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SURGICAL TECHNIQUE

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Modified extracardiac Fontan with a fenestrated pericardial patch

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Abstract

Extracardiac Fontan is a preferred treatment strategy in many centers treating patients with single ventricle physiology, and many of these centers regularly include a fenestration between the extracardiac conduit and the common atrium. Spontaneous closure of the fenestration is a common complication of this technique and is independently associated with increased morbidity and mortality. Recently, we introduced a novel technique for fenestration of the extracardiac conduit wherein a pericardial patch is utilized at the fenestration point with excellent outcomes in the midterm fenestration patency rates, thus reducing the risk of acute post-Fontan complications.

KEYWORDS
congenital heart disease

1 | INTRODUCTION

In many centers that treat single ventricle physiology, the Fontan procedure with an extracardiac conduit has become the surgical technique of choice. While there is an ongoing debate about the clinical benefit of a fenestration between the conduit and the common atrium many centers regularly employ such a fenestration in their surgical strategy.[1]

Short-term patency of the fenestration is a technical challenge in itself and there is still no consensus on a practical and effective technique to ensure long term patency of the fenestration for as long as it is physiologically required.[2] Several techniques have been proposed, but none of these have proven to be definitively effective.[3,4] Below, we describe a case series of patients undergoing extracardiac Fontan with a modification that includes the interposition of a fenestrated biological patch between the conduit and the common atrium as a strategy for improved long term patency of the fenestration.

1.1 | Technique description

After a repeat midline sternotomy, all required cardiovascular structures are carefully identified and isolated including the aorta, common atrium, inferior vena cava (IVC), and the previously created bidirectional cavopulmonary connection (BCPC). After establishing normothermic aortobicaval cardiopulmonary bypass on a beating heart, the inferior atriocaval junction is snared and divided, and the atrial side is closed with a doubly reinforced running suture. The IVC cuff is then anastomosed end-to-side to an 18 mm polytetrafluoroethylene (PTFE) conduit. Subsequently, the right pulmonary artery (RPA) is temporarily occluded proximally and distally, and an incision is made below the previous BCPC. The distal end of the extracardiac conduit, as formed by the PTFE graft, is anastomosed to this inferior side of the RPA. Once the extracardiac graft is completed (Figure 1A1,A2), a 3 × 2 cm oval-shaped window is created on the medial, or atrial facing, a wall of the PTFE conduit (Figure 1B1,B2). An oval bovine pericardial patch of the same size, with a 4.5 mm fenestration, is then sutured on the free edge of this window (Figure 2A1,A2).

A side clamp is then placed on the adjacent atrial wall. The atrium is longitudinally incised and the atrial free edge is directly anastomosed to the pericardial patch 5 mm away from the fenestration (Figure 2B1,B2) (Supporting Information Video 1). After carefully deairing, the side clamp is removed and the RPA and IVC tourniquets are released. The patient is then weaned from cardiopulmonary bypass. Blood flow through the fenestration is verified in the operating room by two-dimensional (2D) transesophageal echocardiography and subsequently by 2D transthoracic echocardiography at the time of hospital discharge.

From June 2008 to December 2018 this technique was adopted in 48 patients who underwent a total cavopulmonary connection (TCPC) in our Institution. With this modification, our fenestration patency rate was 89.6% (43/48 patients) at discharge and 81.2% (39/48) at a mean follow-up of 2.9 years by 2D transthoracic echocardiographic examination. In our precedent 10-year experience, 36 patients underwent a fenestrated extracardiac TCPC with a fenestration patency rate of 61.1% (22-36 patients) at discharge ($P = .04$).

2 | DISCUSSION

While the arguments for the physiological benefit of a fenestrated Fontan, namely augmented cardiac output by improved ventricular preload and reduced systemic venous pressure, are generally accepted, the literature has yet to demonstrate the superiority of this approach.[1] Indeed, the use of this strategy is still influenced by high rates of spontaneous closure of the fenestration in the immediate postoperative period. Indeed, early fenestration closure has also been demonstrated as an independent risk factor for failure and death.[2]

Typically, the physiology of patients after undergoing the Fontan procedure includes many factors that promote thrombotic events, namely venous stasis, low-speed blood flow, and clotting factor abnormalities. In addition to this, the interposition of a prosthetic material within the venous return pathway can itself act as a trigger for clot formation.

The key modifications of the strategy proposed above are not only the use of tissue implants that are less prone to thrombosis, but also to create an atrial anastomosis positioned further away from the fenestration. The use of a relatively robust biological material, such as a pericardial patch, that can sustain adequate tension, reduces the risk of kinking of the conduit and curling at the fenestration and avoids its subsequent closure. A bovine pericardial patch exhibits high biocompatibility, with degrees of stretch and lower thrombogenic risks.[5] Moreover, such a strategy provides a stable landing zone for a closure device, hence facilitating percutaneous closure of the fenestration in the future.

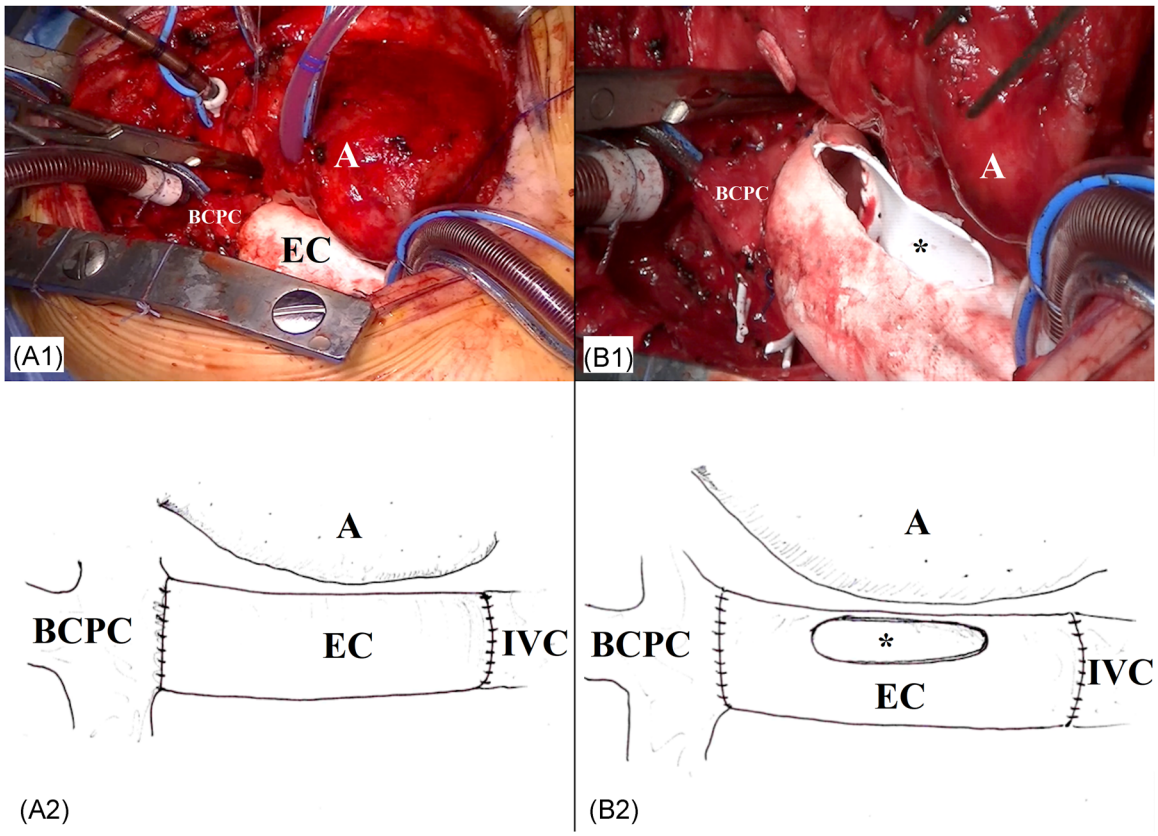

FIGURE 1 Cartoon and matched intraoperative images showing the surgical steps of the extracardiac total cavopulmonary connection with fenestrated pericardial patch interposition. A1, A2, In-situ PTFE extracardiac conduit (EC). B1, B2, A 3 × 1.5 cm window is created on the medial aspect of the conduit (*). A, common atrium; BCPC, bidirectional cavopulmonary connection; IVC, inferior vena cava; PTFE, polytetrafluoroethylene

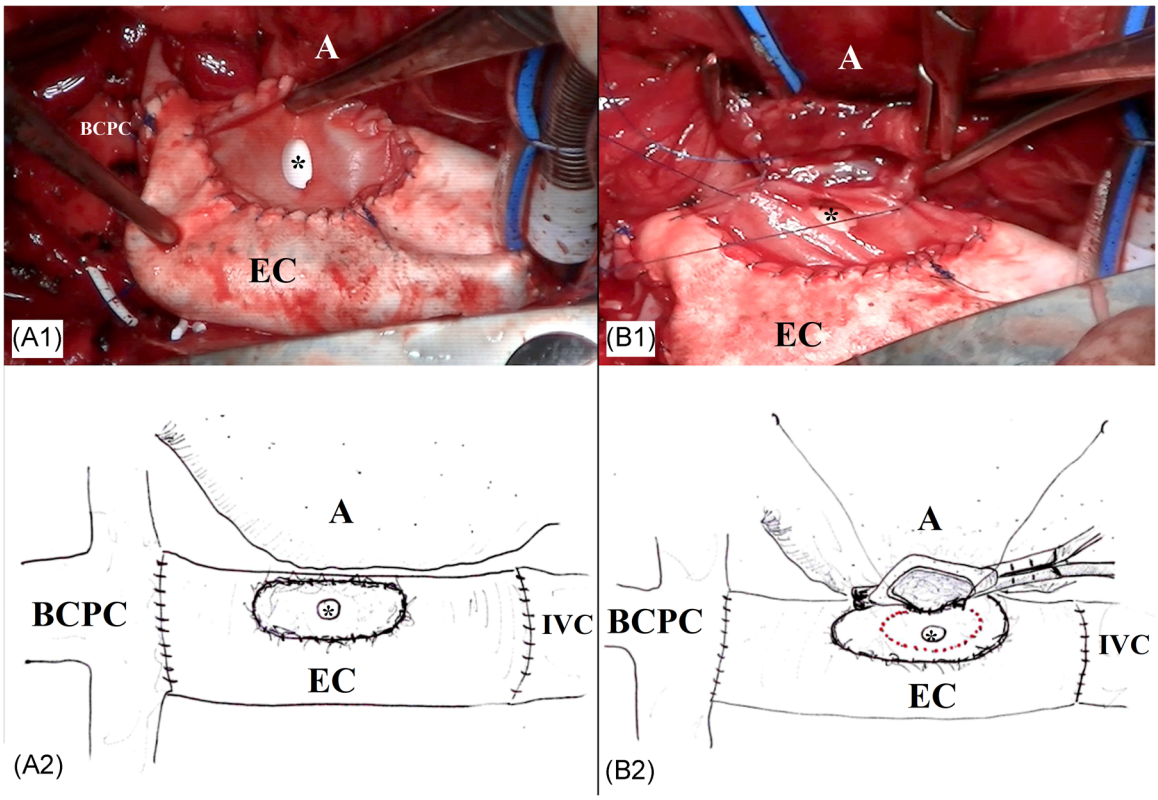

FIGURE 2 Cartoon and matched intraoperative images showing the surgical steps of the extracardiac total cavopulmonary connection with fenestrated pericardial patch interposition. A1, A2, An oval fenestrated bovine pericardial patch is sutured on the conduit window (*). B1, B2, A connection between the common atrium and the biologic patch is created (red dotted line) a few millimeters away from the 4.5 mm fenestration. A, common atrium; BCPC, bidirectional cavopulmonary connection; EC, extracardiac conduit; IVC, inferior vena cava; PTFE, polytetrafluoroethylene

In conclusion, here we introduce an alternative technique for extracardiac Fontan by means of a fenestrated pericardial patch on the extracardiac conduit which improves fenestration patency rates in the midterm postoperative course, thus reducing the risk of acute post-Fontan complications.

AUTHOR CONTRIBUTIONS

All the authors made substantive intellectual contributions to the work described in this paper

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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