Bench valvular surgery in donor hearts before transplantation: Choice versus Necessity

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Abstract

Severe shortage of donor hearts has increased the mortality of patients on the transplant waiting list. However, donor hearts with valvular dysfunction are rarely used. Utilizing donor hearts with valvular lesions that can be repaired or replaced at the time of transplant will decrease waitlist mortality and offer many patients a second chance in life.

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Short Running Title: Valvular surgery in donor hearts

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Abstract

Severe shortage of donor hearts has increased the mortality of patients on the transplant waiting list. However, donor hearts with valvular dysfunction are rarely used. Utilizing donor hearts with valvular lesions that can be repaired or replaced at the time of transplant will decrease waitlist mortality and offer many patients a second chance in life.

Heart transplantation is the gold standard treatment for patients with terminal end-stage heart diseases, however this option is limited by the discrepancy between the number of transplant candidates on the waiting list and the number of available organs.(1) As a result, many patients die waiting for donors. According the 2020 OPTN/SRTR (Organ Procurement and Transplantation Network/Scientific Registry of Transplant Recipients) report, the overall mortality rate among patients on the heart waitlist in the U.S.A was 9 per 100 waitlist-years, and status 1A patients had pretransplant mortality rate of 29.5 deaths per 100 waitlist-years.(2) To alleviate the death on waitlist, efforts have been focused on expanding the donor pool by multiple approaches, including the expansion of the donor criteria. Structural valve diseases have been considered an absolute contraindication for accepting a donor heart. However, several reports have documented successful outcomes after bench (ex-vivo) repair or replacement of valves before heart transplantation.(3-6)

In this issue of the Journal, Rendón et al., (7) described bench aortic valve replacement before heart transplantation in a 39 year-old critically ill patient. They reported a bicuspid calcified aortic valve during back table examination of the donor heart before transplant. Giving the critical condition of the recipient and the lack of proper mechanical circulatory support device, replacing this incidentally discovered calcified valve was the only option to save this patient's life. In developing countries, proper equipment, and medical specialists to adequately evaluate the heart before procurement are not always available, hence, it is possible to discover valvular or coronary artery disease during procurement or during back table organ examination. More importantly, the lack of an advanced mechanical circulatory support program does not give the surgeon other alternatives but utilizing this marginal heart with aortic valve disease. The authors used a bioprosthetic valve instead of mechanical valve to avoid anticoagulation with potential bleeding during posttransplant cardiac biopsies. Structural deterioration of bioprosthesis in young patients is a known risk, however catheter-based valve-in- valve or mechanical valve replacements are options in the future, when the patient is in better condition, should aortic valve stenosis occur.

Utilizing hearts with valvular diseases that need repair or replacement has been reported as case reports or small case series, with acceptable outcomes. In a case series from Portugal, Prieto et al., (5) performed bench repair of the mitral valve on 4 donor hearts before transplant with short total ischemic time. These repairs included one posterio-medial commissurotomy and posterior annuloplasty, one reimplantation of a torn head of the posterior papillary muscle, and two posterior annuloplasties. All repairs and transplant were successful, but one die from persistent profound thrombocytopenia resulting in intracerebral bleeding and death. In another case series Fiore et al., reported successful use of 4 hearts with valvular lesions that underwent repair or replacement at the time of transplantation.(3) Three of them had moderate-severe mitral regurgitation that each required the following: annuloplasty, annuloplasty and chordal replacement, and cleft repair. The 4th showed aortic valve stenosis requiring an aortic valve replacement with a bioprosthesis. They reported no residual mitral regurgitation or aortic stenosis post-operatively. These cumulative experiences along with other case reports showed a total of at least 11 cases of bench mitral valve surgery before transplant with good outcomes. (4, 5, 8-10)

For aortic valve repair or replacement, in addition to the case reported in this current issue of the Journal, (7) there are other 7 cases in the literatures. Of these 8 cases, 1 was repaired with Cabrol commissural annular plication technique (11) the other were replacement with either bioprosthetic (3, 12-14) or mechanical (6, 15) valves. All had excellent outcomes. The mechanical aortic valve is more durable but its need for chronic systemic anticoagulation will complicate posttransplant care, especially during the first year with frequent surveillance endomyocardial biopsy. Besides the advantage of avoiding long term anticoagulation, aortic valve bioprosthesis may outlast the heart recipient, especially those at age 60 years or higher. Bourguignon et al., reported that the freedom from reoperation due to structural valve deterioration for the Carpentier-Edwards Perimount pericardial bioprosthesis at 15 year were 70.8% ± 4.1% and 82.7% ± 2.9%, for the patients with

the age of 60 years or younger, and for those of 60 to 70 years of age, respectively. (16) This freedom from structural deterioration compares very favorable with the long-term survival of the heart recipients of 53% at 10 years.(17) Moreover, available data suggest that immunosuppression may slow down the process of structural valve deterioration. Eishi et al., reported that aortic bioprosthesis in patients with aortitis who received chronic steroid treatment showed lower degree of structural valve degeneration. (18)

In general bench valve surgery in donor hearts at the time of heart transplantation are performed either by choice of by necessity. In the former, the transplant team is aware of the valvular dysfunction in the donor but elects to use it, while in the latter, the valvular abnormality is discovered right before implantation of the donor heart.

Because the valve repair or replacement in donor hearts at the time of transplant potentially increase the risk of complications, it is prudent to select both the recipient and donor carefully. One needs to balance the risk of death on the waitlist versus the increased risk of complications, such as primary graft failure due to prolonged ischemic time (due to the valve repair or replacement), endocarditis, bleeding from systemic anticoagulation for mechanical valves, structural failure of the prosthesis, durability and success of the repair. One technique that will reduce the ischemic time of the donor heart is to perform the bench valvular repair or replacement then implant the heart by anastomosing the left atrial cuffs and the ascending aortas. After these anastomoses are completed, unclamp the aorta to reperfuse the heart while the pulmonary arterial, the inferior and superior vena caval anastomoses are carried out.

For critically ill patients when advanced therapies including mechanical circulatory supports is not available (in developing countries) or is contraindicated (such as infected durable left ventricular assist devices) the decision is usually straightforward. In more stable patients, the decision to use these marginal donors requires thoughtful discussion with, and consent from, patients and their health care surrogates.

In conclusions, the use of donor hearts that require valvular repair or replacement, either by choice or by necessity, will reduce waitlist mortality and may offer many people with a second chance in life, especially for those in areas where resources are limited or where donors are in severe shortage.

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1. Singh TP, Milliren CE, Almond CS, Graham D. Survival benefit from transplantation in patients listed for heart transplantation in the United States. J Am Coll Cardiol. 2014;63(12):1169-78.

2. Colvin M, Smith JM, Ahn Y, Skeans MA, Messick E, Bradbrook K, et al. OPTN/SRTR 2020 Annual Data Report: Heart. Am J Transplant. 2022;22 Suppl 2:350-437.

3. Fiore A, Grande AM, Gatti G, Youssari A, Piscitelli M, Bergoend E, et al. Valvular surgery in donor hearts before orthotopic heart transplantation. Arch Cardiovasc Dis. 2020;113(11):674-8.

4. Massad MG, Smedira NG, Hobbs RE, Hoercher K, Vandervoort P, McCarthy PM. Bench repair of donor mitral valve before heart transplantation. Ann Thorac Surg. 1996;61(6):1833-5.

5. Prieto D, Antunes P, Antunes MJ. Donor mitral valve repair in cardiac transplantation. Transplant Proc. 2009;41(3):932-4.

6. Saito S, Matsumiya G, Ueno T, Sakaguchi T, Kuratani T, Ichikawa H, et al. Bench replacement of donor aortic valve before orthotopic heart transplantation. J Heart Lung Transplant. 2009;28(9):981-3.

7. Rendón JC, Vinck EE, Gómez AQ, Escobar JJ, Suárez S, Echeverri DA. Bench Bioprosthetic Aortic Valve Replacement in a Donor Heart Before. J Card Surg. 2022;(In Press).

8. Michler RE, Camacho DR. Ex-vivo mitral valve repair prior to orthotopic cardiac transplantation. Ann Thorac Surg. 2002;73(3):962-3.

9. Pawale A, Tang GH, Milla F, Pinney S, Adams DH, Anyanwu AC. Bench mitral valve repair of donor hearts before orthotopic heart transplantation. Circ Heart Fail. 2012;5(6):e96-7.

10. Sprengel A, Skwara W, Ziegelhöffer T, Cetinkaya A, Schönburg M, Richter M. Combined mitral valve repair and heart transplantation. Clin Case Rep. 2018;6(4):564-8.

11. Navia JL, Atik FA, Marullo A, Starling RC, Garcia M, Vega PR, et al. Bench repair of donor aortic valve with minimal access orthotopic heart transplantation. Ann Thorac Surg. 2005;80(1):313-5.

12. Patel M, Vahdat KK, Nathan S, Petrovic M, Loyalka P, Kar B, et al. Bioprosthetic Aortic Valve Replacement in a Donor Heart before Orthotopic Heart Transplantation. Tex Heart Inst J. 2017;44(2):135-7.

13. Sultan I, Seese L, Lagazzi L, Gleason TG. Concomitant aortic valve replacement with orthotopic heart transplantation. J Thorac Cardiovasc Surg. 2018;155(5):e151-e2.

14. Rao JN, Prendergast B, Dark JH. Orthotopic heart transplantation with concurrent aortic valve replacement and coronary artery bypass grafting. J Heart Lung Transplant. 2000;19(9):897-9.

15. Larobina ME, Mariani JA, Rowland MA. Aortic valve replacement for aortic stenosis during orthotopic cardiac transplant. Ann Thorac Surg. 2008;86(6):1979-82.

16. Bourguignon T, Bouquiaux-Stablo AL, Candolfi P, Mirza A, Loardi C, May MA, et al. Very long-term outcomes of the Carpentier-Edwards Perimount valve in aortic position. Ann Thorac Surg. 2015;99(3):831-7.

17. Suarez-Pierre A, Lui C, Zhou X, Giuliano K, Etchill E, Almaraz-Espinoza A, et al. Long-term Survival After Heart Transplantation: A Population-based Nested Case-Control Study. Ann Thorac Surg. 2021;111(3):889-98.

18. Eishi K, Ishibashi-Ueda H, Nakano K, Kosakai Y, Sasako Y, Kobayashi J, et al. Calcific degeneration of bioprosthetic aortic valves in patients receiving steroid therapy. J Heart Valve Dis. 1996;5(6):668-72.