Staging the neoaortoiliac system: Feasibility and short-term outcomes

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Background: **The neoaortoiliac system (NAIS) has gained popularity as a durable procedure for treating aortic graft infections. However, one of the disadvantages has been a long operation that can take up to 10 hours. The goal of this study was to assess the feasibility of staging the NAIS procedure with deep vein harvest a day before the aortofemoral bypass and evaluate if staging had any effect on graft patency or morbidity and mortality, or both.**

Methods: **We reviewed data for all the NAIS procedures performed for aortic graft infections at a tertiary care university hospital. The femoral popliteal veins of patients undergoing the staged NAIS were harvested a day in advance and left in situ. The next day patients underwent the prosthetic graft excision with reconstruction using the femoral popliteal veins. Patients with aortic occlusion on presentation were not candidates for vein harvest in advance and underwent a unilateral bypass with a subsequent femorofemoral bypass as a second stage.**

Results: **In the last 8 years, 26 patients (17 men, 9 women; mean age, 62.6 ± 8.3 years) underwent the NAIS procedure for aortic graft infections. Mean follow-up was 15.7 months. Primary assisted graft patency was 100%. There were 11 patients in the staged group and 10 patients in the nonstaged group. All the staged patients underwent vein mobilization a day before excision of aortic prosthesis. Despite undergoing a separate procedure for vein harvesting at a different time, there was no difference in total operative time (12.0 ± 1.8 vs 11.9 ± 2.2 hours), operative blood loss (2.6 ± 1.2 vs 3.4 ± 2.4 L), and requirements for transfusion for blood products (6.7 ± 3.7 vs 6.0 ± 5.4 U) or crystalloid (11.3 ± 3.1 vs 10.9 ± 2.4 L) between the staged group and nonstaged groups. One amputation occurred in each group. The perioperative mortality was 18% for the staged group and 20% for nonstaged group. The 12-month survival was 72% for staged and 70% for nonstaged NAIS. No graft-related complications were observed from the preoperative vein harvest.**

Conclusion: **The NAIS can be staged without compromising the efficacy of the procedure as evident by excellent long-term patency and control of the infection. By reducing the duration of the primary procedure, staging may be beneficial to both the patient and the surgeon. (J Vasc Surg 2008;48:1125-31.)**

Since the first description by Clagett et al[1,2] in 1993, the neoaortoiliac system (NAIS) has proven to be an effective option in the treatment of aortic graft infections. Compared with cadaveric allografts or Rifampin-soaked synthetic grafts, autogenous deep vein reconstruction has been shown to be highly resistant to reinfection and associated with excellent long-term patency.[3-7] Contrary to initial concerns, removal of the deep femoral veins has not been associated with significant venous morbidity.[8-10]

One of the main drawbacks of the NAIS is the shear magnitude of the operation in a typical elderly, malnourished, and septic patient. The duration and complexity of the procedure may be physiologically demanding for both the patient and the surgical team. Surgeon fatigue may be associated with errors of both judgment and technique.[11,12] Clagett has emphasized the benefit of using a two-team approach to complete the entire NAIS procedure: harvest the deep veins, obtain vascular control in a hostile abdomen, excise the infected graft, repair associated bowel injuries, and then perform complex revascularization.

During the past few years, we have increasingly elected to stage the NAIS procedure by dividing it into segments that are less traumatic for the patient and less strenuous for the surgical team. We conducted the present study to assess the outcomes of patients treated with a conventional NAIS compared with the staged NAIS procedure.

METHODS

A prospectively maintained database was queried for all patients treated surgically for aortic graft infections from January 1999 to November 2007 at The University of Arkansas for Medical Sciences. Patients undergoing procedures other than NAIS reconstruction with deep femoral veins were excluded. Medical records were reviewed for demographics, clinical presentation, and associated comorbidities. A noninvasive vascular laboratory evaluation included segmental arterial pressures with ankle-brachial index (ABI) for all patients. Duplex ultrasound (DUS) evaluation was also performed to assess the quality and diameter of the deep femoral and popliteal veins.

The runoff score was determined according to the reporting standards on chronic ischemia published by the Society for Vascular Surgery.[13] The diagnosis of graft infection was based on the clinical presentation, supporting laboratory values, and evaluation of a variety of imaging tech-

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niques, including conventional and computed tomography angiography (CTA), DUS, and radionuclide scanning.

Conventional NAIS. The technique has been previously described by D'Addio and Clagett.[14,15] Under general anesthesia, the patient is prepared and draped from the nipples to the feet. A longitudinal incision along the course of the sartorius muscle is used to expose an appropriate length of deep femoral and popliteal veins. The side branches are divided and suture-ligated. Care is taken to preserve the profunda femoris vein to reduce the incidence of postoperative venous hypertension.

The aortic graft is then exposed through either a transabdominal or retroperitoneal approach and excised. Complete débridement of the aorta and the surrounding tissue is performed. A sufficient length of deep vein is harvested. Reconstruction of the aortofemoral segment is accomplished by either creating a bifurcated pantaloon graft or by a unilateral aortofemoral graft combined with an iliofemoral crossover graft.

Staged NAIS. By definition, we have used the term *staged-NAIS* to refer to any aortoiliofemoral reconstruction using deep femoral popliteal veins in the treatment of aortic graft infection that was not completed in a single operative procedure. The decision to perform a staged procedure was at the discretion of the attending surgeon according to the unique anatomic and clinical features of each patient.

At the initial operation, the deep femoral veins were exposed, the branches divided and suture-ligated, and the incisions temporarily closed over closed suction drains. The femoral veins were left in situ, and flow was not interrupted. Overnight, sequential compression devices were used in addition to routine deep vein thrombosis prophylaxis with 0.5 mg/kg of low-molecular-weight heparin.

The next day the infected aortic graft was excised and the aortic reconstruction undertaken. In selected patients with graft occlusion and ischemia, the NAIS was staged by performing unilateral revascularization of the most ischemic leg, followed by revascularization of the contralateral limb at a later date. Thus, the most symptomatic side was revascularized with autogenous deep vein. For the contralateral limb, subtotal graft excision was performed and the distal anastomosis at the femoral level was not revised. Subsequently, the contralateral side was revascularized with deep vein as a femorofemoral bypass at a later date. In one patient, we did revascularize the contralateral limb at the time of the initial aortounifemoral NAIS with a rifampin-soaked synthetic graft to undergo a planned subsequent removal. All such patients undergoing a hemi-NAIS at a given time were analyzed separately.

To classify the procedure, all patients who underwent preoperative vein harvest were group I, all conventional single-stage NAIS procedures were group II, and patients with graft thrombosis who had unilateral deep vein bypass at one time were group III. The comparison was undertaken between patients who underwent staging by preoperative vein harvest (group I) and those who had a conventional NAIS (group II).

Operative data included American Society of Anesthesiology (ASA) class, total operative time, intravenous crystalloid volume, lowest recorded temperature, and transfusion requirements. Adjunctive surgical procedures were recorded. Postoperative data included hospital course, consisting of length of stay, complications, and mortality.

Graft surveillance with DUS imaging was performed every 3 months during the first year and every 6 months thereafter. If indicated, contrast imaging was obtained using a CTA. Primary and secondary patency and limb salvage data were defined according to the reporting standards for the Society for Vascular Surgery.[13] Graft failure was defined as an occluded graft or reinfection requiring removal of the graft.

Statistical analysis was performed using SAS software (SAS Institute Inc, Cary, NC). Data were reported as mean ± standard deviation. Means were compared using the Fisher exact and Cochran-Mantel-Hansel tests. A Kaplan-Meier method was used to estimate graft patency and patient survival.

RESULTS

During an 8-year period, 26 NAIS procedures were performed for infrarenal aortic graft infections. Two patients were lost to long-term follow-up. Patients with isolated femoral reconstruction and thoracic NAIS were not included in this analysis. There were 11 patients who underwent a staged NAIS (group I) and 10 who had a standard, nonstaged NAIS (group-II). Five patients had unilateral revascularization at a given time, followed by a femorofemoral bypass with deep vein at a later stage (group III).

Demographics. The mean patient age was 62.6 ± 8.3 years (range, 44-78 years). There were 17 men and nine women. Twenty patients had undergone a previous aortofemoral bypass graft, and four patients had an infected aortic tube or aortoiliac graft. One patient with an occluded aortofemoral bypass graft had an infected axillofemoral graft on the contralateral limb. One patient had an infected endograft. Another patient presented with a failed axillofemoral graft, which had been placed to treat a previous aortic graft infection. Of the 26 patients, occlusive disease was present in 17 (65%), eight (30%) had aneurysmal disease, and one patient had both. In three patients the original graft was placed for ruptured abdominal aortic aneurysm repair. Mean ASA class was 3.7 ± 0.5 for the nonstaged group and 4.0 ± 1.0 for the staged group, which was not significantly different.

Presentation. The most common presentation was ischemia, which occurred in 10 (38%) patients (Table I). This included the four patients who had presented with graft thrombosis and underwent unilateral NAIS as the initial stage. The fifth patient in that group had undergone an aortoiliac bypass for a ruptured aneurysm. One limb had been occluded, and he had a femorofemoral bypass. His initial presentation was proximal anastomotic bleeding with pending graft disruption. He underwent an urgent aortouniiliac bypass with deep vein, and 1 week later, the femorofemoral bypass was replaced with deep vein.

Table I. Presentation

Presentation	*Staged (n = 11)*	*Nonstaged (n = 10)*	*Hemi-NAIS (n = 5)*	*Total (n = 26)*
Ischemia, No. (%)	1 (9)	5 (50)	4 (80)	10 (38)
Acute	0	2	2	4 (15)
Chronic	1	3	2	6 (23)
ABI, mean ± SD				
Pre-op, right	0.92 ± 0.1	0.48 ± 0.4	0.43 ± 0.4	
Pre-op, left	0.85 ± 0.3	0.45 ± 0.4	0.45 ± 0.4	
AE fistula/erosion, No. (%)	3 (27)	2 (20)	0	5 (19)
Acute bleeding, No. (%)	1 (9)	1 (10)	1 (20)	3 (11.5)
Sepsis/abscess, No. (%)	3 (27)	2 (20)	0	5 (19)
Constitutional symptoms, No. (%)	4 (36)	3 (30)	2 (40)	9 (35)
Chronic groin sinuses	3 (27)	1 (10)	2 (40)	6 (23)

AE, Aortoenteric; *NAIS,* neoaortoiliac system.

Table II. Operative details and complications

Variable	*Staged (n = 11)*	*Nonstaged (n = 10)*	*Total (n = 21)*[a]
Operative data, mean ± SD			
Operative blood loss, L	2.4 ± 1.6	3.5 ± 2.4	3.0 ± 1.7
NAIS duration, h	9.1 ± 2.6	11.9 ± 1.5	10.4 ± 2.1
Vein harvest duration, h	2.2 ± 0.8	N/A	. . .
Total time, h	12.0 ± 2.1	11.9 ± 1.5	. . .
Secondary procedures, No.			
Gastrostomy	4	5	9
Tracheostomy	2	1	3
Distal bypass/revasc	1	1	2
Colectomy	1	0	1
Fasciotomy	1	4	5
Mesh closure of abdomen	5	4	9
Operations, mean No.	3.9 ± 1.1	3.7 ± 2.9	. . .
Complications, No.			
Renal failure	2	2	4
Post-op bleeding	1	2	3
Respiratory failure	2	1	3
Bowel obstruction/ileus	1	1	2
MOSF	0	2	2
Myocardial infarction	0	1	1
Amputation	1	1	2
Post-op sepsis	4	0	4
Reinfection	1	2	3

MSOF, Multisystem organ failure; *NAIS,* neoaortoiliac system.
[a]Five patients in group III (hemi-NAIS system) have been excluded from the total.

Only one of the 11 patients (9%) in group I (staged) presented with chronic ischemia. In group II (nonstaged), two patients had acute ischemia and three had chronically occluded grafts. Aortoenteric erosion/fistula (AEE/F) was present in five of the 26 patients (19%). In the nonstaged group, 4 patients had AEF. One of these patients had disruption of the proximal anastomosis and underwent an aortic graft replacement with Dacron graft soaked in rifampin. This was followed by a staged NAIS. In the other two patients, the AEF was graft erosion with abscess and was found intraoperatively. Another patient in the nonstaged group had graft enteric erosion from the endograft, which was also discovered intraoperatively. Constitutional symptoms, including fever, malaise, and weight loss, were present in 10 of the 26 patients (38%) on admission. Seven patients presented with chronic groin wounds or sinuses with exposed grafts (Table I).

Operative details. Mean ± SD duration of surgery was 11.3 ± 2.0 hours for the 10 nonstaged NAIS procedures and 9.2 ± 1.7 hours for the 11 staged NAIS procedures. The time to harvest vein in the staged group was 2.2 ± 0.8 hours. Thus, the total operative time was not significantly different in staged vs nonstaged NAIS (Table II, Fig 1).

Blood loss was not significantly different in either group, with 2.5 ± 1.2 L for staged vs 3.5 ± 2.4 L for nonstaged ($P = .3$; Fig 1). No anesthesia-related complications were observed in the staged group during the harvest of the vein graft. The total cumulative crystalloid transfused during the vein harvest and the NAIS the next day was not statistically different from nonstaged group (Fig 1).

Secondary procedures in addition to the NAIS were required in 15 of the 26 patients (57%). Some procedures were performed at the time of aortic graft excision and

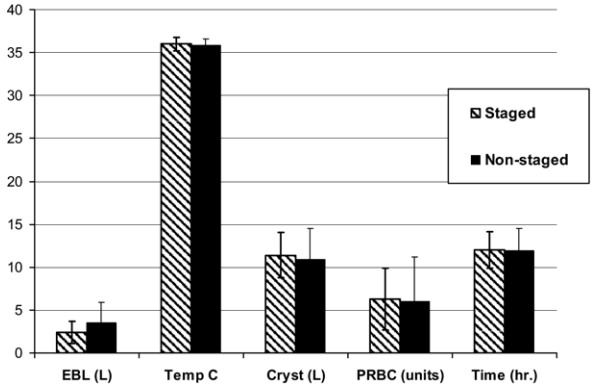
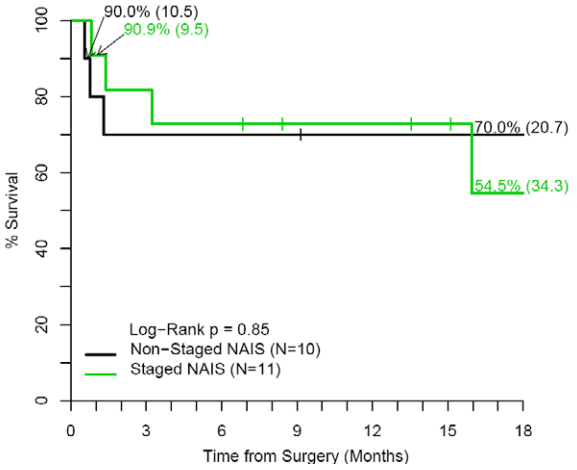


Fig 1. No significant difference was found in estimated blood loss *(EBL)* in liters, lowest recorded temperature in centigrade *(Temp)*, intravenous crystalloid *(Cryst)* requirement in liters, number of packed red blood cell *(RBC)* units transfused, and the total duration of surgery in hours, including vein harvest time, between the staged group *(striped bars)* and nonstaged group *(black bars)*. *Error bars* show the standard deviation.



Numbers at Risk

Time	0	3	6	9	12	15	18
Staged	11	10	9	7	7	6	4
Non-staged	10	8	8	7	7	7	7

Fig 2. Kaplan-Meier survival curve for patients undergoing staged *(green line)* and nonstaged *(black line)* neoaortoiliac system *(NAIS)*, The SE was >10 after 2 months. No difference in perioperative or 12-month survival was observed between the two groups.

bypass (Table II). Each group had the same mean number of procedures during the entire hospitalization: 3.9 ± 1.1 for staged compared with 3.7 ± 2.9 for nonstaged.

Two patients incurred limb loss, one in each group. One patient in the staged group presented with septic emboli to the extremity. Despite revascularization, the limb could not be salvaged. A femoral anastomotic disruption occurred in one patient in the nonstaged group that required ligation and eventually led to amputation.

Outcome

Mortality and survival. The mortality rate, procedurally related or ≤30 days, was 18% (2 of 11) in the staged group and 20% (2 of 10) in the nonstaged group. Mortality for the entire group was 15% (4 of 26). There was no statistical difference between the two groups when mortality was compared. No patients in group III (hemi-NAIS) died in the perioperative period.

Complications. The over all fasciotomy rate was 34% (9 of 26). The fasciotomy rate was 9% (1of 11) in the staged group, 40% (4 of 10) in the nonstaged group, and 80% (4 of 5) in the hemi-NAIS group. Because all four patients presented with severe ischemia from graft thrombosis, we attributed this to ischemia–reperfusion. Two of the four patients with occluded graft presented with acute ischemia. One patient in the staged group had an outflow obstruction of the left iliac vein that led to compartment syndrome at the end of the NAIS procedure, requiring fasciotomy. Four patients in the nonstaged group had fasciotomy, and all of them presented with acute or chronic ischemia. One had a concurrent ipsilateral great saphenous vein harvested for a femoropopliteal bypass and a compartment syndrome developed subsequently.

Other than fasciotomy, acute renal failure was the most common postoperative complication, at 15.3% for the entire group. No patients required long-term dialysis. All complications are listed in Table II.

Mean length of stay (LOS) was 27 ± 18 days for the staged patients and 24 ± 12 days for the nonstaged group, which was not statistically different.

Graft patency. Assisted primary patency after 12 months was 100% for both groups. One patient in the nonstaged group required an angioplasty in one of the vein grafts 2 years after the NAIS. One patient in the staged group required an aortic stent in the native aorta above the vein graft due to an intimal flap. This was discovered on a CT scan shortly after the initial NAIS.

Survival. Survival at 12 months was 72% for the staged NAIS and 70% for nonstaged NAIS, with no difference on log-rank analysis (Fig 2).

Microbiology. The most common organism species were gram-positive (52%), followed by fungal (32%) and gram-negative (24%). Most infections were polymicrobial (40%), whereas only a single organism grew in 32%. No organism was isolated in 28% of the patients.

DISCUSSION

Fundamentals of treatment regarding aortic graft infections include eradication of infection by excision of the graft, restoration of vascular continuity, and improving the overall state of the patient by augmenting immunity and nutrition. Patients who present with an aortic graft infection are generally nutritionally depleted and immunologically compromised: They have been prescribed multiple antibiotic therapies and harbor highly resistant organisms.

The first NAIS was performed 16 years ago, and the series was reported as a novel treatment for aortic graft

infection in 1993.[2] There is little doubt that it is a durable procedure with a very low reinfection or reintervention rate. The NAIS procedure is technically quite demanding, however, and aortic graft excision with an aortobifemoral bypass using both deep veins is a laborious operation. Because of the high complexity and the duration of the operation, it has not been widely adopted other than in a few selected tertiary centers. This article presents a single-center experience of staging the NAIS by preoperative harvest of the deep vein by surgeon's choice.

Harvest of the deep vein is a critical part of the NAIS operation and has to be done properly, with meticulous attention to details. Even in the most experienced hands it has led to unfortunate incidences of graft-related hemorrhage from a popped tie.[16] Thus, it is paramount that the vein harvest is done in a safe and unhurried manner. The vein harvest can take anywhere from 2 to 3 hours, or even longer when performed by a surgeon not familiar with the procedure. This time is added to the front end of the operation. Clagett et al[14] have recommended using a two-team approach, which is dependent on personnel availability and familiarity with the NAIS.

Reilly et al[17] in 1987 demonstrated that staging the extra-anatomic bypass improved outcomes and was physiologically less stressful for the patient. In their series of 101 patients, staging and sequencing was physiologically beneficial.[17]

The surgeon in our series tried to stage the NAIS into several segments instead of performing an enormous operation all at once. Patient selection was at the discretion of the surgeon. One of the methods in patients without signs of ischemia or overt sepsis was preoperative vein mobilization. In this series, the vein harvest a day in advance of the aortic graft excision did not seem to cause any ill effects. We would like to point out a few minor technical variations from the original technique described by Clagett et al.[14,18] In addition to mobilization of the veins a day in advance, when possible, we tried to use the reversed configuration with the femoral popliteal vein graft. Thus, in these cases, the valvulotomy was not performed by eversion of the vein graft. Instead, a single pass of a disposable valvulotome was made, and the vein was then used in a reversed fashion.

Another significant difference was the duration of postoperative antibiotic therapy. In pan-infected grafts or with involvement of fungal organisms, we resorted to perioperative organism-specific antibiotic therapy for 3 to 4 weeks, or even longer, until the patient was nutritionally improved and in a positive nitrogen balance (prealbumin >16 mg/dL).

The fasciotomy rate for the entire series was 34% (9 of 26). Modrall et al[19] have described the predictors of fasciotomy and the increased use of crystalloid as one of the factors. It is conceivable that an operation of shorter duration with decreased blood loss would require less total crystalloid. However, we do not think that there was any difference between the two groups.

Surgeon fatigue is often underestimated and seldom reported. It is a reality, however, and technical errors could be directly related to surgeon fatigue. We have shown that staging saves at least 2 to 2.5 hours from the procedure for aortic graft excision. It is also important to note that NAIS is not usually limited to just an aortofemoral bypass only, but often requires adjunctive procedures. We would like to emphasize that vein harvest one day in advance of a NAIS can only be done in patients with a patent graft. In patients with aortic occlusion, we have revascularized one limb at a time.

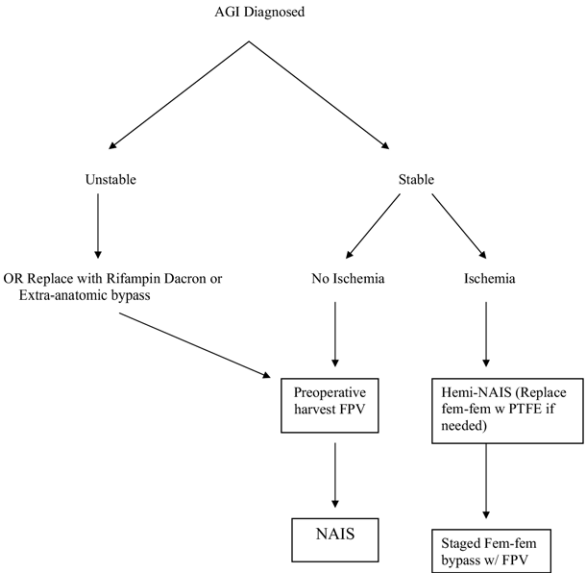


Fig 3. Protocol for treatment of aortic graft infections *(AGI)*. Fem-fem; femorofemoral bypass; *FPV,* femoral popliteal vein; *NAIS,* neoaortoiliac system; *OR*, operating room.

We believe that in limb-threatening ischemia, mobilization of the femoral popliteal vein can lead to disruption of the collaterals and precipitate acute ischemia. In the four patients with ischemic symptoms and graft occlusion, the aortofemoral bypass was performed first. This was done even in the face of low-grade infection or rest pain in the contralateral limb. Femorofemoral bypass with vein was done 4 to 18 days later. These patients have been reported separately.

The mortality of the nonstaged group was 20%. The mortality for the staged group was 18%. There were three graft disruptions; one patient survived the disruption where the femoral anastomosis was ligated and underwent subsequent above the knee amputation. This was despite a gracilis muscle flap procedure. This patient had methicillin-resistant *Staphylococcus aureus* graft infection. The other two patients had proximal disruption, and they did not survive. One of the patients had polymicrobial infections with *Klebsiella pneumoniae* and *Candida* species. The second patient also had a polymicrobial infection involving *Bacteroides fragilis* and *Candida*. We attribute this to recurrent infection. Because of a small sample size, it did not reach statistical significance.

In summary, dealing with aortic graft infection has evolved considerably during the last 5 years at our institution. Every attempt is made to stage the treatment when feasible. The protocol to deal with aortic graft infection is presented in Fig 3.

This study has limitations: The patients were not randomized, and this was a retrospective review. The numbers are small, and staging was at the discretion of the operating surgeon.

CONCLUSION

We believe that staging the NAIS is feasible, with no added complications or untoward graft-related issues. Although harvest of femoral popliteal vein graft at a separate procedure does add another procedure, these patients undergo multiple procedures as seen with patients in the nonstaged group. Furthermore, we believe that staging may help reduce surgeon fatigue. We therefore recommend staging whenever possible, especially if the surgeon is not very familiar with the NAIS.

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AUTHOR CONTRIBUTIONS

Conception and design: AA
Analysis and interpretation: AA, VK, JE
Data collection: NM, AA
Writing the article: AA, JE
Critical revision of the article: AA, JE, MM, VK
Final approval of the article: AA, JE
Statistical analysis: AA
Obtained funding: AA
Overall responsibility: AA

REFERENCES

1. Clagett GP, Valentine RJ, Hagino RT. Autogenous aortoiliac/femoral reconstruction from superficial femoral-popliteal veins: feasibility and durability. J Vasc Surg 1997;25:255-66; discussion 267-70.
2. Clagett GP, Bowers BL, Lopez-Viego MA, Rossi MB, Valentine RJ, Myers SI, et al. Creation of a neo-aortoiliac system from lower extremity deep and superficial veins. Ann Surg 1993;218:239-48; discussion 248-9.
3. Kieffer E, Gomes D, Chiche L, Fléron MH, Koskas F, Bahnini A. Allograft replacement for infrarenal aortic graft infection: early and late results in 179 patients. J Vasc Surg 2004;39:1009-17.
4. Naylor AR, Clark S, London NJ, Sayers RD, Macpherson DS, Barrie WW. Treatment of major aortic graft infection: Preliminary experience with total graft excision and in situ replacement with a rifampicin bonded prosthesis. Eur J Vasc Endovasc Surg 1995;9:252-6.
5. Oderich GS, Bower TC, Cherry KJ Jr, Panneton JM, Sullivan TM, Noel AA, et al. Evolution from axillofemoral to in situ prosthetic reconstruction for the treatment of aortic graft infections at a single center. J Vasc Surg 2006;43:1166-74.
6. Seeger JM, Pretus HA, Welborn MB, Ozaki CK, Flynn TC, Huber TS. Long-term outcome after treatment of aortic graft infection with staged extra-anatomic bypass grafting and aortic graft removal. J Vasc Surg 2000;32:451-61.
7. Zhou W, Lin PH, Bush RL, Terramani TT, Matsuura JH, Cox M, et al. In situ reconstruction with cryopreserved arterial allografts for management of mycotic aneurysms or aortic prosthetic graft infections: a multi-institutional experience. Tex Heart Inst J 2006;33:14-8.
8. Masuda EM, Kistner RL, Ferris EB. Long-term effects of superficial femoral vein ligation: thirteen-year follow-up. J Vasc Surg 1992;16:741-9.
9. Modrall JG, Hocking JA, Timaran CH, Rosero EB, Arko FR 3rd, Valentine RJ, et al. Late incidence of chronic venous insufficiency after deep vein harvest. J Vasc Surg 2007;46:520-5.
10. Wells JK, Hagino RT, Bargmann KM, Jackson MR, Valentine RJ, Kakish HB, et al. Venous morbidity after superficial femoral-popliteal vein harvest. J Vasc Surg 1999;29:282-9; discussion 289-91.
11. Ho P, Ting ACW, Cheng SWK. Blood loss and transfusion in elective abdominal aortic aneurysm surgery. ANZ J Surg 2004;74:631-4.
12. El-Haddawi F, Abu-Zidan F, Jones W. Factors affecting surgical outcome in the elderly at Aukland Hospital. ANZ J Surg 2002;72:537-41.
13. Rutherford RB, Baker JD, Ernst C, Johnston KW, Porter JM, Ahn S, et al. Recommended standards for reports dealing with lower extremity ischemia. J Vasc Surg 1997;26:517-38.
14. D'Addio VJ, Clagett G. Surgical treatment of the infected aortic graft. ACS surgery, principles and practice. New York, NY: WebMD Professional Publishing; 2005.
15. Clagett G. Treatment of aortic graft infection. Curr Ther Vasc Surg 2001:422.
16. Ali A, Bell C, Modrall JG, Valentine RJ, Clagett GP. Graft-associated hemorrhage from femoralpopliteal vein grafts. J Vasc Surg. October 2005 2005;42:667-72.
17. Reilly LM, Stoney RJ, Goldstone J, Ehrenfeld WK. Improved management of aortic graft infection: The influence of operation sequence and staging. J Vasc Surg 1987;5:421-31.
18. Clagett GP, Valentine RJ, Ryan TH. Autogenous aortoiliac/femoral reconstruction from superficial femoral-popliteal veins: feasibility and durability. J Vasc Surg 1997;25:255-66; discussion 267-70.
19. Modrall JG, Sadjadi J, Ali AT, Anthony T, Welborn MB 3rd, Valentine RJ, et al. Deep vein harvest: predicting need for fasciotomy. J Vasc Surg 2004;39:387-94.

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DISCUSSION

Dr Thomas Naslund (Nashville, Tenn). The authors have addressed an important negative feature of the NAIS [neoaortoiliac system]: that being the operation is lengthy and tedious. They have devised a staged procedure without altering the basic operative principles. In this report, the desired result was reached in that lengthy operative time was avoided and outcomes were not changed. Fasciotomy rate is noted to be lower with the staged approach, but we are not informed of the relative incidence of prior saphenous vein harvest in the two groups. This risk factor as well as evolving judgment in performing fasciotomy could explain this observation.

In general, if safety is equivalent, one operation is better than two. Furthermore, the overall efficiency of the operating room is diminished by this staged approach consuming more operating room resources by creating two separate procedures. I have three questions:

First, was there a sentinel case that resulted in the change to utilize a staged approach? Second, have you considered an institutional cost analysis? And third, have you considered cold preservation of the deep veins to allow excision and thigh closure at the first operation and not subject the thighs to added surgery with the second stage?

Dr Ahsan T. Ali. In regards to the first question, there was no sentinel case. We had a patient, we had some information on him, and he was scheduled for a NAIS on a Wednesday. The idea came to us to harvest his veins and mobilize them on Tuesday that will save 2 or 3 hours. I would like to emphasize that harvest of the vein

by someone who hasn't done it before can be tedious and actually should be done a nonhurried manner.

To answer the second question; I completely agree. I think it is more costly. It involves a second anesthesia, but these are very complex patients. There is no simple solution. I think the hospital regards this as a very specialized procedure that I don't think there is a pattern to these patients.

Lastly, we did consider having vein completely harvested a day before and placed in a preservation solution and just closing the incisions permanently, but if you come up short by a centimeter or two, you are going to be kicking yourself, that why didn't I take the appropriate length. I guess you can take extra length, but we have not done that.