Symmetric tricuspidization of a regurgitant quadricuspid truncal valve: A versatile adaptation for aortic valve repair

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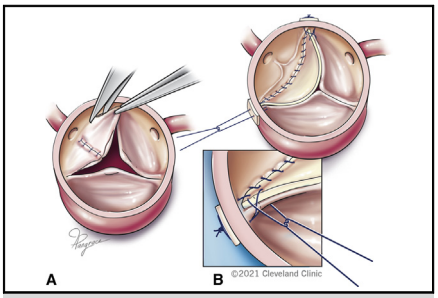

Truncal valve tricuspidization with resection and single pericardial leaflet creation.

CENTRAL MESSAGE

Quadricuspid truncal valve repair with deficient tissue may be addressed by pericardial leaflet to construct a symmetric trileaflet valve without altering the aortic root for future interventions.

Video clip is available online.

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Quadricuspid truncal valve (TV) repair for severe regurgitation is a surgical challenge with several proposed techniques.[1] The ideal operation should result in a competent and durable trileaflet TV with longitudinal growth potential. Cusp resection and annular reduction is 1 proposed technique advocated by some centers.[2,3] However, we have not adopted this technique due to concerns for asymmetric cusp creation, potential aortic root undersizing, and need for coronary artery relocation. Standardization of pericardial leaflet creation with Ozaki templates[4] has reinvigorated interest in surgical valve repair. We present a case of rudimentary cusp resection and single leaflet implantation therapy creating symmetric tricuspidization of a regurgitant quadricuspid TV. The institutional review board at our institution does not require review for isolated case reports that do not contain patient-specific protected health information. Informed consent was obtained from the parents to publish this report.

CASE SUMMARY

A 9-month old, 6.5 kg female with truncus arteriosus underwent neonatal surgical repair. At initial operation, a quadricuspid TV with severe regurgitation was found. Valve inspection demonstrated 2 dysplastic posterior leaflets with a shared commissure below the left coronary (LCA) ostium, and 2 remaining adequately sized leaflets. Temporizing valve repair was performed by side-to-side apposition of the 2 rudimentary leaflets with reduction of TV regurgitation from severe to moderate. As anticipated, after 9 months, her TV regurgitation worsened, with associated left ventricular (LV) dilation and mild dysfunction. Imaging revealed deficient posterior leaflet tissue at the site of her prior valve repair with a large eccentric regurgitant jet (Figure 1). She was scheduled for more definitive TV repair.

After redo sternotomy, a large autologous pericardial patch was prepared in 0.6% glutaraldehyde solution for 6 minutes (Video 1). After institution of cardiopulmonary bypass and cardioplegic arrest, examination of the quadricuspid TV demonstrated 2 small posterior leaflets with a shared commissure below the LCA joined side-to-side from her initial repair with a large area of noncoaptation. The remaining 2 anterior leaflets were adequate size. Valve

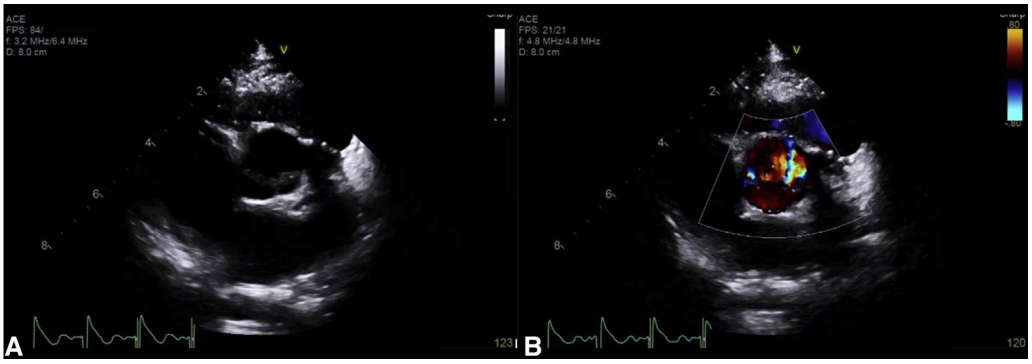

FIGURE 1. Preoperative echocardiogram. A, Short-axis view of quadricuspid truncal valve with dysplastic posterior leaflets joined side-to-side with large regurgitant orifice. B, Color Doppler with large eccentric regurgitant jet.

repair began by shaving thickened tissue at the leading edge of the anterior leaflets. Due to the small size and dysplastic tissue, the posterior leaflets were deemed nonrepairable and were excised (Figure 2, *A*). To reconstruct a left coronary cusp, a single leaflet was constructed from glutaraldehyde-treated autologous pericardium. A #19 Ozaki sizer and template (Japanese Organization for Medical Device Development, Inc, Tokyo, Japan) was used to create a slightly oversized pericardial leaflet to ensure a large area of coaptation and accommodate future aortic root growth. The newly constructed leaflet was sutured to the aortic root with running technique with initial bites deep in the LV outflow tract to create a large sinus of Valsalva and prevent LCA occlusion (Figure 2, *B*). Commisural height was tailored to match native leaflet commissures. The commissures were further reinforced with figure-of-8 commissuroplasty. The valve was tested and the aortotomy closed. The previously placed right ventricle-to-pulmonary artery conduit was replaced with a homograft due to moderate stenosis and regurgitation.

Cardiopulmonary bypass was successfully weaned with excellent hemodynamic parameters. Transesophageal echocardiography demonstrated trivial TV regurgitation with a large area of leaflet coaptation (Figure 3). The newly constructed sinus of Valsalva was robust with unobstructed LCA flow. Postoperative course was unremarkable and she was discharged home on day 6 following surgery. At 1-year follow-up, the patient was asymptomatic, leading an active lifestyle with excellent growth. Transthoracic echocardiography demonstrated mild-to-moderate TV regurgitation with normal LV size and function.

DISCUSSION

Severe regurgitation of a quadricuspid TV presents a difficult challenge to surgeons with limited repair options and no universally accepted technique. Whereas valve competence is the major goal of any repair, durability and implications for future interventions must also be considered. We believe that the commonly cited technique of

VIDEO 1. Intraoperative video demonstrating key steps in surgical procedure. Video available at: https://www.jtcvs.org/article/S2666-2507(22)00080-3/fulltext.

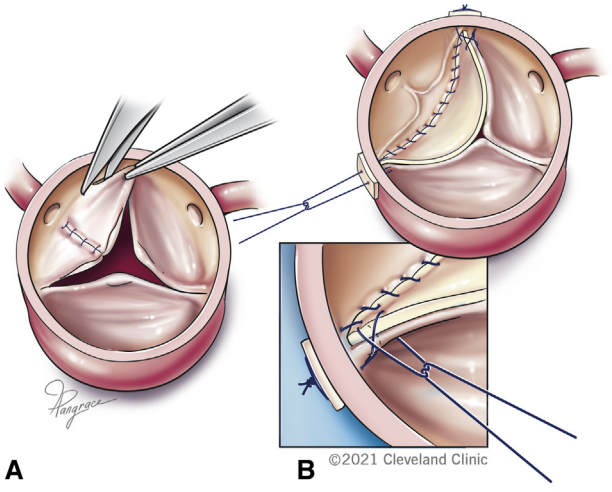

FIGURE 2. Illustration of operative technique. A, Valve examination followed by excision of the small, dysplastic posterior leaflets below the ostium of the left coronary artery. B, Newly constructed pericardial leaflet secured to the aortic root well below the attachment of the excised leaflets with a figure-of-8 commissuroplasty (*inset*).

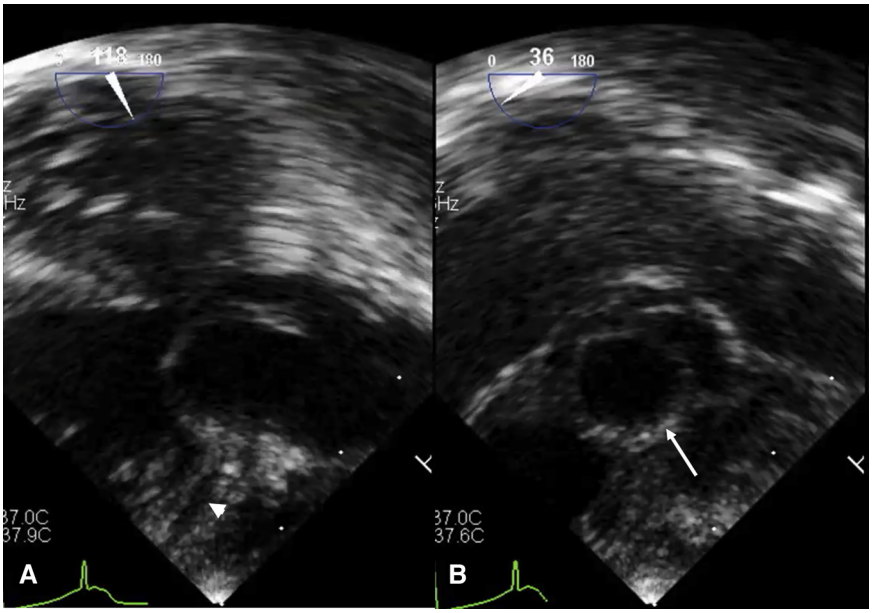

FIGURE 3. Postoperative echocardiogram. A, Long-axis view of truncal valve following repair with large area of leaflet coaptation, robust sinus of Valsalva, and unobstructed coronary flow (*arrowhead*). B, Short-axis view demonstrating slightly oversized pericardial leaflet coapting native leaflets and obliterating the regurgitate orifice.

tricuspidization with cusp resection and annulus reduction does not result in a symmetric trileaflet valve and may distort the geometry of the aortic root complex. Moreover, in the series by Naimo and colleagues,[2] 1 patient required subsequent annular enlargement due to resection of truncal root annulus during tailoring. To avoid these pitfalls, we prefer techniques that spare the aortic annulus and avoid coronary artery relocation, thereby preserving the aortic root for future interventions. Our novel approach for valve reconstruction in a quadricuspid TV with severe regurgitation respects widely held principles of valve repair. Replacing deficient leaflet tissue with autologous pericardial tissue creates a symmetric trileaflet valve with significant coaptation area that will persist despite aortic root growth. In addition, the size of autologous pericardium needed for single leaflet construction is limited; therefore, it can be available despite the redo nature of most of these operations. Finally, replacing the TV with aortic homograft sets the child for lifelong root replacements, which should be avoided when possible in all young patients. As is the case with the Ozaki procedure in the growing child, the durability of our technique is unknown and may be potentially limited by patient growth and biologic tissue degeneration.[5] Although future interventions will most certainly be required, we believe that oversizing the pericardial leaflet to create a large area of coaptation will delay reoperation and position patients well for repeat valve surgery within the native aortic root.

Webcast

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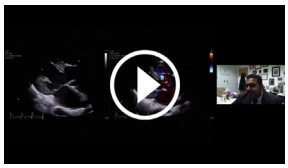

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Discussion

Presenter: Dr Anthony L. Zaki

Dr Igor E. Konstantinov (*Melbourne, Australia*). Thank you very much, Dr Zaki, for your beautiful presentation and congratulations to you and to the Cleveland Clinic team on achieving an excellent early result in such a challenging patient. A few questions come to mind.

As we all know, truncal valve repair is difficult. It's not an easy procedure. And most importantly, very often it is not durable long-term. It was somewhat difficult to appreciate the exact anatomy from your video. Could you please share your thoughts on why the valve could not be repaired by tricuspidization, annular reduction, and without the use of a patch?

Dr Anthony L. Zaki (*Cleveland, Ohio*). Thank you, Dr Konstantinov, for the question and for reviewing our case. For this patient's particular anatomy, our concern was that the 2 posterior leaflets were small and undersized. With the tricuspidization technique with cusp resection and annular reduction, we were concerned that there would be significant area of noncoaptation and residual regurgitation. We have read with great interest that a lot of centers have been successful with this technique, including your own. However, we're hesitant. We think that procedure alters the geometry of the aortic root, which makes future procedures challenging and may lead to multiple reinterventions down the road. Additionally, the focus of our repair is creating three equal, symmetric leaflets. And if 1 of the leaflets left behind is small and undersized, we're concerned about recurrent residual regurgitation.

Dr Konstantinov. Thank you very much. What do you think the long-term prognosis of truncal valve with a replaced cusp in an infant would be?

Dr Zaki. We are optimistic with our patient. As you saw in those immediate postoperative images, we were able to achieve a large area of coaptation, which we believe as the aortic root grows with the child, she will maintain that coaptation and prevent recurrent regurgitation. There is no good data to tell us how long or how durable this type of operation may be, but by recreating 3 symmetric leaflets with a large area of coaptation, we're optimistic that by recapitulating normal anatomy, the long-term durability may be good.

Dr Konstantinov. Your echocardiogram beautifully demonstrated a very nice coaptation area, and an excellent flow in the left main coronary artery that was very gratifying to see. Could you please tell us how you balance between putting a large enough patch to achieve this coaptation, and at the same time, avoid coronary occlusion?

Dr Zaki. That's an interesting point. First of all, we oversize our leaflet to ensure that there is maximal coaptation. And the nadir of the leaflet is brought deep into the aortic root into the left ventricular outflow tract to create a really robust and large sinus of Valsalva, which we believe would prevent coronary occlusion. In addition, kind of extracting from adult data with transcatheter aortic valve procedures, we believe if there's an adequate coronary height in the sinus of Valsalva, that the risk of coronary occlusion with the leaflet motion is low. And if we don't see that complication in the immediate postoperative period before weaning completely off of bypass, we believe it's unlikely that that will develop down the road as the aortic root grows and the degree of coaptation lessens.

Dr Konstantinov. Right, very well. And finally, my last question: As you know, there are no 2 truncal valves that are the same. Truncal valves present a huge spectrum of problems with the valve itself. Could you please tell us, when would you try to repair a truncal valve? And in what circumstances would you have to replace (partially or completely) a truncal valve using the Ozaki technique?

Dr Zaki. It's an interesting question. There's no good data to drive that question, and I think that's important for future work and research. At this point, it's kind of the judgment call of the operating surgeon based on the morphology of the valve, with certain principles in mind. We believe that if you can recreate a symmetric trileaflet valve, then your odds of durability are higher. So we would preserve native leaflet tissue if we felt that after the repair, we're left with 3 symmetric cusps and only would consider pericardial leaflet reconstruction, if that were not the case. But that's an interesting topic, and we hope, as we get more experience with this technique, to have better predictors of which technique to pursue in which situation.

Dr Konstantinov. Thank you very much for your superb presentation; I really enjoyed it. Congratulations again on the excellent early outcome.

Dr Zaki. Thank you very much.