Repair Type Influences Mode of Pulmonary Vein Stenosis in Total Anomalous Pulmonary Venous Drainage

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Background. We hypothesized that primary sutureless (SL) repair of total anomalous pulmonary venous drainage (TAPVD) may have a lower incidence of postrepair pulmonary vein obstruction (PVO) and different modes of PVO compared with standard repair (SR).

Methods. One hundred ninety-five patients who underwent TAPVD repair (1990 to 2012) with the exception of congenital pulmonary vein stenosis, isomerism, and single-ventricle anomalies were included. Survival, reintervention, incidence, degree of PVO were compared between groups. The mode of PVO was expressed as central or peripheral. The Mann-Whitney test, Kaplan-Meier analysis, and Cox regression were used.

Results. The SL group had more infracardiac or mixed TAPVD ($p = 0.02$) and preoperative PVO ($p = 0.07$). There were no differences between SR and SL groups in survival (5-year survival, 83.1% versus 82.5%, respectively; $p = 0.73$) and composite outcome (death, intervention, PVO, 5-year survival, 76.4% versus 80.7%, respectively; $p = 0.225$). The SL group had a lower incidence of PVO of moderate or greater degree (SR, 11.3% versus SL, 2.9%; $p = 0.05$) than the SR group, especially in the infracardiac and mixed TAPVD cohort ($p = 0.011$), with a lower pulmonary vein score (SR, 8 versus SL, 4; $p = 0.01$). The SL group had peripheral PVO exclusively (100%), whereas the SR group predominantly had central PVO (76.4%; $p = 0.005$). There was a trend toward less reoperation in the SL group (SR, 10.4% versus SL, 2.9%; $p = 0.08$). Survival after reoperation was comparable to primary TAPVD repair types as well as reoperation repair types.

Conclusions. Primary SL appeared to be associated with a lower incidence and severity of PVO. The primary SL repair eliminated the risk of developing central PVO, although a relatively benign type of peripheral PVO could occur.

(Ann Thorac Surg 2015;■:■–■)

Survival after surgical repair for total anomalous pulmonary venous drainage (TAPVD) has significantly improved during the last few decades with more than 90% hospital survival in the current era [1, 2]. Nevertheless, postrepair pulmonary venous obstruction (PVO) remains the most significant complication, with high morbidity and mortality. With the standard repair (SR), ie, the direct anastomosis between the pulmonary veins (PV) confluence and the left atrium (LA), the incidence of postrepair PVO has been reported to be as high as 20% [1–4]. The location of PVO associated with standard repair (SR) is typically at the anastomotic site, probably owing to the combination of inflammation, fibrosis, and direct purse string effect. However, anastomotic obstruction could result in diffuse PVO through retrograde extension of the fibrotic process into the upstream PVs [5].

Various types of sutureless (SL) techniques have been introduced and proved to be an effective means to relieve postrepair PVO [3, 6–8]. We initially started using SL as primary repair technique for TAPVD subtypes at higher risk of postrepair PVO, such as infracardiac and mixed, or for preoperative PVO [8]. Based on encouraging initial experiences, the SL has become the primary technique adopted for most of the TAPVD forms [9]. The theoretical advantage of SL repair is to lateralize the suture line away from the confluence edge of the PVs, minimizing the mechanical stimuli for developing obstruction (Fig 1A). The potential disadvantage is that the lateralized suture line on the posterior pericardium may irritate individual PVs and cause peripheral obstruction, which can be difficult to treat (Fig 1B). The main hypothesis is that primary application of SL repair may reduce the incidence of postrepair PVO, thereby reducing reintervention and late death. The secondary hypothesis is that patients who received primary SL repair may have more peripheral PVO with involvement of individual PVs. We attempted to answer those

Accepted for publication April 23, 2015.

Presented at the Fifty-first Annual Meeting of The Society of Thoracic Surgeons, San Diego, CA, Jan 24–28, 2015.

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Published by Elsevier

0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2015.04.121

Abbreviations and Acronyms

LA = left atrium
PV = pulmonary vein
PVO = pulmonary vein obstruction
PVS = pulmonary veins score
SL = sutureless repair
SR = standard repair
TAPVD = total anomalous pulmonary venous drainage

questions by comparing clinical outcomes, postoperative echocardiograms, and cross-sectional images between the two different surgical techniques.

Material and Methods

We retrospectively reviewed patients who underwent surgical repair for TAVPD at the Hospital for Sick Children from 1990 to 2012. The Research Ethics Board approved the study and waived the requirement for patient consent. One hundred ninety-five patients who underwent TAPVD repair (SR, n = 126; SL, n = 69) were included. Patients with congenital PV stenosis, TAPVD associated with atrial isomerism, or single-ventricle anomaly were excluded. Patient demographics are shown in Table 1.

Surgical Techniques

The choice of primary repair was based mainly on the anatomic type of TAPVD. Currently, the SL repair is applied for most of the patients unless there is a large confluence with good-sized individual PVs. Cardiac-type TAPVD is typically repaired by unroofing the coronary sinus and performing a patch closure of the atrial septal defect. The SL repair is indicated for cardiac-type TAPVD when a confluence has a narrow connecting vein to reach the coronary sinus or the right atrium or there is a concern of small individual PVs. The SR was achieved by direct anastomosis between the PV confluence and the LA free edge. A detailed description of SL techniques has been previously reported [4, 9, 10]. Briefly, cardiopulmonary bypass is instituted with aortic and bicaval cannulation. Deep hypothermic circulatory arrest was frequently used in the 1990s, but currently the procedure is done in moderate hypothermia with or without intermittent low-flow perfusion to visualize individual veins. Once all PV orifices were inspected, the remaining procedure was completed under mild hypothermia. The PV confluence was unroofed, and the anterior wall of the proximal individual PVs was resected if the orifices were small. A counter-transverse incision was made on the posterior LA wall, and was often extended into the LA appendage as well as the posterior atrial septum. In the SL repair, the LA incision should be larger than with SR to accommodate the larger anastomosis with the posterior

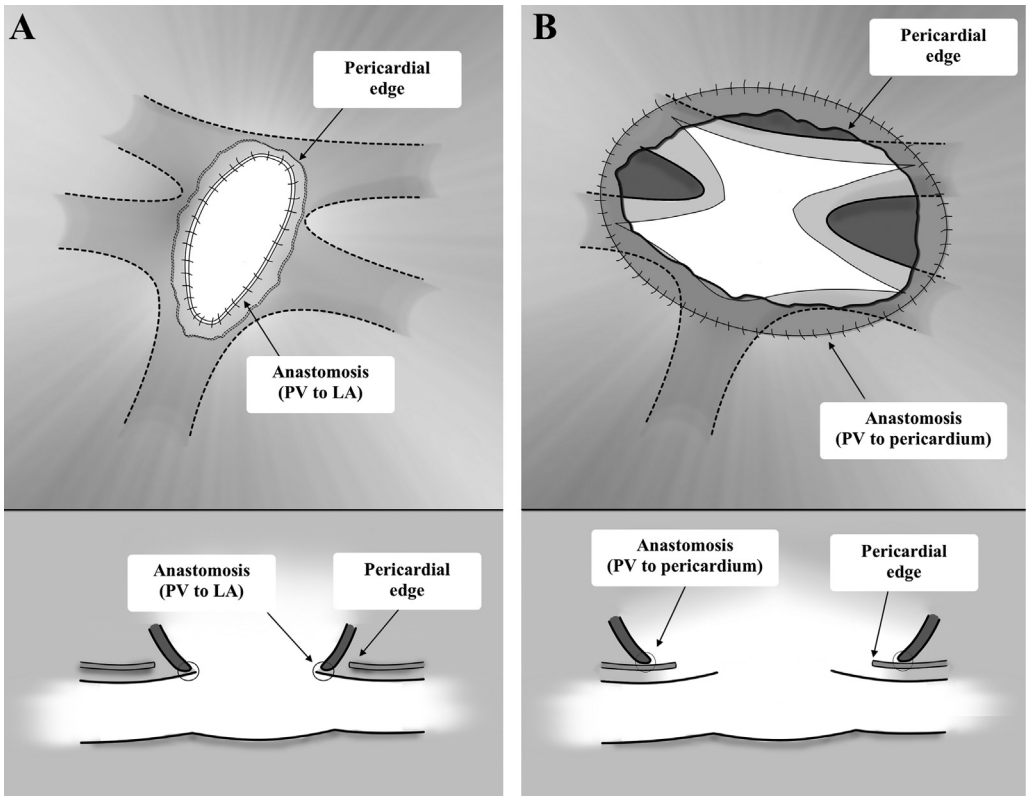

Fig 1. The drawings demonstrate the areas of potential risk of developing pulmonary venous obstruction after (A) standard repair and (B) sutureless repair. (LA = left atrium; PV = pulmonary vein.)