Outcome following tricuspid valve detachment for ventricular septal defects closure

J.W. Gaynor a,*, J.E. O’Brien Jr. a, J. Rychik b, G.R. Sanchez b, W.M. DeCampli a, T.L. Spray a

a Division of Pediatric Cardiothoracic Surgery, The Cardiac Center at The Children’s Hospital of Philadelphia, 34th Street and Civic Center Boulevard, Philadelphia, PA 19104, USA

b Division of Pediatric Cardiology, The Cardiac Center at The Children’s Hospital of Philadelphia, Philadelphia, PA, USA

Received 10 October 2000; received in revised form 5 December 2000; accepted 30 December 2000

Abstract

Objectives: Detachment of the septal leaflet of the tricuspid valve from the annulus (TVD) has been used to improve visualization of ventricular septal defects (VSDs), but may be associated with increased operative time, heart block, and the development of tricuspid regurgitation (TR).

Methods: Patients undergoing VSD closure between 1/1/96 and 31/12/99 were retrospectively reviewed. Follow-up was obtained from the patients’ cardiologists.

Results: Transatrial VSD closure was performed in 172 patients with TVD in 36 (21%) at the surgeon’s discretion. The leaflet incision was repaired with a separate suture (22) or with the VSD patch suture (14). Additional procedures including arch augmentation, closure of atrial septal defects, and closure of additional VSDs were performed in 93 (68%) non-TVD patients and 20 (56%) TVD patients. The median age was 6.2 months (range 1 day to 46 years) and the median weight was 5.9 kg (range 1.5±71.5 kg). Cardiopulmonary bypass (CPB) time was 64 ± 24 min and cross-clamp time was 34 ± 16 min. One hospital death occurred in an infant with tracheal stenosis. No child in either group developed complete heart block. The median duration of postoperative stay was 4 days (range 2±49 days). There were no differences in CPB time, cross-clamp time or postoperative stay between the TVD and non-TVD groups (P > 0.1 for all). At a mean follow-up of 17 ± 15 months, there have been two late deaths unrelated to cardiac disease. No child in the TVD group required reoperation for residual VSD, compared to three in the non-TVD group. No child in the TVD group has greater than mild tricuspid regurgitation. No child in either group has undergone reoperation for TR. Conclusions: TVD is a safe, effective technique to improve visualization of VSD and is not associated with heart block, increased operative time, or TR. TVD may result in improved preservation of tricuspid valve architecture and decrease the incidence of significant postoperative TR.

Keywords: Ventricular septal defects; Tricuspid valve detachment; Tricuspid regurgitation

1. Introduction

The majority of ventricular septal defects (VSD) can be successfully closed using a transatrial approach working across the tricuspid valve. In some patients, however, chordal attachments of the tricuspid valve obscure the margins of the defect (Fig. 1). In these patients, placement of sutures may be difficult resulting in distortion of the tricuspid valve with regurgitation (TR), residual VSD, and heart block. Detachment of the septal leaflet of the tricuspid valve from the annulus (TVD) to improve visualization of VSDs was initially described by Hudspeth and colleagues in 1962 [1]. There has been concern that detachment of the tricuspid valve leaflet might impair valve function, as well as increase operative time and the incidence of postoperative heart block. Several reports, however, have suggested that TVD is a safe technique to improve exposure for closure of VSDs [2–6]. Despite these reports, TVD has not gained acceptance as a useful and safe technique. The current study was undertaken to review our institutional experience with the use of TVD for closure of conoventricular VSDs.

2. Materials and methods

All patients undergoing transatrial closure of conoventricular VSD in our department (The Children’s Hospital of Philadelphia and Newark Beth Israel Medical Center, Newark, NJ) were eligible for entry into the study. Review of the cardiology and cardiothoracic surgery databases identified 172 patients who underwent transatrial closure of
VSD between 1/1/96 and 31/12/99. Patients with other types of VSDs and patients who underwent VSD closure via either the pulmonary artery or a ventriculotomy were excluded. Review of each patient’s medical record was performed. Follow-up data and echocardiography reports were obtained from medical records and via correspondence with the patient’s cardiologist. The study was approved by the Institutional Review Board of The Children’s Hospital of Philadelphia.

2.1. Operative technique

The technique for VSD closure (patch or primary closure) and the use of TVD was at the surgeon’s discretion. When TVD was utilized to improve visualization, a circumferential incision was made in the septal leaflet 1–2 mm from the annulus (Figs. 1 and 2). If necessary, the incision can be extended onto the anterior leaflet to improve visualization of the superior margin of the defect (Fig. 1). The VSD is closed with a patch using a continuous suture (an interrupted technique can also be used) and the patch is attached to the annulus (Fig. 3). The incision in the leaflet is closed with a second suture. Alternatively, the patch suture can be used to close the incision in the leaflet ‘sandwiching’ the patch between the annulus and the leaflet (Fig. 4). Additional procedures were performed as indicated.

2.2. Statistical analysis

All data are presented as either the mean ± standard deviation or the median and range. Comparisons between patient groups were performed using the two-sample t-test.
the 162 patients in whom postoperative echocardiograms were available. Data analysis was performed using the NCSS (Kaysville, UT) statistical software.

3. Results

Transatrial closure of VSD was performed in 172 patients at a median age of 6 months (range 1 day to 46 years) and a median weight of 5.9 kg (range 1.5–72 kg). TVD was utilized in 36 (21%) patients. The VSD was repaired with a patch in 126 patients and primary closure in the remainder. Suture closure of small VSDs was performed in patients undergoing other procedures (resection of subaortic membrane, division of RV muscle bundle, etc.) and in patients with aortic cusp prolapse and aortic insufficiency. Patch closure was performed in all but two of the TVD patients. The leaflet incision was repaired with a separate suture in 22 patients and using the patch suture in 14 patients. Additional procedures were performed in 113 patients, including closure of atrial septal defects or patent foramen ovale in 55, ligation of patent ductus arteriosus in 39, closure of additional VSDs in ten, arch augmentation or repair of interrupted aortic arch in 11, pulmonary valvotomy or arterioplasty in eight, division of right ventricular muscle bundles in 19, resection of the subaortic membrane in seven, and other procedures in six. Additional procedures were performed in 93 (68%) non-TVD and 20 (55%) TVD patients (\( P > 0.1 \)). The mean cardiopulmonary bypass time was 64 ± 24 min and the mean cross-clamp time was 34 ± 16 min. Deep hypothermic circulatory arrest (DHCA) was utilized in 56 patients, with a mean duration of 32 ± 11 min. There was no difference in bypass time or cross-clamp time between the TVD and non-TVD patients (\( P > 0.1 \)). There was one hospital death in the non-TVD group, an infant with associated tracheal stenosis who underwent tracheoplasty at the time of VSD closure. Postoperative extra-corporal membrane oxygenation (ECMO) support for left ventricular dysfunction was utilized for two patients in the non-TVD group. One patient had recovery of left ventricular function and was successfully weaned. The other child’s left ventricular function did not improve and successful cardiac transplantation was performed. One patient in the non-TVD group underwent reoperation during the same hospitalization for closure of a residual VSD. At the time of reoperation, TVD was utilized to improve visualization. No child in either group developed postoperative heart block or required pacemaker implantation. The median duration of postoperative hospitalization was 4 days (range 2–49 days) and was not different between the TVD and non-TVD groups (\( P > 0.1 \)).

3.1. Follow-up

At mean follow-up of 17 ± 15 months, there have been two late deaths unrelated to cardiac disease. No child in the TVD group has required late reoperation for residual VSD, compared to two patients in the non-TVD group. Reoperation was necessary in one child with a small VSD after the development of bacterial endocarditis. No child in the TVD group has greater than mild TR, but six in the non-TVD group have greater than mild TR. No child in either group has undergone reoperation for TR. Freedom from greater than mild TR was 96.1% (95% CL 90.9–98.4%) at 12 months, and 92.6% (95% CL 80.3–97.4%) at 24 and 36 months. Overall freedom from reoperation for residual VSD was 98.7% (95% CL 94.7–99.7%) at 12 and 24 months, and 96.8% (95% CL 88.9–99.1%) at 36 months. Although there was a trend towards less severe TR and a lower incidence of reoperation in the TVD group, the difference did not reach statistical significance (\( P > 0.05 \)).

4. Discussion

Successful transatrial closure of a VSD requires adequate visualization of the margins of the defect in order to avoid residual VSD, creation of heart block, and distortion of the tricuspid valve. In some patients, chordal attachments may obscure the margin of the defects and increase the difficulty of closure. Distortion of the tricuspid valve apparatus with tethering of the chordae or the septal leaflet by sutures may result in postoperative TR. In addition, when visualization of the defect is poor, the risk of residual VSD or surgically created heart block is increased. Detachment of the tricuspid valve septal leaflet from the annulus has been advocated by some investigators as a simple, reliable technique to improve visualization of the margins of conoventricular VSDs [1–6]. Others, however, have expressed concern at the potential risk of postoperative TR and heart block. An alternative technique to improve exposure is detachment of the chordae or papillary muscle from the septum allowing
leaflet retraction. After VSD closure, the chordae are reattatched to the septum or the VSD patch [7].

In the current study, the outcome following transatrial closure of VSD was excellent with minimal mortality or morbidity even in children with significant associated anomalies. The use of TVD did not result in an increased incidence of residual VSD, TR, or surgically induced heart block. Actually, there was a trend toward a lower incidence of reoperation for residual VSD and less severe TR in the patients in whom TVD was used. This finding suggests that the improved visualization of the defect after detachment of the septal leaflet results in more accurate suture placement with less distortion of the tricuspid valve apparatus.

In one of the early reports of transatrial VSD closure, Hudspeth and associates advocated detachment of the septal leaflet of tricuspid valve from the annulus to improve exposure [1]. In the discussion of this report, Kay suggested use of a longitudinal incision in the septal leaflet as an alternative technique to improve visualization [1]. Some investigators subsequently expressed concern that detachment of the tricuspid leaflet would increase the risk of postoperative TR and postoperative heart block. In 1981, Frenckner and associates reported the use of TVD in 27 patients undergoing VSD closure without significant residual VSD, TR, or heart block [2]. Nevertheless, an editorial comment accompanying the report suggested that TVD was rarely necessary and reported results of an informal poll suggesting that the majority of congenital heart surgeons did not utilize the technique. Subsequent reports have confirmed the safety and usefulness of TVD with a low incidence of heart block and TR. Tatebe and colleagues, however, reported moderate TR in two of 13 infants following TVD [5]. They suggested that use of a continuous suture to repair the tricuspid valve incision was a risk factor for TR and should be avoided. In the current study, two techniques, both utilizing a continuous suture, were utilized to repair the incision in the septal leaflet. In the majority, the VSD patch was attached to the annulus and the leaflet incision was repaired with a second suture. Alternatively, the leaflet incision was closed with the same suture used to close the VSD and the patch was ‘sandwiched’ between the annulus and the leaflet. Both techniques were effective and neither was associated with postoperative TR.

This study has several limitations. The study is retrospective and follow-up is limited. Use of TVD was at the surgeon’s discretion, not according to a protocol. It is likely that all of the VSDs could have been closed without TVD, although closure may have been more difficult. Follow-up data were obtained from echocardiograms performed by the referring cardiologists, and thus interpretation and quantification of the residual VSDs and TR may be dependent on the echocardiographer. However, echocardiograms from the patients in whom TVD was not performed were subject to the same limitations. In summary, TVD was utilized in 21% of patients undergoing transatrial VSD closure over a 4-year period. The technique is safe and associated with a low incidence of residual VSD and postoperative TR. No patient developed postoperative heart block. The findings suggest that the incidence of residual VSD and TR may be less in the TVD patients compared to the non-TVD patients. Use of TVD to optimize visualization of the defect may result in improved preservation of tricuspid valve function.

Acknowledgements

This study was supported in part by the Daniel M. Tabas Chair in Pediatric Cardiothoracic Surgery and the Ethel B. Foerderer Fund for Excellence.

References