

# Valve-sparing repair with skeletonization of the pulmonary annulus for tetralogy of Fallot

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## Abstract

Pulmonary valve preservation in tetralogy of Fallot (TOF) repair is one of the most challenging issues. Herein, we describe a novel valve-sparing technique for TOF repair that primarily consists of skeletonization of the anterior part of the pulmonary annulus and gentle dilatation by preserving the pulmonary valve and annulus integrity. With encouraging early results, this technique is suggested to prevent severe pulmonary regurgitation and provide acceptable relief of pulmonary stenosis in patients with TOF.

## KEYWORDS

pulmonary annulus, tetralogy of Fallot, valve-sparing

## 1 | INTRODUCTION

Transannular patch (TAP) reconstruction is the most widely adapted surgical technique for the repair of tetralogy of Fallot (TOF). However, this technique is inevitably followed by severe pulmonary valve regurgitation (PR) which is associated with progressive right ventricular (RV) dilation, biventricular dysfunction, ventricular arrhythmias, and sudden cardiac death.<sup>1</sup> Valve-sparing techniques have been introduced to prevent such adverse sequelae.

Currently, several valve-sparing techniques are in use in the repair of TOF including commissurotomy, intraoperative balloon dilation, cusp delamination, cusp augmentation, and other valve plasty techniques.<sup>2,3</sup> However, mid- and long-term results of these techniques have shown that pulmonary valve function and reintervention rates produce no significant advantage, compared to the TAP repair.<sup>1,2</sup> As of October 2017, we have been using a novel valve-sparing technique in TOF repair which primarily consists of surgical skeletonization of the anterior part of the pulmonary annulus from the adjacent myocardial tissue and gentle dilatation by preserving the pulmonary valve and annulus integrity. Herein, we describe this surgical technique in detail.

### 1.1 | Patient profile

Between October 2017 and February 2019, a total of 12 consecutive patients with TOF underwent this surgery for the total correction of

the TOF. A written informed consent was obtained from each parent or his/her legal representative. The study protocol was approved by the Institutional Review Board.

Of the patients, the mean age was  $10.5 \pm 6.5$  (range, 4-24) months. The mean follow-up was  $9.7 \pm 5.8$  (range, 16-19) months. The mean preoperative pulmonary annulus Z-scores and peak RV-PA gradient were  $-2.8 \pm 0.9$  (range, -1.8 to -3.7) and  $85.8 \pm 7.8$  (range, 80-98) mmHg, respectively. The mean intraoperative post-repair RV-to-systemic pressure ratio was  $0.5 \pm 0.1$  (range, 0.38-0.72) and the peak RV-PA gradient was  $19.8 \pm 6.7$  (range, 9-29) mmHg.

### 1.2 | Surgical technique

After a median sternotomy, standard aortic and venous cannulation through both the superior and inferior vena cavae is performed, and cardiopulmonary bypass is initiated. Following the myocardial arrest, the right atrium is opened. The anatomy of the ventricular septal defect (VSD) and the RV outflow tract (RVOT) obstruction are inspected. Depending on the severity of hypoplasia of the main pulmonary artery (PA), pulmonary annulus, and infundibular stenosis, decision for the length of the right ventriculotomy and pulmonary arteriotomy is made. Transatrial and transventricular division of the obstructing muscle bundles are done. After commissurotomy, leaflet thinning, and mobilization, the Hegar dilators are used to evaluate the size of the pulmonary valve opening. If the pulmonary valve annulus Z-score is less than

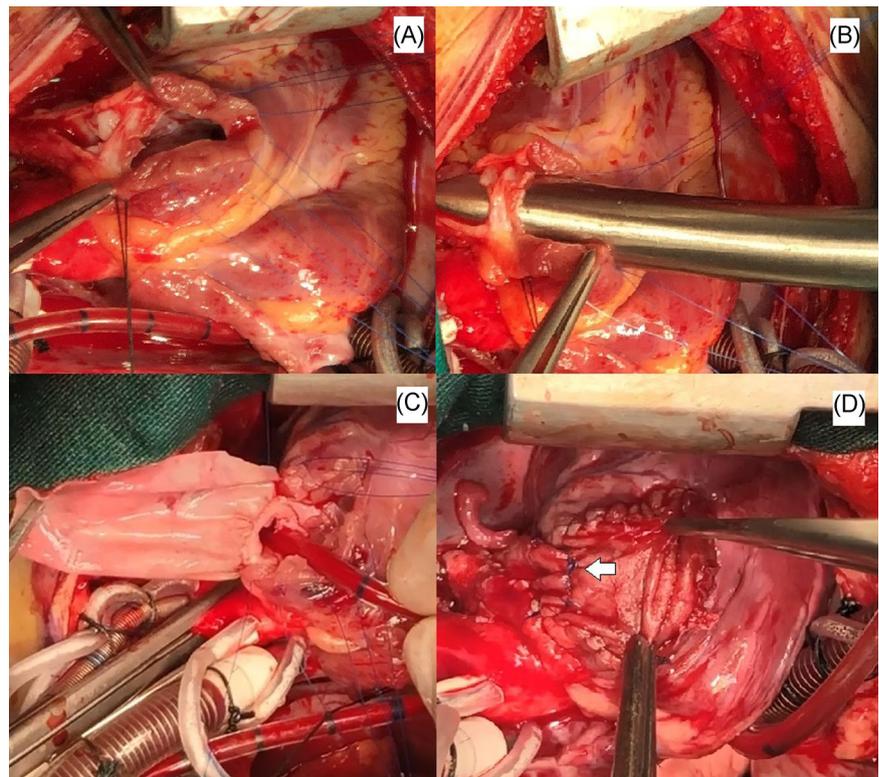
-1.5 and enlargement of the pulmonary valve annulus is required, we use the skeletonization of the anterior part of the pulmonary valve annulus technique. Using this technique, the surrounding muscle over the anterior part of the pulmonary annulus is completely dissected with a 10-blade scalpel, leaving only the fibrous ring of the annulus (Figure 1A). After skeletonization of the anterior part of the annulus, the Hegar dilators are used to gently dilate the pulmonary annulus (Figure 1B). The Hegar dilator size is gradually increased by 1 mm increments to reach 1 mm greater than normal pulmonary valve size. During the dilation, particular care is given to avoid any tear of the pulmonary annulus. Easy dilatation of the pulmonary annulus is achieved after the skeletonization. The VSD is closed through the right atriotomy using a glutaraldehyde-treated autologous pericardial patch with continuous 5-0 polypropylene sutures. A standard TAP of the glutaraldehyde-treated autologous pericardium is prepared. First, PA reconstruction is performed by sewing the pericardial patch over the pulmonary arteriotomy down to the annulus level. The width of the patch at the level of the annulus is adjusted to be larger than the skeletonized annulus segment (approximately 1.5 times larger). The pericardial patch is attached to the annular tissue using approximately 8 to 10 interrupted 6-0 polypropylene mattress sutures. The sutures are tied on the outside of the pericardium (Figure 1C). The proximal extent of the patch over the RVOT is, then, sutured (Figure 1D). The RV and pulmonary pressures are measured after weaning from cardiopulmonary bypass.

All patients were extubated within 5 hours postoperatively and all patients discharged from the intensive care unit on postoperative day 1. The mean length of hospital stay was  $7.3 \pm 2.1$  (range, 13-5) days. All patients were discharged without any complications. During the study period, none of the patients needed any reintervention.

Postoperative echocardiography at discharge revealed a mean pulmonary annulus Z-score and a peak RV-PA gradient of  $-1.4 \pm -0.5$  (range,  $-0.5$  to  $-2.4$ ) and  $26.4 \pm 7.5$  (range, 15-35) mmHg, respectively. Fifty-eight percent of the patients had mild and remaining had moderate PR at postoperative first month. Similarly, 50% of the patients had mild and remaining had moderate PR at postoperative sixth month. None of the patients had severe PR.

## 2 | DISCUSSION

There is still no optimal valve-sparing repair technique in TOF management. Although substantial improvements have been made in valve-sparing approaches in TOF management in recent years, Bacha<sup>3</sup> reported that more than one-third of the patients still require transannular intervention. Intraoperative balloon dilatation, which is used as a valve-sparing technique in TOF, has been associated with progressive PR.<sup>1</sup> On the other hand, Hofferbeth et al<sup>1</sup> reported that 15.4% of patients required reintervention for residual valvular stenosis at a median follow-up of 2.5 years. However, with our skeletonization technique, since there would be no myocardial muscle tissue, over the anterior surface of the pulmonary annulus, we suggest that dilatation of pulmonary annulus is more effective, and the recoil effect is less than in other techniques in which a thick myocardial tissue surrounding the pulmonary annulus is left intact. In addition, attaching a wider pericardial patch to the skeletonized annulus using interrupted sutures may provide further growth capability of the pulmonary annulus. In our practice, we mostly prefer short right ventriculotomy and perform only obstructing band division of infundibular muscle bundles to relieve the RVOT



**FIGURE 1** A, Skeletonized pulmonary valve annulus. B, Dilatation of the pulmonary annulus with Hegar dilators. C, Internal view of the attached pericardial patch to the pulmonary annulus. D, Completed patch reconstruction. Stitches attaching the pericardial patch to the pulmonary annulus (arrow)

obstruction rather than transatrial or transpulmonary valve approaches. Based on our experience, postoperative RVOT function in patients with intact pulmonary annulus may not provide an advantage without ventriculotomy. Moreover, the excessive muscle resection in RVOT would not be needed, if short ventriculotomy and a patch are used to relieve hypoplasia of the right ventricular infundibulum.

In conclusion, despite relatively short follow-up, we believe that this technique prevents severe PR and provide acceptable relief of pulmonary stenosis in patients with TOF with encouraging early results. Nonetheless, further large-scale and mid- and long-term studies are needed to confirm the superiority of this technique.

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## REFERENCES

1. Hofferberth SC, Nathan M, Marx GR, et al. Valve-sparing repair with intraoperative balloon dilation in tetralogy of fallot: midterm results and therapeutic implications. *J Thorac Cardiovasc Surg.* 2018;155:1163-1173.e4.
2. Vida VL, Guariento A, Zucchetta F, et al. Preservation of the pulmonary valve during early repair of tetralogy of fallot: surgical techniques. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu.* 2016;19:75-81.
3. Bacha E. Valve-sparing or valve reconstruction options in tetralogy of fallot surgery. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu.* 2017;20:79-83.

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