Creation of a Neo-Aortoiliac System from Lower Extremity Deep and Superficial Veins

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Objective
This study evaluated the morbidity, mortality, and intermediate term follow-up of patients undergoing replacement of their aortoiliac-femoral systems with lower extremity deep and superficial veins.

Summary Background Data
The most commonly used treatment for aortic prosthetic infection is ectopic bypass and removal of the prosthesis. The overall mortality rate with this approach is approximately 20%, with an amputation rate of 10% to 14%. Other limitations include thrombosis of the ectopic bypass leading to limb loss, reinfection of the ectopic bypass, and aortic stump blowout. Dissatisfaction with this approach has led the authors to develop the following.

Methods
A neo-aortoiliac system (NAIS) was fashioned from lower extremity deep veins (DV), greater saphenous veins (GSV), or both in patients with infected aortobifemoral prostheses (n = 17) and other complex aortic problems (n = 3). Removal of infected prosthetic material, harvest of vein, and creation of NAIS was performed as a single-staged procedure.

Results
The in-hospital mortality and amputation rates were 10% each. The mean (± standard deviation [SD]) operative time was 6.5 ± 1.8 hours and the blood transfusion requirement was 4 ± 3 units. Four patients experienced postoperative gastrointestinal complications with peritonitis and sepsis; NAIS vein graft resisted infection and remained intact. The mean follow-up time was 22.5 ± 16 months. NAISs constructed from GSVs were prone to the development of focal stenoses requiring intervention or diffuse neointimal hyperplasia leading to occlusion. In contrast, all NAISs from larger caliber DVs have remained widely patent. The failure rate of GSV NAISs was 64%, compared to 0% for DV NAISs (p = 0.006). Despite the high failure rate in patients with GSV NAISs, none has required amputation. In patients who had DVs harvested for NAIS reconstruction, limb edema and other signs of venous hypertension have been minimal.

Conclusion
NAIS reconstruction from lower extremity veins is a successful option in patients with extensive aortic prosthetic infection and other complex aortic problems.
Cure of extensive aortic prosthetic infection requires removal of infected prosthetic material and restoration of arterial flow adequate to maintain lower extremity viability. Although multiple operative strategies are available to achieve these objectives, ectopic prosthetic bypass through uninfected tissues coupled with excision of the aortic prostheses is currently the most widely favored.\textsuperscript{1-3} In recently reported large series, operative mortality rates range from 7\% to 25\% and amputation rates range from 5\% to 25\%.\textsuperscript{1-5} This represents a substantial improvement over earlier reports where pooled data from the literature indicated mortality rates of 20\% to 48\% and amputation rates of 11\% to 23\%.\textsuperscript{6-8}

Despite the apparent success of ectopic bypass and excision of infected prosthetic material, major problems remain. Most disappointing is the high rate of acute thrombosis of ectopic prosthetic bypasses. Quinones-Baldrich et al. recently reported a primary patency rate of 43\% at 3 years, with a limb loss rate of 33.9\%. This is a particularly severe problem in patients with infected aortobifemoral bypasses (AFBs) and extensive vascular occlusive disease who require axillo-unilateral profund or popliteal bypasses. In addition to a high rate of thrombosis, reinfection of ectopic prosthetic bypasses and aortic stump blowout remain unresolved issues. Although these problems occur much less frequently than thrombosis, stump blowout is almost always fatal and reinfection of ectopic prostheses often causes limb loss or death.\textsuperscript{9-11}

Dissatisfaction with ectopic prosthetic bypass has led us to rely increasingly upon autogenous, \textit{in situ} reconstruction after removal of the infected prostheses. The autogenous approach was originally championed by Ehrenfeld et al. who reported reconstructing the aortoiliac system by disobliterating occluded aortoiliac segments, coupled with arterial and venous autografts.\textsuperscript{12} Our approach differs in that we have fashioned a neo-aortoiliac system (NAIS) exclusively from superficial and deep lower extremity veins. This report details our experience in patients with extensive aortic prosthetic infections and other complex aortic problems over the past 5 years.

**MATERIALS AND METHODS**

Since 1988, 21 NAIS procedures have been performed in 20 patients at our institution. A single patient underwent two NAIS procedures—greater saphenous vein (GSV) replacement of right AFB limb followed by replacement of the remainder of the AFB with contralateral deep veins (DVs) 4 years later when left limb infection became manifest. This experience represents 64\% of the cases of infected AFBs and aortoenteric erosions (AEFs) or aortoenteric fistulas (AEFs) managed at our institution during this time period. Patients not managed with the NAIS procedure included those presenting with life-threatening AEFs and ruptured anastomotic aneurysms who required emergency operations (n = 4) and those with localized AFB limb infections who were successfully managed with local procedures, which included continuous irrigation with antibiotic solutions, multiple debridements, and muscle flap coverage (n = 6). Only four patients had their original aortic procedure performed at our institution. All patients having NAIS reconstructions have been observed at 6-month intervals with vascular physical examination and noninvasive tests, including ankle-brachial pressure indices, duplex examination of the NAIS, and, in selected patients, magnetic resonance angiography. Six patients had angiography performed approximately 1 week after operation and seven underwent follow-up angiography because of new-onset lower extremity ischemic symptoms.

**Operative Procedure**

NAIS reconstruction begins with procurement of adequate segments of venous autografts. Duplex ultrasonography is used preoperatively to assess the size of GSVs and the patency of DVs. GSV is harvested by standard techniques. In reconstructions combining segments of GSVs and DVs, an effort is made to preserve one or the other in each lower extremity. Vein harvest is considered a "clean" part of the operation; groin sinuses and infected wounds are excluded from the field by placement of adherent, iodine-impregnated plastic sheets (loban, 3M, St. Paul, MN) over contaminated sites.

To harvest a DV autograft, an incision is made over the lateral border of the sartorius muscle beginning in the upper thigh (below the infected groin wound, if present) and extending to the knee (Fig. 1). The sartorius is reflected medially and the superficial femoral-popliteal vein is isolated. Care is taken to preserve the saphenous nerve, major collateral branches of the superficial femoral and popliteal arteries, and the ipsilateral GSV. The adductor canal is opened by dividing the tendon of the adductor magnus muscle, and multiple branches of the superficial femoral-popliteal vein are carefully ligated and divided; large branches are doubly ligated or suture ligated. An important point is to preserve the profunda femoris vein and leave the common femoral vein intact. The junction of the profunda femoris and the common
femoral vein is identified, and the proximal superficial femoral vein is transected and oversewn flush with this junction. The popliteal vein is isolated distally until a length adequate for NAIS reconstruction is achieved. This most often requires mobilization to the level of the knee joint or just below.

Venous autografts are distended with chilled whole blood or a solution consisting of Ringer's lactate (1 L), heparin (5000 units), albumin (25 g), and papaverine (60 mg), and venous valves are cut by passage of a Mills-Leather valvulotome. Autografts are stored in these solutions until required for NAIS reconstruction. Vein harvest incisions are closed completely. To minimize operative time, a two-team approach has been found to be helpful; one team harvests and prepares vein, while the other explores the aorta.

The infected aortic prosthesis is excised and the aorta and periaortic tissues are liberally debrided to achieve a clean proximal anastomotic site and bed for the venous autograft. Suprarenal aortic control by either intraluminal balloon or crossclamp may be necessary to adequately debride the proximal aortic anastomotic site. Three types of proximal anastomoses have been used (Fig. 2). The DV autograft is simply sutured end-to-end to the aorta (Fig. 2A). The largest end of the DV autograft is usually the proximal one and this is most often anastomosed to the aorta. The proximal ends of two GSVs may be sewn together in a “pantaloon” configuration and then anastomosed end-to-end to the aorta (Fig. 2B). Alternatively, the aortic stump may be oversewn and the venous autografts sutured end-to-side to the anterior aorta (Fig. 2C). This latter anastomosis has usually been employed when the aorta is too large or the conjoined GSV autograft is too small to perform an end-to-end anastomosis. A standard, continuous polypropylene (4-0) suture technique is employed between four quadrant fixation sutures. Care is taken to make more advancement on the aorta than the venous autograft because of the greater circumference of the aorta. Because there is usually a good size match between the DV autograft and the aorta, undue advancement and other techniques to compensate for size discrepancy are usually unnecessary to achieve a “comfortable” anastomosis (Fig. 3).

The infected femoral wounds are then opened and all prosthetic material is removed from below. Debridement of infected femoral arterial and surrounding tissues is performed and the tunnels are irrigated with antibiotic solution and mechanically debrided by pulling opened gauze sponges through them. Venous autografts are brought through the old tunnels and anastomosed to the femoral vessels. In many cases, a DV autograft is sutured to the proximal aorta and to the left femoral artery, and a left-to-right DV or GSV iliofemoral (intra-abdominal using old right-tunnel) or femoral-femoral bypass is constructed (Fig. 4). The subcutaneous of the femoral wounds is closed over the venous autografts and the skin is left open. It has not been necessary to cover the venous autografts with muscle flaps. Drainage is rarely employed and antibiotics are usually discontinued in 5 to 7 days. Intermittent pneumatic compression is routinely used postoperatively in patients in whom DV autografts are harvested.

**RESULTS**

The mean (± SD) age of the 20 patients undergoing NAIS reconstruction was 62 ± 10 years (range, 39 to 77
There were 11 men, 9 women, 3 blacks, and 1 Hispanic. The following atherosclerotic features were common: smoking (80%), coronary artery disease (35%), hypertension (30%), and type II diabetes mellitus (10%). Seventeen patients had NAIS reconstruction because of aortic prosthetic infection (15 infected AFBs, 1 AEE, and 1 AEF) and 3 for complex aortic problems. Of these, one patient had juxtarenal aortic occlusion, bilateral severe rest pain, no audible Doppler flow at the ankles, and advanced perineal, scrotal, and pubic hyadenitis suppurativa that contraindicated prosthetic aortic reconstruction. This patient also had an unsuccessful attempt at direct, fibrinolytic therapy and aortoiliac balloon angioplasty before undertaking NAIS reconstruction. Two other patients, both women, had noninfectious problems of multiple recurrent prosthetic AFB or aortoiliac thrombosis from exuberant anastomotic neointimal hyperplasia.

Among the 17 patients with prosthetic infection, 15 had paninfected AFBs (n = 14) or aortoiliac prostheses (n = 1) with pus surrounding the body and limbs of the prosthesis, and 2 had single AFB limb involvement. All aortic prostheses were knitted Dacron and the indications for original operation were aortoiliac occlusive disease (n = 12), aortic aneurysm combined with occlusive disease (n = 4), and aortic aneurysm (n = 1). The mean interval between the original aortic operation and the diagnosis of prosthetic infection was 68 ± 54 months (range, 4 to 192 months) and the modes of presentation included femoral abscesses (n = 7; 4 had bilateral involvement), chronic draining groin sinuses (n = 7; 3 bilateral), infected femoral anastomotic false aneurysms (n = 7; 2 bilateral), and fever, anemia, and gastrointestinal bleeding (n = 2). Almost all patients also complained of malaise and chronic fatigue. Risk factors for infection included multiple femoral reoperations after initial aortic procedure (mean, 3 ± 2 operations; range, 0 to 10 operations), usually for anastomotic aneurysms, limb thromboses, or wound complications. In addition, two patients had chronic renal failure requiring dialysis; one had multiple, large, infected, truncal skin squamous cell carcinomas along with malnutrition and generalized debilitation; and one had severe rheumatoid arthritis requiring chronic immunosuppressive therapy with steroids and cyclophosphamide. Before undertaking NAIS reconstruction, several patients had failure of more conservative, local procedures. These included excision of a single AFB limb with ectopic prosthetic bypass (obturator bypass, 2; axillofemoral bypass, 2), and continuous irriga-

**Figure 3.** Postoperative arteriogram of NAIS reconstruction fashioned from DV autograft anastomosed end-to-end to the aorta.

**Figure 4.** Aorta to left femoral and femoral-femoral bypass constructed from DV autografts harvested from both lower extremities.
tion with antibiotic solution coupled with multiple debride ment (n = 4), muscle flap coverage (n = 2), and debridement with in situ AFB limb replacement with expanded polytetrafluoroethylene (ePTFE) (n = 2). In addition, one patient had infection of a secondary AFB 1 year after removal of an infected primary AFB and placement of axillofemoral bypass that failed because of multiple, recurrent thromboses. All of these patients were treated with prolonged oral or parenteral antibiotics and had healing before signs of recurrent, more extensive infections developed.

Organisms cultured from excised prosthetic material or pus surrounding prostheses included Staphylococcus epidermidis (n = 7), S. aureus (n = 4; 2 methicillin resistant), Pseudomonas aeruginosa (n = 2), β hemolytic Streptococcus (n = 1), Enterobacter aerogenes (n = 1), Bacteroides bivius (n = 1), Proteus mirabilis (n = 1), Propionibacterium acnes (n = 1), and Candida albicans (n = 1). Four patients had polymicrobial infections and four had no growth with routine culture techniques.

NAIS configurations and the use of GSV and DV autografts are illustrated in Figure 5. Veins harvested included bilateral GSVs (seven patients), bilateral DVs (three patients), GSVs and DVs from opposite limbs (three patients), and single limb DVs (seven patients). Distal anastomoses were performed to the following outflow arteries: bilateral common femoral (n = 6), bilateral profunda femoris (n = 5), common femoral and opposite profunda femoris or superficial femoral (n = 3), bilateral common iliacs (n = 2), unilateral profunda femoris (n = 2), profunda femoris and opposite superficial femoral (n = 1), and the proximal end of a saphenous vein femoral-distal bypass (n = 1). Suprarenal aortic control was required in four patients. The mean operative time was 6.5 ± 1.8 hours (range, 4.5 to 10 hours) and the intraoperative blood transfusion requirement was 4 ± 3 units (range, 0 to 9 units), with the additional fluid (Ringer’s lactate and colloid) requirement being 7 ± 2 L. When two teams were used, operative time was always less than 5 hours.

There were no immediate operative deaths; however, two patients died at 28 days and 35 days after operation (in-hospital mortality rate of 10%) of sepsis and multisystem organ dysfunction after gastrointestinal complications (perforated duodenal diverticulum and ischemic small bowel necrosis). Two others survived acute and gangrenous cholecystitis. These patients are of interest because they had NAISs fashioned from DV autografts and all had generalized peritonitis documented by reoperation with cultures in separate patients yielding E. aerogenes, P. maltophilia, and C. albicans. The patient with the perforated duodenal diverticulum also had pancreatic necrosis and required Roux-en-Y jejunal limb closure of the duodenal defect and three subsequent re-explorations for peritoneal cavity debridement and jejunal anastomotic breakdown. The DV autografts were inspected at all re-explorations for peritonitis; in all four
patients, NAIS vein grafts and anastomoses resisted infection and remained intact.

Two patients required above-knee amputation (major amputation rate of 10%). One had pre-existing, nonreversible ischemia from a thrombosed, infected axillo-unilateral femoral bypass. There were no other amputations. Another patient had postoperative DV thrombosis in the lower extremity from which the DV autograft was harvested, and she suffered a nonfatal pulmonary embolus. With the exception of this patient, none of the limbs from patients in whom the DVs were removed had acute edema.

The mean follow-up time was 22.5 ± 16 months (range, 3 to 60 months). In addition to the two in-hospital deaths, another patient suffered a fatal myocardial infarction and stroke 6 months after NAIS reconstruction. In the remaining 17 patients, important differences in patency were noted between GSV and DV NAIS reconstruction. Three patients with GSV NAISs had total occlusion within 1 year from progressive, diffuse, luminal narrowing documented by duplex ultrasound and angiography (Fig. 6A). Biopsy at re-exploration confirmed generalized intimal hyperplasia. One of these patients underwent prosthetic replacement AFB; the remaining two have noncritical lower extremity ischemia with severe claudication, but desire no further intervention. Another four patients had focal stenoses in GSV autografts (Fig. 6B) and three required reoperation with patch angioplasty or femoral crossover limb replacement. Again, these occurred within 1 year and were apparent by new onset symptoms, change in examination, or duplex surveillance. Focal stenoses were most commonly found at valve sites (Fig. 6B) or at areas of kinking, especially in small GSV autografts (Fig. 7A). The proximal anastomotic site was particularly vulnerable to kinks developing in conjoined GSV autografts (Fig. 7B). Both patients with end-to-side GSV grafts to anterior aortic wall anastomosis (Fig. 2B) experienced total occlusion. Only patients with large GSV autografts (diameter of at least 8 mm) had sustained patency.

In contrast, all NAISs from larger caliber DV autografts have remained patent and nonstenotic. Aneurysmal deterioration also has not occurred. The overall failure rate (occlusion or stenosis requiring reintervention) of GSV NAISs was 64%, compared to 0% for DV NAISs (p = 0.006). Follow-up ankle-brachial indices also reflect the proneness of GSV NAISs to fail. In patient limbs reconstructed with DV NAISs, the preoperative and postoperative ankle brachial indices (ABIs) were 0.65 ± 0.33 and 0.85 ± 0.20, respectively (p = 0.07); among patients with GSV NAISs, these values were 0.78 ± 0.24 and 0.45 ± 0.24, respectively (p < 0.001). Despite the failure of GSV NAISs, no amputations were required.

Figure 6. (A) Progressive occlusion of GSV NAIS autograft because of diffuse intimal hyperplasia verified by biopsy at the time of secondary prosthetic AFB. (B) Focal stenosis of GSV autograft at valve site verified by reoperation and biopsy.
Of the 13 patients who had unilateral or bilateral DV harvest, only 2 have had significant chronic limb edema and required compression stockings. One was the patient who had ipsilateral venous thrombosis and the other had the ipsilateral GSVs used for a distal bypass.

**DISCUSSION**

The surgical challenge imposed by aortic prosthetic infection is reflected in the high mortality and morbidity from operations dealing with this problem. Contemporary results of various approaches are shown in Table 1 where data from major series reported since 1980 are pooled. With the exception of aortic prosthesis excision with no revascularization that carries a 38.3% (95% confidence interval [CI], 28.4% to 52.3%) mortality rate and a 47.4% (95% CI, 31.5% to 63.3%) amputation rate, there appears to be no substantial difference between these approaches. The most widely favored approach is currently ectopic prosthetic bypass coupled with excision of the aortic prosthesis. The overall mortality rate is 19.2% (95% CI, 14.6% to 23.8%) and the amputation rate is 13.6% (95% CI, 8.1% to 19.1%) (Table 1) and it seems to matter little whether prosthesis excision precedes or follows ectopic bypass or whether these operations are staged or performed together. Along with high mortality and morbidity, ectopic bypass and aortic prosthesis excision are subject to reinfection of the ectopic prosthesis and aortic stump blowout. In pooled data from reports mentioning these complications,1-5,9,10,21,24,25 the overall incidence of ectopic bypass reinfection was 26 of 164 patients or 15.6% (95% CI, 10.0% to 21.2%) and the incidence of fatal aortic stump blowout was 26 of 305 patients or 8.5% (95% CI, 5.4% to 11.6%). As alternatives to the approaches listed in Table 1, recent reports of *in situ* replacement of infected aortic prostheses with venous and aortic homografts appear promising.26,27 In one large series, an operative mortality rate of 12% was reported in 43 patients in whom infected aortic prostheses were replaced with aortic homografts.28 However, even with this approach, recurrent infection with graft rupture has occurred and late deterioration may be expected.

The 10% mortality and amputation rates observed in the current series of NAIS procedures compare favorably with other approaches in Table 1. However, it is difficult to compare series directly because of the broad heterogeneity in terms of severity of presenting problems, associated comorbidities, inclusion of patients with AEE or AEF (both increasing mortality), infecting organisms, and completeness of reporting. One cannot advocate a single operation for all patients with aortic prosthetic infections; different approaches have applicability in individual patients. Nevertheless, we think that NAIS reconstruction from venous autografts successfully eradicates infection, allows rapid healing of all wounds, minimizes
the risk of reinfection, and eliminates the problem of aortic stump blowout.

Catastrophic disruption of venous autografts has been an ongoing concern but has not occurred. This complication seems most likely when vein grafts are exposed or when virulent gram-negative infections are present, such as those with *P. aeruginosa.* Although this finding has led some to recommend against autogenous reconstruction in the presence of gram-negative infections, Gram-negative infection is associated with elaboration of bacterial protease exproducts that can disrupt vessel walls, especially thin-walled veins. Despite this concern, we have not observed this complication in patients with extensive gram-negative prosthetic infections nor in those who suffered postoperative gastrointestinal problems complicated by widespread peritonitis in whom NAIS vein grafts were virtually bathed in polymicrobial pus.

Our biggest disappointment with the NAIS procedure was the high rate of failure of GSV autografts. The prone-ness of GSV autografts in this position to develop diffuse intimal hyperplasia was also noted by Seeger et al. This problem appears limited to small vein grafts, especially when anastomosed to the aorta in the configuration shown in Figure 2C, and in focal areas of kinks or valve sites. For this reason, it is important to monitor these vein grafts with frequent duplex ultrasound examinations and clinical assessment, especially in the first year after placement. Focal stenoses can be corrected by timely reoperation. Despite this limitation, GSV NAIS occlusion is more gradual than the sudden thrombotic occlusion experienced by patients with ectopic prosthetic bypasses who, in our experience, frequently present with profound, irreversible limb ischemia. We, and others, have noted a high rate of amputation after thrombotic occlusion of axillofemoral bypasses. The slowly progressive occlusion in our patients allowed for early detection, intervention, and, possibly, development of collateral circulation. Notably, none of the occlusions has led to amputations.

In contrast to the experience with GSV NAISs, DV NAISs have remained widely patent. We currently favor DV autografts for NAIS reconstruction and use GSV grafts only if they are large (≥ 8 mm in diameter). We have not observed focal or diffuse intimal hyperplasia in DV or large GSV autografts. The superficial femoral-popliteal vein has a diameter of 1.0 to 1.5 cm and this allows end-to-end anastomosis to a normal caliber aorta with relative ease. Conjoined GSV grafts at the proximal anastomosis are prone to kinks and other unfavorable hemodynamic conditions that predispose to failure. Another advantage of the DV autograft is that minor kinks and areas of intimal hyperplasia at valve sites do not produce hemodynamic disturbances and compromise flow to the degree that similar sized defects would produce in smaller caliber vein grafts. In the experience of Schulman et al. using DV autografts for femoral-popliteal bypass, very large (> 1.2 cm) diameter DV grafts were prone to failure because of mural thromboembolism. We have not observed this and predict that it will not be a problem because of the better size match be-

<table>
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<th>Operation</th>
<th>References</th>
<th>No. of Patients</th>
<th>Incidence</th>
<th>(95% Confidence Interval)</th>
<th>No. of Patients</th>
<th>Incidence</th>
<th>(95% Confidence Interval)</th>
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<td>2, 3, 9, 13–15</td>
<td>18/47</td>
<td>38.3%</td>
<td>(24.4–52.3)</td>
<td>18/38</td>
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<td>(31.5–63.3)</td>
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<td>10, 16–18</td>
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<td>(8.4–39.7)</td>
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<td>3, 19–22</td>
<td>11/41</td>
<td>26.8%</td>
<td>(13.2–40.4)</td>
<td>8/41</td>
<td>19.5%</td>
<td>(7.4–31.6)</td>
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<td>Ectopic bypass, excise prosthesis (any sequence, with or without delay)</td>
<td>1–5, 9, 10, 13–15, 21, 23, 24</td>
<td>53/276</td>
<td>19.2%</td>
<td>(14.6–23.8)</td>
<td>20/147</td>
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<td>(8.1–19.1)</td>
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<td>22/85</td>
<td>25.9%</td>
<td>(16.6–35.2)</td>
<td>10/40</td>
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<td>(11.6–38.4)</td>
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<td>Ectopic bypass first, followed by excision of prosthesis (with or without delay)</td>
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<td>39/183</td>
<td>21.3%</td>
<td>(15.4–27.2)</td>
<td>10/90</td>
<td>11.1%</td>
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<td>8/45</td>
<td>17.8%</td>
<td>(6.6–29.0)</td>
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<td>11.8%</td>
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<td>(14.9–29.1)</td>
<td>5/50</td>
<td>10.0%</td>
<td>(1.7–18.3)</td>
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Table 1. POOLED DATA FROM SERIES OF INFECTED AORTIC PROSTHESES REPORTED SINCE 1980

Mortality

Amputation

No. of Patients | Incidence | (95% Confidence Interval) | No. of Patients | Incidence | (95% Confidence Interval)
between the aortoiliac femoral system and DV autografts. Aneurysmal change also has not been observed, but patients will continue to be monitored for this complication.

The absence of significant limb edema in the majority of patients in whom DV autografts were harvested has been gratifying. This has been the experience of others who have used the DV autograft for femoral-popliteal and other peripheral grafts. Schanzer et al. reported a mild but persistent calf enlargement along with a pattern on strain gauge plethysmography indicative of venous outflow obstruction in the majority of 25 patients who had DV harvest for femoral-popliteal bypass.34 Despite these observations, clinically significant edema requiring compression stockings was rare and no functional disability was seen. This agrees with the findings of Masuda et al. who studied the long-term hemodynamic and clinical outcomes in patients who had ligation of the superficial femoral vein.35 They concluded that there was no correlation between physiologic obstruction of this vein and the clinical state, and that obstruction is well tolerated when the profunda femoris and GSVs are intact. In our series, ipsilateral harvest of the GSVs and DVs in one patient and the postoperative development of venous thrombosis with probable valve damage in another were factors producing edema requiring compression hose. Although Schulman et al. did not find significant edema in limbs from which GSVs and DVs were removed,36 we would caution against this. We also think that preservation of the profunda femoris vein is important in preserving sufficient venous collateral flow to prevent excessive venous hypertension.

References


**Discussion**

**Dr. Robert B. Smith, III (Atlanta, Georgia):** President MacLean, Members and Guests, I wish to compliment Dr. Clagett and his associates for an innovative approach to a particularly vexing problem in vascular surgery and also on their early successful results. They offer us another option, along with graft removal and extra-anatomic bypass as well as in situ replacement of prosthetic grafts, in the attempt to manage these patients. I would like to ask Dr. Clagett to address two issues.

First, is it in the folklore of vascular surgery that certain virulent infections, particularly *Pseudomonas*, don’t lend themselves well to in situ replacement or maintenance of an infected graft if the suture line is involved, because of the risk of anastomotic blowout. Yet, you have treated at least two patients with *Pseudomonas* infection successfully in the face of this thesis.

Second, I must express some concern about the possibility of future dilatation of these large vein grafts. Your observation period is still less than 2 years without aneurysmal dilatation, but I assume that you plan to follow the patients with ultrasound or computed tomography scan to assess graft size and patency at 5 years.

**Dr. Ronald J. Stoney (San Francisco, California):** President MacLean, Fellows and Guests, I enjoyed this paper and had a chance to review Dr. Clagett’s manuscript. I think they’re to be congratulated for bringing this type of material to the Association since aortoiliac perigrafts infection is a major challenge today among reoperative aortic surgical problems.

The in situ autogenous reconstruction of the aortoiliac system after graft removal, as they report, is simply one option for revascularizing the lower extremities after removal of an infected graft. They prefer the use of the deep veins, and their presentation emphasizes that this provided excellent results in the short term.

Saphenous veins, as one might expect, would predictably be less durable. And this has certainly been true with saphenous veins in other high flow vascular beds as contrasted with the lower extremities where they seem to perform better.

I thought I’d ask one question, and that was relative to the long-term patency that the authors really have not had a chance to experience with their patients. What about the late behavior of these grafts? Like Dr. Smith, I wonder about late aneurysmal degeneration with stenosis are possible with these deep veins in this position.

These demanding operations were performed in remarkable time with moderate blood requirements and achieved to my knowledge the best record for morbidity and mortality for this problem. Our own experience at the University of California San Francisco was generated with a similar series of patients and was completed long before this series was begun; in fact, our mortality rates were three times what you heard today and amputation rates twice that. These rates were satisfactory at the time, but certainly with better management of patients and better perioperative care, these results have improved.

We are anxious to minimize some of the operative demands on the patients and surgeons for these synchronous operations such as you heard today. We generally favor staged operations removing the graft after actual creation of an alternate or ectopic bypass.

If the authors can show that this technique they report today consistently achieves the same results long term, then I think this would certainly be a major option for management of patients with aortic graft infection. This report could really cause us to reverse our surgical strategies and return to a syndromic rather than a staged approach. As the saying goes, what goes around comes around.

I enjoyed this paper and thank you for the opportunity to discuss it.

**Dr. George Johnson, Jr. (Chapel Hill, North Carolina):** Dr. MacLean, Dr. Sheldon, this is another very valuable adjunct for these patients who really have a very serious problem. I think there are several important observations that come from this report. One is that he has removed a tremendous amount of the venous drainage from the lower extremity and reports very minimal edema.

Three questions occurred to me as he presented the paper. First, did he leave the groin wounds open? Stoney has put veins into infected areas, but I believe covered them with muscle. Second, how long did he keep these patients on antibiotics? I notice that he did have some recurrent or perhaps persistent infections at 2 months.

The last and most fascinating question, for which there is perhaps no answer, was about his 20% major gastrointestinal complication rate. Can he explain why 20% of the people had major gastrointestinal complications? This is certainly more than with other abdominal operations. Thank you.

**Dr. G. Patrick Clagett (Closing discussion):** I’d like to thank the discussants for their comments and questions.

Dr. Smith raises appropriate concerns about placing these vein grafts in areas infected by *Pseudomonas* organisms. Admittedly, our experience is limited in that only three patients has *Pseudomonas* cultured. Two had preoperative *Pseudomonas* infections that involved AFB limbs and one had postoperative peritonitis with a *Pseudomonas* organism. The problem with these organisms is that they elaborate exoproteases that can dissolve vein grafts. We have seen this in some of our trauma patients where vein grafts have been exposed in addition to being infected with *Pseudomonas*. It is possible that the deep, retroperitoneal position of the NAIS vein grafts affords protection by surrounding the vein grafts with well vascular-