

Original Research

Surgical Treatment of Peripheral Artery Aneurysms

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Introduction: Peripheral arterial aneurysms (PAA) may rupture, cause emboli and ischemia, and local symptoms due to compression.

Methods: A total of 109 patients who underwent surgery for PAA were analyzed retrospectively, including clinical presentation, surgical procedures used, and postoperative follow-up data obtained 10 days after discharge.

Results: True aneurysm was present in 59 (54.1%) patients and pseudoaneurysm in 50 (45.9%). The femoral artery was the most common location. The surgical procedures used were as follows: graft interposition in 31 patients, bypass with synthetic or autologous grafts in 33 patients, aneurysm ligation in 5 patients, primary repair in 41 patients, and patch angioplasty reconstruction in 7 patients. One patient died as a result of massive hemorrhage. In four patients, amputation had to be performed.

Conclusions: It is possible to prevent amputation and other complications, including mortality, during the surgical treatment of symptomatic and asymptomatic PAA.

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An aneurysm is the irreversible dilatation of an artery by more than 50% of its normal diameter. Although an aneurysm can develop in other arterial structures (visceral, peripheral and cerebral),¹ it occurs most frequently in the aorta. Atherosclerotic degeneration is the most common risk factor associated with the development of aneurysm.² Aneurysms are classified according to their pathological morphology (true or pseudoaneurysms), shape (fusiform or saccular), anatomy (aortic, visceral, peripheral), clinical presentation (symptomatic, asymptomatic), and etiology. True peripheral arterial aneurysms (PAA) are most commonly seen in the popliteal arteries, whereas pseudoaneurysms are seen mostly in the femoral artery. During the differential diagnosis of arterial aneurysms, hematomas, pulsatile tumoral masses, arteriovenous (A-V) malforma-

tions, lymphadenopathies, lipomas, and abscesses should be considered.³

The current widespread use of invasive and noninvasive imaging techniques for therapeutic or diagnostic purposes has extended patients' life expectancy, while the higher number of vascular surgical interventions has led to a parallel increase in the incidence of PAA. PAA can be asymptomatic, but can also develop complications such as rupture, embolism, compression, fistula, amputation, and mortality. As a result, early diagnosis and intervention is very important for reducing morbidity and mortality.

In this study, we present the methods of surgical treatment used and the results obtained from patients who underwent surgery for PAA in our clinic (single center).

Methods

A total of 109 patients diagnosed with

PAA, who underwent surgery between September 1986 and March 2007, were examined retrospectively. The data were collected from the registry of our clinic and from operating theater records. Approval from the local ethics committee was obtained. Since the scope of this study was to evaluate the methodology for treatment of PAA, long-term follow-up data were not included. Of the patients enrolled in the study, 82 (75.2%) were males and 27 (24.8%) were females. The mean age of the patients was 52.6 years; the youngest was nine months old, and the oldest 87 years old. The diagnosis of aneurysm was made in 13 asymptomatic patients through routine physical examination and various imaging procedures, which were performed for other reasons (Figures 1 & 2). The other patients were symptomatic and the most common reason for requesting medical assistance was as a result of extremity ischemia associated with aneurysmal thrombosis (Table 1). During the period of diagnosis, angiography (81.5%), Doppler ultrasonography (59.6%), magnetic resonance imaging (MRI) and computed tomography (CT) were used as imaging procedures. True aneurysm was present in 59 (54.1%) patients and pseudoaneurysm in 50 (45.9%) patients. True aneurysms were most frequently seen in the femoral artery (49.1%), followed by the popliteal artery (39%), while pseudoaneurysms were mostly found in the femoral (60%) and brachial (18%) arteries. Multiple aneurysm sites were identified in 12 patients. These aneurysms were true aneurysms. There was bilateral popliteal artery aneurysm in eight patients (Table 2). Most of the true aneurysms (95%) were atherosclerotic-degenerative originated. Three patients with PAA had vasculitis. Almost all of the

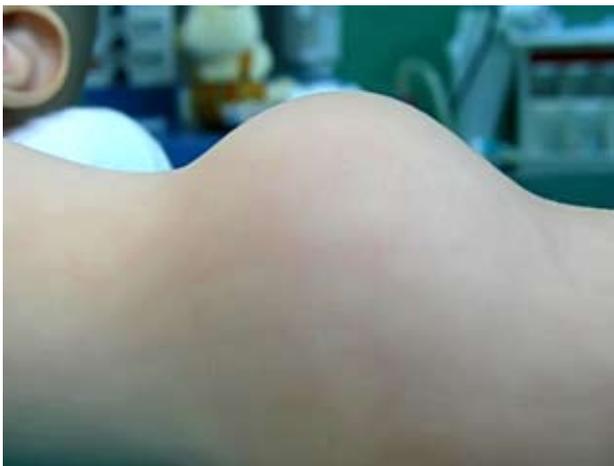


Figure 1. Left arm before surgery: 3-4 cm mass at the elbow.

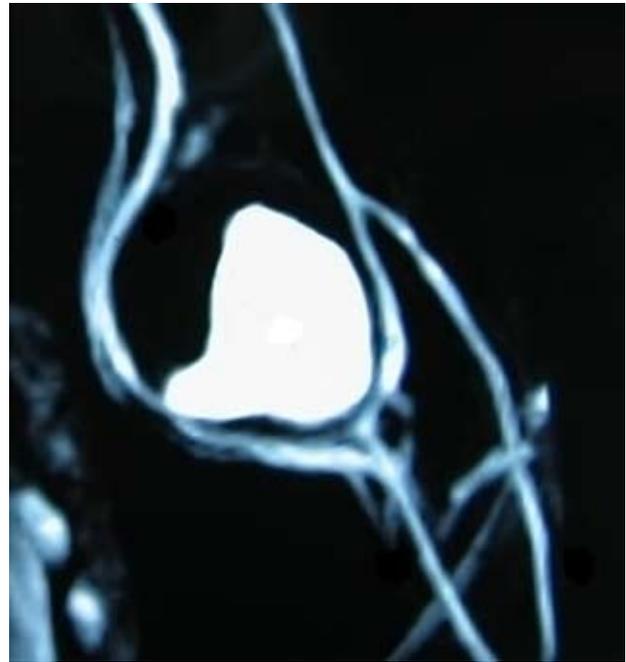


Figure 2. Helical contrast computed tomography. Three-dimensional reconstruction of a brachial aneurysm at the elbow level.

pseudoaneurysms were also iatrogenic (56%) or post-traumatic (18%) (Table 3).

The most common systemic diseases that accompanied PAA in our patients were hypertension, chronic obstructive pulmonary disease, and coronary artery disease. Symptom query was performed during the preoperative examination of the patients who underwent surgery in elective conditions; patients who were thought to be at high risk for coronary artery disease (n=14) underwent coronary angiography. Balloon angioplasty and stenting was performed in 2 of these patients and coronary artery bypass grafting (CABG) was performed in 3 patients. Abdominal aortic aneurysm was identified in 5 patients. Medical treatment was suggested to 3 of these, because the aortic diameter was <50 mm and/or they were asymptomatic, whereas simultaneous graft interposition

Table 1. Patient symptomatology and types of aneurysm.

Symptoms	True aneurysms	Pseudo-aneurysms	Total
Rupture	9	14	23
Emboli-thrombosis	28	8	36
Local compression	10	16	26
Asymptomatic	9	4	13
Infection	3	8	11
Total	59	50	109

Table 2. Aneurysm locations.

Location	True aneurysms	Pseudoaneurysms	Total
Upper extremity:	Brachial artery	5	9
	Subclavian artery	3	2
	Radial artery	1	3
	Axillary artery	2	1
	Ulnar artery	-	1
Lower extremity:	Femoral artery	29	30
	Popliteal artery	23	2
	Infrapopliteal	1	1
Carotid artery	3	1	4
Total	67	50	117

Table 3. Etiology of pseudoaneurysms.

Post surgical	5
Catheterization intervention	28
Trauma	9
Autoimmune diseases	3
Unknown	5

was performed in the remaining 2, since their aortic diameter was >50 mm.

Results

Surgical intervention in emergency or elective conditions was performed in 117 PAA locations, in a total of 109 patients. Forty-one patients underwent primary repair, 33 had bypass with synthetic or autologous grafts, 31 had synthetic or autologous graft interposition, 5 had aneurysmal ligation, and 7 patients underwent patch angioplastic reconstruction (Table 4). Synthetic materials such as Dacron and ePTFE were used as interposition or bypass grafts in patients who had aneurysmal formations in the carotid, subclavian, or femoral arteries, and in the popliteal artery above knee level. On the other hand, autologous venous grafts were used for knee joint, distal and upper extremity aneurysms. In a nine-

Table 4. Surgical procedures used.

Surgical technique	True aneurysms	Pseudoaneurysms
Graft interposition	29	2
Primary repair	-	41
Bypass	33	-
Ligation	5	-
Patch angioplasty	-	7
Total	67	50

month-old child, primary resection and end-to-end arterial reconstruction was successfully performed to treat a brachial artery aneurysm of unknown etiology. This case was reported previously.⁴

Infection, embolism and venous thrombosis were the postoperative complications observed (Table 5). Re-operations were performed on eight (7.3%) patients as a result of complications such as infection and thromboembolism. Continuous administration of antiplatelet aggregation medication (150-300 mg acetylsalicylic acid) was initiated in all patients in whom autologous and synthetic graft materials were used for aneurysmal repair and maintenance, in order to preserve arterial patency. In addition, warfarin treatment was initiated in patients with an international normalized ratio (INR) value between 1.5 and 2.0 who developed postoperative thromboembolic complications or if cardiac dysrhythmias could not be controlled. Warfarin was also prescribed for those with a high degree of atherosclerotic native arterial bed. One patient who underwent emergency surgery for rupture of femoral artery aneurysm died as a result of massive hemorrhage (0.9%). Amputation was performed in a total of 4 patients, in 3 above the knee joint and in 1 above the elbow joint.

Discussion

The prevalence of PAA increases as a result of atherosclerosis, trauma, catheterization procedures and vascular surgery. In recent years, the increase in catheterization procedures and vascular surgical interventions have been important factors in the higher prevalence of this pathology.

The popliteal artery is the most frequent location (70-80%) of true peripheral aneurysms.⁵ In our series, true aneurysms of the femoral arteries appeared to be

Table 5. Complications observed during the postoperative period.

Complication	Number
Infection	8
Embolism	5
Deep vein thrombosis	6
Mortality	1
Amputation	4
Total	24

more common. This figure actually does not indicate any epidemiological or etiological prevalence ratio. Since our clinic is a tertiary health care center, this divergence from the previously published literature may be due to referred cases or to coincidence. On the other hand, pseudoaneurysms in the femoral region were more frequent compared to any other location, as expected.

In emergency rupture cases, the main diagnostic tool was the physical examination. In patients presenting with critical distal ischemia, duplex scanning was also used to evaluate the responsible artery and the distal arterial bed. Conventional or digital arteriograms were also used in cases with distal ischemia, when the duplex findings were indecisive. In general, since arteriograms are lumenographies, they may not be useful for the diagnosis of PAA and are not a standard diagnostic tool. CT angiography and three-dimensional reconstruction imaging can be more useful, and these modalities have been used more often in the last decade. In patients with contraindications for contrast media, magnetic resonance angiography can be performed. Our data show that some type of angiography was used in all of our cases. The ratio of conventional or digital subtraction angiography seems to be high, and this is probably due to the cases that were operated on during the 1980s, when duplex scanning was not easily accessible.

Popliteal artery aneurysms are frequently seen in over 60-year-old male patients. In 50-60% of the cases they are bilateral, whereas in 25-40% they are associated with aortic, iliac or femoral artery aneurysms and are generally symptomatic. Patients may present with claudication and ischemia at rest, and extremity ischemia associated with thrombosis and embolism, neighboring vein and nerve compression. Surgical treatment should be provided to all patients with symptomatic popliteal artery aneurysms, and even asymptomatic aneurysms of more than 2 cm. The suggested method of surgical treatment is proximal-distal ligation of the aneurysm and bypass grafting. The five-year graft patency rates of popliteal artery aneurysms operated under elective conditions (100%) are better

than those in patients who were on the verge of critical leg ischemia and symptomatic patients (74%).⁶ It should be remembered that the risk of amputation following a delay in surgical intervention is very high (20%) if the patient presents with symptoms.⁷ In our clinic, 27 patients had to be operated for popliteal or below-knee arterial aneurysms. Probably because of chronic distal embolization resulting in total occlusion of the distal runoff, the limb and leg ischemia of 3 (11%) patients could not be alleviated in spite of surgical intervention, and amputation was necessary. This figure is actually consistent with previous reports and so may be referred to as “expected”.

Our surgical approach to popliteal artery aneurysms depends on the patient's presentation. When the aneurysmal mass is large enough to cause compression of neighboring structures, we prefer to resect the aneurysm and interpose a graft. Also if the aneurysm extends beyond the tibio-peroneal trunk, simple ligation may not suffice; a graft interposition after the resection is usually needed. When the aneurysmal sac is not too big and does not receive any other collateral tributary it can be simply ligated in addition to a bypass graft. These bypass grafts may be extended and placed distally, around the ankle, when the tibio-peroneal trunk and contributing arteries are occluded. When a below-knee bypass is needed, the first choice should be autologous material.

In the early postoperative period, another amputation of an upper extremity (hand) had to be performed because of gangrene development in a patient who was operated for brachial artery pseudoaneurysm. Aneurysms with a long chronic history can occlude the distal runoff with multiple episodes of undiagnosed embolizations, leading to gangrene development when there is acute thrombosis of the aneurysm.

In a study conducted by Barry et al, it was reported that endoluminal stent graft repair—which can be used for infra-inguinal aneurysms, including popliteal artery aneurysms—could be an alternative to surgical treatment. Although the short-term results were very encouraging, it was suggested that some technical improvements were necessary in order to achieve favorable results in the long term.⁸ Our experience does not include any use of coated stents in popliteal or distal aneurysms.

After popliteal artery aneurysms, femoral artery aneurysms are the most frequent PAA. They may be bilateral, and are frequently associated with other arterial aneurysms, especially in the aortic region.¹ Femoral artery aneurysms that are symptomatic and larger than 3 cm should be treated.

In the upper extremity, aneurysmal developments at the level of brachial and radial arteries are usually secondary to trauma, invasive interventions and atrioventricular fistulae for hemodialysis. On the other hand, aneurysms at the level of the subclavian artery are uncommon and make up only 0.1% of all PAA. Post-stenotic dilatation or atherosclerotic degeneration play a role in their etiology.⁹

Currently, depending on the complexity of the intervention, pseudoaneurysm formation may occur at an increased rate (0.2-3.2%) following cardiac catheterization procedures¹⁰ at various locations. In a study conducted by Katzenschlager et al, the Doppler ultrasonography performed in all patients who underwent femoral artery catheterization revealed a rate of approximately 7.7%.¹¹ We believe that most pseudoaneurysms can be treated with primary sutures, but when the arterial wall defect is large, complete resection of the damaged area and end-to-end reconstruction of the arterial continuity is usually possible. Also, patch angioplasty with saphenous vein patches can be feasible. In addition to the surgical treatment of pseudoaneurysms, less invasive methods may also be used. Compression of the aneurysmal sac with an ultrasonographic probe is a simple, cheap and repeatable noninvasive method. Its success rates can vary, depending on the experience of the practitioner, and have been reported as high as 75% and above.¹² Nevertheless, it is not as efficient in patients receiving anticoagulant treatment, and can also lead to severe symptoms as a result of uncontrollable compression of the femoral nerve. Loose et al published a report of successful repair of pseudoaneurysms in a series of 13 patients using a fibrin tissue adhesive, through a percutaneous method.¹³

Late follow-up data were beyond the scope of this investigation. Late follow-up results are usually dependent on the graft material or the surgical approach, and are available in previously published reports. In this study we aimed to evaluate the acute results of our approach to PAA and included only in-hospital results. The duration of the hospital stay was between 3 and 24 days. Routine outpatient clinical evaluation is carried out 10 days later after the discharge of the patients from our clinic. Surgical site inspection and examination for complications and graft patencies were performed for all patients and any notable events were recorded. Therefore our results include only these follow-up data.

The demographic or epidemiological character-

istics of our series may be different from common practice, because of the nature of our center. Since this is the tertiary health care and educational center of the region, more complicated cases make up a large proportion of our patients. With this in mind, we have tried to evaluate our experience in order to find some points that can be projected to future practice and studies.

In conclusion, due to the risk of rupture, extremity ischemia and amputation, PAA may result in severe morbidity and mortality. It is possible to achieve high success rates in symptomatic and asymptomatic patients through early diagnosis and surgical treatment.

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