

Temporary Tricuspid Valve Detachment for Ventricular Septal Defect Closure: Is It Worth Doing It?

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ABSTRACT

Background: Tricuspid valve detachment (TVD) may improve the access for closing certain ventricular septal defects (VSDs), but it has some potential risks. We aimed to study the benefits and drawbacks of this technique.

Methods: The midterm outcomes of all 20 patients who underwent a TVD closure for VSD were reviewed and compared with a control group of 15 patients with VSD closure without TVD.

Results: There was no significant residual shunt in either group at the last actuarial follow-up. Tricuspid regurgitation occurred in both groups (45% in the TVD group and 27% in the control group, $P = .48$). These lesions were considered insignificant in all patients. There were no atrioventricular blocks, and all patients were in sinus rhythm. The cardiopulmonary bypass times were significantly higher in the TVD group than in the control group (91.6 ± 17.2 minutes versus 68.3 ± 15.7 minutes, $P \leq .01$), as were the aortic cross-clamping times (50.7 ± 12.1 minutes versus 35.9 ± 14.4 minutes, $P \leq .01$).

Conclusion: Our results, along with results from other series, suggest that TVD can be used effectively and safely for closure of certain VSDs.

INTRODUCTION

The majority of ventricular septal defects (VSDs) can be closed transatrially. In most cases, that is achieved effectively and safely through the tricuspid valve. In some patients, however, the entire defect cannot be exposed because of chordal attachments of the tricuspid valve that obscure its margins.

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Closure of such VSDs through the tricuspid valve can be challenging and carries risks of residual leaks, injury of the tricuspid valve, or damage to the conduction system.

Hudspeth et al published in 1962 a novel way of closing such defects—with temporary detachment of the septal leaflet of the tricuspid valve [Hudspeth 1962]. The technique has been further developed and modified—there are reports of detaching the anterior leaflet or radial incision of the septal leaflet of the tricuspid valve [Maile 2003; Russell 2011]. Its use has been extended to closure of VSDs in patients with more-complex malformations, such as tetralogy of Fallot [Koshy 2002]. Studies of several case series have reported on the efficacy and safety of the method, but there are still concerns about the potential for damaging the tricuspid valve and for an increased incidence of rhythm disturbances. According to a survey of 20 congenital heart surgeons in the UK, the technique is performed relatively infrequently. Eight of these surgeons reported that they were not using it at all, and 10 of the other 12 surgeons were using it rarely [Merrick 1999].

We report our experience with transatrial closure of VSDs with tricuspid valve detachment (TVD) to add to the information about the efficacy and safety of this method.

MATERIALS AND METHODS

The hospital ethics committee reviewed and approved the study protocol. The parents of all patients gave informed consent for surgery. The need for additional informed consent for the use of deidentified data of the patients for the study was waived.

Patients

Included in our study were all patients who underwent transatrial closure of a VSD with detachment of the septal leaflet of the tricuspid valve between 2004 and 2011 in our institution.

Operative Technique

Patients underwent their operations with cardiopulmonary bypass with cannulation of both caval veins and the ascending aorta. A left atrial vent was inserted through the right superior pulmonary vein. The aorta was cross-clamped, and cardioplegic arrest was achieved by a single infusion of cold

Bretschneider solution into the aortic root. Caval tourniquets were then tightened. The right atrium was opened. The VSD was examined by retracting the septal leaflet toward the right atrium. The decision to perform a TVD was made intraoperatively. If the borders of the VSD could not be precisely delineated because of the tricuspid subvalvular apparatus, a circumferential incision was made in the septal leaflet 1 mm from the annulus of the tricuspid valve (Figure). The borders of the defect were then easily identified. The VSD was patched with autologous pericardium by means of a continuous Prolene suture that was started at the midpoint of the anterior margin. The septal leaflet of the tricuspid valve was then rejoined with a continuous suture.

Follow-up

The data from follow-up examinations, including echocardiograms, were reviewed, with special attention given to the presence of symptoms, rhythm disturbances (including complete heart block), presence and significance of residual shunts, and presence and grade of tricuspid regurgitation. To assess the potential long-term benefits and disadvantages of the technique, we compared these results with a control group of age-matched patients who had undergone transatrial VSD closure without TVD.

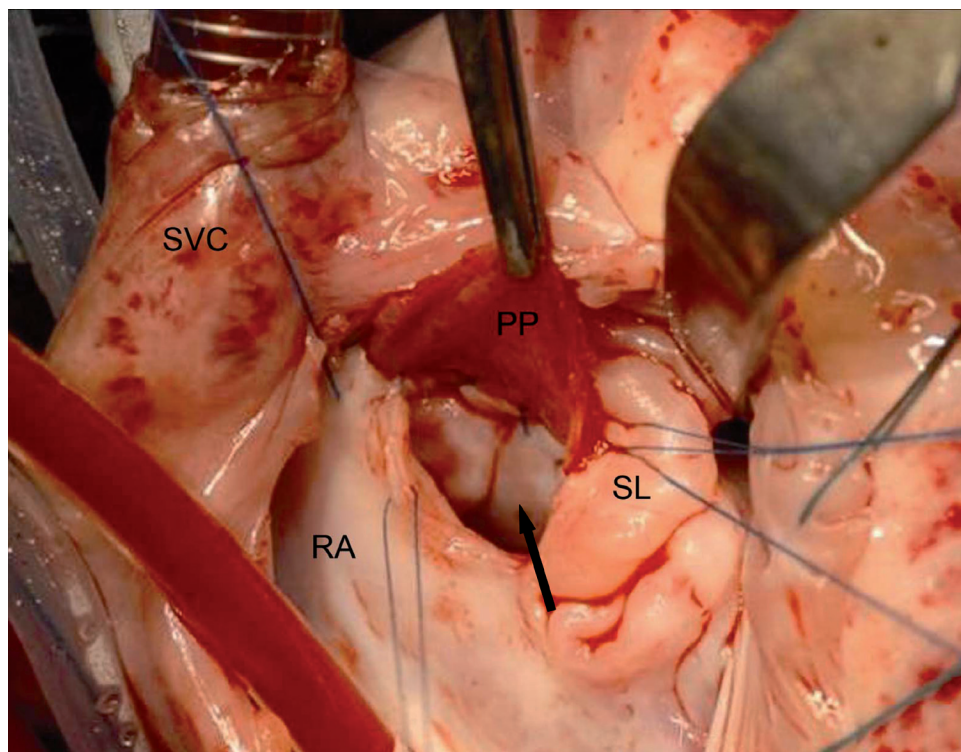
Statistical Analysis

Continuous data were presented as the median and range or as the mean $\pm$ SD, as appropriate. Categorical data were

presented as the number of patients and relative frequencies. Data from the 2 groups of patients were compared with the independent-sample Student *t* test. Categorical variables were compared with the χ^2 test. Statistical analysis was performed with SPSS software (version 16.0; SPSS/IBM, Chicago, IL, USA); a *P* level .05 was considered statistically significant.

RESULTS

The study included 20 patients with transatrial VSD closure with TVD and a control group of 15 patients with simple transatrial VSD closure. The median patient age at operation with TVD was 6 months (range, 2 months to 12 years); the median patient age of the control group was 6 months (range, 1 month to 3.5 years; *P* = .37). One patient from the TVD group had an isolated inlet VSD, 1 patient had an atrio-ventricular septal defect, and all others had perimembranous VSDs. Three of the TVD patients had preoperative aortic valve prolapse with mild aortic regurgitation that did not require interventions on the aortic valve. One patient underwent concomitant atrial septal defect repair, and 1 patient underwent deobstruction of the right ventricular outflow tract. Two of the patients from the control group underwent concomitant atrial septal defect closure. Cardiopulmonary bypass times were significantly higher in the TVD group than in the control group (91.6 ± 17.2 minutes versus 68.3 ± 15.7 minutes, *P* $\leq$.01), as were the aortic cross-clamping times (50.7 ± 12.1 minutes versus 35.9 ± 14.4 minutes, *P* $\leq$.01).



Intraoperative photograph presenting the exposure of a ventricular septal defect (VSD) (arrow) through an incision of the septal leaflet (SL) of the tricuspid valve. PP indicates autologous pericardial patch; RA, right atrium; SVC, superior vena cava.

Reports in the Literature about Ventricular Septal Defect (VSD) Closure with Tricuspid Valve Detachment*

Reference	Patients, n	Mortality, n	Patients with more than mild TR, n	Patients with AV block, n	Patients with significant residual VSDs, n	CPB and aortic cross-clamping times
[Frenckner 1981]	27	2	0	0	0	No data
[Pridjian 1993]	40	0	0	0	0	No data
[Bol-Raap 2003]	39	2	0	No data	0	Longer
[Tatebe 1995]	13	0	2	0	0	No data
[Gaynor 2001]	36	0	0	0	0	No difference
[Koshy 2002]	132	4 (3%)	0	2 with transient AV block 2:1	0	No data
[Aeba 2003]	23	0	0	0	0	Longer
[Maile 2003]	33	0	0	0	0	No data
[Zhao 2003]	122	0	0	0	0	No difference
[Bol-Raap 2003]	46	1	0	1	0	No difference
[Sasson 2006]	44	0	0	0	0	No difference
[Tateishi 2010]	9	0	0	0	0	No data
[Scully 2010]	52	No data	0	0	0	No data
[Russell 2011]	230	0	4	4 (1.7%)	0	No difference

*TR indicates tricuspid regurgitation; AV, atrioventricular; CPB, cardiopulmonary bypass.

There were no deaths in either group. The median follow-up time was 15 months (range, 1-84 months). All patients were asymptomatic at last follow-up. There were no significant residual shunts or reoperations for residual VSDs. None of the patients had tricuspid stenosis; 9 patients (45%) from the TVD group and 4 patients (27%) from the control group had tricuspid regurgitation at follow-up ($P = .48$). It was graded no more than mild in all of these patients. There were no atrioventricular blocks in the 2 groups. All patients were in sinus rhythm.

DISCUSSION

Our study suggests that certain VSDs can be closed transatrially effectively and safely through an incision of the septal leaflet of the tricuspid valve. Our results are in general agreement with the literature on VSD closure with various TVD techniques (>800 patients; Table).

Residual VSDs

We observed no significant residual shunts across the closed defects. According to the literature, TVD seems a reliable method for closure of VSDs. In fact, none of the articles we identified reported a residual VSD requiring reoperation after use of the TVD technique. On the contrary, some authors have reported the incidence of such significant residual VSDs to be higher in control groups of patients who had not undergone their operations with the TVD technique [Gaynor 2001; Zhao 2003]. Remarkably, some of the series included patients with residual VSDs after a first operation, which was performed through a transatrial approach without

TVD [Aeba 2003; Gaynor 2001; Russell 2011]. Reoperation involved TVD and produced a definitive VSD closure.

Frequently, small residual shunts are observed after VSD closure, and their only significance is a small risk for infective endocarditis. They tend to close during follow-up [Bol-Raap 2003].

Tricuspid Valve Function

There have been concerns about the function of the tricuspid valve after temporary detachment of one of the leaflets to expose the margins of a VSD. Possible dysfunctions include tricuspid regurgitation after the operation and growth impairment after the plasty that produces tricuspid stenosis. Like most studies on this issue, all patients in our group had good tricuspid valve function at follow-up. Almost half of the patients with TVD had mild tricuspid regurgitation, but the incidence was not significantly different from that in the control group of patients.

Russell et al used a modified technique of radial incision of the septal leaflet in a relatively large group of patients and reported an incidence of moderate tricuspid valve regurgitation (4%) during follow-up, although this incidence was not different from that of a group of patients who had their VSD closed through the tricuspid valve [Russell 2011]. The series of Tatebe et al included 2 patients with moderate tricuspid regurgitation [Tatebe 1995]. One of these patients had persistent pulmonary hypertension postoperatively, which probably contributed to the tricuspid regurgitation. The other patient had Down syndrome and an accompanying mitral valve cleft. The authors concluded that TVD should be used cautiously in patients with Down syndrome.

A valuable tool in the care of patients requiring TVD for VSD closure is the routine operating room use of transesophageal echocardiography with Doppler color flow mapping. It can show early in the operation not only residual VSDs in many different planes but also significant tricuspid regurgitation, when it is still relatively easy to repair these residual lesions.

Complete Heart Block

One of the main concerns when closing perimembranous or inlet VSDs is the proximity of the conduction system and the potential for damaging it. Andersen et al conducted a large study of >2000 patients whose operations involved VSD closure and reported an incidence of third-degree atrioventricular block of <1% [Andersen 2006]. In their discussion, the authors stated that their experience and data from the literature suggested that the incidence of complete heart block did not depend on whether the surgeon had chosen to detach the septal leaflet of the tricuspid valve. Indeed, the cases described in the literature of complete atrioventricular block after VSD closure with TVD are limited to 4 patients (an incidence of 1.7%, not significantly different from 1.4% in the control group) in the series of Russell et al [2001] and 1 patient in the series of Bol-Raap et al [2003]. We did not observe complete heart block in any of our patients.

Cardiopulmonary Bypass Times

Detachment of the tricuspid valve improves the access to certain VSDs and may shorten the time for placing and suturing the patch. Nevertheless, the technique involves additional cardiopulmonary bypass time for repairing the septal (or anterior) leaflet of the tricuspid valve. In our series, the patients with TVD also had significantly longer cardiopulmonary bypass and aortic cross-clamp times than the patients from the control group. The data in the literature on this issue are controversial. A few other studies have reported significant differences in on-pump and ischemic times between patients with TVD and those without TVD [Aeba 2003; Bol-Raap 2003]. Cardiopulmonary bypass is becoming safer, even for small infants, but the longer cardiopulmonary bypass times are a potential disadvantage of the technique with TVD for VSD closure.

Limitations

Our study is retrospective and suffers from the usual limitations of this design. According to the principles of evidence-based medicine, the benefits and drawbacks of a treatment modality are best analyzed with prospective randomized double-blinded studies. Performing such studies for an issue like TVD for VSD closure is a very difficult task. It is quite difficult and still undetermined how to recognize before surgery the patients who would benefit from TVD. According to most reports and in our practice, the decision is made intraoperatively by the surgeon. Obviously, it is difficult to randomize such patients. Nevertheless, the same surgical team conducted all the operations for the patients with VSDs in this study. Thus, the decision to use the TVD technique was consistent.

CONCLUSIONS

Our results, coupled with the results of published series, suggest that TVD is a valuable technique for closure of certain VSDs. It provides good results with a low incidence of significant residual shunts. It is also safe, as judged by the relatively normal function of the tricuspid valve and by the lack of occurrence of complete heart block.

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