

An Easy Modification of Tube Graft Interposition During Fenestration in Borderline Fontan Circulation

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One of the options for the management of borderline/failing extracardiac Fontan circulation is surgical creation of an atrial fenestration to decompress the systemic venous compartment and improve cardiac output. Depending on the body surface area of the patient, a 5- to 10-mm polytetrafluoroethylene (PTFE) tube graft can be used. When fenestration is required in a patient with failing Fontan circulation, particularly in redo cases, application of a

side-biting clamp may be challenging because of adhesions and a thickened atrial wall. In this article, we present our off-pump technique of atrial-side anastomosis of PTFE graft interposition between an extracardiac Fontan conduit and the atrium without using a side-biting clamp.

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The surgical creation of the right-to-left shunt either through direct fenestration or polytetrafluoroethylene (PTFE) tube graft interposition between the atrium and the Fontan conduit is one of the options for the management of a borderline or failing Fontan circulation [1–5]. The result, at the expense of some degree of desaturation, is a decompressed systemic venous compartment and improved cardiac output. In addition to extensive adhesions leading to difficulty in demarcating the atrioventricular groove (particularly in repeated sternotomy cases), hypertrophy of the atrial wall complicates the application of a side-biting clamp on the atrium during the fenestration procedure. In this article, we report a convenient off-pump technique in which PTFE tube graft interposition between the atrium and the Fontan conduit was performed without application of a side-biting clamp on the atrium.

A 20-year-old male patient with a history of tricuspid atresia, ventricular septal defect, and previous right bidirectional cavopulmonary anastomosis along with atrial septectomy was admitted to our department. He was in sinus rhythm and his condition was classified as New York Heart Association class III. Peripheral oxygen saturation (Spo₂) was 75% to 80%. Preoperative echocardiography revealed a functioning right bidirectional cavopulmonary anastomosis, unrestrictive interatrial communication, and mild left ventricular systolic dysfunction. He had no left atrioventricular valve insufficiency.

On preoperative catheterization, the mean pulmonary artery pressure was 13 mm Hg. A major aortopulmonary collateral artery was closed using a vascular plug. Under

mild hypothermic cardiopulmonary bypass, the Fontan completion was performed using a 22-mm-diameter handmade bovine pericardial tube. On the second postoperative day, the patient's hemodynamic status deteriorated, with an increasing need for inotropic support, and acute renal failure necessitating hemodialysis. The Spo₂ decreased to 70%. The central venous pressure was 22 mm Hg. Recatheterization was performed for the assessment of Fontan circulation. The mean pressure in the Fontan tube was 23 mm Hg. There was no stenosis in the Fontan conduit. Because of high systemic venous pressure, the fenestration procedure was performed as described in the following section.

After fenestration, Spo₂ improved to 90% with a fraction of inspired oxygen of 40%. The pressure in the Fontan tube decreased to 11 mm Hg. In the early postoperative period, fractional shortening of the left ventricle improved from 30% to 44%, and renal dysfunction subsided. The patient was discharged with a good clinical (Spo₂, 92%) and hemodynamic condition on the 20th postoperative day.

Technique

The principle of this technique is to ease the performance of the atrial-side anastomosis of the tube fenestration between the atrium and the extracardiac Fontan conduit. The procedure was performed without using cardiopulmonary bypass. In determining the atrial side of fenestration, the most suitable location of the free wall of the atrium and the best possible geometry of the fenestration tube should be taken into consideration. The desired puncture site of the atrial wall, which would be its relatively thinner part, can easily be determined with simple palpation.

Two pledgeted purse-string sutures of 4-0 polypropylene were placed at the atrial wall in the predefined area of 1.5 to 2 cm² and snared. The body surface area of our case was 2.16 m². Depending on the body surface area

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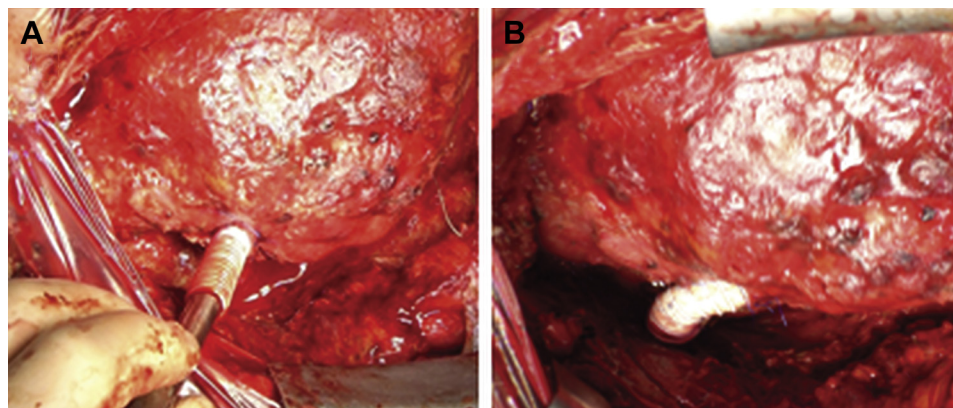


Fig 1. Surgeon's view revealing (A) inserted and fastened polytetrafluoroethylene (PTFE) (10-mm in our case) tube graft using 2 pledgeted reinforced purse-string sutures while the Hegar dilator was in graft and (B) completed PTFE tube fenestration between Fontan tube and atrium.

of the patient, a ringed PTFE tube graft, 5 to 10 mm in diameter, is cut to suit the length (2.5–3 cm in our case) of the fenestration tube. A Hegar dilator the same size of the PTFE tube graft was placed into it. The puncture of the atrium was performed, and bleeding was manually controlled. The puncture site of the atrium was dilated by using smaller-sized Hegar dilators before the insertion of the PTFE graft. Additionally, during puncture, the surgeon should consider the thickness of the atrial wall. The PTFE tube graft along with the Hegar dilator was inserted into the atrium (Figs 1A, 2). According to the estimated atrial wall thickness, 2 to 3 rings should be placed in the atrium. At this point, the dilator prevented bleeding. The purse-string sutures were tied while the dilator was still in the graft to prevent the graft from narrowing because of the effect of the purse-string sutures (Figs 1B, 2). To securely stabilize the graft in place, three interrupted 4-0 polypropylene fixation sutures were placed. During removal of the Hegar dilator from the graft, particular

attention should be paid to prevent air embolism. For this purpose, the patient was put in a head-down position, the lungs were manually distended, and a little pressure was applied on the atrium to increase intraatrial pressure and allow blood to spill over the PTFE graft before clamping it. During anastomosis of the PTFE graft to the Fontan tube, a side-biting clamp was applied to the Fontan conduit. With the completion of the anastomosis and before tying the suture, the side-biting clamp on the Fontan conduit was removed first for removal of air from the PTFE graft. The rest of the procedure was performed in the usual fashion.

Comment

It is well documented that fenestration, either through direct anastomosis or tube interposition, is an effective adjunct in patients with borderline or failing Fontan circulation [3–5]. However, in some cases (particularly in

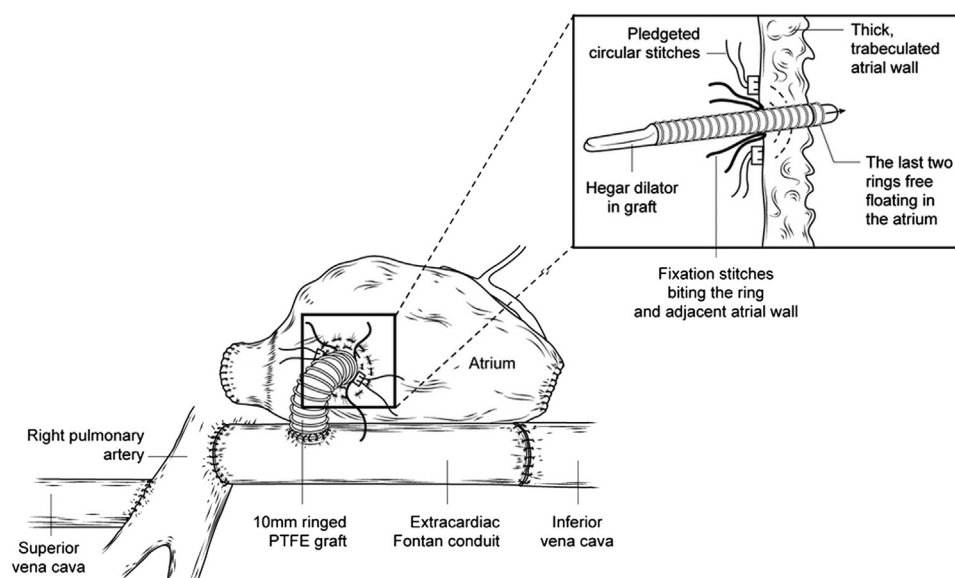


Fig 2. Right lateral view of position of fenestration tube graft. (PTFE = polytetrafluoroethylene.)

repeated sternotomy cases), because of fibrotic epicardial changes and severe adhesions leading to difficulty in demarcating the atrioventricular groove, the right coronary artery may be at risk of injury during application of a side-biting clamp. A hypertrophied atrial wall becomes another challenge in that the application of a side-biting clamp on such an atrium may be difficult, and access to the true lumen of the atrium may be unreliable because of the thickened and trabeculated atrial wall. Therefore, with particular attention paid to the avoidance of an air embolism, our modification seems to be useful for performing a safe, quick, easy, and reliable fenestration without application of a side-biting clamp on the atrium.

For performing this type of modification, we were inspired by Sano and colleagues [6], who described right ventricle-to-pulmonary artery shunting during first-stage palliation of hypoplastic left heart syndrome. When a ringed PTFE graft is to be used in this technique, 2 pledgeted purse-string sutures are placed around the ventriculotomy. With 2 rings inside the ventricle, the graft is inserted into the ventriculotomy. Tweddell and associates [7] have recently described the “dunk technique,” which is similar to Sano and colleagues’ technique except for ventricular muscle resection. In conclusion, our modified technique seems to provide an easy, quick, and reliable atrial connection for

fenestration of the Fontan circulation in patients with a thickened and hypertrophied atrial wall, especially in redo cases.

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