# An out of the box treatment for an infected pseudoaneurysm: Deep to superficial femoral artery transposition

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## ABSTRACT

An infected pseudoaneurysm is a condition that has become more common in recent years, with the proliferation of endovascular intervention and the use of intravenous drugs. If left untreated, an infected pseudoaneurysm can progress to rupture, which can lead to life-threatening hemorrhage. No clear consensus has been reached among vascular surgeons regarding the management of infected pseudoaneurysms, and the literature describes a wide range of treatment techniques. In the present report, we describe an "out of the box" approach to infected pseudoaneurysms: a superficial femoral artery to deep femoral artery transposition, as an alternative to ligation with or without bypass reconstruction. We also describe our experience with six patients who underwent this procedure with 100% technical success and limb salvage rates. Although we implemented this technique for cases of infected pseudoaneurysms, we believe it can also be applied to other cases of femoral pseudoaneurysms when angioplasty or graft reconstruction is not feasible. However, further research with larger cohorts is warranted. (J Vasc Surg Cases Innov Tech 2023;9:101199.)

**Keywords:** Femoral reconstruction; IV drug use; Pseudoaneurysm; Vascular infection

A pseudoaneurysm (PSA) is a condition described in the surgical literature as early as 1946,[1] which has become more common in the past 40 years, with the proliferation of endovascular interventions and the use of intravenous (IV) drugs.[2-4] A PSA is defined as a tear in the vessel wall with subsequent periarterial hematoma formation. If left untreated, a PSA can progress and rupture, which can lead to life-threatening hemorrhage.[5] The most prevalent location of PSA is the common femoral artery (CFA),[5,6] because it is the preferred access site for many interventions.

Treatment of a PSA is particularly challenging when infection is involved. Currently, no clear consensus has been reached among vascular surgeons regarding the management of infected PSAs (IPSAs). The literature describes a wide range of treatment techniques, including primary ligation and groin debridement and various reconstruction techniques with prosthetic or vein grafts. Reported cases have shown suboptimal results, with high rates of residual chronic ischemia and amputation that were more prevalent in the early reports than those from more recent years.[6-8] Most investigators have reported debridement and ligation of the CFA without vascular reconstruction as the preferred surgical treatment, because it is less time consuming and avoids graft infection complications, which is crucial in the setting of sepsis or bacteremia.[9-12] When considering primary ligation, both single artery ligation (CFA alone) and triple artery ligation of the CFA, superficial femoral artery (SFA), and deep femoral artery (DFA), have been described extensively. In these reports, triple ligation resulted in higher reintervention and amputation rates.[13-15]

The demographics of the patients with IPSA are quite homogeneous, and most patients are young IV drug users (IVDUs). These patients typically have low compliance to treatment and lack a proper venous conduit owing to thrombophlebitis from repeated injections. The use of a prosthetic conduit in these patients is not recommended because of the high infection and graft failure rates. In the present report, we describe an out of the box approach for IPSAs (ie, SFA to DFA transposition) as an alternative to ligation with or without bypass reconstruction.

## METHODS

The Tel Aviv Sourasky Medical Center ethics committee approved the present study, and a retrospective review of the medical records from 2010 to 2021 was performed. We examined all cases of IPSA and included the patients who underwent SFA to DFA reconstruction surgery. The patients' surgical records, demographic data, and medical data were collected. All the patients provided written informed consent for the procedure and the report of their case details and imaging studies.

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**Fig 1.** Infected pseudoaneurysm (IPSA) presentation before surgery. Note the necrotic ulceration of the skin.

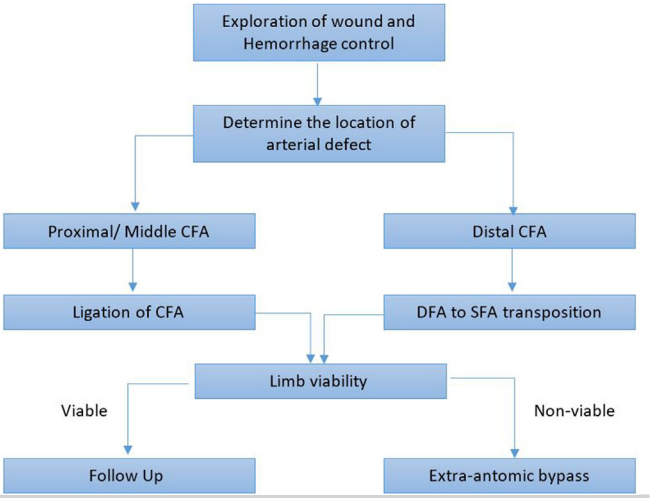


**Fig 2.** Proposed algorithm for infected pseudoaneurysm (IPSA) management. *CFA,* Common femoral artery; *DFA,* deep femoral artery; *SFA,* superficial femoral artery

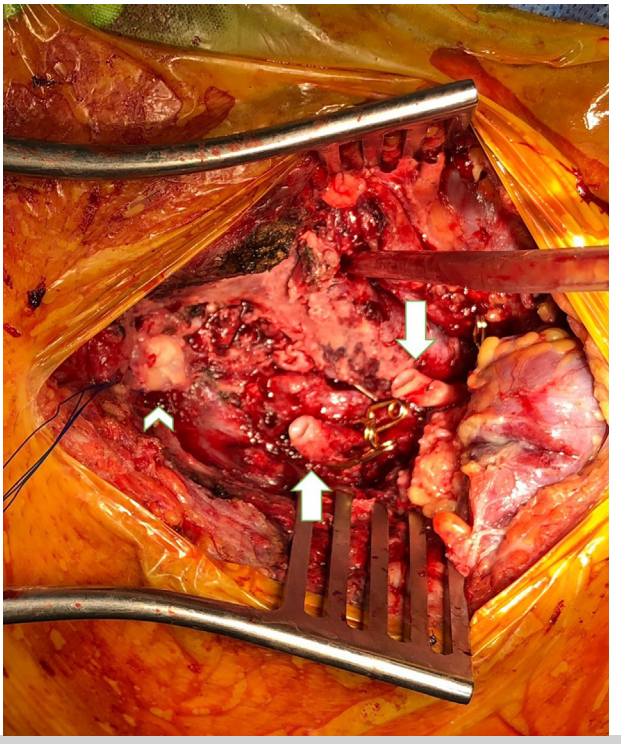

**Fig 3.** Surgical wound after debridement. *Arrowhead* indicates the common femoral artery (CFA) stump; and *arrows,* the deep femoral artery (DFA; *Right*) and superficial femoral artery (SFA; *Left*) stumps.

## SURGICAL TECHNIQUE

Antibiotics targeting gram-positive and skin bacteria were administered after obtaining tissue or pus samples. With the patient under general anesthesia, a skin incision was made over the groin swelling (Fig 1), extending cephalad as needed to achieve proximal control and identify the origin of the IPSA. For three patients, more proximal arterial control was needed and was achieved by a separate horizontal skin incision 3 cm above the inguinal ligament, exposing the external iliac artery in the retroperitoneal space. Debridement was performed, and distal arterial control was obtained after exposure of the SFA and DFA. In cases of extensive infection, a more distal exposure that included the tertiary branches of the DFA was performed. After achieving arterial control, we determined the location of the arterial defect and proceeded in accordance with our IPSA treatment algorithm (Fig 2). For proximal or medial PSAs, we performed a single CFA ligation, preserving the femoral bifurcation. For cases of distal CFA PSAs close to the bifurcation, we performed a DFA to SFA transposition. For this procedure, the IPSA was resected, creating three arterial stumps (Fig 3). The DFA or one of its branches was selected for the anastomosis, according to the infection extent, vessel diameter, and quality of backflow. The CFA was suture ligated and covered with the surrounding tissue. The SFA was mobilized, and its stump was anastomosed end to end to the DFA stump (Fig 4). Limb viability was assessed to determine whether an extra-anatomic bypass was needed. The anastomosis was then covered by the surrounding tissue. The wounds were left open with an iodine dressing and approximation sutures. After sufficient granulation tissue growth, the wounds were treated with vacuum-assisted closure

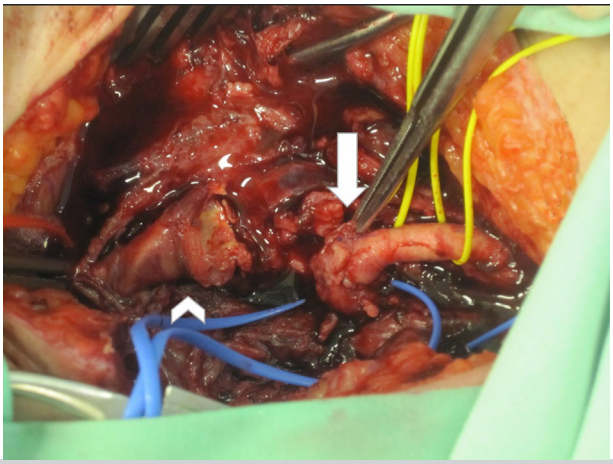

**Fig 4.** After vascular reconstruction. *Arrow* indicates the deep femoral artery (DFA) to superficial femoral artery (SFA) anastomosis; and *arrowhead,* the common femoral artery (CFA) stump.

dressings, additional wound debridement, and approximation sutures, as needed, until closure was achieved. Aspirin was prescribed postoperatively to all the patients.

## RESULTS

Six patients underwent SFA to DFA reconstruction surgery. All the patients had an IPSA at the right groin. Four patients were known IVDUs, one of whom also had a known diagnosis of human immunodeficiency virus infection and another, a known diagnosis of hepatitis C virus infection. Two patients were female septuagenarians with an iatrogenic IPSA after cardiac catheterization. The demographic data are summarized in Table I.

Tissue cultures were obtained in all cases, and blood cultures were obtained for four of the six cases. The bacterial tissue cultures showed mixed growth, which consisted mostly of *Staphylococci* and other skin bacteria. The blood cultures were positive for *Staphylococcus aureus* in two patients.

Infectious disease specialists were consulted for all six patients, and targeted antibacterial regimens were issued according to the bacterial growth (blood or tissue cultures) for ≥5 days after admission. Hospitalization ranged from 8 to 39 days (median, 12 days). The two female patients with an iatrogenic IPSA were rehospitalized within 30 days for unrelated conditions. All six patients were discharged with monophasic arterial pedal Doppler signals and an ankle brachial index of 0.4 to 0.5. None of the patients required reintervention, and none had undergone a major amputation 1 year after surgery. The perioperative and follow-up data are summarized in Table II.

**Table I.** Demographic data (n = 6)

| Variable | Value |
|---|---|
| Sex | |
| Female | 50 (3) |
| Male | 50 (3) |
| Median age, years | 41 (31-72) |
| IVDU | 64 (4) |
| IPSA side | |
| Right | 100 (6) |
| Left | 0 (0) |
| Known infectious disease | |
| HIV | 16 (1) |
| HCV | 33 (2) |
| Imaging before surgery | |
| CTA | 33 (2) |
| Duplex US | 33 (2) |
| Admission inflammatory status | |
| Oral temperature, °C | 37.5 (36.5-38) |
| Leukocyte count, $10^3/\mu L$ | 15.35 (11.3-19) |
| CRP, mg/L | 173 (79-350) |

*CRP,* C-reactive protein; *CTA,* computed tomography angiography; *HCV,* hepatitis C virus; *HIV,* human immunodeficiency virus; *IPSA,* infected pseudoaneurysm; *IVDU,* intravenous drug user; *US,* ultrasound.
Data presented as percentage (number), median (range), or mean (range).

## DISCUSSION

In current vascular practice, IPSAs have become ubiquitous, with IV drug use and endovascular procedures becoming more prevalent.[2-4] IPSA is considered a medical emergency, and prompt intervention is needed to prevent significant morbidity and mortality.[5] Currently, no guidelines or high-level data are available regarding the best treatment of IPSAs.

The vascular reconstruction options for IPSAs are restricted because of several limiting factors. The patient population includes mostly elderly cardiac patients with extensive atherosclerotic disease who might not be suitable candidates for complex vascular reconstruction, or IVDUs, who lack proper venous conduits and are less compliant to long-term treatment and follow-up.

When considering vascular reconstruction for these patients, perioperative and long-term infections are the main concern. The groin is considered an area prone to surgical site infections, especially in debilitated patients and patients lacking proper hygiene, such as IVDUs. Furthermore, the procedure is performed in the setting of bacteremia and gross infection of the groin; thus, performing an extra-anatomic bypass, which often requires the use of prosthetic material, in these patients is not recommended. Autologous veins are usually not suitable as conduits in the IVDU population owing to the multiple drug injections and phlebitis. Also, cryopreserved vein grafts are not readily available in some centers. Furthermore, in our experience, in the case of extensive groin infection, an in situ reconstruction is prone to patch

**Table II.** Perioperative and 1-year follow-up data (n = 6)

| Variable | Value |
|---|---|
| Tissue bacteria | |
| *Enterococcus faecalis* | 16 (1) |
| *Staphylococcus aureus* | 50 (3) |
| *Escherichia coli* | 16 (1) |
| *Pseudomonas aeruginosa* | 16 (1) |
| Blood bacteria | |
| *Staphylococcus aureus* | 32 (2) |
| Negative cultures | 68 (4) |
| IV antibiotics | |
| Vancomycin | 50 (3) |
| Cefazolin | 30 (2) |
| Piperacillin/tazobactam | 16 (1) |
| Median hospitalization, days | 12 (8-38) |
| Mean discharge resting ABI | 0.46 (0.4-0.5) |
| 30-Day readmission | 30 (2) |
| 1-Year mortality | 0 (0) |
| Major amputation | 0 (0) |
| Reintervention | 0 (0) |

*ABI*, Ankle brachial index; *IV*, intravenous.
Data presented as percentage (number), median (range), or mean (range).


**Fig 5.** Computed tomography angiogram 3 months after surgery demonstrating collateral flow from the pelvis after deep femoral artery (DFA) to superficial femoral artery (SFA) transposition.

and/or graft infection and anastomotic pseudoaneurysm formation even when autologous grafts are used after extensive debridement. Therefore, primary vascular reconstruction without the use of a graft presents an attractive solution in these clinical settings.

In the present report, we propose an approach for IPSA treatment that avoids the use of prosthetic materials and does not require the use of an autologous vein graft. This technique relies on collateral circulation to the DFA, preserving flow to the lower leg through the SFA[16] (Fig 5).

The ankle brachial indexes are low after ligation of the CFA; therefore, low values can also be expected after performing the described procedure. We postulate that nonpulsatile flow from the DFA to the SFA, might not be reflected in a change in the ABI but could still contribute important extra flow to the lower limb, allowing for pain-free, good-long term limb survival.

Al Shakarchi et al[17] demonstrated a correlation between the level of arterial ligation and amputation rates. They showed that ligation at the CFA resulted in an amputation rate of 31% but that ligation at the level of the SFA resulted in no amputations at all.[17] In a review of the literature, Georgiadis[7] reported an amputation rate of 6.5% when CFA ligation alone was performed in young patients presenting with an IPSA. Li et al[18] reported a graft infection rate of 38.5% in patients who underwent ligation, debridement, and external iliac artery to SFA bypass with a prosthetic graft as the primary treatment of an IPSA. It is important to note that all these patients had required secondary interventions for graft removal within 9 to 11 months after the primary surgery.[18] Reviewing the reported hospitalization length in the literature, the hospitalization duration for our patients was shorter (median, 12 vs 17.2 days), probably owing to the lack of secondary interventions, shorter antibiotic regimens, and faster recovery time after surgery for our patients.[5,9,16]

It is not disputed that revascularization procedures are more time consuming than ligation alone. However, the literature and our own experience have shown that, in many cases, ligation of the femoral bifurcation without vascular reconstruction can have long-lasting and, sometimes, devastating results. Therefore, we believe our proposed technique offers a better solution, relaying on the collateral circulation to preserve the blood flow to the lower extremity, and providing a faster procedural time than extra-anatomic bypass, without the disadvantages of implanting prosthetic material in a patient with a gross groin infection and bacteremia. From our experience, this procedure results in higher rates of limb salvage, faster recovery after surgery, and improved quality of life. Patients who underwent debridement and femoral bifurcation ligation alone had longer hospitalizations and higher readmissions rates, had required more emergent reinterventions, and had significant lower limb salvage rates.

The described technique has mostly been implemented for IVDUs with IPSAs. However, it can also be applied in other cases of femoral PSAs when angioplasty

or graft reconstruction are not feasible, relying on the existing and developing collateral blood supply to maintain circulation to the affected lower limb.

We acknowledge the limitation of the small cohort in our case series. However, we believe this procedure has the potential to benefit this specific patient population. Thus, evaluating this treatment option in larger cohorts is warranted.

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