# Repair of Thoracic and Thoracoabdominal Mycotic Aneurysms and Infected Aortic Grafts Using Allograft

Joel S. Corvera, MD, David Blitzer, MD, Hannah Copeland, MD, Daniel Murphy, BS, Philip J. Hess, Jr, MD, Saila T. Pillai, MD, MPH, and John W. Fehrenbacher, MD

Division of Cardiothoracic Surgery, Indiana University School of Medicine, Indianapolis, Indiana; and Division of Cardiothoracic Surgery, University of Mississippi School of Medicine, Jackson, Mississippi

*Background.* **Mycotic aneurysm of the thoracic or thoracoabdominal aorta and infection of thoracic or thoracoabdominal aortic grafts are challenging problems with high mortality. In situ reconstruction with cryopreserved allograft (CPA) avoids placement of prosthetic material in an infected field and avoids suppressive antibiotics or autologous tissue coverage.**

*Methods.* **Fifty consecutive patients with infection of a thoracic or thoracoabdominal aortic graft or mycotic aneurysm underwent resection and replacement with CPA from 2006 to 2016. Intravenous antibiotics were continued postoperatively for 6 weeks. Long-term suppressive antibiotics were uncommonly used (8 patients). Follow-up imaging occurred at 6, 18, and 42 months postoperatively. Initial follow-up was 93% complete.**

*Results.* **Men comprised 64% of the cohort. The mean age was 63 ± 14 years. The procedures performed included reoperations in 37 patients; replacement of the aortic root, ascending aorta, or transverse arch in 19; replacement of the descending or thoracoabdominal aorta in 27; and extensive replacement of the ascending, arch, and descending or thoracoabdominal aorta in 4. Intraoperative cultures revealed most commonly *Staphylococcus* (24%), *Enterococcus* (12%), *Candida* (6%), and gram-negative rods (14%). Operative mortality was 8%, stroke was 4%, paralysis was 2%, hemodialysis was 6%, and respiratory failure requiring tracheostomy was 6%. Early reoperation for pseudoaneurysm of the CPA was necessary in 4 patients. One-, 2-, and 5-year survival was 84%, 76%, and 64%, respectively.**

*Conclusions.* **Radical resection and in situ reconstruction with CPA avoids placing prosthetic material in an infected field and provides good early and midterm outcomes. However, early postoperative imaging is necessary given the risk of pseudoaneurysm formation.**

**(Ann Thorac Surg 2018;■:■–■)**


An infected thoracic aortic graft is an uncommon but challenging reoperative problem. For patients who have undergone previous open repair of the thoracic aorta, the infection rate is 0.9% to 1.9% [1–4]. Mortality for reoperative repair is 25% to 75% [2, 3]. Although the increased use of endovascular therapies for primarily descending thoracic aortic disease has reduced morbidity for the initial repair, these interventions are not without infectious complication. The infection rate of an endovascular graft is 0.2% to 0.5% [5–7].

Infection of the native thoracic or thoracoabdominal aorta is another uncommon surgical problem comprising 0.7% to 4.5% of all aortic aneurysms [8]. It has been suggested by Jaffer and Gibbs [9] to treat these entities differently from infected aortic grafts by using operative visceral debranching and thoracic endograft techniques, as the reinfection risk for mycotic aneurysms is less than that of infected grafts. In contrast to this strategy, we have approached primary aortic infections and infected aortic grafts similarly using radical open debridement and in situ repair with cryopreserved allograft (CPA). The bulk of the surgical literature on mycotic aortic aneurysm regards the abdominal aortic and aortoiliac location and mortality is 30% to 40% [9, 10].

While a prosthetic graft has a substantial risk for reinfection when placed in an infected field, CPA has demonstrated resistance to infection and has proven results treating prosthetic and native aortic valve endocarditis [8, 11–15]. Operative results using CPA for native and prosthetic arterial infection still have significant morbidity and mortality in abdominal aortic and peripheral arterial applications; however CPA repair has durable and reinfection-free midterm outcomes [16–20]. Vogt and colleagues [21, 22] described improved early

Accepted for publication April 17, 2018.

Presented at the Sixty-fourth Annual Meeting of the Southern Thoracic Surgical Association, San Antonio, TX, Nov 8–11, 2017.

Address correspondence to Dr Corvera, Department of Clinical Surgery, Indiana University School of Medicine, 1801 N Senate Blvd, Suite 3300, Indianapolis, IN 46202; email: jcorvera@iuhealth.org.

Dr Fehrenbacher discloses a financial relationship with CryoLife.



0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2018.04.050

and late survival using CPA with direct comparison to prosthetic graft in both thoracic and abdominal aortic application. The 2016 American Heart Association Scientific Statement [8] on vascular graft infection, mycotic aneurysm, and endovascular infection provides a Class IIa recommendation for the use of in situ reconstruction using CPA for thoracic aortic graft infection.

This analysis represents the largest study of the use of CPA for in situ reconstruction of the thoracic and thoracoabdominal aorta in the setting of mycotic aortic aneurysm or infection of a prosthetic aortic graft.

## Patients and Methods

The Institutional Review Board of Indiana University approved the study. A retrospective review was performed of 50 consecutive patients who underwent reconstruction using CPA for an infected thoracic or thoracoabdominal aortic graft or a primary infection of the thoracic or thoracoabdominal aorta between January 1, 2006, and December 31, 2016. Patients with isolated aortic valve endocarditis (native or prosthetic), isolated infrarenal mycotic aneurysm, or infected infrarenal graft without a proximal thoracoabdominal aneurysm who had repair with CPA were excluded from the study.

The diagnosis of an infected thoracic or thoracoabdominal aortic graft was made based on the presentation of a constellation of (1) symptoms including fever and sepsis; (2) abnormal laboratory studies including elevated C-reactive protein, sedimentation rate, procalcitonin, or white blood cell count; (3) positive blood cultures or positive cultures of other infectious foci; and (4) radiographic studies showing pseudoaneurysm, abnormal fluid, or air around a surgical graft or endograft. The diagnosis of a mycotic aneurysm includes 1, 2, and 3, and radiographic studies showing a pseudoaneurysm with or without stranding, periaortic fluid, or air that was not thought to be an atherosclerotic penetrating aortic ulceration. Radioisotope-tagged white blood cell scans were not routinely used as a diagnostic study given its lack of specificity [8]. Positron emission tomography with computed tomography (PET-CT) was not used in this study to confirm the presence of an infected graft or mycotic pseudoaneurysm. PET-CT may have a high positive and negative predictive value for graft infection and provides valuable information in the diagnosis of mycotic aneurysm [8, 23–25]. Since the conclusion of this study, we have been using PET-CT when other clinical features were equivocal.

Patients were placed on broad spectrum or specific antibiotics according to the preoperative cultures obtained. The surgical principles of radical debridement of infected and devitalized tissue, foreign material, and prosthetic graft were followed. Aortic reconstruction was performed using ascending or arch, descending aortic, aortoiliac, and femoral artery CPA (CryoLife, Inc, Kennesaw, GA; LifeNet Health, Virginia Beach, VA). To reconstruct the main body aorta, nonvalved ascending and arch CPAs were sutured end to end to reconstitute the aorta. Occasionally, descending CPA was used for a smaller-diameter descending or thoracoabdominal aortic reconstruction. The brachiocephalic branches of the CPA arch were used to attach brachiocephalic or visceral vessels. For thoracoabdominal aortic reconstruction, femoral artery and aortoiliac CPAs were attached to the main body CPA to revascularize visceral arteries. In patients with aortic repair encompassing the aortic root, ascending aorta, and transverse arch, 1.3 $\pm$ 0.5 ascending or arch CPAs were used. In patients with descending or thoracoabdominal aortic repair, 1.9 $\pm$ 1.0 CPAs were used. In extensive ascending, transverse arch, and descending or thoracoabdominal aortic reconstruction, 3.3 $\pm$ 1.3 CPAs were required.

For operations involving the descending or thoracoabdominal aorta with or without arch replacement, our technique has been described elsewhere using deep hypothermia and circulatory arrest [26–28]. Lumbar drains were not placed given the risk of epidural space infection. Motor-evoked potentials and somatosensory evoked potentials were monitored intraoperatively. In the absence of placing lumbar drains for spinal cord ischemia, if the motor-evoked potentials were absent in the lower extremities, aggressive blood pressure elevation was initiated.

Teflon-felt pledgets, which have a high risk for reinfection, were avoided. Self-made CPA tissue pledgets were used if the anastomoses required hemostatic sutures. Adhesive glues or hemostatic gels were not used to avoid placing foreign body in the infected surgical field.

Intraoperative cultures were taken to guide postoperative antimicrobial treatment. In the event that preoperative and intraoperative cultures were negative, broad-spectrum antibiotics were administered. Intravenous antimicrobials were given for 6 weeks postoperatively. Long-term oral agents were administered on a case-by-case basis. Follow-up CT angiograms were performed at 6 months, at 1 year, and biannually thereafter. New pseudoaneurysm formation was interpreted as CPA suture line disruption and surgical reintervention was recommended.

Follow-up was documented in the electronic medical record of our institution. Forty-three of 46 (93%) operative survivors had at least 1 follow-up visit. Mean follow-up was 36 $\pm$ 34 months. Median follow-up was 25 months.

The study is retrospective. Continuous variables are represented as the mean with standard deviation or median with interquartile range. Categorical variables are represented as the number and percentage of the cohort. Mortality was identified by the electronic medical record of Indiana University School of Medicine, the Indiana Health Information Exchange, and the Social Security Death Index. Kaplan-Meier estimates of survivor function and corresponding 95% confidence intervals were calculated and plotted. The statistical software package employed was R (R foundation for Statistical Computing, Vienna, Austria).

## Results

The preoperative patient characteristics are included in Table 1. The mean age was 63 $\pm$ 14 years. Men comprised