Deep infection of infrapopliteal autogenous vein grafts—Immediate use of muscle flaps in leg salvage

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Purpose: **The purpose of this study was to determine the efficacy of an aggressive management of infrapopliteal autogenous vein graft infection.**
Methods: **Among 341 consecutive infrapopliteal autogenous vein bypass grafts performed at the Helsinki University Central Hospital, 14 patients (4%) had infragenicular wound infection that involved the vein graft. Six of these patients had graft rupture and bleeding. An extensive débridement was performed in all patients. Seven of the grafts had to be partially removed and replaced. The wound and the graft immediately were covered with local muscle flaps in 4 patients and with free muscle flaps in 10 patients.**
Results: **One patient died, and another patient underwent above-knee amputation as a result of a persistent infection and necrosis of the local muscle flap during the 30-day postoperative period. No graft rupture occurred after the treatment of the infected conduit. Graft occlusion occurred in 4 patients who underwent regrafting because of graft rupture and in 1 patient with an infected intact conduit. One patient underwent amputation 15 months later because of an uncontrollable infection despite a patent graft and a functioning flap. At the 1-month, 6-month, 1-year, and 2-year follow-up periods, the leg salvage rates were 92%, 75%, 55%, and 44%, respectively. At the same intervals, 92%, 92%, 70%, and 70% of the patients survived and 85%, 68%, 34%, and 34% of the patients were alive without the loss of their legs.**
Conclusion: **Radical surgical débridement and immediate muscle flap coverage seem to offer an effective alternative method to preserve an infected infrapopliteal autogenous vein graft and to achieve leg salvage. Poor results are expected when a regrafting procedure is necessary for the rupture of an infected vein graft. (J Vasc Surg 1998;28:611-6.)**

Wound complications after infrainguinal bypass graft procedures may occur in 7% to 44% of patients.[1,2] As much as 50% of these patients may have deep wound infections with graft involvement.[3] This is a serious complication that leads to the loss of the extremity in up to 79% of the cases, with hospital mortality rates that approach 22%.[4-11] In particular, higher amputation rates are expected more as a result of deep wound infections that occur in the calf or the foot than in the more proximal sites.[12] This clinical entity has been encountered sporadically in the literature, and the treatment is still not well established.[4,8-10,12]

The aim of this study was the retrospective evaluation of the results of an aggressive treatment of deep wound infections. This treatment involved infrapopliteal autogenous vein graft with débridement, with or without the replacement of the infected part of the vein graft and the immediate muscle flap coverage of the tissue defect.

MATERIALS AND METHODS

From January 1993 to October 1996, 169 arterial reconstructions to the crural arteries and 172 reconstructions to the pedal arteries were performed at the Division of Vascular Surgery at Helsinki University Central Hospital. All operations were performed as leg salvage procedures for critical ischemia. Seventy-eight patients (23%) had postoperative wound complications. Fifty-eight patients (17%) had superficial wound complications that corresponded to grades I and II in Szilagyi's classifica-

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tion,[13] whereas grade III infections (ie, deep wound infections with necrosis of the skin and underlying tissue surrounding the graft, graft exposure, or rupture and bleeding) occurred in 20 patients (6%). Of these patients, 14 (4%) had grade III infections that involved an autogenous vein graft situated below the knee. Because proximal autogenous vein graft infection usually carries a good prognosis for coverage with local healthy tissue (ie, rotational muscle flap), which is feasible and highly effective, only those patients who had infragenicular autogenous vein graft infection are included in this study.

Seven of the patients were men, and 7 were women. The mean age was 69 years (range, 55 to 88 years). Six patients had insulin-dependent diabetes, and 2 had non insulin–dependent diabetes. One patient with insulin-dependent diabetes had uremia that necessitated long-term dialysis. Initially, 8 patients had nonhealing ulcers or gangrene at the forefoot, and 1 had an ulcer at the heel and 1 at the Achilles' region. The initial vascular procedure was a femorocrural bypass graft in 4 cases, a femoropedal bypass graft in 7, and a popliteopedal bypass graft in 3. An in situ saphenous vein bypass graft procedure was initially performed in 8 patients and an ex situ saphenous vein bypass graft was performed in 2 patients. One patient underwent cephalic vein bypass grafting, and another underwent vein grafting with the segments of the basilic and great and small saphenous veins. A composite polytetrafluoroethylene (PTFE)/saphenous vein graft was used in 2 patients.

The diagnosis of a graft infection was made on clinical grounds with the presence of cellulitis, abscess, open wound, graft exposure, or rupture. Microbiologic cultures substantiated the clinical suspicion of an infection in all cases. Infection was restricted to the infrapopliteal segment in all but 1 patient, with vein graft involvement also above the knee. In 6 patients, the graft ruptured—2 at the site of the distal anastomosis and 4 above the distal anastomosis at the calf. The mean interval period between the initial procedure and the graft salvage procedure was 40 days (range, 8 to 122 days).

The infected wounds were excised radically in all cases, and tissue specimens routinely were obtained for culture during the graft salvage operation. In 7 patients, the involved part of the vein graft was removed and an interposition bypass regrafting was performed. In the patient with above-knee involvement, the resection of the whole graft was necessary. The bypass graft procedures were performed with 1 or multiple venous segments taken from a remote source in 6 instances. In 1 patient who bled from the distal venous part of a composite graft, the interposition bypass grafting was performed with a 6-mm PTFE graft because of the absence of any suitable veins.

In all patients, a local pedicled or free muscle flap was used to cover the graft and the tissue defect after the débridement. A bypass regrafting procedure plus a free muscle flap (Fig 1) was used in 4 instances, a bypass regrafting plus a local muscle flap procedure used in 2, a free muscle flap alone used in 6, and a local muscle flap alone used in 2. At the level of the proximal third of the leg, the gastrocnemius muscle was used as a pedicled flap in 2 instances, whereas the soleus muscle alone was used in 1 case in which the lesion was in the middle third of the leg. In another patient, the local muscle transfer procedure required both the gastrocnemius and soleus muscle flaps (Fig 2). These 2 types of local muscle flap, however, are limited in size and demand adequate perfusion through their intact pedicles. Therefore, for the management of the lesions of the distal third of the leg, the ankle and the foot, and for large defects at any site, microvascular muscle flaps are usually indicated. Unfortunately, the poor general conditions of 2 patients at high risk calling for regional anesthesia contraindicated the free flap reconstruction and, instead, a pedicled muscle flap reconstruction was performed despite its suboptimal perfusion.

The free muscle flap procedures were performed in the remaining 10 patients, with the rectus abdominis muscle in 5 patients and the latissimus dorsi in the other 5 patients. The arterial anastomoses of the free flaps were made end-to-side directly to the bypass graft, and venous anastomoses were performed end-to-end to a deep system vein with interrupted 7-0 or 8-0 polypropylene sutures and with 4.5 loupe magnification. The transferred muscle then was covered with a split thickness skin graft.

Late additional vascular procedures were performed in 3 patients because of graft occlusion. One patient underwent operation for the banding of an adjuvant arteriovenous fistula, which caused congestive heart failure.

A 250-mg/day dose of acetylsalicylic acid was administered after surgery. Antibiotics were given for 3 to 4 weeks according to the culture results, wound healing, and kidney function. Bed rest with a slight elevation of the leg was indicated for 7 days before the start of gradual ambulation. The follow-up visits took place at 1 and 3 months and every 3 months thereafter. Graft patency was determined

Fig 1. A, Completion angiogram of distal anastomosis of popliteopedal ex situ vein bypass graft. **B,** Eight days later, wound infection and necrosis led to anastomotic rupture and bleeding, which were controlled here temporarily with clamping inflow. **C,** Wound excised, and infected distal graft segment removed and replaced with arm vein. **D,** Wound covered with microvascular latissimus dorsi muscle flap and split thickness skin graft, here a typical bulky appearance at 3 weeks. Later the volume of the flap decreased.

with direct pulse examination and Doppler derived ankle/brachial index measurements, and the viability of the muscle flaps was assessed clinically. Duplex scan examinations were performed when needed. Angiography was performed for 1 patient who was first seen with signs of flap ischemia and congestive cardiac failure as a result of an adjuvant arteriovenous fistula.

The mean follow-up period was 12 months (range, 1 to 48 months).

Cumulative leg salvage—success determinated as a patient alive without the loss of a leg—and survival rates were calculated by means of life-table analysis. The analysis of data was facilitated by the use of a microcomputer database and the statistical software SPSS for Windows 7.0 (SPSS Inc, Chicago, Ill).

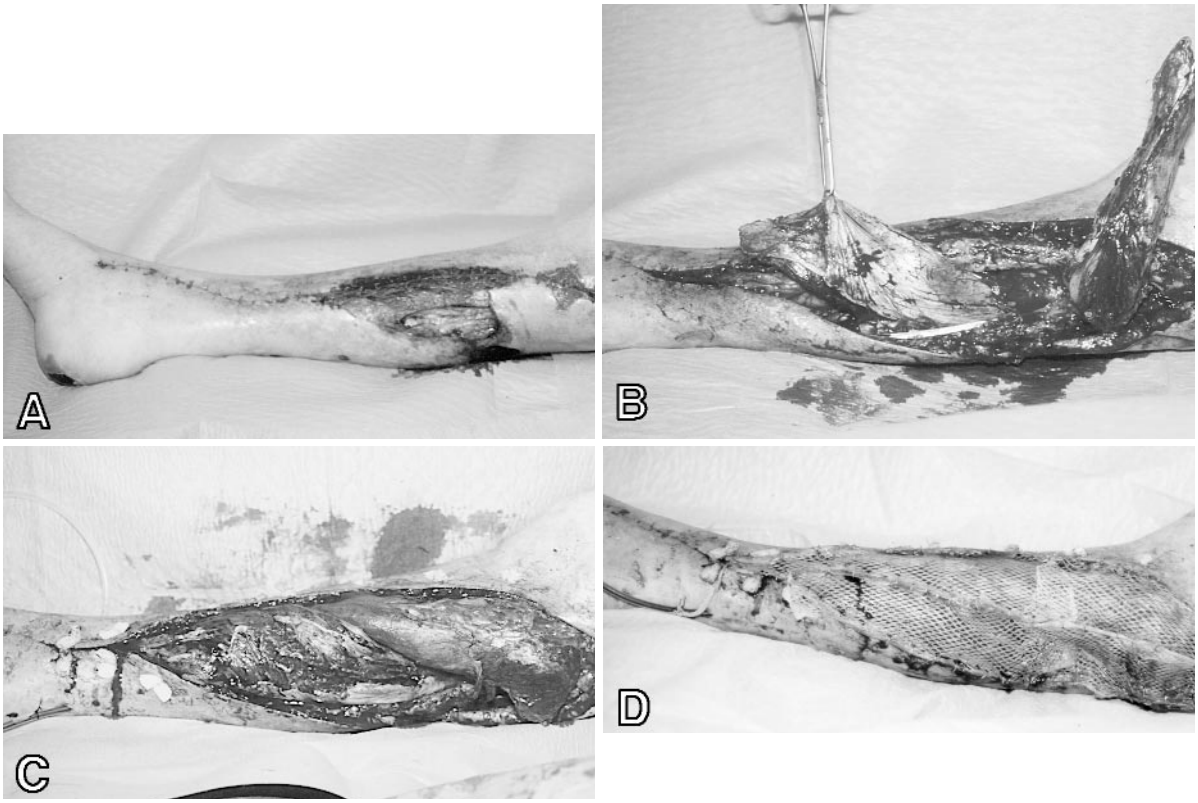

Fig 2. A, Necrotic skin infection involving femoropedal vein graft. After excision, graft was covered with local soleus and medial gastrocnemius muscle flaps. **B,** Flaps raised. **C,** Flaps replaced. **D,** Flaps covered with split thickness skin graft.

RESULTS

The cultures grew 18 different microorganisms (Table I). Of the species, 50% were gram-negative. There were 6 patients (43%) with mixed infections. Three patients (21%) had infections from gram-negative micro-organisms. However, among the patients who bled, 83% of the wounds harbored gram-negative infections.

The mean hospital stay as a result of a graft salvage procedure was 28 days (range, 5 to 82 days). The mean follow-up period was 16 months (range, 0 to 48 months). All patients but 1 had an immediate 30-day postoperative leg salvage. This patient had an above-knee amputation because of a persistent infection and necrosis of the transposed soleus muscle despite an open graft. Twelve patients had primary wound healing during the immediate 30-day postoperative period. In the same period, 1 patient with a patent graft died of a myocardial infarction.

No graft ruptures occurred after the treatment of the infected conduit. Among the patients who underwent a resection of the graft and interposition bypass regrafting because of bleeding, graft occlusion occurred in 4 patients. One of those patients had an immediate occlusion of both the arterial and the venous microvascular anastomosis, which stayed patent after the correction. Other graft occlusions occurred 2, 3, and 8 months after the operation for the infection.

Among the patients with intact conduits, graft occlusion occurred in 1 patient 15 months after a graft salvage operation. One patient underwent amputation because of an uncontrollable infection, despite a patent graft and a functioning flap after 4 months.

At the 1-month, 6-month, 1-year, and 2-year follow-up periods after graft salvage operation, the leg salvage rates were 92%, 75%, 55%, and 44%, respectively. At the same intervals, 92%, 92%, 70%, and 70% of patients survived, and 85%, 68%, 34%, and 34% were alive without the loss of their legs.

DISCUSSION

A deep-seated infrainguinal vascular graft infection is a serious complication that often causes the

Table I. Bacteriology of 14 infrapopliteal autogenous vein graft infections

Bacteriology	*No. of patients*
Pseudomonas aeruginosa	8 (5)*
Enterococcus faecalis	7 (3)*
Staphylococci coagulase negative	5
Staphylococcus epidermidis	5 (4)*
Enterobacter cloacae	4 (1)*
Klebsiella pneumoniae	4 (1)*
Diphtheroids	3 (1)*
Staphylococcus aureus	3
Proteus mirabilis	2 (2)*
Bacteroides fragilis	2
Proteus vulgaris	1 (1)*
Streptococcus viridans	1
Acinetobacter	1
Citrobacter freundii	1
Xanthomonas maltophilia	1
Streptococcus pyogenes	1
Candida albicans	1

*Micro-organisms found in patients who bled.

Table II. A suggestion for a modification to the Szilagyi's classification[13] of graft infections as appropriate for the determination of infrainguinal graft outcome

I.	Infection affects only the skin
II.	Infection extends also into the subcutaneous tissue
III.	The graft is infected, and the site of infection is not of importance
IV.	The graft is infected and ruptured

rupture of the graft.[14] A conservative local management, the ligation of the bleeding source, and the removal of the infected graft with or without remote site reconstruction are the main treatment alternatives. However, in most cases of anastomosis involvement, graft rupture, or bleeding, amputation has unfortunately been the only solution.[15] Long subcutaneously placed grafts are particularly at risk. In fact, if the distal anastomosis is at the pedal or the ankle area where grafts are superficially located and the soft tissue cover is thin, wound healing problems easily are encountered. Little data are available to effectively manage this problem because no author has been able to collect a large series and it is difficult to conduct randomized studies.

The preservation of distal perfusion is important, but a lack of adequate outflow vessels may preclude any revascularization procedure.[3,11,12] A local aggressive treatment plus muscle transposition has been suggested as a highly effective method of covering infected grafts,[12,16] but only a few papers have dealt with infrapopliteal graft complications.[12] Coverage by local muscle transfer often has been reported in an anedoctal manner,[2,4,12] and the use of free muscle flaps has been reported only once.[17] In our series, we used muscle flap coverage in all instances because we believe that it brings well-vascularized tissue, eliminates the dead space, and helps to eradicate the infection, effectively preserving the bypass graft.[18] Some authors[10] favor a delayed coverage approach with local treatment followed by autogenous coverage only when the residual infected debris is eradicated, the quantitative wound cultures fall below 10^5 organisms per gram of tissue, and the wound is granulating. However, delayed wound coverage may cause the desiccation of the vein graft and may expose the patient to the risk of graft rupture.[2,10]

The use of muscle flaps with split skin coverage allows wound closure without tension, which is of major importance in legs with compromised flow and at risk for residual infection. All but 1 of the autogenous vein grafts that were treated without any regrafting procedures were patent during follow-up, and only 1 patient required an amputation because of the progression of the infection despite graft patency and a functioning flap. On the contrary, among the 6 patients who required a regrafting procedure because of graft rupture and bleeding, the functioning muscle flap resulted in immediate primary wound healing in 5 of the patients. One patient had secondary healing, but 3 of the patients underwent further vascular procedures because of graft occlusion. Local or free muscle flap procedures may guarantee adequate protection even in the case of prosthetic bypass regrafting in a clearly infected field as observed in 1 of our patients who had immediate primary wound healing and whose PTFE interposition graft remained patent for 8 months.

Local muscle flaps may have a limited role in the management of an arterial graft infection in the infrapopliteal region because they are limited in size and they are often involved in the infectious process. Furthermore, their feeding vessels can be affected by atherosclerosis or damaged during mobilization. Therefore, the rotational muscle flap should be used only in patients who are at high-risk and who are not candidates for a microvascular muscle transfer, which necessitates a prolonged major operation with general anesthesia.

Surgeons must be aware of the seriousness of a rupture of an infected autogenous vein graft. When the rupture is not responsible for immediate death because of exsanguination,[9] this condition imposes a

regrafting procedure that, even if limited in its extension (ie, interposition bypass graft procedure), often is not followed by graft patency and leg salvage. Our results confirm that wound complications that are usually classified as grade III infections according to Szilagyi's classification[12] may present quite different extensions and gravities. Samson et al[3] proposed a new group III for infections that included those involving the body of the graft but not the anastomosis. They regarded deep wound infections that involved only the anastomosis as group IV infections, whereas those with anastomotic involvement, septicemia, or anastomotic bleeding were included in group V. Our results emphasize the need for consideration of deep-seated graft infections with and without graft ruptures as 2 different entities because their outcome appeared to differ markedly from each other despite an initially successful treatment. Actually, we believe that the muscle flaps also may be used effectively in patients with infected anastomosis with good results and with those obtained when only the body graft is involved. On the contrary, patients with graft rupture must be considered to be at high risk for graft failure and amputation, and such a serious complication deserves to be termed as a grade IV wound infection (Table II).

CONCLUSION

Although some controversy on the topic exists, when a surgeon is faced with a deep-seated infection, radical surgical débridement and immediate muscle flap coverage seem to offer an effective alternative method to preserve infected infrapopliteal autogenous vein grafts and to achieve leg salvage. Poor results are expected when a regrafting procedure is necessary for the rupture of an infected vein graft.

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