

Reviewer #1: In the abstract, please replace the word "review" in the 4th line with an other. This publication is far from a review but a case report.

Authors: done as requested.

The sequence discussion is poor. The authors had not cited any work of the endovascular treatment of these AVF, to pretend that this procedure lead to pulmonar embolism.

Authors: dear colleagues, we added information regarding endovascular treatment (references 2, 4, 5, 6, 7).

Please cite the criterium of success or failure of the endovascular treatment of this AVF to justify your open approach.

Authors: done as requested. Endovascular treatment with placement of a stent graft into the bifurcation of the common femoral artery could have compromised blood flow through the deep femoral artery and also put the patient at risk of stent-graft fracture due to flexible movements in the hip region.

The follow up of your patient is not precised. Did the cutaneous ulcers healed?

Authors: the ulcers healed within 2 months.

Thank you very much for reviewing the article.

Reviewer #2: Thank you for submitting this paper. Open surgery still represents a feasible option to treat patients with post-traumatic arteriovenous fistulas. This manuscript is clear and well written and directly goes to the main point.

Authors: dear colleagues, thank you very much for your positive revision and kind regards.

I only suggest to expand the open procedure steps if you can. Moreover, there are plenty of examples in literature where the endovascular approach is effective, please try to cite some of them in the introduction, below some examples I suggest: - Tufano A, Asero V, Proietti F, Flammia RS, Franco G, Leonardo C. Arteriovenous fistula after robotic partial nephrectomy: Case report and narrative review. Radiol Case Rep. 2022 May 17;17(7):2550-2553. doi: 10.1016/j.radcr.2022.04.038. - Tufano A, Minelli R, Rossi E, Brillantino C, Di Serafino M, Zeccolini M, Cantisani V, Vallone G. Inferior epigastric artery pseudoaneurysm secondary to port placement during a robot-assisted laparoscopic radical cystectomy. J Ultrasound. 2021 Dec;24(4):535-538. doi: 10.1007/s40477-020-00442-1.

Authors: done as requested. The papers mentioned by the respected reviewer have been cited in the manuscript.

Below is the revised version for your convenience. Corrections are in red.

## Abstract

In the modern era of endovascular surgery percutaneous interventions are being widely used to treat a number of vascular disorders including arteriovenous fistulas (AVF). Still, patients with hostile anatomy or complicated cases such as large post-traumatic AVFs may be successfully treated using conventional vascular surgery. This paper presents state-of-the-art treatment options in subjects with post-traumatic AVFs and a case-report of a successful open surgical approach in a patient with a 25 – year old history of a post-traumatic AVF between the common femoral artery and common femoral vein. Open surgery is still a great option to treat patients with post-traumatic arteriovenous fistulas with hostile anatomy or in complicated cases. Concomitant conditions and complications should be addressed promptly.

**Key words:** arterio-venous fistula; AVF; femoro-femoral AVF; open vascular surgery

## INTRODUCTION

Stab, gunshot wounds or other traumas to the groin may lead to the discrete injury to the femoral vessels and nerve with delayed complications. Exact rates of post-traumatic arterio-venous fistulas (AVF) of the lower extremity arteries are not known. When not diagnosed in a timely manner, certain AVF complications may develop. Among them are lower leg edema, heart failure [1], vein dilation and chronic venous insufficiency [2], lower leg ischemia, trophic ulcers.

Percutaneous interventions are being widely used to treat a number of vascular disorders including arteriovenous fistulas (AVF) [3, 4]. Still, patients with hostile anatomy or complicated cases such as large post-traumatic AVFs may be successfully treated using conventional vascular surgery.

We present a case of a male patient with a 25 – year old history of a post-traumatic AVF between the common femoral artery and common femoral vein.

## **CASE REPORT**

A 62 - year old male was admitted to the vascular surgery department with complaints on the lower limb trophic ulcers (Fig. 1) and a pulsatile mass in the left groin. The patient had a history of a single stab wound to his left groin 25 years prior to admission. The subject recalled undergoing a surgical exploration of the left groin back in 1997, and had not contacted any medical professionals ever since. No history of cardiovascular disease in the family.

A physical examination at admission showed that the patient was in a stable condition. Blood pressure was 130/80 mmHg, pulse rate 75 beats per minute, regular, respiratory rate 16, temperature 36.5 °C. There were a large pulsatile mass in the left inguinal area, signs of lower leg ischemia, varicose veins and post-thrombotic syndrome, lower leg trophic ulcers, peripheral neuropathy. Laboratory tests were within normal values.

Duplex ultrasonography (DUS) revealed a communication and turbulent blood flow between the left common femoral artery and left common femoral vein (Figure 2), an aneurysm of the left common femoral vein with calcification of posterior and medial walls (Figure 3), occlusion of the femoral and deep femoral vein distal to their confluence with common femoral vein, and multiple varicose veins on the left thigh.

Contrast enhanced computed tomography angiography (CT-angiography) performed at admission revealed an arteriovenous fistula between the left common femoral artery and left common femoral vein with an aneurysm of the latter, aneurysms of the proximal parts of the left deep femoral vein, femoral vein with further venous occlusion; CT-angiography also revealed dilated left iliac arteries (Fig. 6).

Echocardiography was also performed and showed a normal ejection fraction, insignificant right and left atrial enlargement, mild left ventricular hypertrophy.

Endovascular treatment was avoided in this case due to the following reasons: placement of a stent graft into the common femoral artery would have put the patient at the potential risk of stent fracture related to hip joint flexion; blood flow to the deep femoral artery would have been compromised, too.

We performed an open procedure. An open access to the femoral vessels in the left infrainguinal area (Fig. 4) with some technical difficulties due to extended fibrotic lesions at the sight of the AVF and left common femoral vein aneurysm, closure of the AVF with a synthetic PTFE patch, aneurysmorrhaphy of the left common femoral vein (Fig. 5). We decided to keep the dilated iliac arteries intact in order to avoid the use of extended synthetic grafts in the settings of multiple trophic ulcers. Intraoperative blood loss was 250 ml. The patient was started on aspirin 75mg QD, atorvastatin 20mg QD, heparin 1000 units per hour IV for 24 hours followed by enoxaparin 40mg SC QD, famotidine 40mg QD, amoxicillin/clavulanic acid 875 mg/125 mg IV BID, thioctic acid 600mg IV QD.

Post-operative period was uneventful. On the 7<sup>th</sup> day following the procedure we performed a repeat CT-scanning with contrast enhancement, which revealed the absence of arteriovenous fistula between the left common femoral artery and left common femoral vein with successfully preserved flow through both femoral and deep femoral arteries. Trophic ulcers healed within 2 months following the procedure.

## DISCUSSION

Endovascular surgery has been a leading trend in vascular surgery for the past decades. Arterio-venous fistulas of different nature and localization can be successfully treated using transcutaneous techniques such as endovascular coiling, embolization or placement of a stent-graft depending on the clinical settings [5-7].

As the AVF was located directly across the orifice of the deep femoral artery and was accompanied by a large aneurysm of the left common femoral vein, we decided to perform an open procedure as the placement of an endovascular stent graft might have caused diminished flow through the deep femoral artery and led to the possibility of a

thrombus formation in a dilated common femoral vein with subsequent risks of pulmonary embolism.

Stab, gunshot wounds or other traumas to the groin should be carefully evaluated to exclude injury to the femoral vessels and nerve, which eventually may lead to the formation of arteriovenous fistulas and vascular aneurysms. A misdiagnosis may occur due to simple wound exploration with no prior or further DUS, CT-angiography, or digital subtraction angiography, which are necessary in order to avoid delayed complications [8].

## CONCLUSION

In the era of endovascular procedures, conventional open vascular surgery is still a great option in treatment of post-traumatic arteriovenous fistulas involving femoral vessels in patients with complicated cases leading to aneurysm formation and lower limb ischemia. Possible concomitant conditions or complications such as heart failure or peripheral neuropathy should be addressed promptly.

## ARTICLE HIGHLIGHTS

### *Case characteristics*

A pulsatile mass in the left groin, lower leg ischemia, varicose veins, post-thrombotic syndrome, trophic ulcers, peripheral neuropathy.

### *Clinical diagnosis*

Post-traumatic arteriovenous fistula between left common femoral artery and left common femoral vein (after a single stab wound to the groin 25 years prior to admission). Aneurysm of the left common femoral vein. Post-thrombotic disease. Secondary varicose veins. Chronic lower limb ischemia. Trophic ulcers of the lower leg. Peripheral neuropathy.

### *Differential diagnosis*

Differential diagnosis with a left common femoral artery pseudoaneurysm. CT-angiography clearly revealed a fistula between the left common femoral artery and the common femoral vein with an aneurysm of the latter.

### *Laboratory diagnosis*

There were no clinically significant deviations from normal values in laboratory tests.

### *Imaging diagnosis*

Electrocardiography, echocardiography, CT-angiography, and duplex ultrasonography were used in this case.

### *Pathological diagnosis*

Pathological study confirmed extended fibrotic lesions in the area of resected aneurysm of the left common femoral vein (aneurysmorrhaphy).

### *Treatment*

The patient underwent surgical treatment and received aspirin 75mg QD, atorvastatin 20mg QD, heparin 1000 units per hour IV for 24 hours followed by enoxaparin 40mg SC QD, famotidine 40mg QD, amoxicillin/clavulanic acid 875 mg/125 mg IV BID, thioctic acid 600mg IV QD.

### *Related reports*

Steinmetz O.K., Palerme L.P. Acquired Arteriovenous Fistula. N Engl J Med 2004; 350:2180.

### *Term explanation*

AVF: arteriovenous fistula; CT: computed tomography; DUS: duplex ultrasonography.

### *Experiences and lessons*

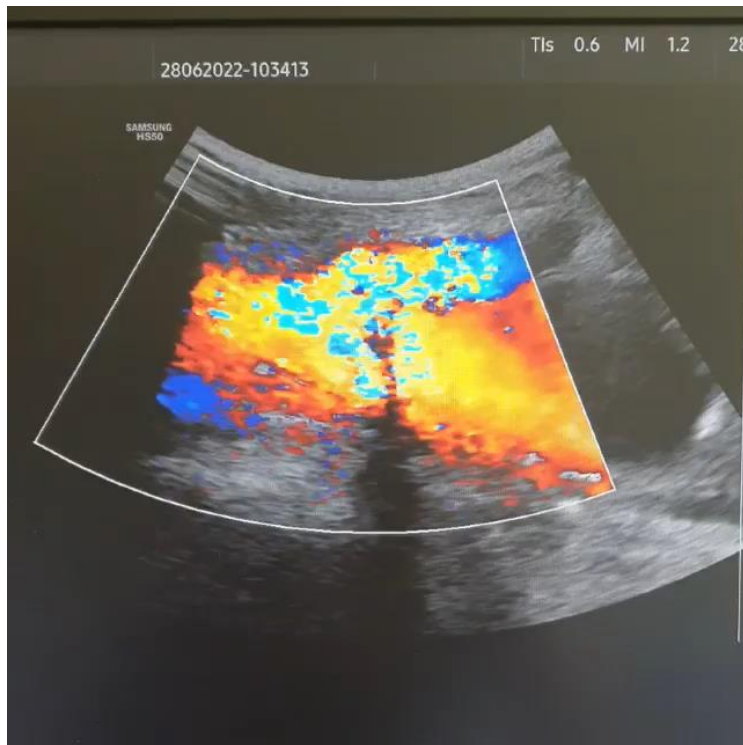
Stab wounds or other traumas to the groin should be carefully evaluated to exclude injury to the femoral vessels and nerve. In the acute setting, a misdiagnosis may occur due to simple wound exploration with no prior or further DUS, CT-angiography, or digital subtraction angiography, which eventually may lead to the formation of arteriovenous fistulas and vascular aneurysms.

## REFERENCES

- 1 **Zhang HY**, Chai DZ. Post-traumatic Femoral Arteriovenous Fistula. *Eur J Vasc Endovasc Surg* 2017; **54**, 377. [DOI:<https://doi.org/10.1016/j.ejvs.2017.04.021>]
- 2 – **Kalinin RE**, Suchkov IA, Kaydakova EY, Mzhavanadze ND, Shanaev IN. Chronic venous insufficiency as a possible clinical manifestation of a post-traumatic lower limb arteriovenous fistula. *Acta Phlebologica*. 2021 ; **22** (3) : 100-4 [DOI: 10.23736/S1593-232X.21.00496-3]
- 3 **Rogel-Rodríguez JF**, Zaragoza-Salas T, Díaz-Castillo L, Noriega-Salas L, Rogel-Rodríguez J, Rodríguez-Martínez JC. Fístula arteriovenosa femoral postraumática, tratamiento endovascular [Post-traumatic femoral arteriovenous fistula, endovascular treatment]. *Cir Cir*. 2017 ; **85** (2) : 158-163. [doi: 10.1016/j.circir.2015.10.010. PMID: 26763666].
- 4 **Gorsi U**, Agarwal V, Savlania A, Behra A, Sandhu MS. Endovascular Management of Lower Limb Arteriovenous Fistula Presenting 8 Years After Gunshot Injury. *Vasc Endovascular Surg*. 2019; **53** (8) : 670-673. [doi: 10.1177/1538574419870679].
- 5 **De Martino RR**, Nolan BW, Powell RJ, Walsh DB, Stone DH. Stent graft repair of iatrogenic femoral arteriovenous fistula: a useful therapeutic approach in a hostile groin. *Vasc Endovascular Surg*. 2010 ; **44** (1) : 40-3. [doi: 10.1177/1538574409347396].
- 6 **Tufano A**, Asero V, Proietti F, Flammia RS, Franco G, Leonardo C. Arteriovenous fistula after robotic partial nephrectomy: Case report and narrative review. *Radiol Case Rep*. 2022 ; **17** (7) : 2550-2553. [doi: 10.1016/j.radcr.2022.04.038].
- 7 **Tufano A**, Minelli R, Rossi E, Brillantino C, Di Serafino M, Zeccolini M, Cantisani V, Vallone G. Inferior epigastric artery pseudoaneurysm secondary to port placement during a robot-assisted laparoscopic radical cystectomy. *J Ultrasound*. 2021 ; **24** (4): 535-538. [doi: 10.1007/s40477-020-00442-1].
- 8 **Nagpal K**, Ahmed K, Cuschieri R. Diagnosis and management of acute traumatic arteriovenous fistula. *Int J Angiol*. 2008; **17** (4) : 214-6. [doi: 10.1055/s-0031-1278313. PMID: 22477453; PMCID: PMC2728918]



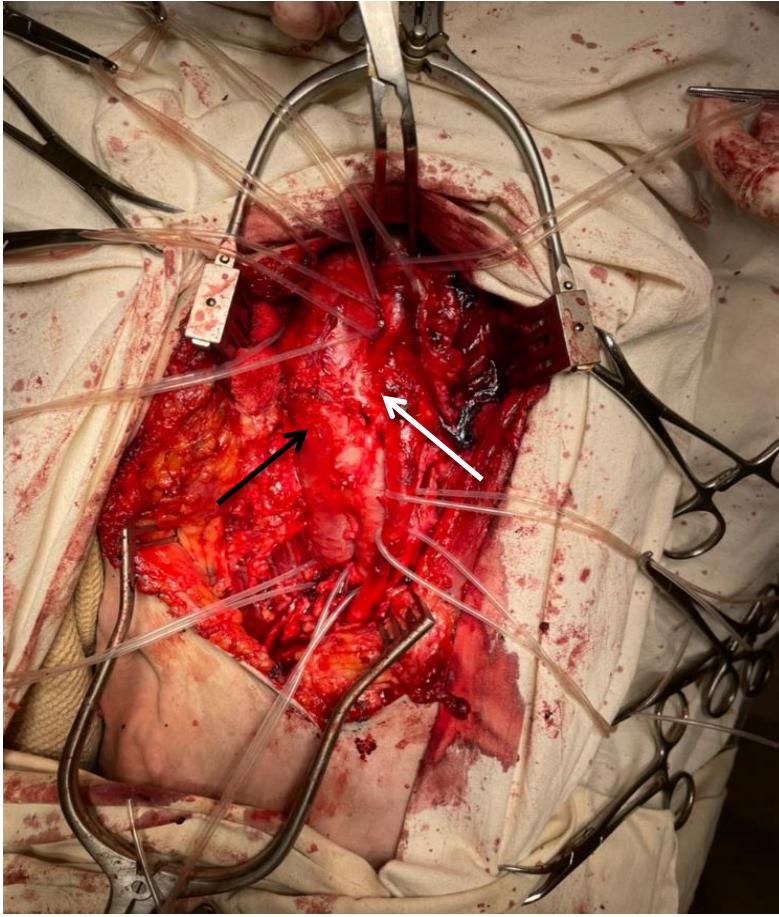
**Figure 1. A photograph depicting trophic ulcers of the left lower leg.**



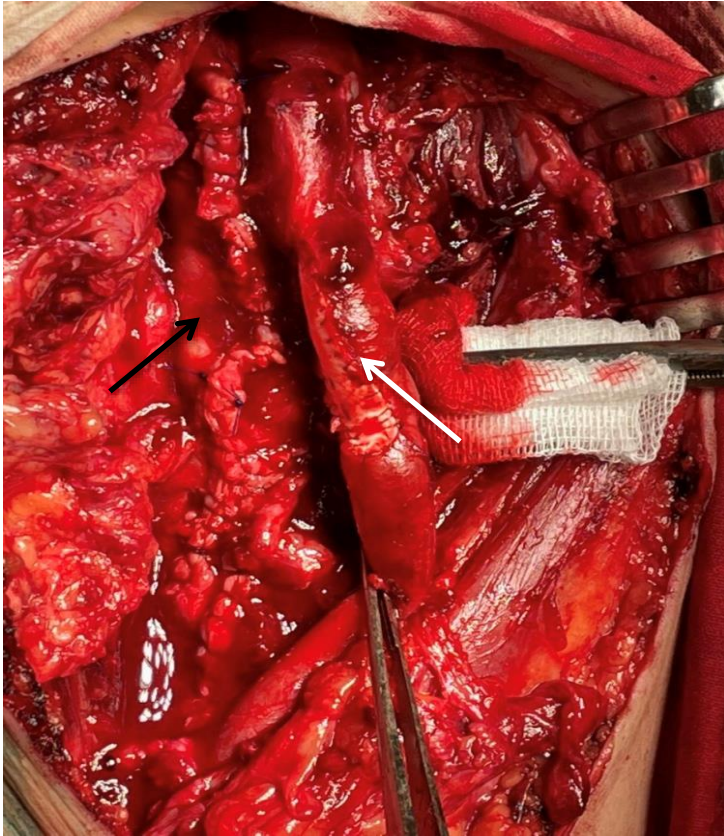
**Figure 2. A sonogram of the left groin showing a communication and turbulent blood flow between the left common femoral artery (on top) and the left common femoral vein (on bottom)**



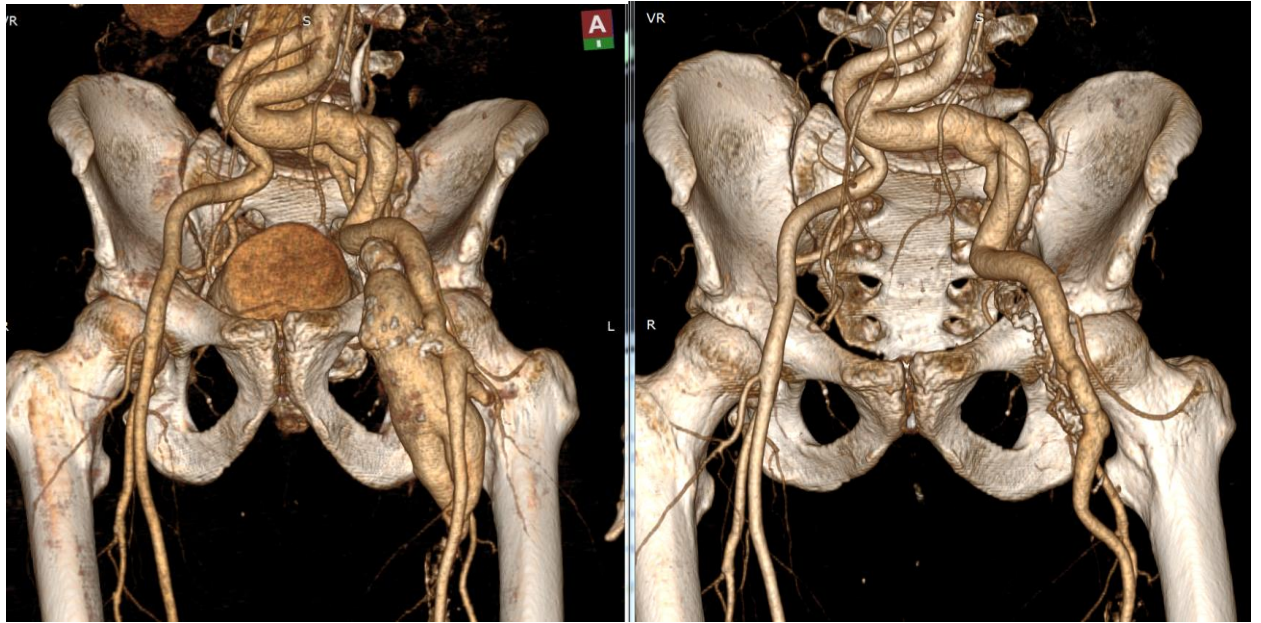
**Figure 3. A sonogram of the left groin showing the aneurysm of the left common femoral vein with calcification of posterior and medial walls.**



**Figure 4. A photograph depicting the arteriovenous fistula between the left common femoral artery and left common femoral vein (white arrow), and the aneurysm of the left common femoral vein (black arrow)**



**Figure 5. A photograph depicting a patch closure to the medial aspect of the common femoral artery (white arrow) and the common femoral vein following aneurysmorrhaphy (black arrow)**



**Figure 6. On the left: CT-scan with contrast enhancement at admission (before treatment) demonstrating arteriovenous fistula between the left common femoral artery and left common femoral vein with an aneurysm of the latter, aneurysms of the proximal parts of the left deep femoral vein, femoral vein with further venous occlusion; CT-scans also shows dilated left iliac arteries. On the right: CT-scan with contrast enhancement before discharge (after treatment) demonstrating the absence of arteriovenous fistula between the left common femoral artery and left common femoral vein with preserved flow through both femoral and deep femoral arteries.**