Sinus node dysfunction after repair of partial anomalous pulmonary venous connection

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Objectives: Sinus node dysfunction is known as a major complication after repair of partial anomalous pulmonary venous connection. We retrospectively analyzed the results of the atrial wall flap technique compared with the results of patch repair or direct suturing in the intra-atrial tunnel technique.

Methods: Between 1991 and 2007, 23 patients (mean age, 6 years; range, 5 months–17 years) with partial anomalous pulmonary venous connection underwent surgical intervention. The right anomalous pulmonary veins drained to either the right atrium or superior vena cava in 8 and 15 patients, respectively. Patients were divided into 2 groups: group F (n = 14), who had repair with an atrial flap, and group N (n = 9), who had repair without an atrial flap. All patients had normal sinus rhythm preoperatively.

Results: No patients had signs of superior vena cava or pulmonary venous obstruction within a mean follow-up of 4.8 years. One patient in group F required pacemaker implantation. In the early postoperative period, sinus node dysfunction developed in 93% of group F and 44% of group N patients ($P < .01$) and was prolonged until discharge in 57% of group F and 0% of group N patients ($P < .01$). At the most recent clinical visit, sinus node dysfunction was identified in 50% of group F patients, whereas all patients in group N had normal sinus rhythm ($P < .02$).

Conclusions: The atrial flap technique, which requires incision or suture crossing the crista terminalis, could cause sinus node dysfunction, whereas the intra-atrial rerouting method with a patch or direct suture maintains normal sinus node function postoperatively.

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Received for publication Sept 7, 2007; revisions received Nov 7, 2007; accepted for publication Dec 7, 2007.

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J Thorac Cardiovasc Surg 2008;136:329-34

0022-5223/$34.00

doi:10.1016/j.jtcvs.2007.12.039

Several methods for repairing partial anomalous pulmonary venous connection (PAPVC) to the superior vena cava (SVC) or the right atrium (RA) have been described since 1958.[1] Ideal surgical repair demands complete closure of the atrial septal defect (ASD) and redirection of the anomalous pulmonary veins into the left atrium without either pulmonary venous or SVC obstruction or injury to the sinus node or its blood supply. The atrial wall flap technique, which was originally established in 1985 for the repair of total anomalous pulmonary venous drainage to the SVC,[2] has been applied because the atrial wall flap was expected to grow, resist infection, and persist for the lifetime of the patient. However, undesirable complications, particularly sinus node dysfunction (SND), have been reported. We retrospectively analyzed the results of the atrial wall flap technique compared with the results of patch repair or direct suturing in the intra-atrial tunnel technique.

Materials and Methods

Patients

Between September 1991 and September 2007, 23 patients (11 male and 12 female patients; age at repair, 5 months–17 years; mean age, 5.6 ± 4.7 years; weight, 6.0–70 kg; mean weight, 19.6 ± 16.3 kg) underwent repair of PAPVC to the SVC or RA. This study was approved by the institutional review board, and patients or guardians of the patients provided informed preoperative consent. Additional cardiac anomalies included ventricular septal defect (n = 3),

CHD

Abbreviations and Acronyms

ASD = atrial septal defect
PAPVC = partial anomalous pulmonary venous connection
RA = right atrium
SND = sinus node dysfunction
SVC = superior vena cava

tetralogy of Fallot (n = 2), pulmonary stenosis (n = 2), and coarctation of the aorta (n = 1). The right anomalous pulmonary veins drained to the RA in 8 patients and to the SVC in 15 patients. Sinus venosus ASDs were present in 9 patients, and fossa ovale was present in 12 patients. The atrial septum was intact in 2 patients. Preoperative electrocardiographic analysis revealed normal sinus rhythm in all patients. None of the patients had cardiac isomerism.

Patients were divided into 2 groups: group F (n = 14), who had repair with a right atrial flap, and group N (n = 9), who had no atrial flap. All patients had normal sinus rhythm preoperatively.

Routine postoperative follow-up included a physical examination, electrocardiographic analysis, and transthoracic echocardiographic analysis. The venous structures were assessed for obstruction by means of 2-dimensional echocardiographic visualization and Doppler echocardiography. Two of the more recent patients underwent thoracic computed tomography in addition to echocardiography to optimally visualize the repair site.

Surgical Technique

A median sternotomy was applied in 20 patients, and a right-sided thoracotomy was applied in 3 patients. The SVC and anomalous pulmonary veins were fully mobilized, and the azygous vein was divided. The aortic cannula was placed in position on the ascending aorta. Separate venous cannulas were placed, with the SVC cannulated directly and high near the innominate vein junction. After cardioplegic arrest, intra-atrial rerouting was performed to drain the anomalous pulmonary veins into the left atrium by using an atrial wall flap, a xenograft pericardium patch, or free autologous pericardium (Figure 1). As for the atrial wall flap procedures, a J-shaped right atriotomy was applied to the anomalous pulmonary vein, which drained into the SVC, or a U-shaped right atriotomy was performed to the pulmonary veins, which were connected to the RA (Figure 2). Twelve patients in group F and 4 patients in group N required enlargement or creation of an ASD. In 1984, Warden and colleagues[3] reported a technique in which the SVC was divided, the cephalic SVC was anastomosed to the right atrial appendage, and the caudal SVC served as a conduit for pulmonary venous drainage to the left atrium. The Warden procedure was applied to 13 of the 14 patients (8 patients in group F and 5 patients in group N) with PAPVC to the SVC, whereas for the remaining patient with the left SVC connecting to the right SVC, division of the right SVC was done.

Follow-up

The patients were followed up from 1.7 to 13 years (mean, 4.8 ± 3.3 years). The postoperative electrocardiograms were evaluated immediately after surgical intervention, at discharge (mean, 38.3 ± 18.8 days), or at the most recent clinical visit.

Sinus Node Dysfunction

SND was defined as the presence of any one of the following: (1) minimum or mean heart rate of greater than 2 standard deviations less than the age-adjusted mean, (2) predominant junctional rhythm, and/or (3) sinus pause of 3 seconds in duration.[4-6] Patients with preoperative complete heart block, pacemakers, or both were excluded from the analysis of SND.

Statistical Analysis

The characteristics of the study population are expressed as frequencies, medians with range, or means with standard deviations, as appropriate. Univariate associations with postoperative late SND among clinical variables were obtained with χ^2, Fisher exact, and unpaired *t* tests, and we decided to investigate the risk factor. Furthermore, multivariate logistic regression analysis was performed with variables that reached a *P* value of less than .20 on univariate testing to investigate which of the factors best predicted the postoperative late SND. Data analysis was performed with StatView 5.0 for Windows (SAS Institute, Inc, Cary, NC).

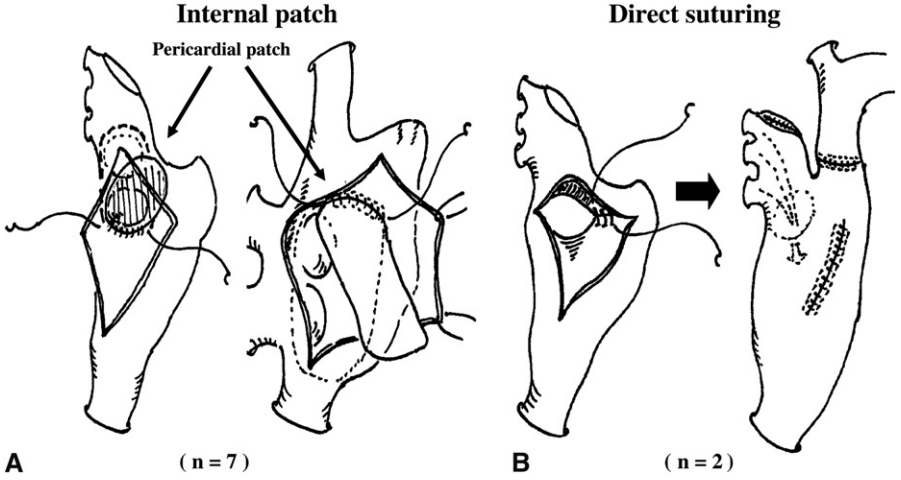

Figure 1. Intra-atrial rerouting with a xenograft pericardial patch or free autologous pericardium (A) or without materials (B).