

# Arterial Allograft Allows In-line Reconstruction of Prosthetic Graft Infection with Low Recurrence Rate and Mortality

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Surgical management of infected prosthetic vascular grafts is associated with a significant risk of recurrent infection, limb loss, and mortality. Treatment options include graft excision with extra-anatomic bypass and in-line repair with prosthetic graft, vein, or artery. We hypothesized that in-line reconstruction using cryopreserved arterial allografts would be associated with a lower recurrent infection rate, limb loss, and mortality than other alternatives. We reviewed all cases where adults underwent surgical management of infected prosthetic aortic, iliac, or femoral bypass grafts with cryopreserved arterial allograft at our medical center from 2001 to 2008. Cryopreserved arterial allografts were used in 21 patients. There were nearly equal number of men (n = 11, 52%) and women (n = 10, 48%). The median age was 63 years and median time since cryoartery repair was 4 years. There have been no deaths in the follow-up period. Complications (19%) included colon perforation (n = 1), lower extremity compartment syndrome (n = 1), limb ischemia (n = 1), and reinfection with pseudoaneurysm and subsequent limb amputation (n = 1). These positive findings of low morbidity and absence of mortality in high risk patients have resulted in a shift at our institution to the preferential use of cryopreserved arterial allograft with in-line reconstruction for infected prosthetic grafts.

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VARIOUS SURGICAL OPTIONS exist to treat prosthetic vascular graft infection, including graft excision with extra-anatomic bypass, in-line repair with antibiotic-bonded prostheses, or autogenous repair with vein, such as the neo-aortoiliac system.<sup>1, 2</sup> Each type of surgical management is associated with the risk of recurrent infection, limb loss, and mortality. Traditionally, the most widely accepted surgical treatment is complete graft excision and extra-anatomic bypass through a noninfected field. Limitations associated with this approach include length of procedure time, thrombosis, aortic stump blowout, and pelvic or colon ischemia due to difficulty revascularizing the inferior mesenteric artery and internal iliac arteries.<sup>2-4</sup> Recent studies suggest that *in situ* replacement may result in equal or improved outcomes to extra-anatomic bypass in appropriately selected patients.<sup>3</sup> Although there have been no randomized trials to directly compare the

options for surgical management of infected prosthetic vascular grafts, cryopreserved arterial in-line reconstruction is an alternative to extra-anatomic bypass in selected patients,<sup>5</sup> and has the advantage of a thick-walled autogenous conduit that is resistant to reinfection and rupture. Although some studies have combined the use of cryopreserved and freshly harvested cadaveric artery and vein for in-line reconstruction, there are limited data on the use of cryopreserved arterial segments for the repair of prosthetic graft infections.

## Objective

The purpose of this paper was to evaluate the use of in-line reconstruction of prosthetic graft infection using cryopreserved aorto/ilio/femoral arteries at a single academic medical center. We hypothesized that in-line repair with these segments would be associated with a lower recurrent infection rate, limb loss, and mortality rate than other reconstruction alternatives.

## Methods

We performed a retrospective review of all patients who underwent surgical management of infected

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prosthetic aortic, iliac, or femoral bypass grafts with cryopreserved arterial allografts at our medical center from January 1, 2001 to December 31, 2008. This cohort of patients was then examined for outcomes, including recurrent infection, limb loss, stenosis, aneurysm formation, death, and need for reoperation. Data were collected in accordance with requirements of our Institutional Review Board. Diagnosis of prosthetic graft infection was made based on fever, elevated white blood cell count, draining sinus tract, inguinal or retroperitoneal abscess on CT scan, and/or absence of graft incorporation at the time of the reoperative procedure. Vascular reconstructive surgery used CryoArtery® (CryoLife, Inc., Kennesaw, GA) Aortoiliac and Femoral Artery at the discretion of the attending surgeon. Follow-up for postreconstruction patients was 100 per cent.

### Results

Twenty-one patients underwent in-line arterial reconstruction using cryopreserved arteries for prosthetic arterial graft infections, with nearly equal numbers of men (n = 11, 52%) and women (n = 10, 48%). The median age was 63 years, ranging from 35 to 83 years. The majority of patients had cardiovascular disease (71%, Table 1), including congestive heart failure, coronary artery disease, myocardial infarction, and hypertension. Four patients in our cohort had malignancy, including bladder, laryngeal, and mandibular cancer and lymphoma. Two patients had Buerger's disease and one had a known hypercoagulable state.

Table 2 lists the organisms grown from infected prosthetic grafts. The majority of grafts were infected with *Staphylococcus aureus* (n = 5, 24%), *Enterococcus faecalis* (n = 3, 14%), and *Escherichia coli* (n = 2, 10%). No organism was cultured in five patients (24%) with clinical signs of infection and lack of graft incorporation; cultures were not sonicated for slime-producing bacteria, which might have increased the culture yield.

TABLE 1. Characteristics of Patients with Arterial Graft Infections

Comorbidity	n	%
Cardiovascular (CHF, MI, CAD, HTN)	15	71
Hyperlipidemia/hypercholesterolemia	10	48
Diabetes mellitus	5	24
Malignancy	4	19
Cerebrovascular	2	10
Buerger's disease	2	10
Nephropathy	2	10
Previous below knee amputation	2	10
Hypercoagulable state	1	5
Hepatitis	1	5

CHF, congestive heart failure; MI, myocardial infarction; CAD, coronary artery disease; HTN, hypertension.

TABLE 2. Organisms Detected from Infected Arterial Grafts

Organism	n	%
<i>Staphylococcus aureus</i>	5	24
<i>Staphylococcus epidermidis</i>	1	5
<i>Staphylococcus coagulase negative</i>	2	10
<i>Pseudomonas aeruginosa</i>	1	5
<i>Enterococcus faecalis</i>	3	14
<i>Escherichia coli</i>	2	10
<i>Klebsiella pneumoniae</i>	1	5
<i>Bacteroides fragilis</i>	1	5
No organism cultured (sonication not used)	5	24

Reconstructions performed (aortic, iliac, and lower extremity) are outlined in Table 3. Most reconstructions involved the aorta (n = 11, 52%) via aorta-iliac or aorta-femoral in-line configuration. Four (19%) reconstructions involved common iliac to femoral in-line cryopreserved artery placement and six (29%) involved lower extremity femoral-femoral or femoral-distal reconstruction.

The median time since in-line cryoartery repair was 4 years. During the median UCLA institutional follow-up of 6.2 months, there were no deaths. There were four complications (19%), including reinfection with pseudoaneurysm at the previous repair site and subsequent limb-loss (n = 1), colon perforation (n = 1), compartment syndrome (n = 1), and limb ischemia (n = 1), which required further treatment (Table 4). The patient with pseudoaneurysm underwent a femoral-to-anterior tibial in-line reconstruction with cryopreserved artery and represented with bleeding and drainage at the posterior portion of the right knee. Treatment necessitated an above-knee amputation. The patient with colon perforation underwent an in-line aorta-left common femoral and right common iliac

TABLE 3. In-line Reconstruction Used for Infected Arterial Prosthetic Grafts

Type	n	%
Aorta-bi-iliac	2	9.5
Aortobifemoral	4	19
Aortounifemoral	3	14
Aorta-iliac and aorta-femoral	2	9.5
Common iliac-femoral	4	19
Femoral-femoral	4	19
Femoral-distal	2	9.5

TABLE 4. Outcomes after In-line Reconstruction of Arterial Prosthetic Graft Infection

Morbidity	n	%
Pseudoaneurysm with limb loss	1	4.8
Colon perforation	1	4.8
Limb ischemia	1	4.8
Compartment syndrome	1	4.8

TABLE 5. *Collected Series of In-line Reconstruction for Arterial Prosthetic Graft Infection*

Series	n	Conduit Type	Conduit Location	Recurrent Infection %	30-Day Mortality %
Zhou et al. <sup>5</sup>	42	MCA	Abdominal	0	17
Gabriel et al. <sup>7</sup>	45	IFF	Abdominal, extremity	not known	18
Teebken et al. <sup>8</sup>	42	IFF	Abdominal, extremity	not known	14
Noel et al. <sup>4</sup>	56	MCA	Abdominal	0	12.5
Leseche et al. <sup>9</sup>	28	IFF	Abdominal	0	17.8
Verhelst et al. <sup>10</sup>	90	IFF	Abdominal, extremity	0	18
Desgranges et al. <sup>11</sup>	18	IFF	Abdominal, extremity	6	18
Vogt et al. <sup>12</sup>	12	IFF	Thoracoabdominal	0	8
Kieffer et al. <sup>13</sup>	43	IFF	Abdominal	5	12
Present Series	21	MCA	Abdominal, extremity	5	0

MCA, manufactured cryopreserved artery; IFF, institution-prepared fresh frozen artery.

reconstruction and required an exploratory laparotomy on postoperative day 11 due to a retro-colonic abscess. The in-line reconstruction in this patient was particularly difficult due to a prior left nephrectomy. The patient with compartment syndrome underwent repair for an infected aortobifemoral bypass, initially diagnosed by groin pain and a positive indium-111 white blood cell scan. This complication was managed with a three-compartment fasciotomy. The complication of limb ischemia occurred in a patient that underwent a right common iliac to common femoral bypass with cryopreserved artery for graft infection. The patient subsequently developed right lower extremity rest pain that required angioplasty 6 months after in-line repair; the limb remained viable.

### Discussion

Arterial allografts have been shown in previous studies to be effective initial treatment for the management of infected arterial prosthetic grafts, although availability and durability have been significant issues. In our series, the use of cryopreserved arterial allografts for in-line repair of infected prosthetic grafts has been associated with no mortality and a low incidence of reinfection. Although one patient developed reinfection with pseudoaneurysm formation and resultant limb loss after femoral-to-distal anterior tibial in-line reconstruction, there have been no reinfections of cryoartery reconstructions of abdominal aortic graft infections.

Table 5 outlines a collected review of studies that have used cryopreserved arteries for reconstruction of arterial graft infections, including commercially and institutionally prepared cadaveric arteries. Most studies demonstrate a low incidence of recurrent infection and a 30-day mortality from 8 to 18 per cent. In comparison, our cohort had similar risk factors for arterial graft infections and a much lower incidence of mortality and recurrent infection. This may be due to preservation techniques, as other studies have included fresh frozen allografts with use of M199, RPMI 1640,

and/or 10 to 15 per cent dimethylsulfoxide,<sup>6, 7, 9</sup> among other agents.

There are limitations in the use of cryopreserved arteries for *in situ* reconstruction. These conduits require preordering from the manufacturer with ABO compatibility matching between donor and recipient. The cryopreserved artery is available as an aortoiliac segment and, to our knowledge, a venous cadaveric one-piece equivalent is not available. The aortoiliac segment is expensive, which may preclude use at some centers; however, because the appropriate shape, diameter, and length can be tailored to the individual patient, this fact may reduce operative time and cost. The alternative neo-aortoiliac system procedure requires two-veins (femoral-popliteal)<sup>1</sup> for construction of the neo-aorta, which adds operating room time or requires a separate surgical team for vein harvest. Moreover, the cryopreserved artery has theoretical advantages over cryopreserved or fresh veins. The artery is thick-walled, which makes it a more durable conduit and less susceptible to virulent bacteria and rupture when placed in an infected field. It also does not require splicing of two conduits to create an aortoiliac substitute.

In conclusion, our results in this high-risk group of patients are encouraging and have resulted in a shift at our institution to the preferential use of cryopreserved arterial allografts for in-line arterial reconstruction of most infected prosthetic grafts.

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