Successful Salvage of an Extracardiac Fontan in the Setting of Purulent Mediastinitis using Antibiotic-Impregnated Beads

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Abstract

Keywords

- ▶ mediastinitis
- ▶ Fontan
- ▶ salvage
- ▶ antibiotic beads

Post-cardiotomy mediastinitis is an especially serious complication after the implantation of prosthetic vascular grafts. Standard of care is irrigation, debridement, and removal of all prosthetic material present in the surgical field. The use of antibiotic impregnated beads at the site of infection has been reported in the salvage of vascular grafts in the adult population. We present the case of a 3-year-old child with hypoplastic left heart syndrome who developed mediastinitis following the Fontan operation. In a nontraditional approach, the Fontan conduit, which was surrounded by gross purulence, was successfully salvaged with the adjunctive use of vancomycin-impregnated beads.

Introduction

The goal of staged reconstructive surgery for children with single-ventricle defects is ultimately to achieve a modified Fontan circulation. This circulation allows systemic venous blood from both the superior vena cava and inferior vena cava (IVC) to return to the pulmonary arteries directly, thereby separating the systemic and pulmonary circulations. Post-cardiotomy mediastinitis is a serious complication affecting 0.2 to 2.0% of the congenital heart surgery population.^{1–6} The presence of prosthetic material makes mediastinitis a particularly difficult infection to eradicate. The modified extracardiac Fontan operation is typically performed with some form of prosthetic material (GoreTex or Dacron) to create a conduit between the IVC and the pulmonary arteries. In managing infected surgical fields, surgical dogma dictates removal of all prosthetic material (taking down the Fontan and reverting to the Glenn cavopulmonary shunt). We present the case of a 3-year-old child whose grossly infected extracardiac Fontan conduit was salvaged with the adjunctive use of locally placed vancomycin-impregnated beads.

Case Summary

This was a 3-year-old girl with hypoplastic left heart syndrome palliated to an extracardiac Fontan using a nonfenestrated, 18-mm Dacron tube graft. The child had excellent pre-Fontan hemodynamics and was thriving with good nutrition. The operation was uneventful using cardiopulmonary bypass and no ischemic time. Preoperative methicillin-resistant *Staphylococcus aureus* (MRSA) screen was negative. The sternum was closed at the completion of the operation, and the child was extubated within 4 hours. Her postoperative course included 48 hours of cefazolin dosed appropriately for her weight. She remained well saturated, afebrile, and did not develop pleural effusions. Her chest tubes were removed on postoperative day 7, and she was discharged home on postoperative day 9. Within 2 days of discharge, she developed purulent drainage from the lower aspect of her surgical incision and was readmitted with fever and malaise. The surgical wound was locally explored and cultured, and she was started on empiric vancomycin. The culture of the surgical site grew MRSA. A transthoracic echocardiogram showed a large mediastinal effusion

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without intracardiac involvement. Her fevers persisted, and blood cultures also grew MRSA. Chest computed tomography demonstrated two mediastinal abscesses: one in the inferior aspect of the anterior mediastinum with fistulous connection to the skin and a second abscess extending between the ascending aorta and the SVC and surrounding, but not compressing, the extracardiac Fontan graft. There were minimal pleural effusions and no ascites (—Fig. 1).

In the ominous presence of computed tomography (CT)-confirmed abscess surrounding a Dacron extracardiac Fontan, we returned to the operating room for a redo sternotomy and inspection of the conduit. There was extensive inflammatory response and large amounts of fluid throughout the mediastinum with an alarming amount of purulence surrounding the Fontan conduit. Fortunately, all visible suture lines were intact. The gross abscess was evacuated, and extensive antibiotic pulse irrigation was used. The mediastinum was drained, and the sternum was left open with the use of a silver-impregnated vacuum-assisted closure (VAC) sponge placed on negative pressure (–25 mm Hg). Systemic antibiotics and enteral nutrition were continued, and the patient remained stable though her ventricular function was markedly decreased.

We performed daily washouts with antibiotic pulse irrigation (50,000 units of bacitracin/L of normal saline) for 4 consecutive days to control overwhelming contamination. At the time of the final washout, the Fontan conduit appeared free of gross purulence. The conduit was then covered with numerous vancomycin-impregnated beads. The mediastinum was drained, and the sternum was closed. The sternum remained healthy and required minimal debridement. The patient demonstrated no further signs of infection, and blood cultures remained negative. Echocardiography, 1 week post-operative, showed continued poor ventricular function but no tricuspid valve regurgitation and no arch gradient. Over the next few days, the patient developed an oxygen requirement, and ultrasound demonstrated persistent right-sided pleural effusion, mild ascites, and moderate hepatomegaly.

Fig. 1 CT with contrast demonstrating the large superior mediastinal abscess (A) immediately surrounding the extracardiac Fontan graft (B). CT, computed tomography.

Given these findings, there was concern for a failing Fontan circulation, and transplant evaluation was initiated. Cardiac catheterization found elevated right ventricular end diastolic pressure (RVEDP) to 18 to 19 mm Hg and pulmonary artery (PA) pressure elevated to 25 mm Hg. The patient was successfully listed for transplant (Status 2). She completed a 6-week course of intravenous (IV) vancomycin and, over that time, improved clinically and was able to be weaned from oxygen and inotropic support and transitioned to oral diuretics. Transthoracic echocardiogram at discharge showed mildly reduced systolic function and a patent Fontan graft with laminar flow. The patient's transplant status would be downgraded at her 3-month follow-up. Repeat cardiac catheterization at 6 months postdischarge demonstrated markedly improved Fontan hemodynamics with an RVEDP of 8 and PA pressure of 12 to 13. She was ultimately removed from the transplant list and has continued to thrive, now 18 months from presentation, without signs of recurrent infection or symptoms of cardiac failure.

Discussion

Mediastinitis in the pediatric population following cardiac surgery is relatively uncommon.^{1–6} Many of the risk factors for post-cardiotomy infection in the adult population are not applicable in children. Intraoperative introduction of organisms is thought to be the primary etiologic process. Mediastinitis typically presents days to weeks after cardiac surgery and requires surgical drainage and debridement for cure.⁴ The presence of prosthetic material, such as the Fontan conduit itself, presents a complicated challenge as the graft is often colonized by the infectious agent. The development of biofilms and the lack of native host factors make infection of the graft itself almost impossible to clear with washout and systemic antibiotics alone. Traditionally, the treatment for a prosthetic graft infection involves removal of all prosthetic material.⁷ In this case, as in other staged procedures, treatment would necessitate taking down the Fontan and reverting to a Glenn cavopulmonary shunt.

Graft-sparing techniques have been described, including wrapping the infected graft with translocated greater omentum, by Bernier et al in a 3-year-old child with an extracardiac fenestrated Fontan.⁸ We report our experience using traditional washout with adjunctive placement of antibiotic impregnated beads in the successful salvage of a Dacron Fontan conduit in the setting of post-operative, purulent mediastinitis.

The use of antibiotics beads is a proven method for the treatment of orthopaedic, soft tissue, and peripheral vascular graft infection in adult populations.^{9–11} Additionally, their use has been documented in the successful salvage of thoracic grafts and prosthetic devices in the adult population.^{12–14} Antibiotic beads have been devised by the mixture of various antibiotics with polymethyl methacrylate, which requires subsequent removal, or, alternatively, bio-absorbable calcium sulfate bone wax.^{13,15} In this case, we used a mixture of 3-g vancomycin powder with 3cc of normal saline. This mixture is formed into a slurry ball that can be molded into any size or

shape. The efficacy of this technique is founded on the delivery of high concentrations of antibiotic at the site of the infected graft by elution over time while avoiding substantial systemic absorption.^{16,17} The in vitro pharmacokinetics of antibiotic beads (of varying antibiotic and carrier compositions) have been studied well,¹⁸ while in vivo studies are more limited in scope.¹⁹ The local concentration and duration of antibiotic delivery in this specific approach to Fontan salvage is still to be established.

This case represents anecdotal evidence that the use of antibiotic impregnated beads can facilitate the treatment of a recalcitrant infection allowing successful salvage of an infected extracardiac Fontan conduit. While this technique may not be the standard of care, it provides a potential alternative when removal of graft material is prohibitively risky. Naturally, it is hard to predict the clinical course had the Fontan been taken down at the initial presentation. Since there were no physiologic symptoms of septic shock, we felt leaving the graft in situ was a reasonable alternative. The use of antibiotic impregnated beads could be considered in any pediatric patient for the treatment of postoperative mediastinitis where infected prosthetic material must be salvaged. This approach is a simple adjunct to traditional mediastinal washout with prolonged systemic antibiotic administration and does not require novel surgical technique. Furthermore, combination of this adjunctive therapy with other reported approaches to graft salvage, such as omental translocation, could work synergistically to provide an alternative to traditional graft removal, washout, reversion of circulation, and re-do Fontan procedure.

Conflict of interest
None.

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