

# Success of Tricuspid Valve Detachment for Ventricular Septal Defect Closure: An Assessment of Midterm Tricuspid Valve Function

Çağatay Bilen<sup>1</sup> , Gökmen Akkaya<sup>1</sup> , Osman Nuri Tuncer<sup>1</sup> , Yüksel Atay<sup>1</sup> 

<sup>1</sup>Ege University, Cardiovascular Surgery, Bornova, Turkey

**Address for Correspondence:** Çağatay Bilen, **E-mail:** [cagataybilen86@gmail.com](mailto:cagataybilen86@gmail.com)

**Received:** 12.03.2019; **Accepted:** 08.05.2019; **Available Online Date:** 28.05.2019

©Copyright 2019 by Dokuz Eylül University, Institute of Health Sciences - Available online at [www.jbachs.org](http://www.jbachs.org)

**Cite this article as:** Bilen Ç, Akkaya G, Tuncer ON, Atay Y. Success of Tricuspid Valve Detachment for Ventricular Septal Defect Closure: An Assessment of Midterm Tricuspid Valve Function. J Basic Clin Health Sci 2019; 3:69-72. <https://doi.org/10.30621/jbachs.2019.586>

## Abstract

**Introduction:** Ventricular septal defect (VSD) is the most common congenital heart anomaly. In surgical treatment, the transatrial approach is frequently utilized because of causing less right bundle block and ventricular scarring. However, some VSDs are obscured by the chordae tendineae or a pouch formation of the septal leaflet; therefore, alternative techniques are required. In such cases, tricuspid valve detachment (TVD) provides a complete visualization and ease to access to ventricular septal defects. In this study, we evaluated the results of the patients of whom we performed TVD.

**Patient and Method:** Our study includes 50 patients who underwent TVD during the procedure with the diagnosis of perimembranous VSD. Patients were examined by transthoracic echocardiography (TTE) before and after operation and the valvular functions are evaluated. All patients were kept in follow up for 3 months after discharge.

**Results:** The mean age of the patients was 27.56±34.81 months. At the end of the study, all patients were in New York Heart Association class I. There was no residual shunt through VSD. Except 4 patients with mild tricuspid regurgitation (TR), the TTE has not revealed any TR in majority of patients.

**Conclusion:** We suggest that, in appropriate patients, VSD closure can be performed safely with a TVD application thru an incision of the septal leaflet of the tricuspid valve without any adverse effect on function or growth at of the valve at midterm follow-up.

**Keywords:** Ventricular septal defect, tricuspid valve detachment, congenital heart surgery

## INTRODUCTION

Ventricular septal defect (VSD) is the most common congenital heart anomaly (1,2). Most of the cases are small and stay asymptomatic while a significant number of the cases close spontaneously (3). Unless VSDs do not spontaneously close, in advanced years they may present with aortic valve insufficiency, endocarditis and pulmonary hypertension that require surgery.

In surgical treatment, the transatrial approach is frequently utilized because of less right bundle block and ventricular scarring risks rather than the right ventricular approach. However, some VSDs are located under the tricuspid valve. Such cases remain a challenge due to the visualization of the VSD margins were inappropriate, therefore hardening to determine the suture lines.

The procedure of separating the septal leaflet of tricuspid valve from the annulus, aiming to see the VSD better was first described by Hudspeth et al. at 1962 (4). At first tricuspid detachment procedure

was thought to cause valve regurgitation, longer operation time and increase heart block risk. But recent studies showed that if it is used at proper patients, provides better results (5). However, long term results of this technique are not well-known.

In this study, we evaluated the results of the patients of whom we performed tricuspid detachment.

## METHODS

Our study included 48 patients who were diagnosed with perimembranous VSD between 07/11/2007 and 01/01/2018 and undergoing tricuspid valve detachment (TVD) during the procedure. TVD procedure was performed thereby the VSD's were located under the tricuspid valve, boundaries of the VSD weren't clear and it was hard to reach.

**Operative Technique**

Mediastinal access was utilized via median sternotomy. We performed aorto-bicaval cannulation followed by cardiopulmonary bypass (CPB). Hypothermia was provided. Diastolic arrest was achieved using topical cold and blood cardioplegia. Right atriotomy incision was done parallel to the atrial groove. The VSD was visualized after pulling the septal leaflet towards right atrium. The tricuspid valve was incised from a distance of approximately 1 mm from the region where the septal leaflet was connected to the annulus. VSD was closed by continuous suture technique with a patch starting from the middle of the anterior margin. When the suture line reached to the two ends of the tricuspid valve, the patch was sutured between the annulus and leaflet. Afterwards, the leakage test with saline infusion was applied. The right atriotomy was closed and the decannulation process was carried out. After the bleeding control, the flats were closed proper to anatomy and the operation was terminated.

**Follow Up**

Tricuspid valve was assessed by transthoracic echocardiography before operation, at postoperative week 1, at postoperative first month and third month follow-up.

**Statistical Analysis**

All data were presented with mean±standard deviation, median and interval data. Tricuspid regurgitation (TR) severity is 0, absent or insignificant in echocardiographic reports; 1, mild; 2, moderate; 3, rated as heavy. Statistical analysis was performed using the SPSS 17.0 program.

**RESULTS**

The mean age of the patients was 27.56±34.81 months. 28 of the patients were female (Table 1). PDA ligation in 3 patients, 8 pulmonary artery banding, 1 aortic coarctation repair and 1 aortic arc extension were performed concurrently to the VSD closure operation (Table 3).

In all operations, VSD was closed by using Goretex patch. Mean cardiopulmonary bypass time was 67.1±17.55 minutes and

mean aortic cross clamp time was 53.87±14.78 minutes. Mean intubation and duration in the intensive care unit were 17.7±3.92, 5±3.66 hours, respectively (Table 2). There was no mortality during the hospital stay or in follow-up.

In addition to VSD closure, ASD closure performed in 10 patients, PDA ligation in 1 patient, and subaortic membrane resection in 1 patient. Eight patients underwent pulmonary artery enlargement procedure by using pericard patch with the cause of the previous pulmonary artery banding procedure. In 10 patients, milrinone was administered for 24 hours with the dosage of 0.25 mcg / kg / min for right ventricular dysfunction (Table 2).

Patients were evaluated by transthoracic echocardiography before and after operation. Tricuspid insufficiency grades of those are shown at the graphic 1.

All patients were kept in follow up for 3 months after discharge. At the end of the study, all patients were in New York Heart Association class I.

**DISCUSSION**

VSD is the most common congenital heart disease, therefore surgical techniques well developed thus a standardization has occurred (6). An adequate exposure of the VSD is crucial to avoid complications such as residual ventricular septal defect, TR and complete heart block. However, in some patients, chordal connections may cause difficulties in visualization of the entire VSD margin. Therefore, several tricuspid valve detachment (TVD) techniques, which were initially described by Hudspeth

**Table 1.** Demographic and preoperative findings

Variable	Value
Age (month)	27.56±34.81
Weight	10.64±7.20
<b>Gender</b>	
Male	20
Female	28
<b>NYHA functional class</b>	
I	38
II	10
<b>Grade of tricuspid regurgitation</b>	
None	40
Mild	8

NYHA = New York Heart Association; Data are presented as mean±SD or as number and percentage

**Table 2.** Previous operations

Variable	Value
Patent ductus arteriosus ligation	3
Pulmonary artery banding	8
Aortic arch enlargement	1
Aortic coarctectomy	1

**Table 3.** Intra- and postoperative data

Variable	Value
Cardiopulmonary bypass time (min)	67.1±17.55
Aortic cross-clamp time (min)	53.87±14.78
<b>Additional surgical procedures</b>	
Atrial septal defect closure	10
Patent ductus arteriosus ligation	1
Subaortic membrane resection	1
Pulmonary artery enlargement	8
Intensive care unit stay (h)	17.7±3.92
Intubation time (h)	5±3.66

No patient had postoperative tricuspid stenosis. All patients were in New York Heart Association functional class I at the time of follow-up evaluation. Data are presented as mean ± SD or as number.

and colleagues (4) in 1962, have been introduced to improve visualization and to achieve a complete repair of hard-to-expose VSDs, aiming to diminish occurrence of postoperative morbidities and improve outcome. Temporary tricuspid valve detachment (TVD) provides a clear view of the angles between the conal septum, the aortic annulus, and the ventriculo-infundibular fold, meanwhile minimizing the incidence of residual defects (7). In the advancing years, further variants TVD consisting of septal leaflet detachment have also been described in the pediatric literature (8-10). Moreover, circumferential detachment of the septal or anterior leaflets, longitudinal incision of the septal leaflet, subvalvular tricuspid apparatus detachment (chordae papillary muscle or both) from septum have all been described in prior reports examining the tricuspid valve dysfunction at short term follow up (11).

Despite there were controversies in past decades, as a consequence of the reports from several centers, TVD utilization became worldwide.

Weymann et al. (12) compared the outcomes of 14 previous studies and their own results. Larger series did not identified any residual VSD, contrary, the incidence of significant residual VSD was observed higher in control groups among patients who had not undergone VSD closure without TVD application (10, 13). Nonetheless, within this study, we declare that our results corroborate the literature.

CPB time is also a debatable issue. Temporary TVD may shorten the time by easing the placing and suturing the patch. Nevertheless, the technique requires additional cardiopulmonary bypass time during the repair of the septal (or anterior) leaflet of the tricuspid valve. Recent studies indicate different results. Fraser et al. (11) and Pourmoghadam et al. (14) measured a significant increment in both CPB time and X-clamping time. On the other side, Gaynor et al. (9) and Russell et al. (10) reported no differences between TVD or non-TVD performed groups. Although we did not have a chance to compare our operative timing result with a control group according to study design, we are in opinion that, by the lights of developing technologies and advancing surgical techniques, CPB becomes safer and reliable, even for small infants. Furthermore, in a recent study, a successful VSD closure with TVD was reported in a case younger than 3 months old (15).

There have been concerns regarding the function of the tricuspid valve after TVD hence, possible dysfunctions involves tricuspid regurgitation following the operation and growth impairment after the plasty that produces tricuspid stenosis. Similarly, to most studies on this issue, in our follow up we have not observed more than mild regurgitation. In a meta-analysis including 1014 patients from 14 studies except 4 patients, there was no TR more than mild degree (12). Moreover, regarding to their long term follow up results (mean 2343 days) including 164 patients, Fraser et al. (11) suggest that TVD did not compromise long-term valve durability however, did not impose increased morbidity. Within a smaller sample size, Lucchese et al. (16) confirmed the aforementioned outcomes in their study

consisting of 68 patients with a mean 5.9 years follow-up. They verified usual tricuspid valve growth meanwhile no tricuspid stenosis formation. Therefore, they assumed that TV growth was unimpaired by TVD utilization.

Total heart block is counting as a rare but vital complication in cases of whom undergoing TVD while closing the perimembranous or inlet VSDs. Andersen et al. (17) conducted a large cohort containing >2000 patients whose operations involve VSD closure and reported an incidence of third-degree atrioventricular block was below <1% (13). The several authors stated that their experience and data from the literature suggest that the incidence of complete AV block development was independent factor from how the surgeon decided to detach the septal leaflet of the tricuspid valve whether with TVD or not. Indeed, the whole cases which were reported in the literature so far with complete AV block following TVD utilization were only 5. 4 of them belong to the series of Russell et al. (10) and left, in the series of Bol-Raap et al. (18) As well as our results are free from the total AV block and in agreement with the literature.

To summarize, several studies with large groups are examined TVD utilization by different point of views. The results tend to encourage the surgeons to benefit from performing TVD with reduced residual shunt rate in similar CPB and X-clamping time without improved AV block occurrence and TR development in long term follow-up.

According to these evidences and criticizing our outcomes, we suggest that VSD can be closed with a reliable and safe TVD application thru an incision of the septal leaflet of the tricuspid valve.

---

**Informed Consent:** Written informed consent was obtained from patient who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - ÇB; Design - GA; Supervision - YA; Fundings - YA; Materials - ONT; Data Collection and/or Processing - GA; Analysis and/or Interpretation - ONT; Literature Search - GA; Writing Manuscript - ÇB; Critical Review - YA

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study has received no financial support.

## REFERENCES

- Hoffman JI, Kaplan S. The incidence of congenital heart disease. *J Am Coll Cardiol* 2002;39:1890-1900. [CrossRef]
- Danford DA, Martin AB, Fletcher SE, et al. Children with heart murmurs: can ventricular septal defect be diagnosed reliably without an echocardiogram? *J Am Coll Cardiol* 1997;30:243-246. [CrossRef]
- Gabriel HM, Heger M, Innerhofer P, et al. Long-term outcome of patients with ventricular septal defect considered not to require surgical closure during childhood. *J Am Coll Cardiol* 2002;39:1066-1071. [CrossRef]
- Hudspeth AS, Cordell AR, Meredith JH, Johnston FR. An improved transatrial approach to the closure of ventricular septal defects. *J Thorac Cardiovasc Surg* 1962;43:157-165.

5. Sasson L, Katz MG, Ezri T, et al. Indications for tricuspid valve detachment in closure of ventricular septal defect in children. *Ann Thorac Surg* 2006;82:958-963. [\[CrossRef\]](#)
6. Jacobs JP, Mavroudis C, Jacobs ML, et al. Lessons learned from the data analysis of the second harvest (1998-2001) of the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database. *Eur J Cardiothorac Surg* 2004;26:18-37. [\[CrossRef\]](#)
7. Lin YJ, Chang JP, Chien SJ, Liang CD, Huang CF, Kao CL. Novel method for evaluating tricuspid valve function after tricuspid valve detachment in the repair of perimembranous ventricular septal defects. *Tex Heart Inst J* 2012;39:806-808.
8. Maile S, Kadner A, Pretre R. Detachment of the anterior leaflet of the tricuspid valve to expose perimembranous ventricular septal defects. *Ann Thorac Surg* 2003;75:944-946. [\[CrossRef\]](#)
9. Russell HM, Forsberg K, Backer CL, Wurlitzer KC, Kaushal S, Mavroudis C. Outcomes of radial incision of the tricuspid valve for ventricular septal defect closure. *Ann Thorac Surg* 2011;92:685-690. [\[CrossRef\]](#)
10. Gaynor JW, O'Brien JE Jr, Rychik J, Sanchez GR, DeCampi WM, Spray TL. Outcome following tricuspid valve detachment for ventricular septal defects closure. *Eur J Cardiothorac Surg* 2001;19:279-282. [\[CrossRef\]](#)
11. Fraser CD, Zhou X, Palepu S, et al. Tricuspid Valve Detachment in Ventricular Septal Defect Closure Does Not Impact Valve Function. *Ann Thorac Surg* 2018;106:145-150. [\[CrossRef\]](#)
12. Weymann A, Georgiev S, Vogelsang C, et al. Temporary tricuspid valve detachment for ventricular septal defect closure: Is it worth doing it? *Heart Surg Forum* 2013;16:99. [\[CrossRef\]](#)
13. Zhao J, Li J, Wei X, Zhao B, Sun W. Tricuspid valve detachment in closure of congenital ventricular septal defect. *Tex Heart Inst J* 2003;30:38-41.
14. Pourmoghadam KK, Boron A, Ruzmetov M, et al. Septal Leaflet versus Chordal Detachment in Closure of Hard-To-Expose Ventricular Septal Defects. *Ann Thorac Surg* 2018;106:814-821. [\[CrossRef\]](#)
15. Bang JH, Park CS, Park JJ, et al. Detachment of the tricuspid valve for ventricular septal defect closure in infants younger than 3 months. *J Thorac Cardiovasc Surg* 2016;152:491-496. [\[CrossRef\]](#)
16. Lucchese G, Rossetti L, Faggian G, Luciani GB. Long-term follow-up study of temporary tricuspid valve detachment as approach to VSD repair without consequent tricuspid dysfunction. *Tex Heart Inst J* 2016;43:392-396. [\[CrossRef\]](#)
17. Andersen HO, de Leval MR, Tsang VT, Elliott MJ, Anderson RH, Cook AC. Is complete heart block after surgical closure of ventricular septum defects still an issue? *Ann Thorac Surg* 2006;82:948-956. [\[CrossRef\]](#)
18. Bol-Raap G, Weerheim J, Kappetein AP, Witsenburg M, Bogers AJ. Follow-up after surgical closure of congenital ventricular septal defect. *Eur J Cardiothorac Surg* 2003;24:511-515. [\[CrossRef\]](#)