Paper I

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Local Infections After Above-Knee Prosthetic Femoropopliteal Bypass for Intermittent Claudication

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ABSTRACT

Background: **The use of prosthetic grafts in the treatment of intermittent claudication is still a controversy. Prosthetic bypass for this usually benign condition may in some cases lead to a graft infection. This potentially disastrous complication is difficult to manage.**

Methods: **One hundred forty-one consecutive operations done on 129 patients between January, 1990 and December, 2001 in a single university vascular unit have been studied. Lymphatic complications and local infections have been related to preoperative risk factors, complications, secondary procedures, and outcome.**

Results: **During a mean follow-up period of 42 months, lymph complications occurred after 18 operations, surgical site infection after 11 procedures, and graft infection after 17 operations. Eleven infected grafts were treated successfully without graft excision. Six of these grafts healed with antibiotics only. The risk of developing a local infection was significantly correlated with postoperative lymph fistula. Reoperative surgery was associated with graft infection. Graft infection caused by *Staphylococcus aureus* always warranted surgery, either local revision or graft excision.**

Conclusions: **The present series had a high frequency of graft infections. Our data suggest that a selective approach should be taken towards excision of infected femoropopliteal prostheses. The need for and extent of surgery should be individualized according to the clinical presentation of the graft infection and the type of bacteria involved. We advocate a conservative attitude towards surgical treatment of intermittent claudication.**

FIRM CRITERIA for conservative, endovascular, or surgical treatment of intermittent claudication have not yet been established [1]. The knowledge of operative complications is therefore of particular importance when deciding upon the treatment modality, especially since the natural history of intermittent claudication is benign [2].

Prosthetic grafts are commonly used in above-knee bypass surgery for lower limb isch-emia. The outcome of these operations is often reported in terms of patency rates. Complications are reported less frequently despite the fact that these are well known to vascular surgeons. Reports concerning graft infections in complete series of infrainguinal prosthetic bypass operations in peripheral vascular surgery are scarce and the reported incidences of graft infection are in the range of 0–5% [3–8].

The management of infected grafts is difficult and controversial [4,9–12]. The treatment options are antibiotics only, or antibiotics in combination with surgical revision or excision of the infected graft. The purpose of this paper

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is to report the treatment and outcome of local infections after above-knee femoropopliteal prosthetic graft bypass surgery for intermittent claudication.

PATIENTS AND METHODS

All above-knee prosthetic femoropopliteal bypass operations for intermittent claudication done from January, 1990 to December, 2001 in one vascular unit were recorded prospectively in a database registry. One hundred and forty-one grafts in 129 patients (93 men and 36 women) were studied. Fifty-seven grafts were polytetrafluoroethylene (PTFE) and 84 were polyester. One hundred and twenty-four operations were primary and 17 were secondary procedures (12%). The distribution of preoperative risk factors is illustrated in Table 1.

The skin preparation was uniform throughout the period with adherent plastic skin draping before surgery as a standard procedure. The primary operations were performed by surgeons in training or by specialists in vascular surgery, whereas specialists did all the secondary operations. From 1990 to 1999, prophylaxis of cefuroxime 1.5 g was administered intravenously three times during the day of surgery with the first dosage given at induction of anaesthesia. From 1999, the antibiotic was changed to 2 g of cephalothin three times intravenously. The grafts were followed with duplex scanning and ankle-brachial pressure indices 1, 3, 6, and 12 months after surgery and annually thereafter. The mean and median graft follow-up periods were 42 and 62 months (range, 1–124 months, respectively).

Table 1. Association of Recorded Preoperative Risk Factors and Incidence of Graft Infection in 141 Operations

Preoperative risk factors	*N (%)*	*Impact on graft infection*
Heart disease	66 (47)	n.s.
Hypertension	71 (50)	n.s.
Diabetes	16 (11)	n.s.
Lung disease	24 (17)	n.s.
Serum creatinine >125 mmol/L	14 (10)	n.s.
Smoking	100 (71)	n.s.
Reoperative surgery	17 (12)	$p = 0.03$

To convert serum creatinine to mg/dL, multiply by 0.01131.

n.s., not statistically significant.

Lymphatic complications and local infections were recorded throughout the follow-up period. Lymph fistula was defined as at least 2 days of continuous leakage of clear fluid from the incision [13]. Lymphocele was diagnosed in cases with a subcutaneous fluid collection in the absence of a hematoma or a surgical site infection [13]. Szilagyi's clinical classification of infection was applied (3). Surgical site infections were confined to either dermis (grade I) or the subcutaneous tissue without involving the graft material (grade II). Surgical site infection was not recorded in cases of graft infection. Graft infection was diagnosed in cases with a tender, erythematous, pulsatile mass overlying the prosthetic material, and in cases with exposed graft, or if there was persistent drainage from a sinus tract close to the prosthetic material. This definition is equivalent to grade III in Szilagyi's classification [3].

The treatment algorithm of the infected grafts was initiated with an ultrasound scan in cases with clinical signs of local infection. If an abscess was present, needle aspiration was done. In some cases, the graft infection was obvious due to graft exposure. Pus samples from the abscess or the infected graft were obtained and cultured. All infected grafts were treated with antibiotics for at least three months. Persistent infection warranted surgery. The choice of surgical treatment depended on whether the whole graft was infected or only part of it, and on the clinical response of the antibiotic treatment. Some infections were treated with surgical revision of the tissue surrounding the graft but leaving the graft *in situ*. Excision of the graft with or without graft replacement was performed in selected cases.

The preoperative risk factors were analyzed for impact on local complication rates and the lymphatic complications were checked for correlation with surgical site or graft infection. The Student *t*-test was applied to compare continuous data and the Fisher exact test was applied for comparison of categorical data. The software program Statistica 6.0 (StatSoft, Inc., Tulsa, OK) was used for statistical computa-

tions. Differences were considered statistically significant at $p < 0.05$.

RESULTS

The mean age of the patients was 68 years (range, 50–88 years), 72 years for women and 67 years for men. This difference is significant ($p < 0.01$). There was no difference in the distribution of complications between PTFE and polyester grafts.

Lymphatic complications

Lymphatic complications were recognized after 18 operations (13%). Nine were lymph fistulas and nine were lymphoceles. Two of the lymphatic complications occurred after secondary bypass operations. The lymph fistulas were diagnosed significantly earlier than the lymphoceles (13.5 versus 27 days after surgery, $p = 0.01$). All nine lymphoceles were treated conservatively. One resulted in a surgical site infection after 71 days, but no graft infections appeared in this group.

In the lymph fistula group (nine limbs), two patients developed surgical site infection and three developed graft infection. Postoperative lymph fistula was associated with local infection ($p = 0.016$). Six lymph fistulas were treated non-operatively and three required surgery. These operations did not influence the infection risk.

Diagnosis and risk of infection

Surgical site infection was diagnosed after 11 operations (7.8%) and graft infection after 17 operations (12%). Thus, a local infection involved 19.8% of the grafts during follow-up. Positive bacterial cultures were obtained from 15 infected grafts. The remaining two cases were diagnosed on a clinical basis. Thirteen graft infections occurred within the first three months postoperatively with a mean time of 23 days (range, 7–63 days) after surgery. Four occurred late with an average of 680 days (range, 269–1083 days) postoperatively.

Twelve graft infections occurred after primary operations (10%), whereas five occurred after secondary operations (29%), $p = 0.03$. All infections recorded after reoperative procedures were graft infections.

None of the other recorded preoperative risk factors had a significant influence on local infection. The associations between preoperative risk factors and graft infection are illustrated in Table 1.

Treatment and outcome of graft infection

Six infected grafts were excised with two subsequent amputations. Another two patients were treated with a new bypass, whereas two were left with persistent intermittent claudication. The six excised grafts were contaminated with *Staphylococcus aureus* in three cases and *Staphylococcus epidermidis* in two cases. In one case, the bacterial culture was negative.

Eleven infected grafts were treated *in situ,* of which five had surgical revision of the infection surrounding the graft and six were treated with antibiotics only. All infected grafts left *in situ* healed and stayed open throughout the observation period.

None of the six infected grafts treated with antibiotics only were infected with *Staphylococcus aureus*. In these cases, *Enterobacteriaceae* was cultured either alone or in combination with *Staphylococcus epidermidis* in five cases. In one case, the bacterial culture was negative. None of the 17 graft infections were caused by methicillin-resistant staphylococci.

In the four cases of late infection, *Staphylococcus epidermidis* was cultured from three grafts and *Staphylococcus aureus* in combination with *Enterobacteriaceae* from one graft. The latter was treated with surgical revision with the graft left *in situ.* Of the three grafts infected with *Staphylococcus epidermidis,* one was treated with antibiotics and healed, one graft was excised and replaced by a new prosthesis, and the last was excised and replaced by an *in situ* vein bypass. None of the four late graft infections were followed by amputation.

A total number of 45 secondary procedures were performed on the 17 infected grafts (Table 2). These included a wide variety of procedures such as incision and drainage, surgical revision, graft excision, a new bypass procedure, or amputation.

Table 2. Etiology, Treatment, and Outcome of Early and Late Graft Infections following Femoropopliteal Bypass Surgery

Days after surgery	*Bacterial species*	*Treatment*	*No. of secondary procedures*	*Outcome*
7	*S. aureus*	Graft excision	4	Amputation
63	*S. aureus*	Graft excision	3	Amputation
14	*S. aureus*	Graft excision	3	Persistent intermittent claudication
33	Negative bacterial culture	Graft excision	5	Persistent intermittent claudication
7	*S. epidermidis* and *Enterococcus*	Surgical revision	1	Healed
12	*S. epidermidis*	Surgical revision	1	Healed
14	Negative bacterial culture	Antibiotics only	0	Healed
22	*S. epidermidis* and *Enterococcus*	Antibiotics only	0	Healed
22	*S. epidermidis*	Antibiotics only	0	Healed
22	*S. epidermidis* and diphtheroids	Antibiotics only	0	Healed
28	*E. coli, Enterococcus,* diphtheroids and *S. epidermidis*	Antibiotics only	0	Healed
35	*S. aureus* and *Enterococcus*	Surgical revision	8	Healed
36	*S. aureus* and *Enterococcus*	Surgical revision	4	Healed
269[1]	*S. aureus*	Surgical revision	4	Healed
683[1]	*S. epidermidis*	Surgical revision	1	Healed
685[1]	*S. epidermidis*	Graft excision and replacement	5	Healed
1083[1]	*S. epidermidis*	Graft excision and replacement	6	Healed

[1]Late graft infections.

DISCUSSION

The rate of local infections after above-knee prosthetic femoropopliteal bypass surgery is usually in the range of 5–14%, which is lower than in the present study [14]. This may be due to rather wide definitions of lymphatic and infectious complications and to accumulation over time. The graft infections that occurred late in this series emphasize the need of a long observation time to achieve a full overview. Seventeen grafts were implanted as secondary procedures which are reported to have a higher complication frequency, as was the case in our series [13].

The frequency of lymph fistula and lymphocele in this study was 13%, which exceeds the range of 0.5–10% reported previously [13]. In the present study, lymph fistulation was associated with increased local infection risk. This finding correlates well with previous reports [15–17]. None of the three patients with an operated lymph fistula developed graft infection, whereas three out of six in the non-operated lymph fistula group did. However, this difference is not significant owing to the small sample size. Several authors have recommended surgical treatment of lymph fistulas following vascular surgery in the groin [13,16,17]. The surgical treatment of choice of lymph fistulas is a layered groin wound exploration avoiding deeper uninfected tissues [13]. If possible, the site of leakage should be identified and ligated. The role of antibiotic treatment in the management of lymph fistulas is not clear.

Superficial surgical site infection was diagnosed after 11 operations (7.8%). This incidence is higher than what is reported from most studies, although surgical site infection rates up to 44% after infrainguinal bypass operations have been reported [3,4,6–8,18].

Three graft infections occurred after a lymphatic complication. The other 14 graft infections were probably due to contamination at the time of surgery or to delayed wound healing. Re-operative surgery was associated with graft infection in our series. Such an association has been reported previously [4]. All infections following re-operative surgery appeared as graft infections and not surgical site infections. This may be due to the complicated wound healing often seen after re-operative surgery.

Graft contamination usually occurs at the time of surgery [11,19]. However, the clinical appearance of the infection may be delayed for weeks or months. The nature of the bacteria involved, the size of bacterial inoculum, and local host defenses determine the course of graft infection [11,19,20]. Alternatively, graft infections may be the result of bacteremia episodes during follow-up, although no evidence for this etiology exists. The skin preparation before surgery may be a matter of discussion. Some vascular centers use iodophor-impregnated plastic skin draping. In our series plain plastic draping was used. This draping has been shown to be as effective as iodophor-impregnated draping in reducing the groin bacterial numbers at the time of surgery [21].

A graft infection rate of 12% is higher than the previously reported incidence of 0–5% [3,5–7]. Leaving out the secondary operations in our series, the graft infection rate comes down to 9.7%. However, studies of graft infections following above knee prosthetic femoropopliteal bypass are scarce and most infections are never reported. The true infection rate is therefore essentially unknown. The Szilagyi classification of graft infections applied in this study may also represent a problem. The presence of a tender, erythematous, pulsatile mass overlying the prosthetic material might theoretically represent a deep surgical site infection and not a true graft infection. If this were the case, the true number of graft infections in the present study might have been lower. Diabetes mellitus has been reported as a risk factor for graft infection [22]. However, that could not be documented in our study.

Fourteen graft infections occurred within 3 months postoperatively, and four infections appeared much later (mean, 680 days). This substantiates the fact that a longer observation period will reveal more graft infections. In other reports on graft infection, the follow-up has been in the range of 2–62 months [3,5]. This may in part explain the differences in graft infection rates.

The dominating bacteria species in the early infections in our series were *Staphylococcus aureus* and *Staphylococcus epidermidis*, either alone or in combination with *Enterobacteriaceae*. *Staphylococcus epidermidis* caused three of the four late infections in this series. Both these findings agree with previous studies [3,5,8]. The late infections often have a subclinical latency due to the avirulent nature of these bacteria [11,19,20].

Surgery for graft infection has been reported to have high morbidity and mortality [6,23]. In the present study, six of 17 infected grafts (35%) were excised, resulting in two amputations. Eleven grafts treated *in situ* healed. All late graft infections needed surgical treatment but none of these patients were amputated.

Staphylococcus aureus was cultured from seven of the 12 infected grafts that needed surgical treatment and from none of those that were treated with antibiotics alone (five grafts). The infected grafts from which *Staphylococcus aureus* was cultured were the ones with the poorest outcome (Table 2). This correlates with a previous report [23]. In the 10 non–*Staphylococcus aureus* infections, *Staphylococcus epidermidis* was found in all cases with a positive bacterial culture (eight grafts), either alone or in combination with other bacterial species. Five of the 10 non–*Staphylococcus aureus* infections were treated successfully with antibiotics alone. This indicates that nonoperative treatment of graft infection may be successful in selected cases when *Staphylococcus aureus* is not involved.

Graft infections after peripheral bypass surgery with implantation of prosthetic material represent immense burdens to the patients as well as to the health care system. Considering the benign natural history of intermittent claudication, complication rates should be surveyed continuously in order to weigh these ill effects against the gain of the treatment. The graft infection rate in the present series is high compared to other reports. This has led to fewer of these operations in our department and a great scrutiny of every process connected to the procedures. A restrictive attitude towards femoropoliteal bypass surgery for intermittent claudication has been advocated for several years and the results of the present study support this policy.

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