A Hybrid Technique to Treat Inguinal Wound Infection after Arterial Surgery with Lateral Femoral Bypass and Intra-Incisional Negative Pressure Wound Therapy

Yi-Fan Wu

Wuhan University Zhongnan Hospital

Dong Zhang

Wuhan University Zhongnan Hospital

Ai-Xi Yu

Wuhan University Zhongnan Hospital

Baiwen Qi

Wuhan University Zhongnan Hospital

Chao Jian (✉ chaojian@whu.edu.cn)

Wuhan University Zhongnan Hospital

Research

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Abstract

Background: Patients with the inguinal wound infection after arterial surgery remains clinical challenge. Sustaining lymphatic leakage have been shown as a common and potentially serious complication. However, it remains clinical challenge for surgery to deal with this tough problem.

Methods: This study describes a hybrid technique of using radical debridement, lateral femoral bypass (LFB) and intra-incisional negative pressure wound therapy (iNPWT) for single-staged treatment of complex inguinal wound infection after arterial surgery (IWI-AS).

Results: Between January 2017 and June 2021, 5 IWI-AS cases treated with this new method were identified. Of the patients, 3 were males and 2 were females. The average age was 49.4 years (range, 33 to 77 years). 4 cases suffered emergent operations due to the sudden bleedings. after vascular bypass reconstructions and an average of 2.2 (range:1-3) iNPWT, all cases achieved wound healing at an average duration of 4.6 weeks (range: 3-6weeks). Moreover, all cases showed no bacterial growth and grafts patency as indicated by doppler ultrasound or CT angiography postoperatively. One case did not receive bypass imaging evaluation at postoperative 12 months. Weakness of quadriceps femoris was observed in one case.

Conclusion: single-staged therapy of LFB and iNPWT hybridization is a technically handy and effective method for treatment of inguinal wound infection after arterial surgery.

Introduction

Femoral artery diseases in groin, resulting from trauma, tumor resection, iatrogenic injuries are very common. In-situ anatomic reconstruction is standard management for inguinal arterial defects. However, of these arterial intervention cases, 2% to 5% patients suffer sustaining lymphatic leakage¹⁻³. Approximately 5% patients developed a groin wound infection^{4,5}. Femoral artery defect in the setting of groin lymphatic leakage and wound infection makes vascular reconstruction and wound healing more complicated and challenge. The failure of treatment conclusively leads to limb loss and life-threatening problems.

Multiple-staged management of inguinal wound infections after arterial surgeries has been increasingly reported^{6,7}. In this study, we introduced a hybrid technique, including aggressive debridement, intra-incisional negative pressure wound therapy (iNPWT) and lateral femoral vascular bypass implant with great saphenous vein, to synchronously address the limb revascularization and wound healing for IWI-AS in single stage. we reviewed our results to assess the efficacy of this single-staged treatment for inguinal wound infections after arterial surgeries.

Methods

In this study, patients with inguinal wound infection after arterial surgery who underwent radical debridement, lateral femoral vascular bypass and intra-incisional NPWT from January 2017 to June 2021 were retrospectively reviewed. Patient demographic information and therapy details and clinical outcomes, including gender, age, cause of disease, comorbidities, operations, microbiology of wound, type of vascular graft, times of NPWT, wound healing, duration from surgery to wound healing, patency of bypass, recurrence of infection and lymphatic leakage, limb salvage, major adverse events (MAEs) were recorded. Ethics board approval for

retrospective study involving humans was obtained from Ethics Committee of Zhongnan Hospital of Wuhan University, Wuhan, China.

Operative procedure

For bleeding cases, ligations of rupture arteries were obligatory for hemostasis. Then an aggressive debridement was performed by excision of fascia and suspect infected tissue except for femoral nerve and veins until wounds bled. Wounds were sealed with 1% povidone-iodine solution for sterilization and irrigated with at least 9L saline.

2 incisions near middle inguinal ligament or in contralateral inguinal region (in case 4) and in middle 1/3 of thigh were made as counterincision to expose the uninvolved external iliac artery (EIA) or contralateral superficial femoral artery (SFA) (in case 4) and ipsilateral SFA, deep femoral artery (DFA). The bypass was initially tunneled under the incised inguinal ligament in the proximal incision and passes through the rectus femoris muscle (in case 4, firstly passes through skin of the lower abdomen) to the distal incision. The channel needs to be fully expanded to at least 3cm width to avoid compressing grafts. The great saphenous vein in thigh were preferred as conduits in 4 patients. The great saphenous vein in shank as alternative was considered in context of the exhausted great saphenous vein in thigh in case 5. In proximal incision, the EIA or contralateral SFA (in case 4) as an inflow vessel, was anastomosed with inverted great saphenous vein in end-to-side manner. After confirming that the graft was patent without blood leakage, the autograft was delivered to distal incision via the tunnel and anastomosed to SFA and DFA in end-to-end manner (Figure 1). After most of the debrided wound was sutured. Vacuum drainage apparatus was inserted into the remaining 3cm unclosed wound and served as intra-incisional NPWT.

Postoperative Management

One week postoperatively, wound secretion was subjected to bacterial culture. the wound was observed at the weekly renewal of VSD device. The wounds were completely closed until the drainage volume <50 mL every 24 hours and then treated by conventional wound dressing change or another NPWT until wound healed. Microbiology-based sensitive antibiotics were applied for a minimum of 6 weeks. CT angiography and vascular ultrasound examinations were employed to confirm the patency of bypass at postoperatively 1-2 months.

Results

5 consecutive patients (3 males and 2 females) with an average age of 49.4 years (range, 33 to 77 years) were included. The case series were described in Table 1. All cases received initial in-situ femoral arterial reconstructions for different causes, including 1 cases of trauma-related femoral artery occlusion, 1 case of tumor resection-related femoral defect and 1 case of extracorporeal membrane oxygenation (ECMO) catheter-related femoral artery rupture and 2 cases of catheter-related femoral artery pseudoaneurysm. Of these, initial vascular grafts were vascular prostheses in 3 cases, and great saphenous veins of thighs in 1 case. In particular, case 5 received another great saphenous vein implant operation due to the anastomotic bleeding after initial surgery with prosthesis. Case 2 initially received a reconstruction with damaged femoral artery resection and end-to-end anastomosis. Post-operative Inguinal lymphatic leakages and infections were manifested by the unhealed wound and persistent serous and pyogenic discharge from incision. Wound infections were evidenced by microbiological test around grafts, including *klebsiella pneumoniae*, *enterococcus faecalis*, *staphylococcus aureus*, *escherichia coli*, *staphylococcus epidermidis*.

As the failure of previous vascular reconstruction, all cases received these salvage surgeries including radical debridement, lateral bypass with great saphenous vein and intra-incisional NPWT. 4 of 5 patients received emergent surgeries due to the unexpected bleedings on prior arterial anastomoses. 1 of 5 patients received selective operation. All cases employed EIAs as inflows (except for case 4), SFAs/DFAs as outflows and GSVs as grafts. In case 4, the contralateral SFA is selected as inflow due to the ipsilateral EIA occlusion (Table2).

As shown in table 2, after an average of 2.2 (range:1-3) intra-incisional NPWT treatments, all cases achieved wound healing at an average duration of 4.6 weeks (range: 3-6weeks) from the definitive surgery to wound healing. Moreover, the one-week postoperative pathogen examinations showed no bacterial growth in all cases. All affected limbs were successfully revascularized which indicated by unobstructed arterial grafts via doppler ultrasound examinations or CT angiography at discharge. All cases kept primary patency at postoperative 12 months except for case 1. This patient did not participate in the visit and underwent angiography at postoperative 12 months due to tumor recurrence. All limbs were salvaged without amputation. Incomplete femoral nerve injury, manifested as weakness of quadriceps femoris, was observed in case 5 preoperatively. The quadriceps femoris force was restored after intensified rehabilitation.

Selected case report

A 38-year-old male was admitted with left vertebral pseudoaneurysm for endovascular therapy via inguinal percutaneous femoral arterial access (Case 5). 4 months later, the patient felt pain in the left groin area. Physical examination revealed a pulsating mass at entry site and extreme swelling in the left lower limb. CT angiography showed that there was a 5cm*6cm pseudoaneurysm in the common femoral artery, and the patient was re-admitted to receive false aneurysm resection and first revascularization procedure with in-situ artificial blood vessel transplantation. However, the patient presented persistent lymphatic leakage with at least 150ml/day discharge. On the 14th day after the first reconstructive operation, the patient suddenly experienced bleeding from the anastomosis of the transplanted blood vessel and underwent an in-situ revision surgery with autologous great saphenous vein transplantation (Figure 2a,b). Thereafter, the lymphatic leakage was not ceased spontaneously and a secondary wound infection with staphylococcus epidermidis was verified by bacteriological examination. Dressing change, debridement and NPWT treatment were employed for a certain interval, the wound yet not healed. However, sudden anastomosis bleeding occurred again on the 21st day after the second surgery. The patient was then subject to the definitive surgery with radical debridement, simultaneous EIA-SFA lateral bypass with autologous saphenous vein transplantation and intra-incisional NPWT treatment (Figure 3a, b). 1 week later, microbiology test of wound discharge showed that there was no bacterial growth. After receiving another two intra-incisional NPWT treatments, the drainage volume of the wound was less than 50ml within 24 hours. Then the wound was sutured at 3 weeks after and healed at 6 weeks after the last operation (Figure 4a, b). 6 weeks and 12months postoperatively, CT angiography of affected limb showed that the graft was unobstructed without obvious stenosis (Figure 5a, b).

Discussion

The groin wound infection after arterial surgery remains a significant clinical challenge. Multiple factors, including rich lymphatic tissue and fascia tissue, the proximity to the perineum, predispose inguinal femoral arterial reconstruction to complicated with infections^{8,9}. In particular, persistent lymphatic leakage after arterial reconstruction in the groin has subsequently emerged as a common and potentially serious complication.

Persistent epithelial breach poses the wound and graft at high risk of secondary infection, these serious complications were presented in all of our cases series. The complex conditions imply that it is notoriously difficult to treat and do not succumb to the remedy for simple vascular reconstruction surgery. The goal of treatment for IWI-AS should be to salvage the limbs and their functions. In our case series, all patients achieved well-vascularized lower limb, elimination of infection and wound healing in 6 weeks after intra-incisional NPWT surgeries.

For complicated femoral arterial injury, ligation is the simplest approach, collateral branches around the hip avoid limb loss in most healthy populations in case of ligation, but it is inevitable to cause critical ischemia and disability in lower limb, especially in patients with pre-existing arterial disease^{8,10}. Therefore, ligation is not firstly recommended. The optimal strategy is supposed to rebuild the trunk of artery to maximize blood supply for limb salvage. In situ arterial reconstruction often failed to restore aortic blood flow in the setting of infected groin, which was attribute to uncontrolled infection and erosion-related bleeding^{11,12}. In this regard, the bypass strategy was proposed. For bypass technique, the graft is tunneled through uninfected tissue, it protects the graft from erosion of infection. LFB and OCB are the frequently-used extra-anatomical techniques and have comparable effect in graft latency and limb salvage^{8,13-15}. Nonetheless, OCB is more technically-challenging than LBP due to the difficult traverse of obturator foramen. It also has a risk of obturator vessel and nerve injury and potentially damages the collateral circulation of affected limb, whereas LBP is close to anatomic site and less invasive to surrounding tissues⁸. Additionally, given LBP is operatively convenient and time-saving, it is quite suitable for emergent bleeding cases¹⁵. Notably, 25% patients suffered acute bleeding⁶. In our study, all cases suffered sudden bleedings and received emergent LFB operations. All affected lower limbs were succeeded to be well revascularized without graft re-perforation that indicated by the distal pulses of dorsalis pedis arteries and vascular ultrasound at final follow-ups.

As ready-to-use grafts, prosthetic conduits are extensively used in vascular surgeries. Indeed, our cases also received prosthesis reconstructions in previous surgeries. Prosthesis-related bacteria colonization often leads to recurrence of wound infection, thus once infecting, the prosthetic graft would inevitably be completely removed. Although harvest of autograft, such as great saphenous vein, maybe bring donor site damage and the graft needs massive further process, including dilation and branch ligations, autograft was still the first choice in term of its long-lasting durability and resistance to infection, especially in young populations and infected setting¹⁶. Cryopreserved human cadaveric allografts present comparable performance with autografts but take relative higher cost and serve as alternative substitute for vascular graft in the absence of autografts⁸.

Sustaining inguinal lymphatic leakage and secondary infection are another challenge for wound healing. Unsurprisingly, debridement, especially radical debridement, is obligate and primary to infected wound. The debridement may be not enough for wound healing. Vascularized muscle flaps and NPWT therapy were well-documented methods for treating lymphatic leakage and infection, in particular for graft-preserved cases^{1,9,16-18}. However, the use of flaps is often restricted to the already compromised blood supply of muscle and surgeon's skills. NPWT, as another reliable method for infected wound, was prophylactically and therapeutically applied alone in groin wound following vascular surgery and showed good results¹⁸. However, there were 6.4% reinfections and 7.1% bleeding events in previous report¹⁹. In addition to debridement, the times and manners of NPWT application also play a role in recurrence of infection. Our previous study indicated that NPWT in intra-incisional manner was much more effective for drainage and compressing lymphatic tubes than that in closed-

incisional manner²⁰. Therefore, we enveloped the NPWT device in incision on basis of aggressive debridement and performed periodic replacement of intra-incisional NPWT until the volume of drainage was less than 50ml every day. All cases showed negative wound bacteria result after the first NPWT and achieved wound closure after 1-3 times of NPWTs. Providing reinfection was occurred, muscle flap could serve as a remedy. Nevertheless, bypass graft was away from NPWT, the NPWT caused bleeding was not observed in our study.

Major adverse event was quadriceps femoris weak in case 5. Although we had carefully protected the femoral nerve, quadriceps femoris weak still appeared. We did not know the situation of muscle before the surgery. We also had no electromyographic evidence to affirm the incomplete nerve injury-related muscle weak. In fact, it cannot exclude disuse-atrophy cause. Finally, strength of quadriceps femoris was restored via rehabilitation.

As a fact, there are several limitations in this study. Firstly, CT angiographies were not routinely performed in all patients at last visit, as the patients concerned about the radiation hazard, thus long-term durability were not well evaluated postoperatively. Secondly, this is a retrospective study. Recall bias probably existed. Thirdly, the study had only 5 patients. Thereby, the power of conclusions is limited. In all, the reliable outcomes need to be further validated in well-designed study with larger populations.

Conclusion

In conclusion, the hybrid technique of lateral femoral bypass combining with intra-incisional NPWT is a technically handy and effective method for single-staged treatment of inguinal wound infection after arterial surgery, in particular with emergent bleeding from erosive graft.

Abbreviations

LFB: lateral femoral bypass; **iNPWT**: intra-incisional negative pressure wound therapy; **IWI-AS**: inguinal wound infection after arterial surgery; **MAEs**: major adverse events; **EIA**: external iliac artery; **SFA**: superficial femoral artery; **DFA**: deep femoral artery; **NPWT**: negative pressure wound therapy

Declarations

Authors' contributions

Chao Jian, Baiwen Qi and Yifan Wu conceived of the study and participated in its design and coordination and wrote the initial manuscript draft. Yifan Wu and Dong Zhang carried out the operations and revised manuscript. Aixi Yu participated in collection and interpretation of the data. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are available

from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Zhongnan Hospital of Wuhan University, Wuhan, China

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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Tables

Table 1. Demographic and Clinical Characteristics of Patients

Case No.	Gender/age(years)	Cause of disease	Previous surgeries	preoperative microbiology
1	Male/65	Tumor resection-related FA defect	Tumor affected FA resection + in situ FA reconstruction with vascular prosthesis	Klebsiella pneumoniae
2	Male/34	Trauma-related FA occlusion	Damaged FA resection + end-to-end FA anastomosis	Enterococcus faecalis
3	Female/77	Catheter-related FA pseudoaneurysm	Pseudoaneurysm resection + in situ FA reconstruction with vascular prosthesis	Staphylococcus aureus
4	Female/33	ECMO catheter-related FA rupture	Damaged FA resection and in situ FA reconstruction with GSV	Escherichia coli
5	Male/38	Catheter-related FA pseudoaneurysm	Pseudoaneurysm resection + in situ FA reconstruction with vascular prosthesis and with GSV	Staphylococcus epidermidis

EMCO, Extracorporeal membrane oxygenation

FA, femoral artery

GSV, great saphenous vein

Table 2. Operation details and clinical outcomes of patients

Case No.	Operation				Times of iNPWT	Duration from surgery to wound healing(weeks)	postoperative microbiology	Bypass patency#	
	Emergency	Inflow	Outflow	Graft				A	B
1	Yes	EIA	SFA	GSV	3	6	Negative	Yes	NA
2	Yes	EIA	DFA,SFA	GSV	2	4	Negative	Yes	Yes
3	Yes	EIA	SFA	GSV	1	3	Negative	Yes	Yes
4	No	cSFA	SFA	GSV	2	4	Negative	Yes	Yes
5	Yes	EIA	SFA	GSV	3	6	Negative	Yes	Yes

EIA: external iliac artery

SFA: superficial femoral artery

DFA: deep femoral artery

cSFA: contralateral superficial femoral artery

GSV: great saphenous vein

#: Bypass patency was evaluated at different time, time A was at discharge, time B was at postoperative 12 months. NA represents the case did not participate the graft patency evaluation in the follow-up.

Figures

Figure 1

Schematic of lateral femoral bypass surgery. a External iliac artery. b Contralateral superficial femoral artery. c Superficial femoral artery. d Deep femoral artery. e Great saphenous vein. f Infected graft and wound.

Figure 2

a CT angiography showed the anastomotic bleeding (red arrow) after the first femoral artery surgery with in-situ prosthesis reconstruction. b CT angiography showed patency of graft (red arrow) after the second femoral artery reconstruction surgery with in-situ great saphenous vein of thigh reconstruction. The anastomotic bleeding occurred at 3 weeks postoperatively.

Figure 3

a Wound view before the third femoral artery reconstruction surgery. The previous vein graft was ligated immediately due to the anastomotic bleeding. b Wound view after radical debridement and proximal and distal anastomoses of bypass (blue arrows).

Figure 4

a Wound view after 3 times intra-incisional negative pressure wound therapies, the unclosed wound (blue arrow) was for vacuum drainage apparatus insertion. b Wound healing view at 6 weeks postoperatively. The two incisions in right leg were used for great saphenous vein harvest and healed (blue arrows).

Figure 5

a CT angiography showed patency of graft [red arrow] at discharge after the third femoral artery reconstruction surgery with great saphenous vein of shank bypass reconstruction. b CT angiography showed patency of graft [red arrow] 12 months after the third femoral artery reconstruction surgery with great saphenous vein of shank bypass reconstruction.