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Original Article

Endovascular Treatment of Popliteal Artery Aneurysms

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ABSTRACT

Background: With the recent advances in endovascular techniques and the emergence of more flexible endoprosthesis, the treatment of popliteal artery aneurysms has become more frequent. The objective of this study was to evaluate the short and mid-term clinical outcomes of the treatment of popliteal artery aneurysms with the use of a flexible endoprosthesis. **Methods**: Retrospective longitudinal study conducted in two sites from January of 2011 to February of 2014. Populational characteristics, procedure-related data, and radiologic imaging were evaluated at a mean follow-up of 1 year. Morbidity and mortality rates, complication rates, and stent patency rates were obtained. **Results**: A total of 13 male patients, mean age 66 ± 9 years, were submitted to popliteal artery aneurysm treatment in 15 limbs. Run-off vessel evaluation showed that most patients had at least two patent arteries in the legs (92.3%). Stents were implanted in the middle segment in 57.1% and in the distal segment of the popliteal artery in 42.9% of the procedures. Target lesion revascularization was achieved in all of the cases and two stents were required in four limbs. Seventeen Viabahn™ and two Multilayer™ stents were used. During the 12-month follow-up there were no stent fractures. The primary patency rate was 53.3% and limb salvage rate was 100%. **Conclusions**: Endovascular treatment of popliteal artery aneurysm was shown to be effective in the mid-term follow-up.

DESCRIPTORS: Aneurysm. Popliteal artery. Blood vessel prosthesis. Stents. Treatment outcome.

RESUMO

Tratamento Endovascular dos Aneurismas de Artéria Poplítea

Introdução: Com os recentes avanços nas técnicas endovasculares e com o surgimento de endopróteses mais flexíveis, o tratamento das lesões aneurismáticas da artéria poplítea tem se tornado mais frequente. O objetivo desse estudo foi avaliar os desfechos clínicos a curto e médio prazos do tratamento de lesões aneurismáticas da artéria poplítea com o uso de endopróteses flexíveis. **Métodos**: Estudo retrospectivo, longitudinal, realizado em dois centros, no período de janeiro de 2011 a fevereiro de 2014. Foram avaliados características populacionais, dados do procedimento e imagens radiológicas no seguimento médio de 1 ano, sendo obtidas as taxas de morbimortalidade, complicações e perviedade da endoprótese. **Resultados**: Treze pacientes do sexo masculino, com idade de 66 ± 9 anos, foram submetidos ao tratamento de aneurismas de artéria poplítea em 15 membros. Na avaliação do leito de deságue, a maior parte dos pacientes possuía pelo menos duas artérias da perna pérvias (92,3%). O implante do stent ocorreu no segmento médio em 57,1% e, no segmento distal da artéria poplítea, em 42,9% dos procedimentos. Foi possível realizar a revascularização da lesão-alvo em todos os casos, sendo que, em quatro membros, foi necessário o uso de dois stents. Foram utilizados 17 stents Viabahn® e 2 stents Multilayer®. Durante o seguimento de 12 meses, não ocorreram fraturas de stents. A taxa de perviedade primária foi de 53,3% e a de salvamento de membro de 100%. **Conclusões**: O tratamento endovascular do aneurisma de artéria poplítea demonstrou ser eficaz no seguimento de médio prazo.

DESCRITORES: Aneurisma. Artéria poplítea. Prótese vascular. Stents. Resultado do tratamento.

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Popliteal artery aneurysm is the most prevalent peripheral aneurysm and the most commonly treated, constituting a clinically relevant pathology.[1] However, this disease is rarely addressed in the literature.[2] Recently, some researchers have reported their experiences, derived from single centers, with endovascular treatment of these aneurysms with satisfactory results.[3,4] However, the Groningen group, one of the pioneers in endovascular treatment of this arterial segment, reported high frequency of endoprosthesis fractures in the follow-up of these patients.[5]

The objective of this study was to assess the clinical outcomes in the short and medium term with the use of a flexible endoprosthesis for the treatment of aneurysmal lesions of the popliteal artery.

METHODS

Type of study

This was a retrospective, longitudinal, observational study performed in two reference centers for cardiovascular diseases, from January of 2011 to February of 2014. Cases of popliteal artery aneurysm treated via endovascular route were evaluated.

Inclusion and exclusion criteria

The candidates for the performance of endovascular procedures were patients of both genders, symptomatic or asymptomatic, with popliteal artery aneurysms with diameter > 2 cm. Symptoms included: limiting intermittent claudication secondary to embolization of the popliteal aneurysm; pain at rest in the affected limb secondary to embolization of the popliteal aneurysm; acute arterial occlusion secondarytoacute thrombosis of the popliteal artery aneurysm; or ipsilateral ulceration.

Patients were excluded from the procedures when they had creatinine clearance < 30 mL/kg/min, history of severe allergy to iodinated contrast agents, or significant arteriosclerotic disease in the aortoiliac and/or femoral regions.

All patients were studied with Doppler ultrasound and preoperative angiography. In this study, the assessed patients had lesions restrictedto the popliteal artery and the presence of at least one leg artery as distal runoff.

Endovascular procedure

All procedures were performed in the Hemodynamics Laboratory of the Endovascular Intervention Center (Laboratório de Hemodinâmica do Centro de Intervenções Endovasculares [CIEV]) of Instituto Dante Pazzanese de Cardiologiaand in the Hemodynamics Laboratory of Hospital Salvalus, both located in São Paulo, SP, Brazi.

The patients received clopidogrel 75 mg/day and acetylsalicylic acid (ASA) 100 mg three days before the procedure. The use of clopidogrel was maintained for at least 30 days and the ASA, indefinitely.

Patients were treated under local anesthesia. Antibiotic prophylaxis was performed using 1.5 g of cefuroxime at the time of anesthesia induction. The approach was preferably performed through the ipsilateral common femoral artery, by anterograde puncture using valved Prelude® 6 F sheath (Merit Medial Systems, South Jordan, United States). Target lesions were transposed via lumen using a 0.035' × 150 cm hydrophilic Radifocus® guide wire (Terumo Interventional Systems, Somerset, United States) together with MPA-1 5 F and/or JR 5 F diagnostic catheters (Cordis Corporation, Warren, United States). After passing through the target aneurysmal lesion, a 0.035 × 260 cm super-stiff Amplatz guide wire (Boston Scientific, Natick, United States) was positioned to exchange the Dryseal GORE® 8 F sheath 11 F (WL Gore & Associates Inc., Flagstaff, States), depending on the diameter of the chosen endoprosthesis and its passage. In all cases, the GORE® Viabahn® endoprosthesis (WL Gore & Associates, Inc., Flagstaff, United States) or Multilayer® endoprosthesis (Cardiatis, Isnes, Belgium) was used. Radiographic control was performed with Siemens – Axiom Artis Flat Panel equipment or in a hybrid room using Siemens – Artis Zeego equipment (Figure 1).

The immediate postoperative period was conducted in the surgical wardin all cases and local hemostasis was performed with manual compression for 40 minutes.

Postoperative follow-up

Patients were followed without patient assessment at 15, 30, 90, and 180 days after endovascular treatment. Doppler ultrasound was performed at 30, 90, and 180 days after surgery in order to identify significant restenosis, defined as re-occlusion > 50% (Figure 2). X-rays of the knee joint in posteroanterior and lateral views at 30 and 180 days were performed in order to identify endoprosthesis fractures (Figure 3).

Outcomes and definitions

The analyzed outcomes were: (1) immediate technical success when the endoprosthesis was implanted in the desired site; (2) therapeutic success, when the aneurysm was treated as previously planned, without the presence of leaks in the control arteriography; (3) perioperative morbimortality, for deaths and complications recorded up to 30 days postoperatively; (4) primary patency, which indicated uninterrupted patency after the revascularization procedure; and assisted primary patency, which expressed cases in which rescue procedure was performed for treatment of critical stenosis during patient follow-up; (5) major amputations, regarding transfemoral and transtibial amputations; (6) minor

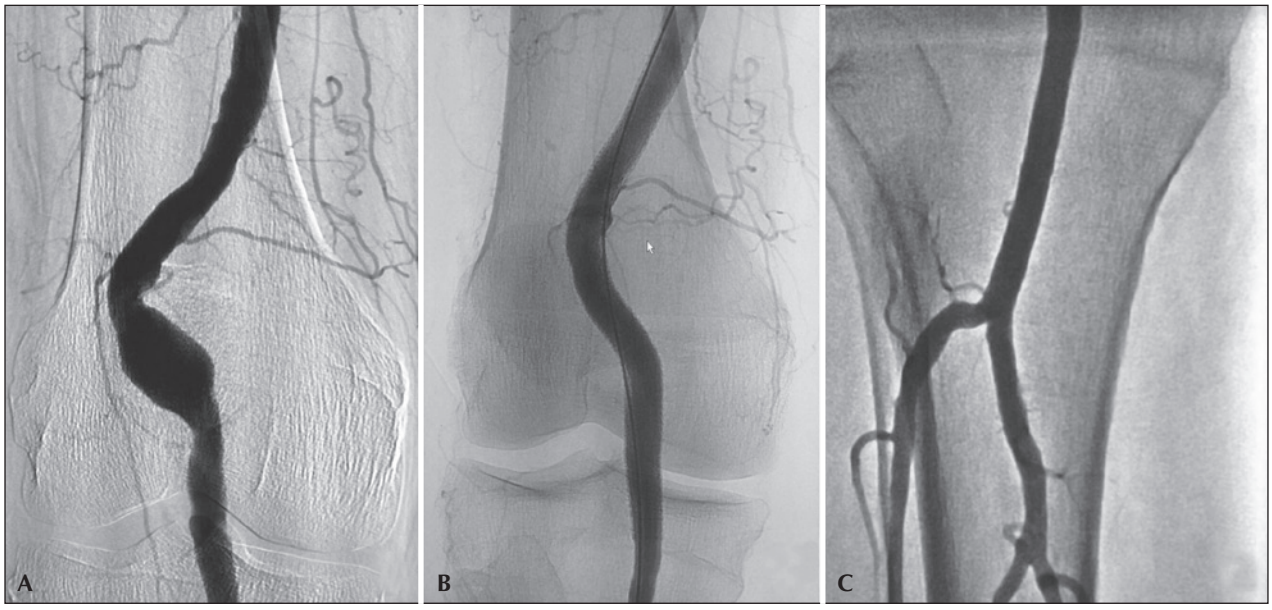

Figure 1 – Endovascular treatment of popliteal artery aneurysm. (A) Fusiform aneurysm of the supra-articular popliteal artery. (B) Arteriography after implantation of the endoprosthesis, with no evidence of leaks. (C) Arteriography of the leg arteries, with no evidence of dissection or embolization.

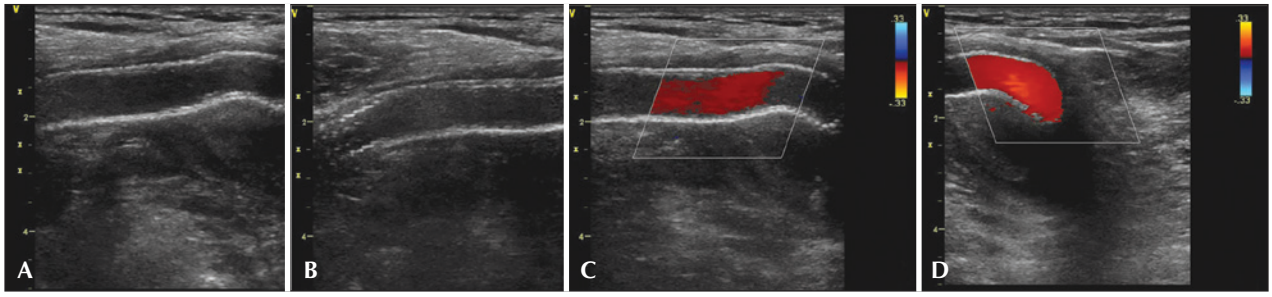

Figure 2 – B-mode vascular ultrasound and color ultrasound after implantation. (A) B-mode ultrasound of the endoprosthesis showing no signs of stent fractures. (B) B-mode ultrasound showing the connection of the two overlapping endoprostheses. (C) Color ultrasound showing no signs of stenosis or neointimal hyperplasia. (D) Color ultrasound at the level of the joint region showing its run-off.

amputations, regarding amputations at the foot level; (7) stent fractures, for disconnected or twisted prosthesis mesh; and (8) limb salvage rate.

STATISTICAL ANALYSIS

Data were shown as absolute value, frequency, mean, and standard deviation. An event-free survival curve was constructed using the Kaplan-Meier method. The analysis was performed using SPSS®, version 17.0 (IBM Corp., Armonk, United States).

RESULTS

The study included 13 patients with popliteal artery aneurysms and 15 popliteal artery aneurysms were treated by endovascular technique. The mean age was 66 ± 9 years; all were males and slightly over 30% were diabetics. Regarding the clinical picture, 13 limbs were symptomatic; of these, most (40.0%) had mild claudication (Table 1). One patient had prior history of acute arterial occlusion and the aneurysms were thrombosed in four limbs (26.7%).

Regarding the target lesion, 20% of cases were in the proximal segment of the popliteal artery (P1), 53.3% in the middle segment (P2), and 26.7% in the distal portion (P3) (Figure 4). In the run-off assessment, most patients had at least two patent arteries (80.0%), and the fibular artery was the most frequently found. The mean diameter of aneurysms was 4.2 mm (range 2.1 to 6.2 mm) and most were fusiform (86.7%) (Table 2).

Target lesion revascularization was feasible in all cases, and in four limbs it was necessary to using two stents, achieving 100% technical success. Seventeen

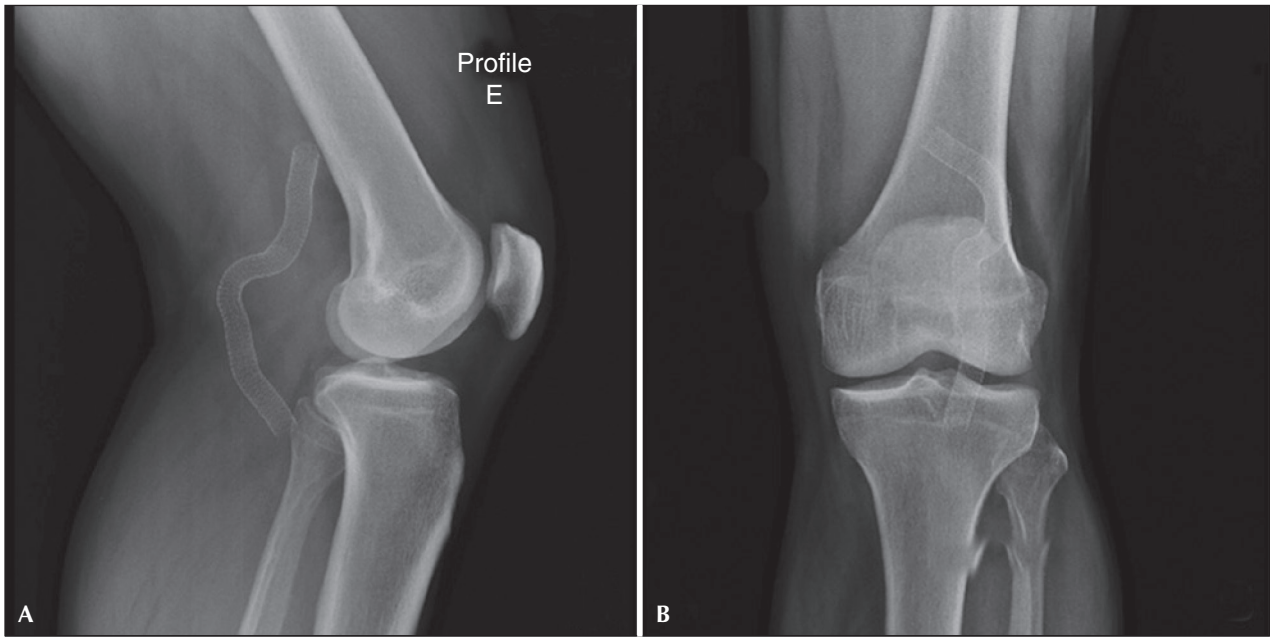

Figure 3 – Follow-up X-ray after endoprosthesis implantation. (A) Left profile with knee in semiflexion. (B) Posteroanterior view, both showing no signs of fracture.

TABLE 1
Baseline clinical characteristics

Variables	n = 13 patients/ 15 limbs
Age, years	66 ± 9
Male gender, n (%)	13 (100)
Comorbidities n (%)	
Arterial hypertension	12 (92.3)
Diabetes mellitus	4 (30.8)
Dyslipidemia	11 (84.6)
Smoking	9 (69.2)
Coronary artery disease	1 (7.7)
PAOD	9 (69.2)
Clinical picture, n (%)	
Asymptomatic	2 (13.3)
Mild claudication	6 (40.0)
Moderate claudication	1 (6.7)
Severe claudication	4 (26.7)
Ulceration	2 (13.3)
Prior arterial occlusion, n (%)	1 (6.7)
Pre-procedure ABI	0.82 ± 0.25

PAOD: peripheral arterial occlusive disease; ABI: ankle-brachial index.

Viabahn® (89.4%) and two Multilayer® stents (10.6%) were used. Therapeutic success was attained in 73.3% of cases. There were no dissection or embolization cases in the intraoperative periods. There were no deaths related to the procedure or in the perioperative period.

The mean follow-up of patients was 11.8 months (range 4 to 36 months). There were no deaths. Type IA endoleak was observed in one limb that developed stent occlusion, which was submitted to thromboembolectomy and new endoprosthesis interposition. The presence of type II endoleak was observed in two limbs, which were clinically followed, with no noticeable aneurysmal sac growth during follow-up. Seven limbs (46.7%) showed stent occlusion: three were treated exclusively with chemical thrombolysis; one was submitted to mechanical thromboembolectomy followed by graft confection; one was submitted to mechanical thromboembolectomy followed by thrombolysis and implant of a new Multilayer® endoprosthesis; and two patients were treated with recanalization and implant of another Viabahn® endoprosthesis (Table 3).

The limb salvage rate was 100%. There was an increase in ankle-brachial index (ABI) from 0.82 ± 0.25, preoperatively, to 0.85 ± 0.20 at hospital discharge. The primary patency rate was 53.3%. In two cases, it was necessary to implant a new endoprosthesis, which generated a secondary patency rate of 66.7% (Figure 5). There were no stent fractures during the follow-up period.

DISCUSSION

Aneurysmal disease of the popliteal artery has a difficult endovascular treatment, due to the biomechanical stress present in this region. Complex rotation, traction, compression, and stretching forces act at the same time

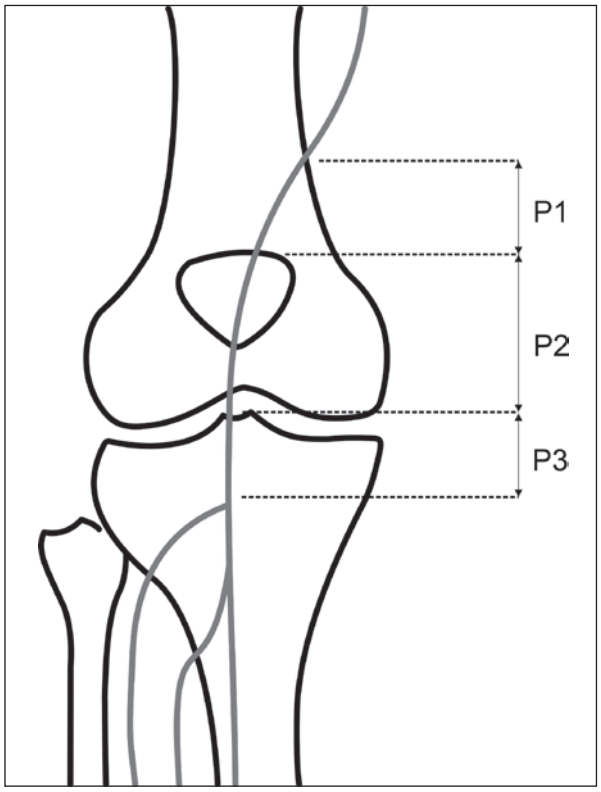

Figure 4 – Schematic representation of the popliteal artery segments. P1 corresponds to the proximal segment, ranging from the adductor canal to the upper border of the patella; P2 is the middle segment, from the upper border of the patella to the joint line; P3 corresponds to the distal segment, from the joint line to the emergence of the anterior tibial artery.

TABLE 2
Angiographic characteristics of the lesions

Variables	n = 13 patients/15 limbs
Involvement of the superficial femoral artery, n (%)	2 (13.3)
Involvement area, n (%)	
P1	3 (20.0)
P2	8 (53.3)
P3	4 (26.7)
Number of run-off arteries, n (%)	
0	1 (6.7)
1	2 (13.3)
2	8 (53.3)
3	4 (26.7)
Bilaterally, n (%)	2 (15.3)
Aneurysm thrombosis, n (%)	4 (26.7)
Aneurysm diameter, mm	4.2 (2.1-6.2)
Morphology, n (%)	
Saccular	2 (13.3)
Fusiform	13 (86.7)

over a short arterial segment and on the stent.[6,7] For many years, these aneurysms were treated with surgical grafts, using autologous vein or endoaneurysmorrhaphy. However, the high rates of patency and low mortality rates are accompanied by considerable perioperative morbidity, in addition to the necessity of reoperations and hospital readmissions.[8,9]

Marin et al.[10] were the first to perform endovascular repairs of popliteal artery aneurysm. Currently, endovascular treatment is an alternative to the open repair, due to its advantages, such as less bleeding, faster recovery in the postoperative period, and shorter hospital length of stay.[11,12] Its major limitation is the proximity to the knee joint line, so that the implanted endoprosthesis is submitted to constant physical stress and increased risk of occlusion and migration.[6,7]

Clinical manifestations of popliteal aneurysm include acute arterial thrombosis, distal embolism, nerve or venous compression, and rupture.[13,14] Most can be clinically diagnosed when the diameter is > 3 cm, and can be suspected in the presence of pulse in the popliteal fossa.[13,14] 30% to 40% of aneurysms are asymptomatic at the time of the primary presentation in most series.[13] In the present study, only 13% were asymptomatic preoperatively, which is consistent with a more severe patient profile.

CT angiography, arteriography, and angioresonance should be performed to attain adequate endovascular planning, aiming at evaluating the proximal and distal arteries, as well as aneurysm characteristics. Therefore, the correct diameter and the length of the endoprosthesis to be used can be determined.

There is a consensus in the literature that a popliteal artery aneurysm > 2 cm, with or without thrombi, and symptomatic popliteal artery aneurysms of any diameter should be treated.[15] The elective open surgical repair has a rate of limb loss < 5% in 10 years.[1,2,15]

TABLE 3
Complications during the follow-up of treated patients.

Outcomes	n = 15 limbs
Endoleak, n (%)	
IA	1 (6.7)
IB	0
II	2 (13.3)
III	0
Major amputation, n (%)	0
Minor amputation, n (%)	2 (13.3)
Endoprosthesis occlusion, n (%)	7 (46.7)
Aneurysm progression to another segment, n (%)	1 (6.7)

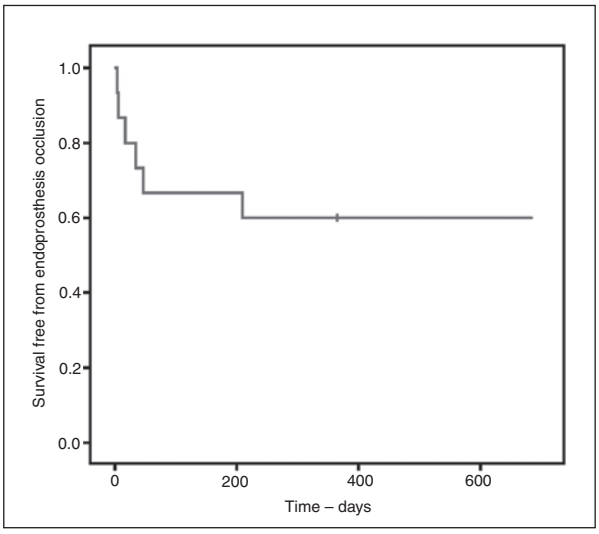

Figure 5 – Kaplan-Meier curve of survival free from endoprosthesis occlusion.

All patients received ASA and clopidogrel; ASA has been shown to reduce prosthesis occlusion rates in the infrainguinal segment.[15] This benefit is increased by its association with clopidogrel, according to the CLAFS Study (Clopidogrel plus long-term aspirin after femoral-popliteal stenting).[16] Tielliu et al.[17] found that 42% of stent occlusions occurred by the first month and 75% by the 6 month of follow-up, which is why the association of antiplatelet agents must be maintained for 6 months.

The mean number of patent run-off leg arteries in the present study was two. Several authors defend that this is one of the major interference factors in stent patency,[1,2,17] as the best results are found in the absence of superficial femoral artery disease and tibial artery occlusions.[15]

The primary patency in the present series was 53.3% and the secondary, 66.7%, in the follow-up period – slightly lower values than those found at the 2 year follow-up by Lovegrove et al.[18] (77% and 80%, respectively). Mohan et al.[19] observed that 33% of occlusions occurred within 1 month and 66% within 4 months; only two occlusions occurred late, generating primary patency of 80% and secondary patency of 88% at one year. Howell et al.[20] reported endoprosthesis thrombosis in 31% of 13 aneurysms and Gerasimidis et al.[21] in 4 of the 12 treated cases at 1 year.

Six patients underwent reintervention due to early detection of abnormalities by echo-Doppler ultrasound, since only 13% had symptoms. Several authors have suggested that a routine Doppler assessment may lead to an increase in the assisted primary patency.[22]

Endoleaks were observed in 20% of the present cases, similarly to that found in other series (0–20% at 1 year).[1,2,3,15] For popliteal artery aneurysm repair, endoprostheses with coverage area in the anchoring site of at least 3 cm of proximal and distal healthy artery are required, to prevent endoleaks and migrations.[15]

Of a total of 56 cases assessed in a cohort study, which compared endovascular treatment with the open surgical treatment, the primary and secondary patency at 16 months was the same in both groups, with occurrence of endoleak in three of the 15 cases selected for the endovascular treatment.[23] In the present series, of the three cases with endoleak, one was type IA and two were type II. The first was treated with interposition of a new endoprosthesis and the others were clinically followed, with no increase in the aneurysmal sac or clinical complications.

Antonello et al.,[24] in a prospective randomized study evaluating 30 asymptomatic patients, reported the occurrence of endoprosthesis acute arterial thrombosis in one patient (6.7%) with a mean follow-up of 46 months, with no statistically significant difference regarding patency, when compared to open surgery treatment. These results were probably attained due to the fact that the patients selected for the study had good anatomical condition (run-off score < 8, according to the Joint Council of the Society for Vascular Surgery). In the present series, of the 15 analyzed cases, seven developed endoprosthesis occlusion, making reoperation necessary in these cases, while maintaining a limb salvage rate of 100%.

Study limitations

The small number of cases, the heterogeneity of treated popliteal artery segments, the medium-term follow-up, and the lack of an established algorithm for clinical follow-up of these patients should be considered in the interpretation of these results.

CONCLUSIONS

The endovascular treatment of popliteal arterial aneurysms was shown to be effective in the medium-term follow-up. The patency rates of the treated popliteal arteries demonstrate the need for the stringent follow-up of these patients.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING SOURCES

None declared.

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