

Endovascular Treatment of Popliteal Artery Aneurysms

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Objective. To present the results of the endovascular treatment of popliteal artery aneurysms.

Methods. From April 1999 to January 2002, 11 patients, aged 40–94 years, with 12 popliteal aneurysms were treated. Nine (75%) underwent an endoluminal repair, of whom three were done emergently due to a aneurysm rupture. Aneurysm diameter was 28–105 (mean 69) mm. A Hemobahn stent graft was inserted in six, Wallgraft in two and Passager in one case.

Results. During a mean follow-up of 14 (3–31) months, four (44%) thromboses occurred: two in the early postoperative period (30 days) and two during the late postoperative period. Two of the four occluded grafts were successfully reopened, and in the one a stenosis of the distal end of the stent graft was treated with balloon dilatation. Patency rates at 1 and 12 months were 64/47% (primary patency) and 88/75% (secondary patency), respectively.

Conclusion. Initial experience with endovascular treatment of the popliteal aneurysm in high-risk patients yielded modest results. Larger number of patients and further follow-up time is necessary to evaluate the long-term results.

Key Words: Popliteal artery aneurysm; Endovascular; Stent graft.

Popliteal aneurysms, despite their rarity,¹ account for 70–80% of all peripheral artery aneurysms.^{2–5} They are clinically very significant, as they can lead to limb-threatening situations. About half are bilateral, and accompanied by aortic or femoral aneurysms.^{6–9} Patients may be asymptomatic, and the aneurysm is discovered by coincidence,^{7,9} or present acutely with thrombosis or peripheral embolisation.⁸ Rupture is uncommon,^{7,8,10} but one, which calls for immediate operation. Symptomatic aneurysms, as well as asymptomatic aneurysms of more than 2 cm in diameter,^{11–13} are considered candidates for elective surgery.¹¹

In a number of situations, endovascular management has replaced open surgical repair, as the first option. Potentially, also popliteal aneurysms are treatable through an endovascular approach, but is the setting appropriate with the proximity to the knee joint and is it durable?

The aim of this paper was to present the initial experience and results obtained from treating nine patients with popliteal aneurysm using the endovascular method.

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Materials and Methods

Between April 1999 and January 2002, 11 patients with 12 aneurysms of the popliteal artery were admitted in our service. Nine patients, eight men and one woman, were treated endovascularly. Patients' ages ranged from 40 to 94 with an average age of 67 years. All patients were considered as high risk for an open procedure due to severe cardiac, pulmonary, cerebral or other systematic disease (Table 1). Most aneurysms were considered to be atherosclerotic (Table 2), except one patient who had Adamantiades–Behcet disease, and another patient thought to have a post-traumatic aetiology, after a bullet wound to the popliteal artery. Two (22%) patients had aneurysms in both popliteal arteries.

Three patients underwent emergent treatment following rupture of the aneurysm. A fourth patient, with aneurysms in both popliteal arteries presented with acute ischemia of the right leg due to thrombosis and underwent femoro-popliteal bypass followed by stenting of the left popliteal artery aneurysm. The remaining five patients underwent elective reconstruction. In two patients their major symptom was intermittent claudication and in three others the aneurysm was asymptomatic and was discovered as

Table 1. Coexisting disorders.

	N	%
Heart disease, coronary disease	4	44.4
Cerebral disease (dementia, Parkinson)	2	22.2
Pulmonary disease	1	11.1
Adamantiades–Behcet disease	1	11.1
Tuberculosis	1	11.1
Inflammatory bowel disease	1	11.1
Related thrombophilia	1	11.1

a palpable mass in the popliteal cavity during physical examination.

Pre-operative assessment was done using angiography and/or CT scan. The aneurysms ranged in diameter from 28 to 105 mm, with a mean of 69 mm (Table 3). In 7 cases, the aneurysm was located above knee, while in the two others it was located below knee. In 4 patients, the status of the run off vessels is graded poor (0–1 vessels), and in 5 patients good (2–3 vessels) (Table 4).

The following graft types were used: in six we used a Hemobahn (Gore-tex) graft with a PTFE graft and nitinol (nickel–titanium) stent. In 2, a Wallgraft (Schneider) graft with a stent covered externally with PET. And the last patients had a Passager (Meadox Medical) graft with a nitinol stent covered externally with a polyester graft. Used on one patient. All types had self expandable stents.

The operation was carried out in a special surgical room, equipped with a SIAS SM9-HF C-arm and the possibility to convert to open operation in case of failure of the endovascular procedure. Under local anaesthesia the ipsilateral common femoral artery is exposed, 5000 IU of heparin are administered intravenously and then a guide wire 0.035 in. is introduced into the femoral artery, orthograde, and advanced into the popliteal artery distally to the aneurysm. A 6Fr sheath is introduced, the boundaries of the aneurysm are determined by angiography, the sheath is changed to a larger one (depending on the graft: 9Fr sheath for the Hemobahn stent graft or 10–11Fr for the Wallgraft) and the stent graft is emplaced and opened under continuous radiological monitoring (Fig. 1). An angiography is then performed to check the exclusion of the aneurysm, the guide wire and the sheath are removed and the arterial and inguinal incisions are sutured.

Table 2. Risk factors.

	N	%
Smoking	6	66.6
Arterial hypertension	4	44.4
Hyperlipidemia	2	22.2
Diabetes mellitus	1	11.1

Table 3. Preoperative imaging.

	N	%
DSA	3	33.3
DSA + CT	1	11.1
CT	3	33.3
DSA + U/S	1	11.1
DSA + CT + U/S	1	11.1

While hospitalised the patients were given low molecular weight heparin and antibiotics. The medication regimen prescribed for patients on discharge is presented in detail in Table 5.

The follow-up protocol consisted on regular clinical check ups in 1, 3 and every 6 months and a Triplex monitoring if necessary. All patients remained in permanent contact with our service and informed us about any acute event that occurred. None of them was lost in follow-up.

Results

Aneurysmal exclusion was successful in all nine cases and none required conversion to open surgery. In four patients, a second stent graft was needed due to the length of the aneurysm (Table 5). Patients were hospitalised for between 2 and 14 days, with an average of 6.4 days. The follow-up period ranged from 3 to 31 months with an average of 14 months.

Three patients (Pt no. 1, 2 and 8) presented with rupture (Table 4).

One patient died in the peri-operative period, for a peri-operative mortality of 11%. This patient pt no. 2 presented with a ruptured aneurysm. He also had an abdominal aortic and iliac aneurysms and died on the third post-operative day from cardiac shock, probably caused by acute myocardial infarction, while the graft was patent (Table 5).

Four (44%) patients developed thrombosis of the stent graft: pts nos. 1, 3, 5 and 9:

Pt no. 1 also had acute ischemia of the leg due to embolisation. During the procedure she underwent balloon thrombectomy and angioplasty. There was immediate thrombosis of the graft, but after thrombectomy the graft remained patent until she died of unrelated causes 3 months later.

Pt no. 3 had originally presented with claudication. After thrombosis of the Wallgraft within the first 30 days, the patient again developed claudication. However, as symptoms were mild, and his ABI remained improved, no further treatment was instituted (Table 5).

Pt no. 5 developed thrombosis after 2 months. After successful thrombolysis, the graft thrombosed 1

Table 4. Aneurysm, location (above knee–below knee), run off vessels.

Patient	Aneurysm	Location	Run off vessels
A	Popliteal-ruptured	AK	1
B	Popliteal-ruptured	AK	3
C	Popliteal	AK	1
D	Popliteal	BK	1
E	Popliteal	AK	2
F	Popliteal—post traumatic	AK	1
G	Popliteal	AK–BK	2
H	Distal end of SFA—popliteal-ruptured	AK	2
I	Popliteal	AK	2

month later. This time thrombolysis was unsuccessful. As he had only claudication (200 m), no further revascularisation was attempted. The situation remained stable at 11 months.

Pt no. 9 developed thrombosis of the graft at 5 months and presented with critical ischemia of the foot. Thrombolysis reopened the graft. A stenosis at the distal end of the graft, imaged by angiography (Fig. 2), was dilated to 5 mm.

The remaining three patients, in addition to one of the patients with rupture, had an uneventful course with a median follow-up of 25 months.

The 1 and 12 months primary and secondary patency rates as estimated with the Kaplan–Meier method were are 64/47% (primary) and 88/75%

(secondary), respectively. None of the patients underwent amputation.

Discussion

Endovascular reconstruction of the popliteal artery aneurysm is a new method and worldwide there is as yet little accumulated experience.^{14–19} The first grafts were hand-made, and used a metallic stent covered externally with a graft or a vein.²⁰ Commercially manufactured grafts have simplified the operation and facilitated exclusion of the aneurysmal sac with a team experienced in endovascular techniques. Quite often, the aneurysms are long and their exclusion requires

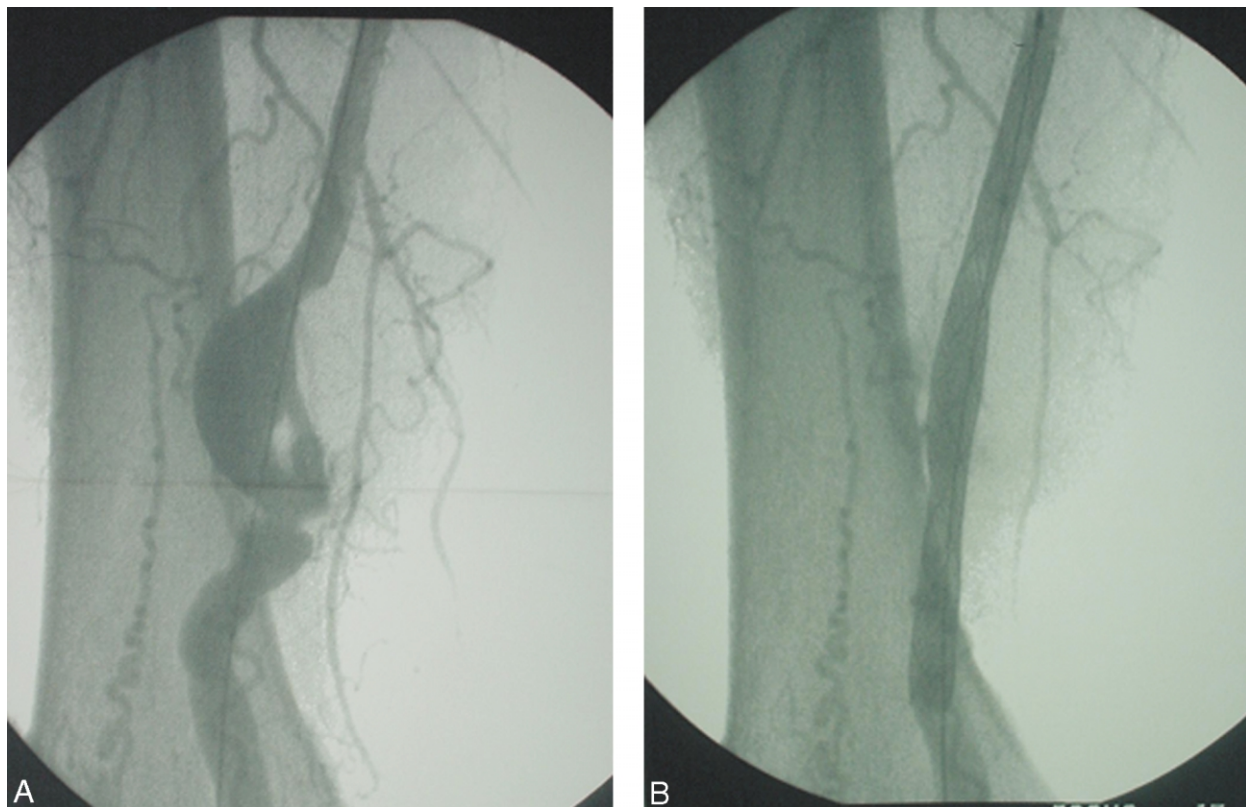


Fig. 1. (A), (B): Right popliteal artery aneurysm, placement of a Wallgraft stent graft.

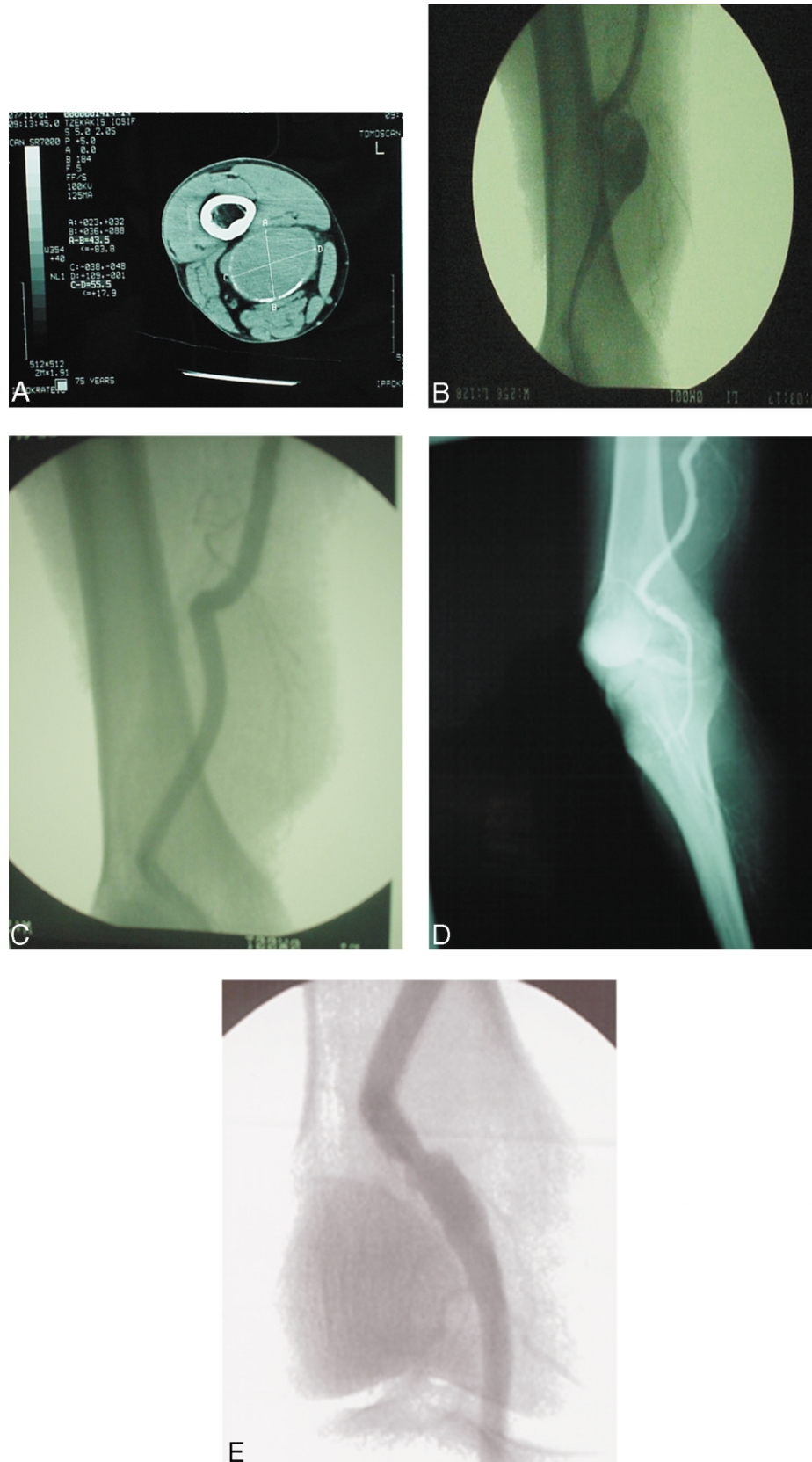


Fig. 2. (A–C): Right popliteal artery aneurysm, placement of a Hemobahn stent graft (Pt no. 9). (D): Thrombosis of the stent graft 7 months postoperatively. Angiography after thrombolysis shows stenosis of the distal end of the stent graft. (E): Operational angiography after balloon dilatation.

Table 5. Type, number and size of grafts used, follow-up time, discharge medication, and outcome.

Graft	Graft size (mm)	Follow-up (months)	Discharge medication	Outcome
A Hemobahn (2)	7 × 100 7 × 150	3	LMWH × 2	Thrombectomy on 1st postop. day—graft patent
B Hemobahn (2)	11 × 100 13 × 100			Died on 3rd POD—graft patent
C Wallgraft	12 × 70	8	Acenocoumarol 1 mg/day, aspirin 100 mg/day	Thrombosis at 30 days
D Hemobahn	9 × 150	19	Acenocoumarol 1 mg/day, aspirin 100 mg/day	Graft patent
E Hemobahn (2)	8 × 100	11	Acenocoumarol 1 mg/day, aspirin 100 mg/day, after the 2nd thrombolysis, acenocoumarol 4 mg/day, aspirin 100 mg/day	Thrombosis at 30 days—successful thrombolysis. Re-thrombosis at 60 days—unsuccessful thrombolysis
F Passager	8 × 150	31	Acenocoumarol 1 mg/day, aspirin 100 mg/day	Graft patent
G Hemobahn (2)	9 × 150 9 × 100	4	Acenocoumarol 1 mg/day, aspirin 100 mg/day	Graft patent
H Wallgraft	9 × 100	31	LMWH × 1, aspirin 100 mg/day	Graft patent
I Hemobahn	7 × 150	5	Instruction for acenocoumarol 2 mg/day, converted to 1 mg/day, aspirin 100 mg/day	Thrombosis at 5 months—successful thrombolysis. Distal stenosis of the graft—PTA—graft patent

applying more than one grafts, which was the case in half of the patients in the current series.

The close relation with the knee joint requires very flexible and compliant endovascular grafts. Hemobahn grafts made of a PTFE-lined nitinol stent with thermal memory seems to best meet the requirement for great flexibility in the graft. The run off vessels, as observed in our series of patients are often poor due to atherosclerosis and to peripheral embolism from emboli occurring from the aneurysmal sac, which may contribute to the early thrombosis observed in three instances (Table 5).

The modest results in our series—with primary and secondary patency rates at 1 years of 47 and 75%, respectively—were comparable to the experience in 12 cases of Henry *et al.*¹⁶—primary patency of 73% and a secondary patency of 81%—and the report by van Sambeek's *et al.* on 4 cases in which one thrombosed and two were converted.¹⁷

Though anticoagulant treatment may add to the maintenance of patency, graft thrombosis was fairly common. In the current series, it did not create serious problems nor required amputation, also noted by others.¹⁶

Compared to open repair, endovascular reconstruction has two distinct advantages: it can be used with high-risk patients and it avoids dissection in the popliteal fossa, and thereby the risk of damaging veins and nerves that run alongside the popliteal artery. However, the endovascular method is relatively new and published results are ambiguous. Though available series are small, long-term durability have not been convincing and more definite conclusions require larger series of patients and longer follow-up.

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