

Surgical Treatment of Ruptured Infectious Femoral Pseudoaneurysms Caused By Intravenous Drug Abuse: A Nonemergent (Postponed) Operation Pattern May Be a Possible Alternative

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Research Article

Keywords: infectious femoral pseudoaneurysm, drug abuse, surgical treatment

Posted Date: December 17th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-1127602/v1>

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Abstract

Objective: To evaluate the possibility of surgical treatment of ruptured infectious femoral pseudoaneurysms caused by intravenous drug abuse in a nonemergent operation pattern, with retrospective analysis of clinical data and experience at a single center.

Methods: Clinical data of 85 consecutive patients presenting with groin area active or recent hemorrhage due to a ruptured infectious femoral artery pseudoaneurysm related to drug abuse who were treated in the First Hospital of Changsha, China, from July 2008 to June 2020 were collected and analyzed.

Results: A total of 74.1% of patients presented with active hemorrhage, and 36.5% presented with significant hypotension at admission. The average interval between arrival and operation was 34.7 ± 4.7 hours. Vital physiological parameters and overall situation improved significantly after sufficient preoperative preparation. Satisfactory hemostasis can be achieved by bandage compression or local skin suture. No case was transferred to urgent operation due to severe bleeding, and 1 postoperative death case was observed in the cohort. The main operative- and postoperative-related indicators were satisfactory and close to those in the emergent operation pattern.

Conclusion: While emergent or urgent operation is the mainstream surgical treatment for ruptured infectious femoral pseudoaneurysms, nonemergent (postponed) operation with sufficient preoperative preparation might also be an acceptable and comparable choice in some cases.

Introduction

Infectious femoral artery pseudoaneurysm (I-FAP) is a common complication caused by repeated intravenous drug injection^[1]. In addition to painful and pulsatile lumps in the femoral region, drug abusers with pseudoaneurysms often present with abscesses, cellulitis and endocarditis, which together contribute to disease progression and eventually lead to aneurysm rupture and active bleeding. Due to the low compliance, lack of knowledge of disease and inferior economic conditions of this specific population, minor early-stage presentations, such as local swelling or a pulsatile lump in the groin area, are often less compelling for patients seeking medical assistance. A large number of cases are transferred to the hospital with active bleeding after the aneurysm eventually ruptures. The coexistence of life-threatening hemorrhage and hemodynamic instability always imposes great challenges for clinical management. Although there is not yet a universal acknowledgment on the optimal management of I-FAP, emergent or urgent surgical intervention has been commonly advocated under such circumstances in most vascular centers, with the primary aim of hemostasis to save both the life and limb.^[2]

However, in the real world, especially in less developed areas, depending on the actual medical condition and resources, many emergent procedures are accomplished at the sacrifice of limited preoperative evaluation, preparation, consultation, therapeutic alternatives, and sometimes inferior outcomes. This research is based on the experience of a single center in treating ruptured I-FAP in a nonemergent

operation pattern, with the aim of discussing whether a postponed surgery strategy would be feasible and comparable in such a scenario.

Methods

Patients: Clinical data of 85 consecutive patients presenting with groin area active or recent hemorrhage due to ruptured infectious femoral artery pseudoaneurysms related to drug abuse who were treated in the First Hospital of Changsha, China, from July 2008 to June 2020 were collected and analyzed. Patients with pulsatile pumps and intact skin coverage but no signs of bleeding were excluded. Cases of femoral artery pseudoaneurysm caused by other factors, such as iatrogenesis or inflammation by other pathogens, were not enrolled. A detailed history inquiry and physical examination were conducted at admission. All methods were carried out in accordance with relevant guidelines and regulations. Ethical committee approval was acquired from the Medical Ethic Committee of The First Hospital of Changsha, and informed consent was obtained for every patient.

Evaluations: Diagnostic assessment was made by clinical examination at arrival. Common physical parameters were collected, followed by duplex ultrasound of the groin or enhanced computed tomography (CT). Auxiliary examination also included routine blood investigations, chest X-ray, ECG, abdominal ultrasound and contagious disease screening at arrival and repeated before the operation or after if necessary. Bacterial culture of the infectious tissue was conducted after surgical resection.

Treatments: All patients received prompt local bandage compression after the initial inspection in the emergent room, regardless of the severity of bleeding. For patients with recurrent hemorrhage after compression, a bed-side local suture of the skin wound was performed under local anesthesia followed by bandage compression. Patients were asked for lower extremity immobilization on bed lest dysfunction of the compression. Central venous access was established, and vital sign monitoring was applied. For hemodynamically unstable patients, fluid resuscitation and blood transfusion were selectively adopted. [Electrolyte disturbance](#) were corrected, and antibiotics were administered. The time between admission and operation was generally 24-48 hours in this study. During this period, preoperative evaluation, multidisciplinary consulting and preoperative preparation were completed, and the therapeutic alternatives and possible consequences were comprehensively discussed with the patient and family.

The therapeutic strategy depended on the patients' individualized characteristics, anatomic factors and informed choice. Primarily, there were 2 operation modalities: solely tricephalous ligation (including common femoral artery, superficial femoral artery and profound femoral artery) and ligation with prosthetic bypass, both followed by aneurysm resection and infectious tissue debridement. All procedures were performed under general anesthesia. The bypass procedure was performed before the handling of the infectious aneurysm sac, and an extraanatomic bypass was adopted away from the infected field to avoid graft contamination from the external iliac artery to the superficial femoral artery, with the conduits running at the lateral side of the thigh. The wounds of proximal and distal vessel anastomosis were closed with drainage, while the residual cavity of infectious aneurysm was left open

and tightly packed with sterile gauze. Considering the often unsatisfactory condition of peripheral veins in this population, autogenous conduit bypass, such as saphenous bypass, has not been considered. Endovascular stenting was not adopted based on obvious local infection.

Postoperative treatments include wound care, antibiotic therapy and limb ischemia assessment. Observation and dressing of wounds were performed every day, just waiting for natural healing, with no vacuum sealing drainage or secondary closure adopted. Antibiotic therapy was initialized with broad-spectrum antibiotics followed by drugs based on bacterial culture and lasted for at least 2 weeks.

Nutritional support treatment were particularly emphasized in this scenario and administered for most patients to promote wound healing. The circulation of the affected lower extremities was evaluated by skin temperature, color and ABI and confirmed by postoperative CTA if possible. Limb ischemia aggravation after surgery was defined as a significant skin temperature drop, persistent limb ischemic pain, ABI below 0.3 or imaging examination revealing poor blood perfusion of the distal limb.

Follow-up: Follow-up information, including mortality, postoperative bleeding, wound healing time, wound infection, residual ischemic symptoms, and incidence of lower limb amputation, was obtained via outpatient return visits or through a telephone survey with patients/relatives. There were 38 cases (37.8%) followed for more than 1 year, and the incidence of conduit infection and death were collected.

Statistical analysis: Means and standard deviations were calculated for quantitative data. Frequencies and percentages were calculated for qualitative data. All statistical analyses were performed using IBM SPSS Statistics 22.0.0.0 (IBM, Armonk NY, USA).

Results

In this retrospective study, clinical information of 85 patients (85 legs) was collected during the last 12 years, with 58 men and 27 women. The average age was 36.5 ± 5.3 years, with a drug abuse history of 3.54 ± 1.1 years. The mean interval between detectable aneurysm formation and the first rupture was 5.8 ± 5.5 months, and the mean duration from rupture to hospital arrival was 1.2 ± 0.4 days. A total of 74.1% of the patients arrived with active bleeding, and 36.5% presented with significant hypotension (mean blood pressure < 70 mmHg). All patients, regardless of the presentation of active bleeding, received groin area bandage compression. Twenty-three patients with active massive bleeding at arrival or repeated bleeding after compression received a bed side suture of the skin tear under local anesthesia. Specifically, recurrent or repeated bleeding after compression occurred in 37 cases, with a mean blood loss of 83.6 ± 13.6 ml, and all cases were detected and treated in a timely manner. All rebleeding occurred in patients with solely bandage compression, and none occurred in patients after skin suture. Preoperative blood transfusion was administered in 29 cases. The mean resuscitative treatment and preoperative preparation duration was 34.7 ± 4.7 hours. The general demographic characteristics are shown in Table 1.

Table 1: General Demographic Characters:

Age (Years)	36.5 ± 5.3
Gender (Male: Female)	58: 27
Drug abuse history (Years)	3.54 ± 1.1
Interval between aneurysm formation and rupture (Months)	5.8 ± 5.5
Interval between rupture and hospital admission(Days)	1.2 ± 0.4
Active bleeding at arrival	63, 74.1%
Significant Hypotension	31, 36.5%
Bandage compression	85, 100%
Skin suture	23, 27.1%
Total Recurrent bleeding	37, 43.5%
Repeated Bleeding after local bandage without suture	37/62, 59.7%
Repeated Bleeding after local bandage with suture	0/23, 0%
Blood loss during preparation (ML)	83.6 ± 13.6
Blood transfusion	29, 34.1%;
Interval between arrival and operation (Hours)	34.7 ± 4.7

Vital physical and physiological parameters at arrival and before the operation are shown in Table 2. The MBP, HR and hemoglobin were significantly improved, and liquid electrolyte disturbance was corrected after sufficient preoperative resuscitation therapy. However, there was a significant drop in serum albumin and enlargement of the lower extremity circumference. There was no significant change observed in temperature, WBC or pH. The physical and physiological parameters at arrival and before the operation are shown in Table 2.

Table 2. Physical and Physiological Parameters

	At Arrival	Before Operation
Mean Blood Pressure*	70.2± 7.3	79.4± 9.8
Heart Rate*	94.3± 11.8	83.4± 9.2
Temperature	36.8 ± 1.4	37.1± 1.5
Hemoglobin*	79.4± 9.7	92.4± 8.4
WBC	13.7± 4.7	12.8± 3.9
Serum Albumin*	32.1± 4.5	29.7± 5.1
PH	7.32 ± 0.05	7.38 ± 0.03
Na*	131.7 ± 4.5	138.4± 4.2
BUN*	11.7 ± 2.7	8.5 ± 3.2
Lower extremity circumference(CM)*	43.4± 5.5	47.3± 6.7

*Significant with P<0.05

No case had been transferred to the urgent operation room due to massive bleeding in the preoperative period. Among the 85 cases, a one-stage bypass procedure was adopted in 79 cases, with a prosthetic conduit applied from the external iliac artery approximately to the superficial femoral artery distally via the lateral side of the thigh. For the remaining 6 cases, solely tricephalous ligation was adopted due to extensive aneurysm occupation or extensive infection. The mean operation duration was 147.4 ± 35.7 minutes, with blood loss of 326 ± 54.8 ml. The postoperational stay was 5.4 ± 1.3 days. Postoperative bleeding was observed in 2 patients in the bypass group, with one re-explored and the other patient dying. For the 6 patients who received only the ligation procedure, limb ischemia aggravation was observed in 2 cases and immediately after the surgery, and amputation procedures were conducted. For the other 4 patients, there was no obvious ischemia aggravation. For those followed up over 1 year (38, 44.7%), the incidence of conduit infection was 46.8% and received conduit removal without reconstruction. 3 patients (7.9%) died due to uncertain reasons. Operative-related parameters and follow-up are shown in Table 3.

Table 3. Operative Related Parameters and follow-up

Transferred to urgent operation due to severe bleeding	0
Surgical strategy (Bypass: Ligation)	79: 6
Operation duration (Minutes)	147.4 ± 35.7
Intro-operative Blood loss (ML)	326.5 ± 54.8
Post-operation stay (Days)	5.4 ± 1.3
Complications	
Post-operational bleeding	2 2.4%
Limb ischemia aggravation	2 2.4%
Reintervention	1 1.2%
Amputation	2 2.4%
Death (in hospital)	1 1.2%
Long term follow-up	38, 44.7%
Conduits infection	14, 36.8%
Death	3 7.9%

Discussion

Infectious femoral artery pseudoaneurysm (fa-IPA) is a both common and severe complication of intravenous drug administration by repeated nonsterile groin punctures, and the treatment remains controversial. The early clinical manifestation in most cases is local swelling or palpable pulsatile lump at the affected groin area, with or without subtle pain. With these minor symptoms at the early stage, together with insufficient disease cognition and inferior socioeconomic conditions, a significant proportion of patients are not sufficiently motivated to seek medical assistance. This may explain why the unusual long interval between aneurysm formation and hospital arrival was observed in this study. The aneurysm gradually enlarges as the disease progresses, with the aggravation of local tissue infection and eventually leading to sudden sac rupture and massive hemorrhage, which often place patients under life/limb-threatening circumstances. According to our experiences, approximately 75% of cases are urgently transported to the emergency room with varied bleeding due to a ruptured aneurysm sac, and more than one-third are hemodynamically unstable at arrival. The high proportion of cases with active bleeding at admission is in accordance with that reported by Becker et al. (68%)^[3] and Xu Jian et al. (72.4)^[4]. The latter also observed nearly 1/3 of cases to be faint due to hemodynamic instability. Due to massive hemorrhage and an unstable general condition, these patients are typically at high risk of death or limb loss, the management is quite challenging, and the overall prognosis remains unsatisfactory.

The optimal management of ruptured I-FAP is not yet universally accepted. However, arguments are mainly concentrated on some hot topics, including the chief surgical strategy (ligation without bypass/with bypass/in situ repair)^[5,6,7], specific bypass indication (all/none/selective)^[8,9], the type of graft conduit (autologous/synthetic/biological)^[3,10], or the intervention methods (open surgery/endovascular/hybrid technology)^[4,11,12]. However, there are few discussions on surgical operation timing. Emergent or urgent surgical intervention is generally claimed in almost all vascular centers in treating ruptured I-FAP with the primary objective of reliable hemostasis and life savings^[3,4]. We also admit that kind of strategy is both reasonable and practical under most circumstances, as surgical intervention remains the first choice of bleeding due to any large artery rupture.

Therefore, the most important question is as follows: Do we need any discussion on operation timing, if urgent surgery, as the only choice in such a critical situation, is universally believed and practiced? Does it make any sense?

We believe it is still of some significance to discuss the feasibility of a delayed, nonemergent surgical intervention and the possibility of rendering a practical alternative. We based this argument on two main considerations. The first is that discreetly delayed surgical interference timing is not necessarily impractical, as we thought, and it might be safe enough if well conducted. The second is an ideal emergent operation modality that is not universally practical in every area or every time in the real world.

On Medical quality and security

We believe all urgent operations are by principle the last resort, in circumstance of compelling emergency without other effectual alternatives. Due to the lack of more comprehensive preoperative preparation and evaluation, urgent operations are basically inferior in every aspect compared to selective operations. The long-term chaotic lifestyle makes drug abusers commonly present with impaired immune function, lower nutritive conditions, chronic organ dysfunction, and infection of the groin area. Sudden rupture and massive hemorrhage always bring about severe hemodynamic instability and internal environmental disorders. Performing a complicated surgical procedure under such urgent circumstances actually places patients under typically higher risk both for anesthesia and the procedure itself. According to this study and our experiences, temporarily satisfactory hemostasis could be achieved by local compression and other techniques, even for those with massive bleeding. The overall condition can be significantly improved after 24-48 h fluid resuscitation and blood transfusion, thus providing a better preoperative condition.

Moreover, with the restrictions of medical resources and conditions, a definitive operational strategy sometimes cannot be perfectly implemented in an urgent situation. All related resources might be immediately mobilized in developed medical institutions; however, in some less developed areas or in particular periods (e.g., the COVID-19 pandemic), this availability is quite questionable. When autogenous veins are not suitable and biological grafts are not available, prosthetic grafts might be the only alternative when reconstruction is considered. If even prosthetic grafts were not available, compelled sole

ligation is most likely to be the only choice. The nature of an urgent operation might justify any possible procedure but at the same time means a sacrifice of better solutions. In contrast, an appropriately delayed operation timing may be better and safer, which allows more preoperative evaluation, preparation and communication.

On practical feasibility of urgent operation

An urgent operation requires medical management of all respects to be efficiently carried out in a quite short time, which imposes a great challenge and pressure on the vascular team and multidisciplinary team cooperation. This kind of cooperation can be carried out in advanced institutions with satisfactory efficiency and quality. Nevertheless, in the real world, there might be some impediments. For some areas of the world, medical financing still remains a major consideration for patients, which cannot be fully raised in the short term and subsequently affects strategy making. In some cultural backgrounds, patient consent and informed choice could not be achieved before time-consuming communication and discussion. In some areas of tension physician–patient relationships, without the participation and endorsements of related family members, urgent medical interference might incur possible medical conflicts, especially when the outcome is not satisfactory. Last, for the area of medical source scarcity, preoperative examination and evaluation might also need more time to be accomplished. For example, contagious disease screening might not be finished within several hours in many centers, which may put surgeons under extra exposure risks. Under such circumstances as discussed above, a delayed operation, if feasible, may be more appropriate than an urgent hasty operation.

Another important question also worth debating is whether life-threatening hemorrhage in this situation can be safely controlled by local compression and bandages until planned operation.

All of the above discussion and claims should be based on a fundamental fact: the feasibility and safety of bleeding control via local bandages until delayed operation, which is the main aim of this research. There are several important results we observed from this study.

First, for the rupture of femoral artery pseudoaneurysm and the consequent mass bleeding, unlike mostly assumed, it proved to be both feasible and reliable to achieve satisfactory hemostasis by some nonoperational measures. No preoperative death was observed in this study, and none of the cases with observed life-threatening bleeding necessitated an urgent operation after proper local bandage compression. Although the incidence of interval bleeding (37, 43.5%) was relatively high in our observation, most of them were minor bleeding, which can be immediately discovered and easily resolved by reinforcing the compression or exerting an extra local skin suture. Especially for patients after local skin sutures, no recurrent hemorrhage has been observed.

Second, after more comprehensive preoperative preparation, the overall physical condition can be significantly improved, with the hemodynamic indicators stabilized and disturbance of the inner environment corrected, and without the results compromised. Patients remained stable in the perioperative period, and no severe complications were observed after the following operation or

anesthesia. There is no direct comparison conducted between the prognosis of nonurgent operations and urgent operations due to actual clinical practice and experimental design. Nevertheless, comparable results can still be speculated on several main factors, including mortality and the incidence of severe complications, such as ischemia aggravation, postoperative bleeding, reintervention, and amputation, when compared to previous reports^[3,8,13,14].

Third, preoperative local compression and skin sutures do not significantly lead to local infection aggravation or systematic infection deterioration, as they might be easily questioned. After 24-48 hours, most of the patients in this cohort still had received extra-anatomy bypass. Some patients did not have enough bypass space because of the large aneurysm sac or extensive local infection, and a sole ligation was the only choice. No case presented any presentation of deterioration of systematic inflammation, such as septic shock, or increased inflammation indicators. We assume this may be due to the low immune state of this population. The incidence of graft infection was near 40%, which is in accordance with other reports. Local compression exacerbated the overall swelling of the affected limb, as observed, by extra impedance of venous drainage, which might add some inconvenience to surgical manipulation. However, this adverse effect is neither as severe to affect dissection or identification nor affects wound healing.

According to our experiences, the appropriate interval between arrival and operation should be 24-48 hours. Some patients underwent surgery more than 72 hours in this cohort for various reasons, and comparable results were obtained. However, on the one hand, 24-48 hours is generally enough to achieve satisfactory preparation in most places, and on the other hand, it might be inappropriate to further postpone due to potentially increased risks of repeated bleeding or aggravation of infection.

One of the key points is preoperative hemostatic techniques. For most cases, bandage compression is a sufficient measure to achieve temporary hemostasis. It should be addressed the bandage must cover the whole hips with abduction of both legs. Several pads of carbasus under the bandage would provide extra compression of the wound site. The patients should be asked to immobilize on bed because hip joint movement would rapidly lead to malfunction of the bandage. (shown in Fig 1.). For those who are admitted with massive hemorrhage, bedside local suturing of the skin tear is both simple and effective. It provides extra tension of the coverage tissue and helps prevent bleeding. In most circumstances, when a direct suture cannot be achieved due to tension, a suture with compression material tamping in the skin tear would reduce the tension. (shown in Fig 2.)

There are some shortages of this study. First, it is a retrospective and descriptive analysis of a single center, with limited cases and less satisfactory follow-up. Another important shortage is the lack of control. A direct results comparison between urgent operation and delayed operation cannot be acquired. However, when compared with other reports, which mostly adopted urgent operation strategies, there was no significant inferiority observed in some important indicators, including patient mortality, complication rate, and surgical treatment outcome. Reinfection of grafts remains an important problem; however, it is the same for urgent operations, and it did not bring together any severe complications, as we observed.

Conclusion

A large proportion of patients with I-FAPs arrive at the emergency department with a ruptured aneurysm and active bleeding. While an urgent operation strategy is commonly accepted in most centers, we believe that an appropriately delayed operation pattern may also be a practical and safe alternative. Satisfactory hemostasis can be achieved by good bandage compression or local skin suture and does not adversely affect further surgical procedures or outcomes. With more comprehensive preoperative evaluation, preparation and consultation, the overall condition of patients can be significantly improved and thus permit better operative strategy making and safer surgical treatment rendering.

Declarations

Fundings: None

Conflict of Interest: The authors declare that they have no conflicts of interest.

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Figures



Figure 1

Demonstration of appropriate bandage compression of the groin area in order to control bleeding.



Figure 2

Demonstration of local suture with a compression material tamping in the skin tear to less the tension.