

# Upper extremity arterial aneurysms: Etiology, management, and outcome

## Aneurismas arteriales de extremidad superior: etiología, manejo y resultado

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### Abstract

**Background:** Upper extremity arterial aneurysms are not common clinical conditions. It may causes ischemic gangrene or limb losses as a result of thromboembolic events due to endothelial damage. In this study, we aimed to investigate the etiology, management, and long-term outcome. **Methods:** A total of 55 upper extremity aneurysms between January 2009 and April 2018 were retrospectively investigated. The mean age was  $41 \pm 13$  years, and the women and men were 13 (23.6%) and 42 (76.4%). The mean follow-up was  $43 \pm 18$  months. **Results:** The incidence of pseudoaneurysm was higher than the true aneurysm (64.5% vs. 35.5%). 30 (84%) patients who had pseudoaneurysm repaired primarily and 6 (16%) patients had patchplasty. About 58% of the true aneurysm caused by blunt trauma. 4 (21%) true brachial aneurysm patients were required emergency intervention due to distal ischemia. 16 (84.2%) patients operated using by saphenous vein graft. The primary and secondary patency was 87.5% and 93.8%. No limb or life loss occurred during follow-up. **Conclusion:** Pseudoaneurysms are more common among upper limb aneurysms and they occur mostly by iatrogenic causes. Blunt trauma can be main cause of the true aneurysm. Surgical resection of the aneurysm and interposition of saphenous vein graft provides excellent results in the long-term.

**Keywords:** Aneurysm. Blunt trauma. Pseudoaneurysm. Upper extremity.

### Resumen

**Antecedentes:** los aneurismas arteriales de las extremidades superiores no son condiciones clínicas frecuentes. Puede causar gangrena isquémica o pérdida de extremidades como resultado de eventos tromboembólicos por daño endotelial. En este estudio, nuestro objetivo fue investigar la etiología, el tratamiento y el resultado a largo plazo. **Métodos:** Se investigaron retrospectivamente un total de 55 aneurismas de las extremidades superiores sometidos a reparación quirúrgica entre enero de 2009 y abril de 2018. La edad media fue de  $41 \pm 13$  años, y las mujeres y los hombres tenían 13 (23.6%) y 42 (76.4%). El seguimiento medio fue de  $43 \pm 18$  meses. **Resultado:** La incidencia de pseudoaneurisma fue mayor que el aneurisma verdadero (64.5% frente a 35.5%) y fue causado por un traumatismo iatrogénico. 30 (84%) de los pseudoaneurismas reparados con cualquier injerto, 6 (16%) pacientes requirieron plastia con parche. 58% del aneurisma verdadero causado por traumatismo cerrado. 4 (21%) pacientes con aneurisma braquial verdadero requirieron intervención de emergencia debido a isquemia distal. 16 (84.2%) pacientes fueron sometidos a operación de reparación de aneurisma mediante injerto de vena safena. La permeabilidad primaria y secundaria fue del 87.5% y 93.8%. No se produjeron pérdidas de miembros ni de la vida durante el

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seguimiento. **Conclusión:** Los pseudoaneurismas son más comunes entre los aneurismas de miembros superiores y ocurren principalmente por causas iatrogénicas. El traumatismo cerrado es la principal causa del verdadero aneurisma. La resección quirúrgica del aneurisma y la interposición con injerto de vena safena proporciona excelentes resultados a largo plazo.

**Palabras clave:** Aneurisma. Traumatismo cerrado. Pseudoaneurisma. Extremidad superior.

## Introduction

Upper extremity arterial aneurysm is not a common scenario. This entity may discuss under two major categories such as true aneurysm and pseudoaneurysm. Most of the true aneurysm causes by both penetrating injury or blunt trauma and degenerative disease<sup>1,2</sup>. The pseudoaneurysm mostly caused by the iatrogenic factor includes puncture for angiography or arterial blood drawing<sup>3,4</sup>. The common characteristics of both types of upper extremity aneurysms are that most of them seen in the brachial and radial arteries, in contrast, the subclavian and axillary arteries are less affected due to their anatomical localization. The actual incidence of such aneurysms in the general population is unknown, as there is no comprehensive study in the literature.

Aneurysms originating from the upper extremity arteries cause complications related to thromboembolism on the hands and fingers. In that case limb loss rate seen quite higher compared with the lower extremity arterial aneurysms, so early diagnosis and adequate treatment is essential<sup>2,5</sup>. In this study, we aimed to investigate the etiology, our treatment strategy, and long-term outcome in the light of 10 years of experiences.

## Materials and methods

### Patient selection

Between January 2009 and April 2018, a total of 55 patients who underwent surgical repair for upper extremity arterial aneurysms were retrospectively analyzed. Patients with a history of penetrating injury or blunt trauma, degenerative artery disease, and iatrogenic aneurysm were included in this study. All operators were vascular surgeons.

The mean age of the patients was  $41 \pm 13$  years (ranged 23-77 years), the female and male patient count were 13 (23.6%) and 42 (76.4%), respectively. The patients described a history of trauma average of  $11 \pm 9$  (range 5-23) months before hospitalization. In iatrogenic aneurysm patients, the time interval was shorter as  $2.3 \pm 1.6$  weeks.

All of the aneurysms were evaluated using by M-mode and color Doppler ultrasound (US) to measure length and diameter, to see presence of thrombosis both in aneurysm sac and distal arterial condition. Computed tomography was not routinely performed<sup>6</sup>.

### Operative technique

Intraoperative saphenous vein graft evaluation was performed using by Doppler US. 6 mm polytetrafluoroethylene (PTFE) ringed graft was used in patients who had previously ablated or removed saphenous vein and structural deformation. In patients who had pseudoaneurysm, the local anesthesia or axillary nerve blockage was preferred. After applying proximal and distal arterial clamping, the pseudoaneurysms opened. A 6/0 polypropylene suture was used for injured artery. If the arterial injury is not capable of primary repair, adjacent forearm vein used as patch material and performed patch plasty.

Aneurysm sac was prepared under general anesthesia, and heparin was administered at the appropriate dose (75 U/Kg) for patients who had true aneurysmal dilatation. After clamping from the proximal and distal of the aneurysmatic artery, the aneurysm sac was opened. Aneurysmectomy was performed completely. Embolectomy was performed using by Fogarty catheters in patients who had thrombus at distal arteries. End-to-end graft interposition was performed using by autologous saphenous vein graft or 6 mm PTFE ringed graft. 150 or 300 mg acetylsalicylic acid (ASA) was given to the patients as daily single dose daily, and warfarin applied for patients who had PTFE graft during 1 year according to INR value additionally. Doppler US was performed routinely in the next postoperative day, 1<sup>st</sup>, 3<sup>rd</sup>, and 6<sup>th</sup> months, and then once a year for all patients.

### Statistical analysis

Statistical analysis was performed with SPSS version 24.0 program (SPSS Inc. Chicago IL, USA). Mean and Standard deviation values were used to present descriptive analysis. Percentage was used to evaluate non-parametric variables.

**Table 1. Pre-operative patient characteristics and managements**

		True aneurysm (n = 19)	Pseudoaneurysm (n = 36)
Mean age (year)		41 ± 13	
Female		13 (23.6%)	
Male		42 (76.4%)	
Hypertension		27 (49%)	
Hyperlipidemia		14 (25%)	
Coronary artery disease		33 (60%)	
Clinical presentation			
Pain		17 (31%)	
Pulsatile mass		51 (92.7%)	
Discolorate		4 (7.2%)	
Edema		3 (5.5%)	
Distal thrombosis		4 (7.2%)	
Localization of aneurysm			
Subclavian		1 (5.3%)	
Axillary		1 (5.3%)	
Brachial		12 (63.2%)	9 (25%)
Radial		5 (26.2%)	27 (75%)
Surgical management			
Emergency operation		4 (21%)	3 (8.3%)
Simple suture			31 (86%)
Patch plasty			5 (14%)
Saphenous vein graft		16 (84.2%)	
PTFE ring graft		2 (10.5%)	
Bovine internal mammalian artery		1 (5.3%)	
Diameter of aneurysm		2.1 ± 1.2	2.4 ± 1.5
Hospital stay (day)		2.5 ± 1.6	1.1 ± 0.4
Mean follow-up (month)		43 ± 18	

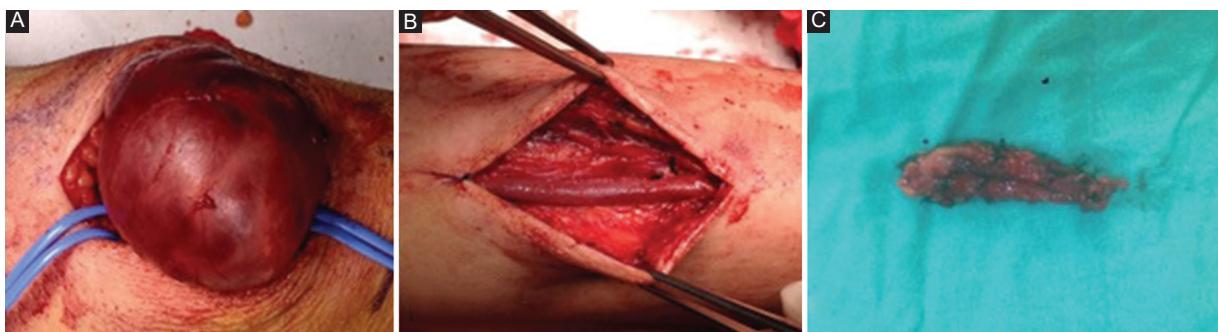
## Results

The pulsatile mass was the most common clinical findings for aneurysmal dilatations. True aneurysmal dilatations more often localized at brachial region, whereas the pseudoaneurysms mostly seen at the radial artery; this is because of the radial artery is favored for coronary angiogram access. Majority of the true aneurysmal dilatation (58%) found to be caused by blunt trauma in the case series. Degenerative arterial disease (16%) such as Behcet's disease and adventitial cystic necrosis was the main etiology of the idiopathic aneurysmal dilatation. Four (21%) patients who had true brachial aneurysm underwent emergency intervention due to limb ischemia (Table 1).

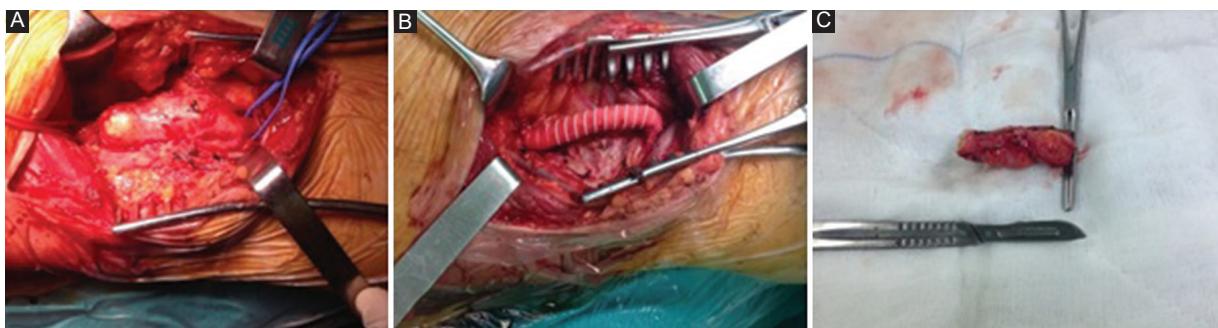
In 16 (84%) patients who had true aneurysmal dilation, autologous saphenous vein graft used for repair (Fig. 1). One of the applied saphenous vein grafts was occluded at 9<sup>th</sup> day after operation, embolectomy was

performed, and the graft flow was restored. Embolectomy failed in one patient who had no flow in the interposed saphenous vein to the distal radial artery at postoperative 7<sup>th</sup> month. Any further intervention was considered for that patient because there was no ischemic complication. The primary and secondary patency of the saphenous graft was 87.5% and 93.8% consecutively after 43 ± 18 months of follow-up.

The rest of 3 (16%) patients deprived autogen graft due to absence of saphenous vein or severe varicosity on saphenous vein again. In these patients, 6 mm PTFE ringed graft was used (Fig. 2). Graft infection occurred after 2 weeks in one of this patient who was a drug-abuser. The PTFE graft was removed, and bovine jugular vein was used after tissue debridement. Graft thrombosis was found in other patient at 3<sup>rd</sup> postoperative day and embolectomy successfully performed. The patient was given warfarin and ASA daily as treatment.



**Figure 1.** Radial artery aneurysm repair with autologous saphenous vein. **A:** aneurysm exposure. **B:** saphenous vein interposition. **C:** aneurysm material.



**Figure 2.** Brachial artery aneurysm repair with PTFE ring graft. **A:** aneurysm exposure. **B:** graft interposition. **C:** aneurysm material.

In this series, the incidence of the pseudoaneurysm was found to be higher than the true aneurysmal dilatation (64.5% vs. 35.5%). All the pseudoaneurysms were developed by iatrogenic causes (Table 2). 30 (84%) of the pseudoaneurysm repaired by primary technique, and 6 (16%) patients required patch plasty to avoid involved segment stenosis after repair. Two brachial and one radial pseudoaneurysm ruptured and underwent emergency surgery. All the pseudoaneurysm repaired without complication and long-term results did not found stenosis or occlusion. No limb loss or aneurysm reoccurrence observed during the follow-up period.

## Discussion

The incidence of the upper extremity arterial aneurysms is much less than the lower extremity. Etiology includes iatrogenic, idiopathic, penetrating injury, and blunt trauma. Iatrogenic factors include puncture for angiography and blood sample drawing. Most of the pseudoaneurysm causes by iatrogenic injury<sup>3,4</sup>. Uncontrolled hypertension, anticoagulations, and inadequate compression after arterial blood drawing may play important role of its formation. Pseudoaneurysms occur

**Table 2. Types and etiologies of the aneurysms**

Types of aneurysm	Etiology	N (%)
True aneurysm	Blunt trauma	11 (20)
	Penetrating injury	5 (9)
	Degenerative disease	3 (5.5)
Pseudoaneurysm	Iatrogenic	36 (65.5)
Total		55 (100)

in a shorter period and have a higher risk of rupture, and most of them can be preventable according to the nature of its formation<sup>7,8</sup>. The incidence found in our series is around 65%. In our series, we performed primary repair technique under local anesthesia or axillary nerve blockage according to the patient's willingness in pseudoaneurysm treatment. Long-term results are excellent after repair, and the length of hospital stay is limited to 1 or 2 days. In contrast with that, true aneurysm mostly caused by penetrating injury or blunt trauma and degenerative arterial disease<sup>1,2</sup>. Our investigation revealed that true aneurysms after injury occurred in a longer period.

Theoretically, as a result of blunt trauma, the vascular structure trapped between the trauma object and the bone or joint, and there is no significant bleeding other than ecchymosis due to the flexibility of the artery after trauma. In penetrating injury traumas, due to the regional anatomical proximity of the neurovascular bundle, the development of functional neural losses always exists with the traumatic aneurysm<sup>2,5</sup>. Most of the limb loss happens when the severe trauma causes adjacent nerve and more considerable surrounding tissue injury and concomitant necrosis or contamination<sup>5</sup>. In our series, no severe neurological consequences encountered except the temporary loss of motor function in a left subclavian artery aneurysm and sensory function in a brachial artery aneurysm. Some studies showed that degenerative arterial diseases such as Behcets disease and adventitial cystic necrosis may cause peripheral arterial aneurysm<sup>9,10</sup>. In our series, two patients with Behcets disease have brachial artery aneurysm; the ascending aortic aneurysm co-exists in one of them. Adventitial cystic necrosis was found in one patient with axillary artery aneurysm.

Due to its superficial localization, the upper extremity arterial aneurysms can be diagnosed easily than the lower extremity aneurysms. In the most comprehensive study of the upper extremity aneurysms, the presence of pulsatile mass was the most common. In our series, the most common symptom was ischemic complaints such as intermittent pallor and cooling in addition to the presence of pulsatile mass<sup>11</sup>. If the upper extremity arterial aneurysms are not treated, complications of thrombosis, bleeding, and a-v fistula are likely to develop<sup>12</sup>. Although endovascular techniques or similar procedures are increasingly used for upper extremity arterial aneurysms, due to lack of long-term results, we remain to prefer surgical approach<sup>12-14</sup>. Surgical approach is based on the excision of the aneurysm sac and the maintenance of arterial flow. Continuous arterial flow should be ensured by end-to-end anastomosis with autologous saphenous vein graft, if possible. Reconstruction of the arterial structure with autologous vein graft is an appropriate approach for the preservation of the distal extremity, especially at brachial and more proximal arterial aneurysms<sup>5,15</sup>. We did not prefer the upper extremity adjacent veins in our patients because of the risk of aneurysm formation during long-term follow-up<sup>16</sup>.

Our study showed the saphenous vein and PTFE ring graft to the brachial artery showed excellent patency due to adequate run-off. The debate of repair or ligation of the radial artery has been continuing for

more than two decades<sup>17,18</sup>. Studies are suggesting that the long-term patency of the saphenous vein anastomosed to the radial artery is unsatisfactory leads to ligation of the radial artery. Our opinion is to repair the proximal radial artery and provides blood flow if there is an on-site facility and experienced operators. The most distal radial artery might be ligated because the vein graft patency at this level is not satisfying.

Endovascular therapy may also be considered as an option. However, we did not choose it because the cost of endovascular treatment was higher and the surgical results were satisfactory. In the presence of suitable conditions, endovascular treatment can be applied and more studies can be done.

## Conclusion

Upper extremity aneurysms are mostly seen as iatrogenic pseudoaneurysms. Surgical treatment consists of simple suturing and patch plasty. Most of the true aneurysms occur in the later period after blunt trauma, aneurysms due to degenerative disease are much less common. Long-term results of aneurysm resection and saphenous graft interposition are excellent. It may be reasonable to ligate aneurysms in the distal radial artery.

## Synopsis

This retrospective study revealed that the majority of upper extremity arterial aneurysms are pseudoaneurysms and can be preventable. Blunt trauma might cause true aneurysm in a longer period. Autologous vein graft is the best choice for true aneurysm repair.

## Author contribution

EC Ata conducted data analysis, critically revised manuscript, and approved final version. MO Beyaz and I Demir participated in study design, data analysis, interpretation, wrote manuscript, and approved final version.

## Conflict of interest

We declare no conflict of interest in this study.

## Ethics approval

This is a retrospective study, so it was exempted from ethics committee approval. The study results

were endorsed by the Ethics Committee of Istanbul Medipol University.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

**Confidentiality of data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors declare that no patient data appear in this article.

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