Management of early (<30 day) vascular groin infections using vacuum-assisted closure alone without muscle flap coverage in a consecutive patient series

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Objective: **Vacuum-assisted closure (VAC) therapy without muscle flap coverage is our primary approach for graft preservation in early, deep groin infections with and without exposed grafts; however, concerns exist regarding its safety. We report our experience in a consecutive series of patients with early groin infections managed without muscle flap closure.**

Methods: **All patients with early (<30 day), deep vascular groin infections without (Szilagyi II) or with (Szilagyi III) exposed vascular graft or suture line between January 2004 and December 2008 were reviewed. Graft preservation followed by local wound care with VAC was attempted in all with intact anastomoses, patent grafts, and absence of systemic sepsis. Szilagyi classification, microorganism cultured, duration of VAC use, time to healing, additional interventions, and follow-up data (limb salvage, survival) were analyzed.**

Results: **Twenty-two patients (26 groins, mean age 69.1 ± 9.5 years [range, 44-86 years]) presented with deep groin infections 16 ± 5 days (range, 7-28 days) after the index procedure (bypass-polytetrafluoroethylene [n = 11], autologous vein [n = 3], endarterectomy/patch [n = 6], extra-anatomic bypass [n = 5], percutaneous closure device [n = 1]). Grafts were exposed in 12 groins (Szilagyi III, nine with suture lines). VAC was started one to six days (median, three) after operative debridement. All had positive wound cultures and received culture-directed antibiotic therapy for 47 ± 45 days (range, 14-180 days). Length of stay was significantly more in Szilagyi III, whereas mean VAC use and time-to-healing were similar. Mean follow-up was 33.4 ± 19.5 months (range, 2-72 months). All wounds healed (mean, 49 ± 21 days). Two treatment failures occurred in the Szilagyi III group (17%). One patient had bleeding from the anastomotic heel eight days after debridement, had graft removal/in situ replacement and one presented with reinfection on day 117 and had partial graft removal/extra-anatomic bypass. There was no perioperative mortality or limb loss, but six late unrelated mortalities and one amputation at 46 months unrelated to the groin infection.**

Conclusions: **Management of early, deep groin wound infections with debridement, antibiotics, and VAC treatment is safe and enables graft preservation in the majority of patients with minimal morbidity, no perioperative limb loss, or mortality. (J Vasc Surg 2010;51:1160-6.)**

Groin incisions play a central role in various vascular surgical reconstructions and have gained widespread use with the adoption of endovascular aneurysm repairs, and complex hybrid reconstructions for atherosclerotic occlusive disease in addition to their traditional use in bypass procedures, endarterectomies, and access procedures. However, groin incisions may be complicated by wound dehiscence, lymphatic fistula or infections in 5% to 10% of patients following these procedures.[1-3] After vascular surgery, groin complications may be limb- or life-threatening, especially for early, deep wound infections.

The initial treatment of early deep groin infections includes surgical debridement and antibiotics. Management of patients with exposed synthetic grafts is especially challenging. Graft excision and extra-anatomic or in situ bypass or patch replacement using autologous, rifampin-soaked, or silver-impregnated materials have been used. However, due to the high morbidity and mortality associated with these operations, various graft preservation techniques have been increasingly utilized in an attempt to improve outcomes.[4-6]

Graft preservation may be considered when the anastomosis is intact, the whole graft is not involved with infection, the patient has no systemic signs of sepsis, the graft is patent and the offending organism is not *Pseudomonas aeruginosa*.[7,8] Aggressive debridement, intravenous antibiotics, and various muscle flaps have been widely reported and are currently the most commonly used treatment in

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these patients. However, this treatment algorithm may not be feasible in some patients (such as high perioperative risk, malnutrition, or severely scarred groins) and is reported to have a reinfection rate between 0% and 35%.[5,6,8-10] Local wound care without muscle flap closure has been reported in patients who are poor operative candidates with a greater than 75% initial success rate.[11,12]

Treatment of deep groin wound infections with vacuum-assisted closure systems (VAC) with[13,14] or without muscle flap coverage[15-20] has been reported, including our initial experience in four patients with exposed grafts who were successfully treated with no reinfections to date.[20] Although four[15,16,18,20] of the five reported studies for the management of groin infections with exposed grafts did not report any early or late bleeding or infectious complications, Svensson et al[19] reported one early bleeding and three late false aneurysms after using VAC therapy in patients with groin infections and cautioned for this complication with the use of VAC therapy in these patients. Brehm et al[21] also reported a patient who developed massive bleeding with VAC therapy for groin infection after axillary-bifemoral bypass.

We have been primarily using VAC without muscle flap coverage following aggressive debridement in patients who develop early postoperative deep groin infections with or without graft or suture line exposure following our initial favorable experience,[20] and the goal is to report our experience in a consecutive patient series.

MATERIAL AND METHODS

All patients who developed deep groin infections requiring operative debridement without (Szilagyi II) or with graft involvement (Szilagyi III)[22] <30 days following vascular procedures in whom a graft preservation was attempted in Veterans Administration Western New York Healthcare System between September 2003 and August 2008 were included in our analysis. Patients who presented with late (>30 days) graft infections (n = 7) and those who had superficial wound dehiscence managed with local wound care only or cellulitis treated with oral antibiotics were excluded. Patients with noninfected seromas, hematomas, or other wound problems were also not included in this series. Patient demographics, the initial indication for intervention, type of intervention, type of graft materials used, time to first presentation with groin infection, the second procedure performed, time to VAC placement, length of stay, duration of VAC use, time to complete healing, and follow-up information (the condition of the groin, graft, ipsilateral limb, and overall health) were recorded.

When patients were diagnosed with an early, deep groin infection, blood and wound cultures were obtained along with white blood cell count, and they were started empirically on intravenous broad-spectrum antibiotics (vancomycin plus piperacillin/tazobactam, or ciprofloxacin in those with penicillin allergy). When possible, patients underwent imaging to determine the extent of infection, followed by operative debridement (Fig 1, *A*) and deep wound culture. Patients' wounds were assessed daily during the dressing change using ionic silver-containing gel. The VAC system was applied when the wound was free of necrotic or infected tissue and hemostatic (one to six days after operative debridement). The VAC was set on continuous negative pressure of 125 mm Hg. If the anastomosis was exposed, a nonadhering dressing (Kendall, Curity, Tyco Healthcare, Mansfield, Mass) was used to keep the anastomosis from coming in direct contact with the sponge. The VAC sponges were changed three times a week, (Fig 1B-D) and minor bedside debridements were performed during sponge change when needed, two to three times per patient. No patients required debridements in the OR after initiation of VAC therapy. All patients were kept on culture-directed intravenous antibiotics for 2 to 26 weeks, depending on the presence of exposed anastomosis or prosthetic graft and the virulence of the cultured bacteria.

The patients with exposed grafts or anastomoses were kept in the hospital until the exposed graft was completely covered with granulation tissue. Patients without graft exposure were kept in the hospital until the base of the wound showed healthy granulation tissue formation and did not need further debridements during VAC sponge changes. All patients were followed in our vascular surgery wound clinic until the wounds were completely healed. None of the wounds required skin grafting. Patients were then followed in our vascular surgery clinic at three months, six months and every six months thereafter. Only two patients in our series had CT examinations 6 and 12 months after the groin infection, both of whom had no signs of persistent/recurrent infection. All other patients underwent clinical examination, in addition to the routine vascular graft follow-up by our vascular laboratory.

Data analysis was performed using SPSS 16.0 software (SPSS Inc, Chicago, Ill). Demographic comparisons were made using two-tailed Fisher's exact test for categorical variables, and *t*-test for continuous variables. Institutional Review Board approval was obtained for the study.

RESULTS

There were 22 patients (26 groins) who had Szilagyi II (14 groins) or Szilagyi III (12 groins) infections. Four of the patients included in this series were previously reported.[20,23] Four patients had bilateral groin involvement, two of whom had bilateral Szilagyi II infections, and two with Szilagyi II and III infections in each groin. All patients were males (mean age 69.1 ± 9.5 years [range, 44-86 years] with no difference between groups). The comorbidities and indications for intervention are listed in Table I. Patients were classified as American Society of Anesthesiologists (ASA) 3 (67%) or ASA 4 (33%). Most procedures were performed for critical limb ischemia (73%), while one patient had femoral patching after endovascular stent graft repair of an abdominal aortic aneurysm. The initial procedures performed are listed on Table II. Twenty groins had polytetrafluoroethylene (PTFE) grafts, two had bovine pericardial patches, three had autologous

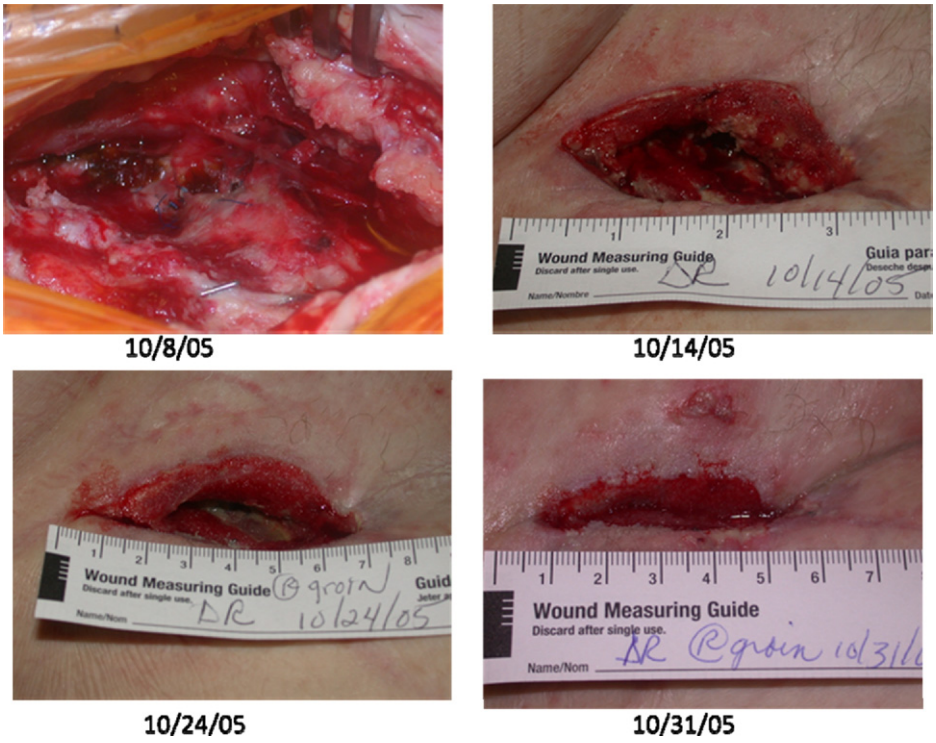

Fig. Early wound breakdown after a redo femoral-popliteal bypass with a PTFE graft and iliac stenting for iliac occlusion in a 68-year-old patient with diabetes and heel gangrene. **A**) After the initial debridement, **B**) six days later, four days after VAC was started, **C**) 16 days after initial debridement, and **D**) 23 days after debridement. The wound healed completely on day 35 (not shown).

Table I. Comorbidities, indications for intervention

Comorbidity/indication	*%*
Coronary artery disease	82%
Hypertension	91%
Diabetes mellitus	50%
Chronic obstructive pulmonary disease	41%
Smoker (active)	36%
Hyperlipidemia	86%
Renal insufficiency	41%
Dialysis	14%
Indication	
Claudication	23%
Rest pain	32%
Tissue loss	41%
Abdominal aortic aneurysm	4%

Table II. List of initial operations

Initial operation	*N (%)*
Femoropopliteal/distal bypass	
With PTFE	11 (42.3%)
With vein	3 (11.5%)
Femoro-femoral bypass with PTFE	3 (11.5%)
Axillary-bifemoral bypass with PTFE	2 (7.6%)
Femoral endarterectomy with patch	
PTFE	3 (11.5%)
Bovine pericardium	2 (7.6%)
EVAR, with PTFE patch closure of CFA	1 (3.8%)
Percutaneous SFA intervention with closure device	1 (3.8%)

CFA, Common femoral artery; *EVAR*, endovascular aneurysm repair; *PTFE*, polytetrafluoroethylene; *SFA*, superficial femoral artery.

vein grafts, and one had an infected pseudoaneurysm with a braided suture from the closure device on the femoral artery. In the Szilagyi 3 group, 10 patients had PTFE grafts, one had autologous vein, and one patient had an infected pseudoaneurysm with the braided suture with exposed prolene at the base of the wound following primary repair of the femoral artery.

The time to presentation with infection ranged from 7 to 28 days (mean, 16 ± 5 days). The deep groin wound infection was preceeded by lymphorrhea in two patients and wound breakdown in three patients. Fourteen of the groins did not have exposed grafts following debridement (Szilagyi II), and the remaining 12 had Szilagyi III infections. In 9 of the 12 Szilagyi III infections, at least part of the anastomosis was exposed after debridement. Fourteen of the 22 patients had CT scans before debridement, showing perigraft fluid with (n = 4) or without perigraft air (n = 5) in 9 of the 12 patients in the Szilagyi III group and pseudoaneurysm in one. None of the patients in this group had perigraft fluid outside the groin. For the five with Szilagyi II infections who had CT scans, the CT demonstrated the absence of graft involvement in all patients.

Table III. Culture results from wounds

Culture result	*N*
Polymicrobial	11*
Methicillin-resistant *Staphylococcus aureus*	3
Methicillin-sensitive *Staphylococcus aureus*	4
Pseudomonas	1
Escherischia coli	1
Proteus mirabilis	2
Enterococci	1
Vancomycin-resistant *enterococcus*	1
Klebsiella	1
Enterobacter cloacae	1

*One patient had *Pseudomonas.*

Six patients had fever (>38°C) at presentation, three in each group. The white blood cell count at presentation was 13.2 ± 7.1/mm^3 in the Szilagyi II group, and 11.9 ± 7.0/mm^3 in the Szilagyi III group (P = .630), with 54% of patients in Szilagyi II and 50% of patients in Szilagyi III being >10K. The culture results are shown in Table III. The majority of the infections were polymicrobial. *Pseudomonas aeruginosa* was isolated from two groins, one of which was also infected with *Escherichia coli*, and *Enterococcus faecalis*. Only one patient had positive blood cultures for methicillin-sensitive *Staphylococcus aureus*, who was the first patient treated in this series.[23]

The time to VAC was 3.0 ± 1.8 days in the Szilagyi II and 2.1 ± 0.9 days in the Szilagyi III groups (P = .197). The duration of VAC use ranged from 6 to 53 days and was 28 ± 12 days in the Szilagyi II and 26 ± 15 days in the Szilagyi III group (P = .684). The hospital length of stay was significantly longer in patients with Szilagyi III infections (10 ± 13 days vs 20.5 ± 13 days, P = .04). Wound healing was achieved in 49 ± 20 days (range, 7-100 days), with no difference between groups (P = .772).

There were two failures (one early, one late) in the Szilagyi III group. The first was an 86-year-old patient with diabetes, coronary artery disease, hypertension, and dementia, who presented with left limb ischemia one year after endovascular repair of his 7-cm aneurysm and underwent a femoro-femoral bypass with an 8-mm ringed PTFE graft. He developed bilateral wound breakdown, fever (39°C), and leukocytosis (27,900/mm^3). After initiation of broad-spectrum antibiotic therapy, his wounds were debrided with exposure of the right groin anastomosis (but not the left anastomosis). VAC therapy was started the following day, and his wounds were improving. His right groin culture grew *Enterococcus fecalis*, *Escherichia coli*, and *Pseudomonas aeruginosa*, whereas his left groin grew *Proteus mirabilis*. He developed a sudden bleeding from his right groin eight days after the debridement and was emergently taken to the OR. The bleeding was noted from the anastomotic heel and was repaired with 5/0 prolene sutures. After he was stabilized overnight, we removed the graft the next day and replaced it with a cryopreserved femoral vein graft (8-10 mm diameter) after arterial anastomotic debridement. He was discharged to a rehabilitation facility 35 days later, and the wounds were both healed on 55 days. He died seven months later in a nursing home with a CT and duplex result showing a normal graft with no signs of infection one month prior to his demise. This case was previously reported as part of a technique description.[23]

The second patient is a 59-year-old male with congestive heart failure, coronary artery disease, and chronic obstructive pulmonary disease who had an axillary-bifemoral bypass for a failed aortobifemoral bypass. Three and a half years later, he presented with an occluded axillary-bifemoral graft and rest pain and underwent thrombolysis, followed by bilateral patch angioplasties (PTFE) of the femoral anastomoses. He subsequently developed a right groin infection, which was debrided 16 days after the graft revision. The wound culture grew *Pseudomonas aerigunosa*. VAC was started on the following day, and was kept for 20 days, and he completely healed his wound in 30 days, and was kept on intravenous antibiotics for three months. He presented on the 117th day with recurrent groin infection, underwent debridement with partial graft removal, and a bypass to his above-knee popliteal artery using a heparin-bonded PTFE graft originating from the afferent limb of the axillary-bifemoral graft. His wound completely healed in 35 days, and is currently free of disease during his last visit 18 months after the last procedure.

Mean follow-up was 33.4 ± 19.5 months (range, 2-72 months). The overall success rate was 100% in the Szilagyi II group and 83% for the Szilagyi III group on an intent-to-treat basis. There was no perioperative mortality, and all wounds were eventually healed. One amputation occurred in a patient at 49 months, unrelated to the groin infection. There were no late infections, and there were six unrelated mortalities during the follow-up period.

DISCUSSION

Groin infections following vascular procedures are not uncommon, and the presence of synthetic grafts in the open wound presents even more of a challenge for the vascular surgeon. Graft preservation in patients with early postoperative groin wound complications is attempted in the majority of these patients, and the use of muscle flaps has been successfully used for this purpose, which was reported to be particularly effective in early groin infections.[5,10] However, use of the muscle flap does not guarantee a successful outcome, and muscle flap necrosis and reinfection with resultant failure has been reported to occur in up to 35% of patients.[9] In addition, mortality rates up to 25% have been reported,[6] mostly due to the poor overall condition of the patients. Extremely scarred groins and poor nutritional status may also become significant issues when major surgical reinterventions are contemplated in these poor-risk patients. Seify et al[8] reviewed the management of prosthetic graft infections in studies reported between 1989 and 2004, encompassing 223 patients, 70% of whom were managed with graft preservation and 74% with muscle flap coverage. The mortality rate was 11%, limb loss was 13%, and of the initially preserved grafts, 12% later

required excision. They identified time to infection, type of graft, and *Pseudomonas* infection being associated with poorer graft salvage rates and higher amputation rates.

Local wound care without the use of muscle flaps has been used with reasonable amputation and perioperative mortality rates. Calligaro et al[11] reported a 12% mortality and 4% amputation rate in 51 patients with infected prosthetic grafts, about 71% of which could be preserved successfully by using repeated operative debridement and antibiotic or povidone-iodine-soaked dressings. After the initial description of the vacuum-assisted therapy for wound care, the VAC therapy has been widely adopted by vascular surgeons, and its use in groin wounds with lymphorrhea[24] or wound infections inevitably followed, even in those with exposed grafts, although this is not recommended by the manufacturer.[25] Successful VAC use has been reported following infected pseudoaneurysm of the femoral artery following primary or patch closure[15] and exposed vein grafts,[26] as well as those who had synthetic patch or grafts in the groins with no bleeding or reinfections.[16,18,20] Pinocy et al[16] reported the use of PVA-vacuum sponge system in 24 patients with Szilagyi III wound infections, 18 of whom had synthetic patches following endarterectomies and six of whom had aortobifemoral bypass grafts. They used a closed suction system in which they closed the wounds over the sponge system that was connected to a Redon drain, and applied 400 to 600 mm Hg negative pressure. They re-explored the wounds at seven days and replaced the sponge, and the wounds were finally primarily closed after another week. They reported no reinfections at 12 months. Our group[20] also reported four patients with groin infections and exposed synthetic grafts successfully treated with debridement and VAC, without further surgical procedures. In another large series presented (unpublished) by Mayer et al,[27] 44 patients (52 sites) with perivascular infections or lymphatic leaks were treated with the VAC system, with a 100% success rate, no rebleeding or reinfections, and a mean VAC application time of 34 days. They applied the VAC sponges directly on the vessels without any problems. Kotsis et al[18] successfully treated eight patients (six of whom had Szilagyi III infections) with early groin infections with 100% success; no rebleeding or reinfections were reported. However, bleeding from the exposed anastomosis has been reported.[19,21] Svensson et al[19] recently reported two early bleeding and three late infected pseudoaneurysms in 33 patients with vascular groin infections treated by VAC. These authors hypothesized that the early bleeding was probably inevitable and was likely due to residual infection at the suture lines, and may have been hastened by the use of the VAC.

After our initial favorable experience with the use of VAC without muscle flap coverage for early groin infections,[20] we started to use this method preferentially with continued success. We found that the use of VAC in patients with deep groin infections without an exposed graft was very effective. The wounds treated in our series were large, and the time to healing was not different than those with exposed grafts. However, the length of stay was significantly less in this subgroup than those with exposed grafts, and there was no bleeding or other wound healing problems. We feel that patients who have exposed grafts should be kept in the hospital until the grafts are not visible at the base of the wounds. The one patient who had massive bleeding in our series bled from the heel of the anastomosis while in the hospital, and the outcome would have been much worse had this occurred outside the hospital. Of note, the bleeding site was clearly not in direct contact with the sponge but was likely due to the residual infection at the anastomosis. This patient had pseudomonas as part of a polymicrobial infection in the groin that bled. Replacement of the graft with an in situ cryopreserved vein graft was successful, achieving complete wound healing. The second patient who failed also had *Pseudomonas aeruginosa*, and in retrospect, should probably not have had graft salvage attempt. Although some authors did not observe worse outcomes with *Pseudomonas* infection,[5,10] others have reported increased amputation rates or poorer graft salvage.[7,8,31] Calligaro et al[7] reported only 40% graft salvage when the offending organism was *Pseudomonas*. *Pseudomonas* infection was associated with 60% limb loss in a series reported by Seify et al.[8] Since both our patients with Szilagyi III infections with *Pseudomonas* infections eventually needed graft removal, we now recommend graft removal in early *Pseudomonas* groin infections with exposed grafts.

Almost all patients who had bleeding or reinfection in the reported series[19,21] had significant graft infection and were likely poor case selections for any type of graft preservation, as did both of our cases with *Pseudomonas* infections. Patients who have infected pseudoaneurysms or any history of bleeding, suggesting that the anastomosis is not intact, are likely not candidates for any graft preservation techniques, including muscle flaps. We think that the early groin infections in the patients in our series mostly represent a wound infection with graft present, rather than an early or late graft infection presenting as an infected pseudoaneurysm or wound infection localized to the groin. We think that the latter are poorer candidates for any type of graft preservation techniques, and we favor graft removal with either in situ replacement or extra-anatomic bypass in these patients.

It is important to differentiate between early and late graft infections when making a treatment choice for patients with groin infections. In the series by Perler et al[5] involving muscle flaps for graft preservation, all grafts with acute presentations were successfully salvaged, whereas it was 60% in the chronic group. Mertens et al[28] reported a very high (82%) failure rate, when anything less than total excision was used. Taylor et al[9] reported that six out of nine patients with muscle flaps had recurrent infection, in a group of early and late infections. Calligaro et al[29] reported that even though there was no difference in amputation or mortality rates between early (<two months) or late graft infections, early graft infections were more likely to be treated by complete graft preservation (61% vs 26%, $P = .0001$). All the patients successfully treated with VAC in

Kotsis et al,[18] Pinocy et al,[16] and Mayer et al,[27] as well as our previous series were in patients with acute infections, and the series by Svensson et al[19] included patients with early and late infections, and the timing of presentation was not specified in the patients who had failures. However, there have clearly been some early failures reported in early groin infections, including one patient in our series, and the patient reported by Brehm et al.[21] The importance of repeated wound inspections and application of the VAC after confirmation that all bleeding has stopped, and there is no grossly obvious residual infection in the wound cannot be overemphasized, since most of the early failures are likely due to residual infection at the anastomosis, which leads to the bleeding in these patients. Eradication of infections from chronic graft infections is less likely to be successful by VAC alone, and graft excision with in situ or extra-anatomic bypass procedures coupled with selective use of muscle flaps would be the treatment of choice in these patients. We performed partial or total graft excision in all patients who presented with late graft infections during the study period (data not shown). Armstrong et al[30] recently reported their experience with the selective application of muscle flaps in mostly late (90%) graft infections, and graft preservation was attempted in only 3 of the 89 patients.

In conclusion, VAC in early groin infections following radical debridement, combined with culture-directed antibiotics is safe (intact anastomosis, patent graft, no sepsis, no pseudomonas) and can be considered as an alternative to muscle flap, especially in high-risk patients with fibrotic groins and/or poor nutritional status. It is associated with minimal morbidity, reinfection, limb loss, and mortality. VAC can be used in patients with exposed grafts/suture line, but close monitoring is necessary for possible bleeding, which is likely due to residual infection at the anastomotic line. Finally, *Pseudomonas* infection is a relative contraindication for graft preservation; graft removal with reconstruction should be considered early in these cases.

AUTHOR CONTRIBUTIONS

Conception and design: HD
Analysis and interpretation: HD, CL, PL, GC, LH, MD
Data collection: HD, CL
Writing the article: HD
Critical revision of the article: HD, CL, PL, GC, LH, MD
Final approval of the article: HD, CL, PL, GC, LH, MD
Statistical analysis: HD
Obtained funding: N/A
Overall responsibility: HD

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