Infrainguinal Anastomotic Arterial Graft Infections Treated by Selective Graft Preservation

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The purpose of this study was to determine whether the type of graft material and bacteria involved in an infrainguinal arterial anastomotic infection can be used as guidelines for graft preservation. Between 1972 and 1990, the authors treated 35 anastomotic infections involving a common femoral or distal artery. The graft material was Dacron in 14 patients, polytetrafluoroethylene (PTFE) in 14, and vein in 7. Of the 14 Dacron grafts, immediate graft excision was required for overwhelming infection in eight patients (bleeding in five, sepsis in three) and for an occluded graft in one patient. Three of five patients failed attempted graft preservation because of nonhealing wounds. Thus, 12 of the 14 Dacron grafts ultimately required graft excision. Of the 21 "smooth-walled" vein and PTFE grafts, 10 required immediate graft excision for occluded grafts (five PTFE, one vein) or bleeding (three PTFE, one vein). Ten of the remaining 11 (91%) patients with patent "smooth-walled" grafts, intact anastomoses, and absence of sepsis managed by graft preservation healed their wounds and maintained distal arterial perfusion. Wound cultures grew pure gram-positive cocci in 17 of 21 "smooth-walled" graft infections *versus* 8 of 14 Dacron graft infections. In the absence of systemic sepsis, graft preservation is the treatment of choice for gram-positive infections involving an intact anastomosis of patent PTFE and vein grafts. Regardless of the bacterial cause, the authors recommend that any infrainguinal anastomotic infection of a Dacron graft be treated by immediate excision of all infected graft material.

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A TRADITIONAL PRINCIPLE in the treatment of an infection involving an arterial graft anastomosis has been total graft excision.[1,2] This management is predictably associated with a high amputation and mortality rate. If possible, selective preservation of grafts may improve the poor outcome of these complications.[2-4] At least three prerequisites should exist for graft preservation to be considered: (1) the graft must be patent; (2) the anastomosis must be intact (*i.e.*, no bleeding); and (3) the patient must not be septic.[2,3] If the patient cannot meet these criteria, then immediate graft excision is mandatory if one adheres to the principle of life before limb.

During the past 20 years, we have maintained a policy of attempted graft preservation for peripheral arterial anastomotic infections if the above conditions are met. It is unclear whether "smooth-walled" arterial grafts such as autologous vein and polytetrafluoroethylene (PTFE) are more resistant to infection, or possibly are more easily sterilized once infection has become established, than knitted or woven Dacron grafts.[3,6-10] The bacterial flora of a graft infection also may play an important role in successful graft preservation. Gram-negative rods may be more difficult to eradicate and more likely to cause generalized sepsis and anastomotic bleeding than gram-positive cocci.[11,12] Certain gram-positive organisms (coagulase-negative *Staphylococcus epidermidis*) can produce a mucin or slime that promotes bacterial adherence and colonization of an arterial prosthetic graft.[6] The purpose of this study was to determine if the type of graft and bacteria influenced the outcome of infrainguinal arterial anastomotic infections and whether guidelines could be established for attempted graft preservation.

Methods

The records of all patients treated for graft infections involving a common femoral or distal artery at Pennsylvania Hospital between January 1, 1972 and October 30, 1990 were reviewed. Patients were excluded if (1) the anastomosis was not directly involved with the infectious process but only the body of the graft was exposed (six

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patients); (2) despite fulfilling criteria for attempted graft preservation, immediate graft excision was performed instead (three patients); (3) more than one type of graft was present in the infected site because this prohibited analysis of either graft (four patients); and (4) the infection involved the stem or proximal anastomosis of an aortofemoral graft, because these were treated by immediate and total graft excision (five patients).[2,13]

Thirty-five patients remained for analysis and were included in the study. The average age was 66 years (range, 48 to 85 years). There were 22 men and 13 women. Average follow-up was 32 months (range, 3 to 94 months). Infection involved the anastomosis to a common femoral artery in 29 patients, the popliteal artery in four patients, and the tibial arteries in two patients. There were 14 infected Dacron grafts (eight aortobifemoral grafts, six peripheral grafts), 14 peripheral PTFE grafts, and seven peripheral vein grafts. The indication for revascularization was limb salvage in 26 patients, claudication in five patients, and aneurysmal disease in four patients.

Our management of anastomotic arterial graft infections involving a common femoral or distal artery depended on clinical findings and status of the graft. Sixteen patients presented with an infected, patent graft (five Dacron, five vein, six PTFE) unassociated with generalized sepsis and with an intact anastomosis. Additional revascularization procedures were unnecessary when preservation of patent grafts was successful. Critical aspects in treating these patients included (1) repeated, aggressive *operative* excision of all infected soft tissue, including debridement of any exudate on the graft or artery; (2) administration of appropriate intravenous antibiotics for at least 6 weeks (by a Hickman catheter)[14]; (3) wet-to-dry antibiotic-soaked dressing changes three times a day; and (4) once healthy granulation tissue was present, liberal use of a myocutaneous muscle flap to provide early graft coverage with viable autologous tissue.[15]

Patients presenting with a disrupted anastomosis (nine cases), an infected occluded graft,[7] or generalized sepsis[3] were treated with immediate graft excision, repeated operative wound debridements, intravenous antibiotics, and revascularization procedures when necessary. Extra-anatomic grafts tunneled through lateral routes to avoid contaminated wounds was our revascularization procedure of choice. Inflow sites for these bypasses included the uninfected, proximal ipsilateral or contralateral limb of an aortobifemoral graft, the descending thoracic aorta,[16] and the uninvolved axillary, external iliac or common femoral arteries. Preoperative arteriography of the aortic arch and axillary arteries is recommended to rule out inflow artery stenosis when an elective axillofemoral bypass is considered.[17] Arterial outflow sites included the distal, uninvolved deep or superficial femoral, popliteal, or tibial arteries. A less commonly used method to maintain arterial circulation after graft excision included placement of autologous tissue (cephalic or saphenous vein or an endarterectomized, occluded segment of superficial femoral artery) as an interposition graft after extensive debridement of the wound.[18]

When a patient presented with generalized sepsis or a disrupted anastomosis, the infected part of the graft was immediately excised. The involved artery was ligated when it was grossly infected or occluded. The artery was oversewn or patched with autologous vein or artery if it was patent and appeared minimally involved with the infectious process.

If a patient presented with an occluded infected graft and an intact anastomosis, the graft was either totally removed and the artery handled in the previously described fashion, or subtotal excision of the graft was performed, leaving an oversewn 2- to 3-mm cuff of graft left on the underlying patent artery. This technique maintained flow through an artery, which was frequently essential to attain limb salvage.[3]

Results

Dacron Graft Infections

Of the 14 Dacron graft infections, nine patients required immediate graft excision (Fig. 1). Eight of the nine patients presented with evidence of overwhelming infection manifested by anastomotic bleeding (five patients) or systemic sepsis (three patients), which prohibited consideration of graft preservation and necessitated immediate graft excision. One other patient presented with occlusion of both the right limb of an aortobifemoral Dacron graft and a femoropopliteal Dacron graft.

Five patients with anastomotic Dacron graft infections presented with patent grafts and infected, intact anastomoses, and without systemic sepsis. These patients were managed with attempted graft preservation. Delayed graft excision proved necessary, however, in three of these patients for nonhealing wounds at 2 weeks, 3 weeks, and 4 months after initial treatment of the infection despite aggressive local treatment of the wound. The first of these patients required total excision of a femoropopliteal Dacron graft with a vein patch applied to the common femoral and popliteal arteries. The second patient underwent excision of the left limb of an aortobifemoral graft. A PTFE bypass was anastomosed to the proximal uninvolved limb of the graft and tunneled lateral to the infected wound and down to the distal deep femoral artery. The third patient initially presented with purulent drainage from the left groin. Despite a patent, functioning aortobifemoral graft with an intact anastomosis, progressive ischemia in the distal leg occurred.

Revascularization was not feasible because of lack of an outflow artery, and an above-knee amputation was

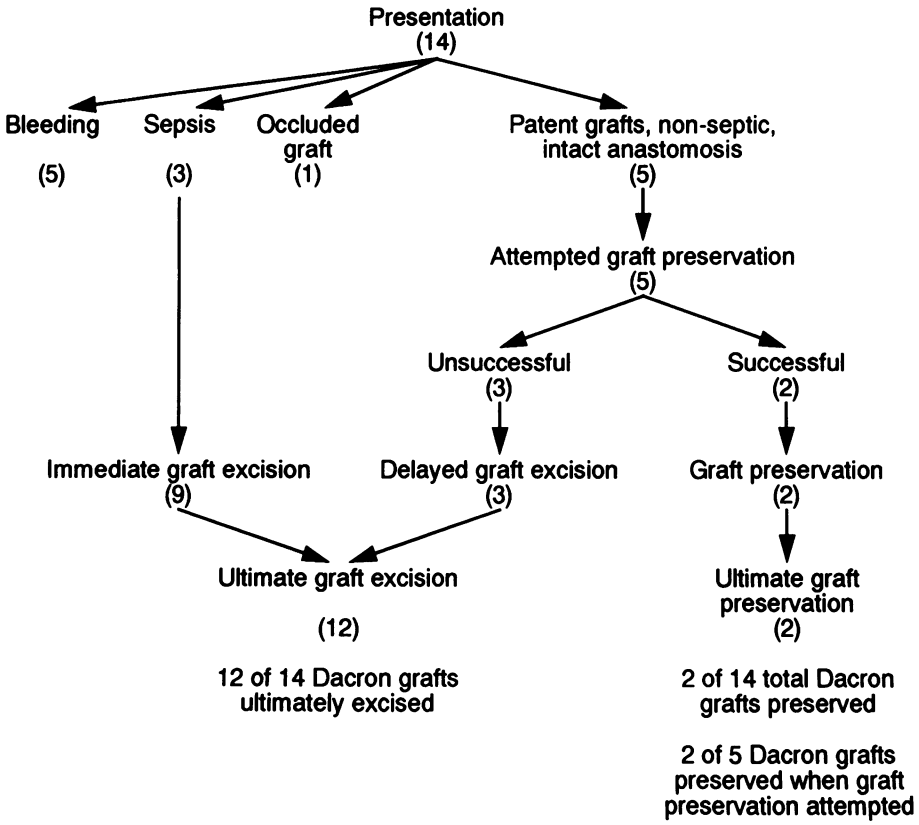

FIG. 1. Presentation and outcome of 14 infrainguinal anastomotic Dacron graft infections.

necessary. Three months after the amputation, the left groin still showed poor healing; the patient developed signs of sepsis and was treated by excision of the entire aortobifemoral graft, oversewing of the aortic stump and common femoral artery, and a right axillosuperficial femoral artery PTFE bypass. All three patients subsequently did well. The two patients with infected anastomotic Dacron grafts that were successfully managed with graft preservation were discharged after 3 and 7 weeks of intensive wound care and have done well.

Thus, of the 14 anastomotic Dacron graft infections, graft preservation could be considered in only five cases and was ultimately successful in only two (14%) patients.

"Smooth-walled" Graft Infections

Of the 21 "smooth-walled" anastomotic graft infections, immediate graft excision was necessary in 10 patients (Fig. 2). Six patients presented with occluded grafts (five PTFE, one vein) and four presented with a disrupted anastomosis (three PTFE, one vein). Graft preservation was attempted in the other 11 patients who presented with a patent "smooth-walled" graft, an intact anastomosis, and without systemic sepsis. This treatment was successful in 10 patients initially and also after long-term follow-up. None of these 10 patients needed additional revascularization procedures to prevent limb loss. The one patient with a "smooth-walled" graft who failed attempted graft preservation had chronic renal failure and an infected, patent common femoral interposition PTFE graft. This was treated with advancement of a sartorius muscle flap along with the previously mentioned adjunctive treatments. Three weeks later, it was apparent the wound was not healing, and the graft was removed. Two days later, the patient required an above-knee amputation and a week later died of sepsis.

Thus, graft preservation was successful in 48% (10/21) of all patients with an anastomotic "smooth-walled" graft infection. If only patients are considered who were candidates for and treated by attempted graft preservation, however, this management was successful in 91% (10/11) of patients.

Bacterial Flora

Of the 35 anastomotic infections, pure gram-positive cocci were cultured in 25 cases, pure gram-negative rods in three cases, and both types of organisms in seven cases. *S. epidermidis* and *S. aureus* were present in 25 and seven of the infected wounds, respectively. Of the 12 Dacron grafts that required graft excision, pure gram-positive bacteria were cultured from eight wounds, pure gram-negative bacteria from one wound, and both types of bacteria from three wounds. One Dacron graft infection that

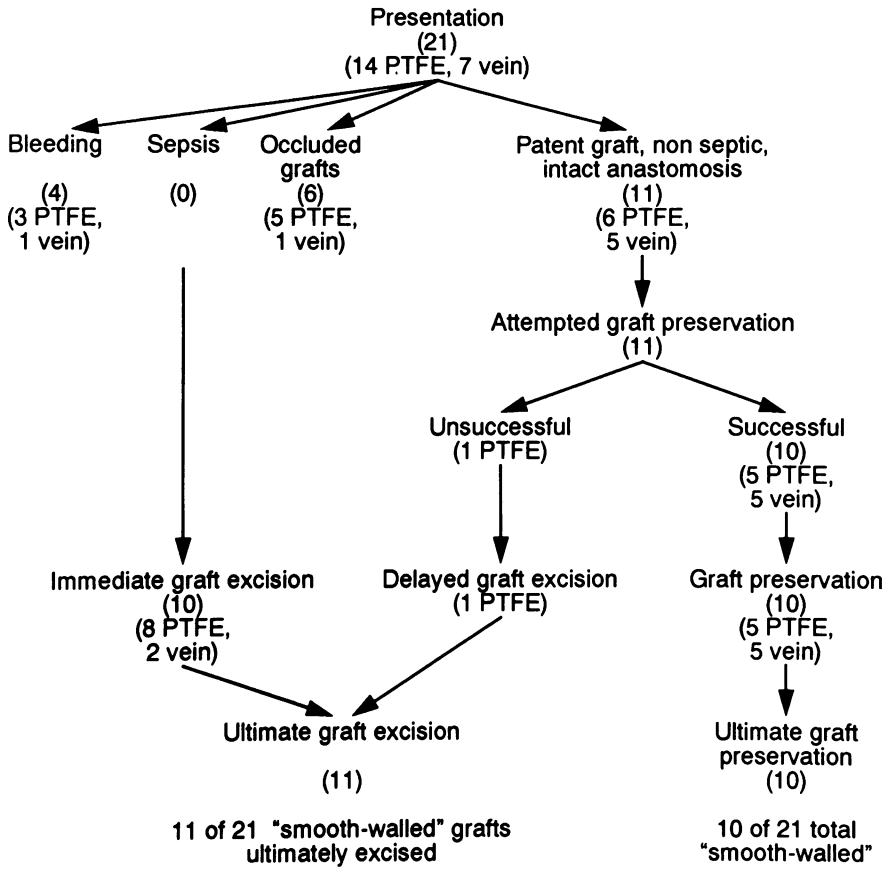

FIG. 2. Presentation and outcome of 21 infrainguinal anastomotic smooth-walled vein and PTFE graft infections.

was successfully managed by graft preservation was due to a gram-negative bacteria, and the other was due to both gram-positive and gram-negative organisms. Of the 10 "smooth-walled" grafts that were successfully treated by graft preservation, eight cultures grew pure gram-positive bacteria, one grew pure gram-negative bacteria, and one grew both gram-positive and gram-negative organisms.

Revascularization Procedures

Revascularization procedures were necessary in seven of the 19 patients treated by immediate graft excision and in none of the 16 patients treated by attempted graft preservation. Extra-anatomic bypasses were tunneled through lateral uninfected fields in five patients, and interposition grafts (one PTFE, one cephalic vein) were placed *in situ* after excision of the infected graft and extensive wound debridement in two patients.

Muscle Flap Advancement

Advancement of a muscle flap was used in seven of 16 patients treated by attempted graft preservation to provide early coverage of the exposed graft. Wounds healed in six of seven patients with a muscle-flap, *versus* six of nine patients without a flap. Of the 11 "smooth-walled" grafts treated by graft preservation, seven patients were treated by muscle flap advancement; the wounds of six healed, and one died of sepsis. The wounds of the other four patients with "smooth-walled" graft infections, who were not treated with muscle flaps, healed. None of the five patients with Dacron grafts treated by attempted graft preservation had a muscle flap. The wounds of two patients healed.

Discussion

The two major advantages of graft preservation in the management of anastomotic infections are: (1) Difficult and extensive dissection through scarred tissue is avoided; and (2) Arterial perfusion to a threatened limb is maintained without resorting to complex revascularization procedures. The type of graft and bacteria involved in an anastomotic infection appear to play key roles when selective graft preservation is attempted.[3,6–8,12] Several studies have suggested that bacterial adherence to Dacron graft interstices may be more difficult to eradicate than from interstices of other types of grafts such as vein or PTFE.[6,8,10] Our results suggest that infection of a Dacron graft also may be more likely to present with overwhelming infection such as sepsis or a disrupted anastomosis.

In these circumstances, graft preservation cannot be considered. Because most anastomotic Dacron graft infections presented with these grave complications, and because attempted Dacron graft preservation was successful in only two of five cases, we recommend excision of a Dacron graft once it is determined that the anastomosis is infected. Although some authors have suggested that infections involving the distal limb of aortofemoral Dacron grafts can be managed by graft preservation,[4,5] we do not currently agree with this recommendation.

The outcome in our patients with "smooth-walled" grafts, namely vein or PTFE, suggests that these grafts are less likely to present with manifestations of overwhelming infection and can be successfully treated by graft preservation. These results may be due to the finding that the interstices of these grafts do not allow deep penetration and persistence of bacterial growth.[6] Successful use of PTFE interposition grafts to replace infected, distal anastomotic aortofemoral Dacron graft pseudoaneurysms also has been reported.[19] This technique is acceptable when the infected Dacron graft is well incorporated without gross evidence of infection. We have only limited experience with this method.

Although not evident in our study because of the marked predominance of gram-positive organisms as the cause of the infections, the type of bacteria causing a graft infection may play a key role in the outcome of these complications because gram-negative bacteria have been reported to be more virulent than gram-positive organisms.[11,12] Most Dacron grafts excised in our patients were infected by pure gram-positive isolates, and therefore our low rate of salvage of infected Dacron grafts cannot be attributed to a predominance of gram-negative bacteria. Similarly, most "smooth-walled" graft infections were caused by pure gram-positive cocci, and therefore recommendations favoring graft preservation in the presence of gram-negative bacteria cannot be made because of the small number of these type of organisms causing infection in our series.

Recently we have been more aggressive with the use of muscle flaps to provide early coverage of an infected graft. Because this adjunctive technique was used in most (7/11) patients with "smooth-walled" graft infections, and in none of the five patients with Dacron graft infections, possibly graft preservation would have been more successful for Dacron graft infections had muscle flaps been used more liberally. Of note, six of nine patients in our series managed by attempted graft preservation had their wounds heal without the benefit of a muscle flap, and the only patient with a "smooth-walled" graft treated by attempted graft preservation with an unsuccessful outcome had placement of a muscle flap on the infected graft.

Based on these results, the following management plan is recommended for patients with an anastomotic infection of an infrainguinal arterial bypass (Fig. 3). Graft preservation can be accomplished successfully with long-term intravenous antibiotics, muscle flap advancement, and aggressive operative debridement of the wound, graft, and artery if the following conditions are met: (1) the graft is PTFE or vein, (2) the graft is patent, (3) the anastomosis is intact, (4) the patient is not septic, and (5) the causative bacteria are gram-positive organisms. Although graft preservation occasionally may be successful for anastomotic Dacron graft infections, we recommend that any such infection involving a common femoral or distal artery, regardless of the type of bacterial cause, be treated by immediate excision of all infected graft material.

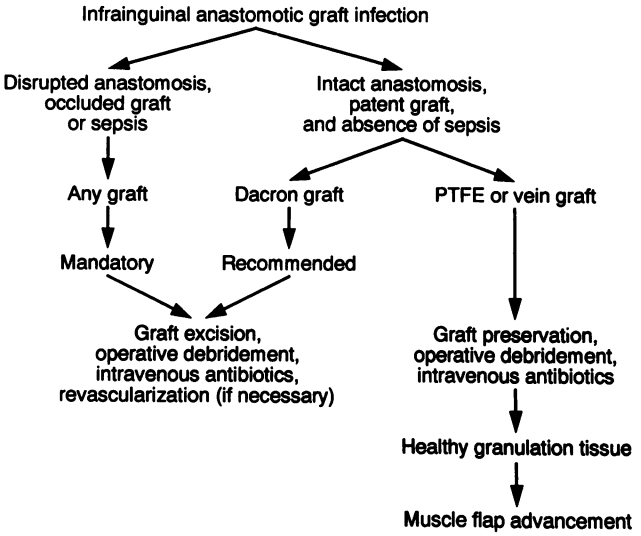

FIG. 3. Recommended management protocol of infrainguinal anastomotic graft infections.

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