and clinical data	Group 1 (43 cases)	Group 2 (18 cases)	*P*	OR and 95%CI
Mean age	73.4	74	0.6	
Females	2 (4.5%)	0	0.3	
Smoker or past smoker	35 (81%)	15 (71%)	0.5	
Coronary artery disease	16 (37%)	6 (28.5%)	0.5	
Hyperlipidemia	13 (30%)	6 (28.5%)	0.9	
Diabetes	4 (10%)	2 (10%)	0.9	
Arterial hypertension	34 (79%)	20 (95%)	0.05	
Asymptomatic	22 (52%)	15 (71%)	0.1	0.4, 0.2−1.2
Symptomatic	21 (48%)	6 (29%)		
Claudication	6 (14%)	2 (9.5%)		
Acute ischemia	14 (32%)	3 (14%)		
Rupture	−	1 (5.5%)		
Chronic ischemia	1 (2%)		−	

(9.9 hours, SE: 8.4, $P = 0.04$). Thrombolysis was successful in 8 of the 13 patients in group 1 and in one patient of group 2. The remaining patient of group 2 had complete recanalization of PAA but only partial recanalization of tibial vessels.

Two major complications occurred during thrombolysis, both in group 1—one patient developed a severe (<50,000) thrombocytopenia, requiring the cessation of thrombolytic drug and of heparin, whereas the other patient suffered from a contralateral femoral pseudoaneurysm, requiring surgical repair during the same intervention for the treatment of the PAA.

In one case of a patient with known PAA presenting with severe pain of the affected leg, a contained rupture of a large (5 × 6 cm) PAA was present at preoperative computed tomography scan, and this case was treated with an endovascular procedure.[12]

Operative Details

In open surgery group, nine cases were treated with aneurysmectomy and prosthetic interposition, whereas in seven cases, the aneurysm was opened and a prosthetic graft was placed inside the aneurysm in a manner similar to that used to repair aortic aneurysms. In 27 cases, proximal and distal ligation of the aneurysm with bypass grafting (21 with prosthetic graft and 6 with autologous vein) was carried out. A medial approach was used in 39 cases (90.5%) and a posterior approach was used in 4 cases. In 36 interventions, the inflow vessels were the common or superficial femoral artery, and in the remaining 7, it was the above-knee popliteal artery. The outflow vessel was in most cases the below-knee popliteal artery (37 cases, 86%), and in 6 cases, it was the tibioperoneal trunk or a tibial vessel. Intraoperative stop-flow thrombolysis[13,14] was used in four patients. Associated interventions at distal anastomotic site were performed in nine cases (vein cuff in four cases, patching in two cases, and arteriovenous fistula in the remaining three), whereas two patients had common-to-deep femoral artery short bypass for concomitant involvement of common or deep femoral arteries.

In this group, all the patients had intraoperative administration of 30 IU/kg of intravenous heparin at arterial clamping.

Postoperative and long-term medical treatment consisted of single antiplatelet therapy in 2 cases, double antiplatelet therapy in 28 cases, and oral anticoagulation therapy in 13 patients, the regimen for anticoagulation or antiplatelet being determined just on the basis of distal perfusion.

In group 2, 20 patients had endoprosthesis placement (Hemobahn or Viabahn, W.L. Gore & Associates Inc, Flagstaff, AZ); in the remaining patient, a multilayer nitinol stent was used (Cardiatis Multilayer 3D Stent; Cardiatis SA, Isnes, Belgium).

In 14 cases, ipsilateral surgical femoral approach was used, whereas 7 patients had ipsilateral percutaneous access. Inflow vessels were superficial femoral artery in 15 cases and proximal popliteal artery in 6 cases; the outflow vessel was in all but one case the below-knee popliteal artery, whereas in the remaining patient, it was the tibioperoneal trunk.

The mean number of placed stents was 2 (range: 1−5), with a mean length of 220 mm (range: 100−350). The mean number of stents significantly increased in the period 2008 to 2010 with respect to 2005 to 2007 (1.4 and 2.4; $P = 0.05$, 95% CI: −1.9/−0.008), whereas there were no significant differences in terms of the mean length of arterial coverage (185 mm and 250 mm; $P = 0.1$, 95% CI: −160.1/31.5). Associated proximal stenting

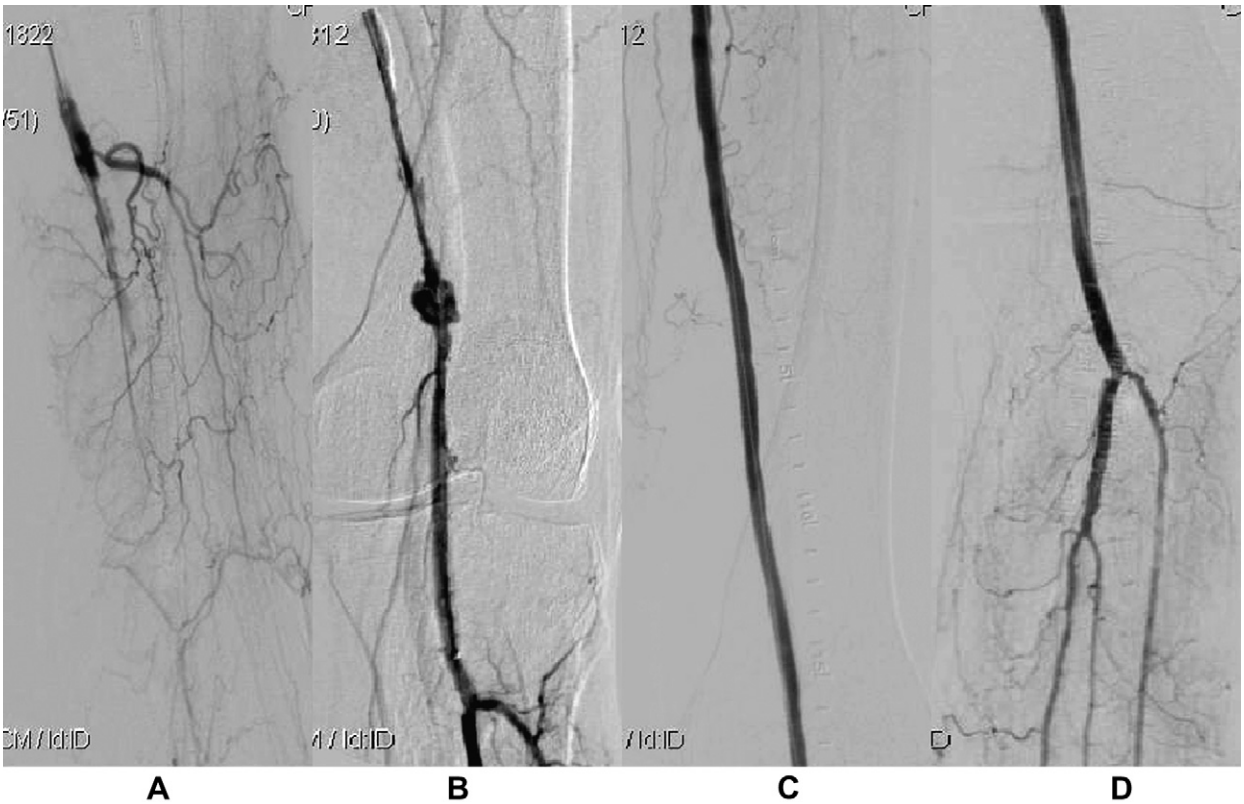

Fig. 2. Thrombosed popliteal artery aneurysm treated with thrombolysis and endovascular repair: (**A**) preoperative angiography, (**B**) completion angiography after successful thrombolysis, (**C**) and (**D**) final result after the placement of endograft.

was performed in four cases to achieve an optimal proximal sealing.

All the patients of group 2 had intravenous administration of 5000 IU of sodium heparin at the beginning of the procedure. Postoperative and long-term medical treatment consisted of double antiplatelet therapy in all the cases.

Perioperative (<30 Days) Results

Technical success occurred in all the patients of group 2. Early results are listed in Table II.

There was one perioperative death in a patient of group 2 who underwent concomitant endovascular aneurysm repair and PAA endografting. On postoperative day 1, the patient developed an acute thrombosis of popliteal endografting, which required conversion to below-knee femoropopliteal bypass, followed by major amputation due to graft occlusion. During postoperative course in intensive care unit, the patient suffered from a fatal acute myocardial infarction. At 30 days, two thromboses occurred in group 1—one case was successfully treated with thrombolysis and stenting of distal anastomosis, whereas the other case lead to major amputation, despite a new surgical attempt; in group 2, two thromboses were recorded, both successfully treated with thrombolysis, one case with adjunctive distal stenting. Another below-knee amputation was performed in a patient of group 1 treated for acute PAA thrombosis who developed an irreversible ischemia of the foot, despite the good patency of surgical revascularization. Both the amputations in group 1 occurred in patients operated on for acute ischemia.

Cumulative 30-day death and amputation rate was 4.5% in group 1 and 4.7% in group 2 (P = 0.9, OR: 1.02, 95% CI: 0.08−11.9).

Other early reinterventions were required in both groups; in group 1, one patient suffered from an acute bleeding from the distal anastomosis, requiring surgical revision. In group 2, one patient developed postoperative bleeding at the site of arterial catheterization and underwent surgical repair of common femoral artery lesion.

As a consequence, there was a trend toward a higher percentage of reinterventions in group 2 than in group 1 (P = 0.06, OR: 2.1, 95% CI: 0.6−6.6).

At univariate analysis for the risk of perioperative thrombosis in the whole group, the presence of acute ischemia (P = 0.03, OR: 1.2, 95% CI: 0.9-1.8) and of

Table II. Early (<30 days) results in groups 1 and 2

Events	Group 1 (43 cases)	Group 2 (21 cases)	*P*
Death	—	1 (4.7%)	0.1
Thrombosis	2 (4.5%)	3 (14.2%)	0.2
Amputation	2 (4.5%)	1 (4.7%)	0.9
Reintervention	2 (4.5%)	4 (19%)	0.06
30-day death and amputation rate	2 (4.5%)	1 (4.7%)[a]	0.9

[a]Amputation and death in the same patient.

diabetes ($P = 0.005$, OR: 1.5, 95% CI: 0.8–2.5) were found to significantly affect the outcome; there was also a trend toward poorer patency rates in patients with coronary artery disease ($P = 0.07$, OR: 1.1, 95% CI: 0.9–1.4). At multivariate analysis, only diabetes was found to be associated with poorer patency rates at 30 days ($P = 0.04$, OR: 0.7, 95% CI: 0.4–1.1).

Follow-up Results

Follow-up was available in 61 interventions (96.5%) with a mean follow-up period of 22.5 months (range: 1–60). In this period, there were no new deaths, whereas 1 amputation and 11 graft thrombosis occurred. Mean duration of follow-up was similar between the two groups (23.5 months and 20.5 months, respectively; $P = 0.9$, 95% CI: −6.6/12.2).

Estimated primary patency rates at 24 months were 78.1% in group 1 and 59.4% in group 2 ($P = 0.2$, log-rank: 1.7, 95% CI: 0.7–7.4; Fig. 3). Seven thromboses occurred in group 1—in three cases, thrombolysis followed by percutaneous transluminal angioplasty of distal anastomosis (in two cases with stenting) was performed. Three patients had graft thrombosis without critical ischemia and were medically managed, whereas in the remaining case, major amputation was necessary. In group 2, there were four late thromboses—two cases were managed with thrombolysis followed, in one case, by stenting of the proximal part of the endograft. In one case, conversion to below-knee bypass was necessary, whereas the remaining patient had graft thrombosis without critical ischemia and was medically managed. Recurrent thrombosis occurred in two patients, one in each group, leading to intermittent claudication, and it was medically managed. Freedom from reintervention rates at 24 months were 79% in group 1 and 61.5% in group 2 ($P = 0.2$, log-rank: 1.6, 95% CI: 0.6–7.3); estimated 24-month secondary patency rates were 81.6% in group 1 and 78.4% in group 2 ($P = 0.9$, log-rank: 0.04, 95% CI: 0.1–4.7; Fig. 4), whereas freedom from amputation rates were 92.7% and 95%, respectively ($P = 0.7$, log-rank: 0.1, 95% CI: 0.8–7.9).

In one patient in group 2, a type II endoleak from a large genicular artery was noted at 12 months, with a slight increase (<5 mm) in sac diameter with respect to preoperative value, which is still under surveillance.

Univariate and multivariate analyses for the risk of graft thrombosis during follow-up in the whole group demonstrated that only the need for tibial anastomosis/landing significantly affected that outcome (Table III). The same separate analysis in the two groups demonstrated that in group 1, primary patency was significantly affected by the need of a tibial anastomosis both at univariate and multivariate analysis (Table IV), whereas in group 2, no factor was found to significantly affect the outcome (Table V).

DISCUSSION

Open surgical repair is a well-established method of treatment of PAAs, providing excellent results in several studies with large number of patients and long-term follow-up data analysis.[8–10,15,16] On the basis of these results and considering the high risk of severe complications in patients with untreated aneurysms,[17,18] it is nowadays accepted that the indication for treatment is the presence of asymptomatic aneurysms larger than 20 mm in patients at low surgical risk.[6] Also in symptomatic lesions, particularly in the presence of limb-threatening ischemia due to PAA thrombosis or embolization, results of open surgery, even if poorer than those obtained in elective situations,[19] are still satisfactory,[20] provided that an aggressive policy of tibial salvage, including preoperative and intraoperative thrombolysis,[5] is adopted.

In the past decade, with the introduction and wide diffusion of endovascular techniques also in peripheral arterial district and with the development of low-profile flexible cover-stents for distal applications, endovascular repair has been proposed for the treatment of PAAs, and promising results have been reported by different authors.[21–26]

Also, in our institution, where a large experience on open repair of PAAs, providing excellent early and long-term results, has been collected and reported in past years,[5,10] we have been using endovascular treatment in selected patients with PAAs since 2005.

The trend of open and endovascular procedures in this period reflects both the need for taking

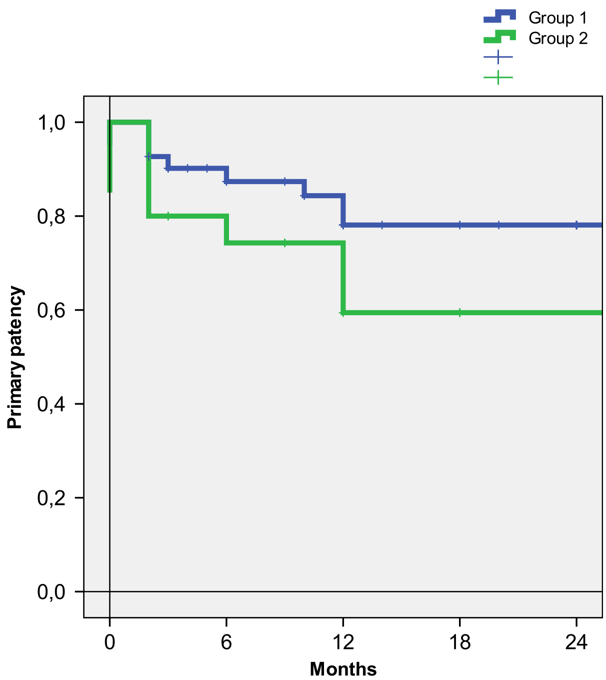

Fig. 3. Kaplan—Meier curve for primary patency during follow-up with number of patients at risk and standard error values at each time interval.

Months	0	12	24
Group 1 (number at risk)	40	29	17
SE	0.03	0.05	0.06
Group 2 (number at risk)	19	8	5
SE	0.07	0.09	0.10

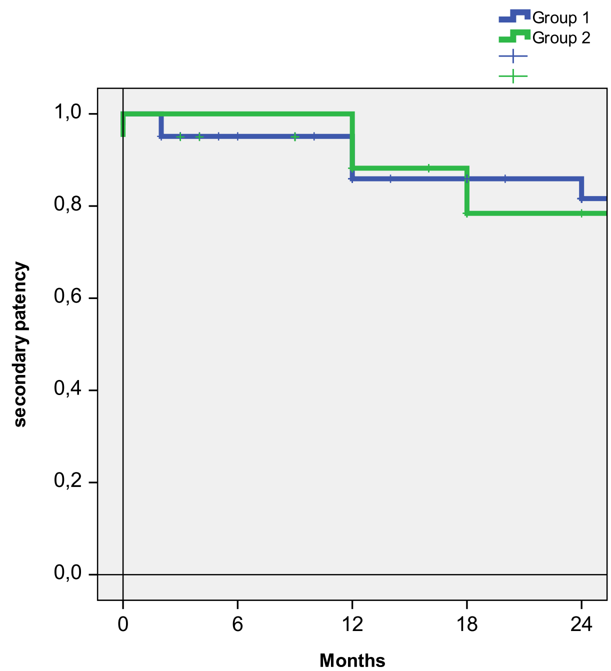

Fig. 4. Kaplan—Meier curve for secondary patency during follow-up with number of patients at risk and standard error values at each time interval.

Months	0	12	24
Group 1 (number at risk)	40	28	19
SE	0.02	0.06	0.07
Group 2 (number at risk)	19	13	8
SE	0.05	0.08	0.10

confidence with this novel approach and the possibility to manage long and complex lesions, requiring more than one graft and the coverage of a longer arterial segment, also with more flexible and precise devices, as demonstrated by the evolution of our experience.

In this article, we analyzed our early and intermediate results of endovascular treatment of PAAs and we compared them with those obtained with open repair in the same period.

A recent meta-analysis[25] reported an overall comparison of the endovascular versus the open intervention for 43 and 116 patients, respectively.

Antonello et al.[27] compared, in a randomized study, the results of 15 open repairs with those of 15 endovascular procedures performed in asymptomatic PAAs with good runoff status, and they found no significant differences between the two options at 12-month follow-up, with some advantages for endovascular repair in terms of operative time and hospital stay. The same authors updated their study[23] with the analysis of 21 endovascular procedures compared with 27 open interventions performed in asymptomatic PAAs, and they still found no differences in terms of primary and secondary patency at 72 months, with a 14% rate of late conversion to open surgery.

Curi et al.[24] retrospectively reviewed their results in 15 endovascular PAA repairs compared with 41 open interventions; similar to the previously cited studies, endovascular treatment was performed mainly in asymptomatic patients (13 cases, 87%) and all acute PAA thromboses were treated with open intervention. Estimated 24-month patency rates were similar between the two techniques, with 83% and 100% of primary and secondary patency, respectively, for endovascular treatment.

Stone et al.[28] reported seven cases of endovascular treatment, performed in all but one case in asymptomatic patients, and 48 open interventions; even if the study was not appositely designed to compare the outcomes of the two procedures, two of the seven endografts thrombosed during follow-up, whereas graft thrombosis occurred only in two patients undergoing open repair. However, the

Table III. Univariate and multivariate (for significant factors at univariate) analyses for primary patency during follow-up

	Univariate analysis				Multivariate analysis		
Analyzed factors	Log-rank	*P*	95% CI	OR	95% CI	OR	*P*
Diabetes	2.5	0.07	0.08−1.1	0.3			
PAA thrombosis	0.2	0.1	0.2−3.6	1.1			
Symptomatic PAA	0.5	0.3	0.2−1.7	0.6			
Limb-threatening ischemia	1.2	0.5	0.2−2	0.7			
Runoff score 0−1	1.3	0.2	0.6−4.9	1.7			
Preoperative thrombolysis	0.2	0.5	0.5−5.7	1.4			
Endovascular intervention	0.1	0.1	0.7−6.1	2.1			
Tibial anastomosis/landing	5.7	0.03	1.1−11.9	3.7	1.3−15.7	4.6	0.01

PAA, popliteal artery aneurysm.

Table IV. Univariate and multivariate (for significant factors at univariate) analyses for primary patency during follow-up in group 1

	Univariate analysis				Multivariate analysis		
Analyzed factors	Log-rank	*P*	95% CI	OR	95% CI	OR	*P*
Diabetes	0.7	0.5	0.06−4.5	0.6			
PAA thrombosis	0.4	0.6	0.2−2.8	0.7			
Symptomatic PAA	0.02	0.6	0.1−2.6	0.5			
Limb-threatening ischemia	1.5	0.4	0.1−2.1	0.5			
Runoff score 0−1	2.7	0.07	0.8−20.1	4.1			
Preoperative thrombolysis	0.05	0.9	0.2−4.3	1			
Posterior approach	0.4	0.4	0.05−3.9	0.4			
Tibial anastomosis	10.5	0.006	1.7−29.4	7.2	1.1−22.3	4.9	0.03
Prosthetic graft	1.7	0.7	0.08−5.5	0.6			

need for secondary procedures to maintain the patency of the graft was significantly higher in open surgery group.

Results of our series are similar to those reported by Antonello[23] and larger than those reported by Curi et al.[24] and Stone et al.[28] in terms of number of endovascular procedures; moreover, the percentage of symptomatic PAAs treated with endografting was largely higher (29%), and approximately one-quarter of the patients of endovascular group had only one patent distal vessel. This fact can explain the relatively lower rates of 24-month primary and secondary patency in our series in comparison with the previously cited ones and with those reported in the recent meta-analysis by Cina.[25]

Although our groups were homogeneous under a statistical point of view, there was a trend toward higher percentage of worse patients (symptomatic with poorer runoff status) in the open group, which must be taken into account when analyzing our results.

We did not find any clinical or anatomical factor affecting immediate and late failure of endovascular procedure; however, this is probably because of the relatively small number of patients and events.

The outcome of open repair remains excellent in our experience, despite the use of prosthetic grafts, confirming the results of our previous studies, both in symptomatic and asymptomatic patients. As previously reported,[10] we found the need for distal tibial anastomosis to significantly affect follow-up graft patency in this study also, and this was the only factor associated with an increased risk of late failure in open repair group.

We did not find significant differences between the two groups in terms of primary and secondary patency; however, there was a trend for poorer primary patency rates in the endovascular group (possible type I statistical error). One can suppose that at a longer follow-up period with a larger number of patients and events, this difference may become significant, suggesting the need for deeper and longer analysis.

In acutely thrombosed PAAs, our aggressive policy of tibial salvage, with the use of intra-arterial thrombolysis in selected patients with

Table V. Univariate analysis for primary patency during follow-up in group 2

	Univariate analysis			
Analyzed factors	Log-rank	*P*	95% CI	OR
Diabetes	2.9	0.09	0.04−1.3	0.2
PAA thrombosis	0.1	0.6	0.07−5.9	0.6
Symptomatic PAA	0.3	0.7	0.08−5.9	0.6
Limb-threatening ischemia	1.2	0.6	0.06−5.1	0.5
Runoff score 0−1	0.1	0.8	0.09−7.2	0.8
Tibial landing	0.6	0.4	0.04−4.5	0.7
Percutaneous access	0.4	0.5	0.2−18.1	1.9
Adjunctive proximal procedure	1.1	0.2	0.03−2.8	0.2
More than one stent placed	0.2	0.6	0.2−10	1.4
More than 200 mm of stent length	0.5	0.4	0.3−12.5	1.9

moderate ischemia, maintained its effectiveness in approaching this potentially catastrophic complication; after the patency of popliteal artery and tibial vessels is restored, it is now possible to choose between open and endovascular repair on the basis of clinical and anatomical consideration; this was also our strategy, and the two patients who had thrombolysis followed by endovascular repair had optimal results, with graft patency and limb salvage during follow-up.

The rate of both perioperative and late reinterventions was similar between the two groups, even if we again found a trend toward a higher risk of early reintervention among patients treated with endovascular repair. This is a previously unreported finding and should probably be considered when planning an endovascular procedure, even though the risk of developing an endoleak is low in our experience and probably it does not represent the main complication of endovascular repair of PAAs.

This study has several limitations. It is a retrospective nonrandomized study, with a relatively short period of follow-up, and a low number of events, making type I statistical error possible both in perioperative and follow-up analysis. On the other hand, in our opinion, the relative homogeneity between open and endovascular groups in terms of clinical presentation and runoff status under a statistical standpoint adds some value to the study, which well reflects the current daily practice.

In our experience, endovascular repair, in the presence of a suitable anatomy and with good tibial runoff, is not only feasible but also safe and with 2-year results that are clinically acceptable and not significantly different from open repair. However, a randomized controlled trial should better define the true role of endovascular technique in the management of PAAs.

CONCLUSIONS

Endovascular treatment of PAAs provided, in our initial experience, satisfactory perioperative and intermediate results, not significantly different from prosthetic open repair in patients with similar clinical and anatomical status. There is, however, a trend toward poorer primary patency rates among patients endovascularly treated, who also seem to require more frequently a reintervention. These findings suggest the need for further analysis at a longer follow-up with a larger number of patients.

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