

# Modified half-turned truncal switch operation for posterior transposition of the great arteries with left ventricular outflow tract obstruction



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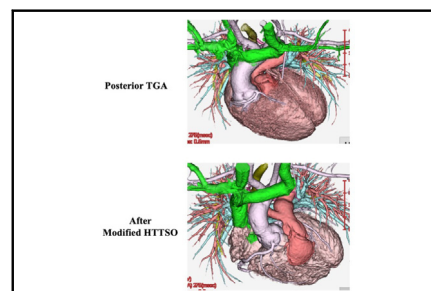
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Side-by-side great arteries in posterior TGA are successfully switched with modified HTTSO.

### CENTRAL MESSAGE

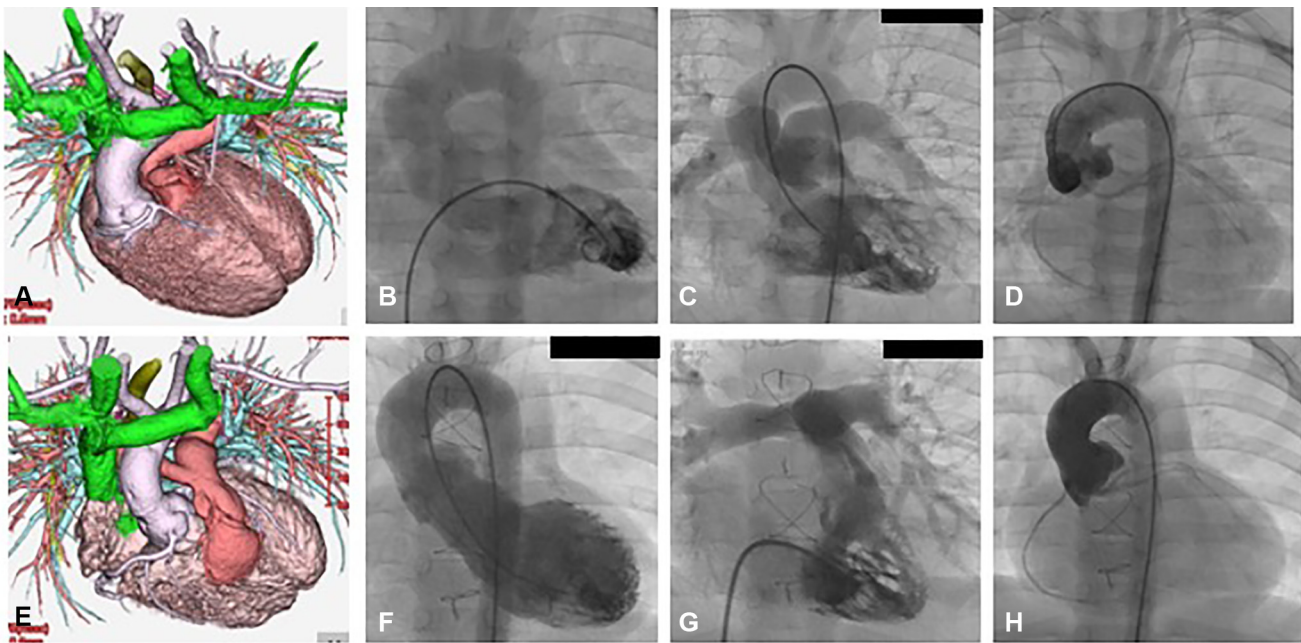
Hemodynamically faultless outflow tracts are achieved with careful surgical simulation by neo-RVOT creation and detached pulmonary valve implantation in posterior TGA with side-by-side great arteries.

▶ Video clip is available online.

There are many surgical options for the spectrum of malposition of the great arteries, depending on the degree of malposition, as well as ventricular septal defect (VSD) location and size. The half-turned truncal switch operation (HTTSO) was developed for transposition of the great arteries (TGA) or the TGA-type double-outlet right ventricle (RV) with left ventricular outflow tract (LVOT) obstruction,<sup>1</sup> providing wide and straight outflow tracts.<sup>2,3</sup> Antero-posterior arrangement of the great arteries is reportedly the appropriate indication for this operation, but side-by-side arrangement is not a contraindication. The HTTSO with surgical modification was successfully performed for a case of posterior TGA with side-by-side arrangement of the great arteries. This patient's guardian provided written consent for publication of this report. Institutional Review

Board approval was waived in our institutional policy because this article was categorized as a case report.

A boy aged 2 years and 11 months weighing 13.8 kg with posterior TGA and infundibular (IF) and pulmonary valvular stenosis was referred to our hospital for surgical repair. The great arteries were arranged side-by-side with levoposition of the pulmonary artery and dextroposition of the aorta (Figure 1, A). The pulmonary valve had bicuspid valvular stenosis with 76% of the normal annulus. The VSD was located in the remote position, 110% of the size of the normal aortic valve annulus. The IF septum was almost aligned with the interventricular septum. The volumes of the right and left ventricles were 103% and 136% of the normal volumes, respectively (Figure 1, B and C). The coronary arterial pattern was Yacoub type A (Figure 1, D).

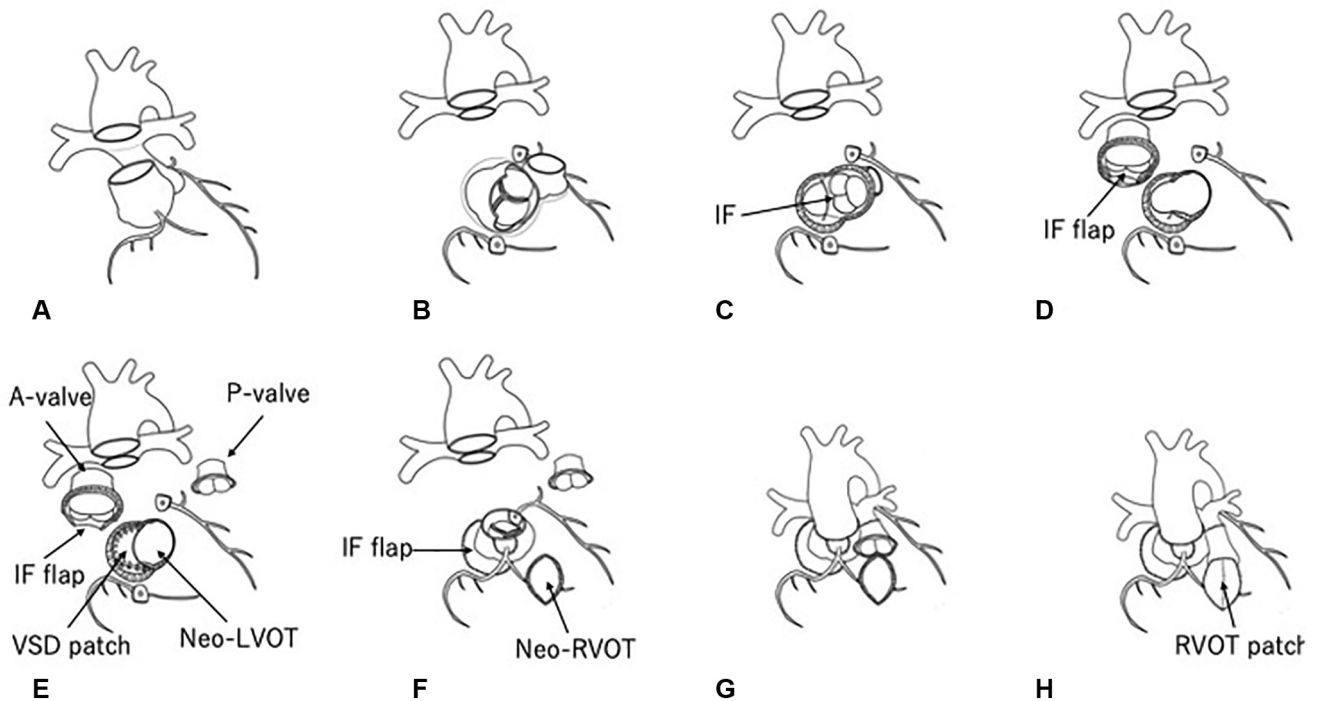


**FIGURE 1.** Preoperative and postoperative morphologies. Preoperative and postoperative superior views of 3-dimensional computed tomography views (A and E). Preoperative and postoperative cineangiography. Left ventriculography in end-systole (B and F). Right ventriculography in end-systole (C and G). Aortography in end-diastole (D and H). Postoperative cineangiography was evaluated 1 year after the operation. A, Great arteries arranged side-by-side (levoposition of the pulmonary artery and dextroposition of the aorta). B, Left ventriculography shows an enhanced aorta through the VSD. C, Right ventriculography shows the enhanced aorta and pulmonary artery. Valvular and subvalvular stenoses are found. C, No aortic valve insufficiency is visualized. The coronary arterial pattern is Yacoub type A. E, The aortic valve is repositioned at the LVOT. The pulmonary valve is implanted at the RV outflow portion. F, Left ventriculography shows a wide and straight outflow tract. G, Right ventriculography shows physiologic outflow tracts. H, Aortography shows no aortic valve insufficiency and no coronary artery kinking.

After median sternotomy and chemical cardiac arrest, the aorta was transected approximately 10 mm above the sinotubular junction (Figure 2, A). The pulmonary trunk was transected just below the bifurcation. The right and left coronary arterial buttons were excised (Figure 2, B). The truncal block was harvested en bloc (Figure 2, C and D). In contrast to the original method, the aortic valve was separated from the pulmonary valve. An adequately sized pulmonary valve was obtained by commissurotomy. The IF above the VSD, attached to the aortic valve, was resected longitudinally (Figure 2, C). The VSD was closed using a curved-design expanded polytetrafluoroethylene patch to prevent residual LVOT obstruction (Figure 2, E). The aortic valve was half-turned horizontally and anastomosed to the LVOT orifice, where the pulmonary valve was connected (Figure 2, F). The superior margin of the VSD patch was anastomosed to the aortic valve annulus. Both coronary buttons were anastomosed to the corresponding aortic wall defects. The pedicle IF septal flap was flipped up and

anastomosed to the aortic valve defect at the RV inflow portion (Figure 2, F). The ascending aorta was reconstructed in an end-to-end fashion. The neo-right ventricular outflow tract (RVOT) was created in the RV outflow portion, where the pulmonary valve was reimplemented (Figure 2, F and G). The distal stump of the pulmonary trunk was anastomosed directly to the pulmonary bifurcation. The anterior wall of the neo-RVOT was augmented with the expanded polytetrafluoroethylene patch (Figure 2, H) (Video 1).

Postoperative computed tomography demonstrated that the RVOT was reconstructed at the outlet portion of the RV (Figure 1, E), and cineangiography 1 year after the operation showed that the LVOT and RVOT were wide, with smooth ventricular ejections (Figure 1, F and G) and no coronary arterial problems (Figure 1, H). Recent echocardiography 3 years after the operation revealed good ventricular functions only with a tiny aortic valve insufficiency (Figure E1, A and B) and mild RVOT obstruction (Figure E1, C and D).

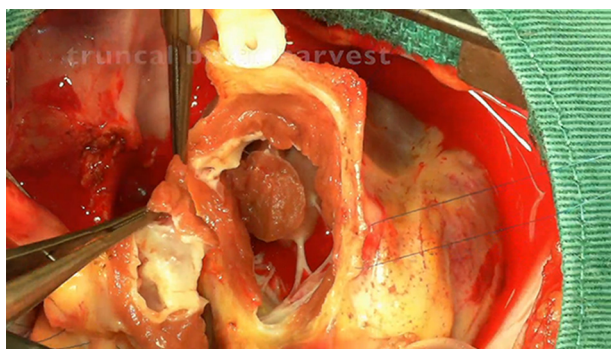


**FIGURE 2.** Operative schemes of the modified half-turned truncal switch operation. A, The ascending aorta is transected. B, The pulmonary artery is transected. The right and left coronary arterial buttons are excised. C, Harvest of the truncal block starts from the anterior wall of the RV. D, The truncal block is harvested en bloc. The IF above the VSD is resected longitudinally. E, The pulmonary valve is separated from the truncal block. The VSD is closed using a curved-design patch. F, The aortic valve is half-turned horizontally and reimplanted to the neo-LVOT. The IF flap is flipped up, and the original aortic valve defect is closed with this IF flap. The right and left coronary buttons are anastomosed to the aortic defects. The neo-RVOT is created at the RV outflow portion. G, The ascending aorta is anastomosed to the aortic root. The pulmonary trunk is anastomosed to the pulmonary bifurcation. H, The pulmonary valve is anastomosed to the neo-RVOT, and the anterior wall of the neo-RVOT is augmented. *IF*, Infundibular; *A-valve*, aortic valve; *P-valve*, pulmonary valve; *VSD*, ventricular septal defect; *LVOT*, left ventricular outflow tract; *RVOT*, right ventricular outflow tract.

There were many anatomic restrictions in the surgical approach for this patient. First, the VSD was located in a remote position. Although the arterial switch and VSD closure are supposed to be applied in a common posterior TGA with subpulmonary VSD, this was not appropriate for this patient with a remote VSD. The Rastelli procedure was also not without several concerns for this patient. In this procedure, a large intraventricular tunnel might decrease RV volume, and the reconstructed LVOT could be more winding and restricted.<sup>3,4</sup> Moreover, the tricuspid valve orifice would be partially covered with the baffle, and the RV inflow could be impaired. Second, the original aortic valve was located at the RV inflow portion (Figure 1, A). In the common TGA with anteroposterior arrangement, the neo-RVOT orifice is located just in front of the LVOT. After

performing the original HTTSO for this patient, the pulmonary valve would be implanted to the inflow portion, with the risk of turbulence in the RV. Therefore, for this patient, the original method was modified; the neo-RVOT was created at the outflow portion, and the separated pulmonary valve was implanted there (Figures 1, E, and 2, F and G), similar to pulmonary root translocation.<sup>5</sup> In addition, by reimplanting the half-turned aortic root, not only was the pedicle IF flap effectively used to close the original aortic valve defect (Figure 2, F), but also coronary arterial buttons were snugly anastomosed to the confronted aortic defect without distortion or stenosis.

In summary, the pulmonary valve was detached and implanted to the newly created RVOT during the HTTSO. This modification is useful and anatomically appropriate

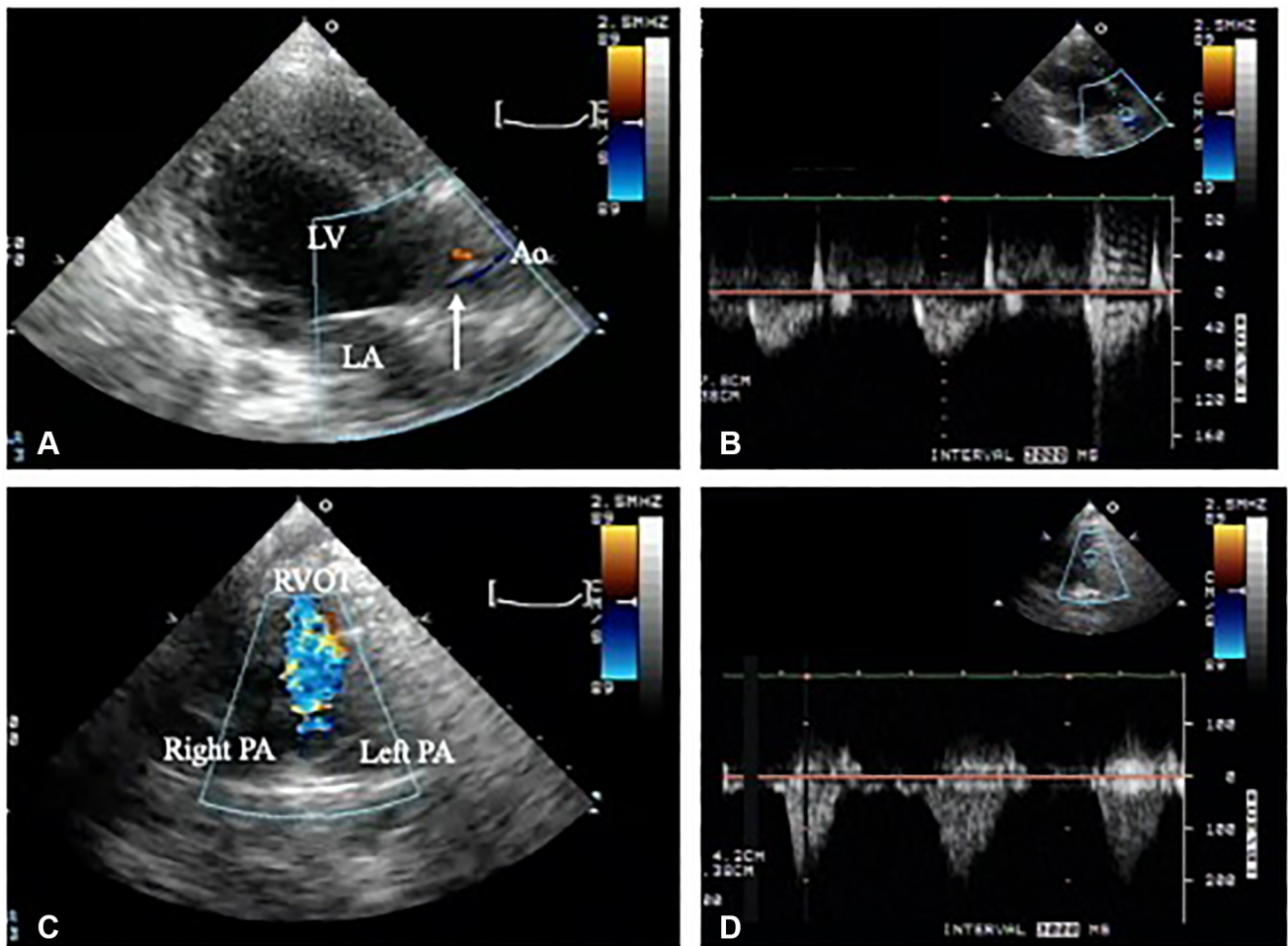


**VIDEO 1.** The aorta is transected approximately 10 mm above the sinotubular junction. The pulmonary trunk is transected just below the bifurcation. Both coronary arterial buttons are excised. The truncal block involving both semilunar valves is harvested en bloc. Both ends of the IF septum are resected longitudinally. The VSD is closed using a curved-design patch to prevent residual LVOT obstruction. The aortic valve is half-turned horizontally and anastomosed to the LVOT orifice. The superior margin of the VSD patch is anastomosed to the IF. Both coronary buttons are anastomosed to the corresponding aortic wall defects. The IF flap is flipped up and anastomosed to the aortic valve defect at the RV inflow portion. The ascending aorta is reconstructed by end-to-end anastomosis. An adequately sized pulmonary valve is obtained by commissurotomy. The pulmonary valve is anastomosed to the newly created orifice at the RVOT. The distal stump of the pulmonary trunk is anastomosed directly to the pulmonary bifurcation. The anterior wall of the neo-RVOT is augmented with the patch. Video available at: [https://www.jtcvs.org/article/S2666-2507\(23\)00189-X/fulltext](https://www.jtcvs.org/article/S2666-2507(23)00189-X/fulltext).

for this spectrum, producing excellent outflow tracts for both right and left ventricles.

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**FIGURE E1.** Echocardiogram 3 years after the modified half-turned truncal switch operation. A, Longitudinal view with color Doppler showed wide and straight LVOT with tiny aortic valve insufficiency (*white arrow*). B, Maximum velocity at LVOT was measured as 0.8 m/s. C, Axial view with color Doppler showed physiologically positioned RVOT with mild valvular stenosis. D, Maximum velocity at RVOT was measured as 2.0 m/s. *LV*, Left ventricle; *Ao*, aorta; *LA*, left atrium; *RVOT*, right ventricular outflow tract; *PA*, pulmonary artery.