"Close But No Cigar": Successful Aortic Valve Repair Using Autologous Pericardium

Saqib Masroor[1]

[1]University of Toledo Medical Center

January 25, 2022

Title: *"Close But No Cigar": Successful Aortic Valve Repair Using Autologous Pericardium*

Author: *Saqib Masroor, MD, MBADivision of Cardiothoracic Surgery, Department of Surgery, University of Toledo Medical Center Toledo, OH USA*

Manuscript: *Aortic Valve Reconstruction surgery using autologous pericardium: The experience in Vietnam*

Meeting Presentation: None

Disclosure: *None*

Word Count: *1385*

Corresponding Author:

Saqib Masroor, MD, MHS

Chief, Division of Cardiothoracic Surgery

University of Toledo College of Medicine and Life Sciences

3000 Arlington Avenue, Toledo, Ohio 43614

Phone: 419-383-5150

Fax: 419-383-3149

The history of aortic valve repair with pericardium starts with Yacoub and Batista who used a single patch of bovine pericardium to construct an entire tri-leaflet aortic valve in patients with both aortic stenosis as well as regurgitation (1,2). As little as possible of the free edge of the leaflet was resected and a large strip of glutaraldehyde-fixed bovine pericardium was sutured to the cut free edge of the leaflets. This created very tall leaflets and very high commissures in order to increase the coaptation of the valve leaflets. However, the excessive leaflets had a tendency to bend towards the sinuses of Valsalva, occasionally causing serious coronary ischemia by obstructing coronary ostia (3).

To keep the leaflets away from the sinuses and avoid the coronary ischemia, Duran used a plastic container with three consecutive bulges to mold the shape of the leaflets during fixation (3). Pericardium was draped over these bulges during glutaraldehyde fixation to give the neo-leaflets a curved shape facing away from the sinuses. Using this technique, the group reported a survival of 85% with a mean follow up of 10.5 years, in a population of patients with a mean age of 31 years. Freedom from structural valve degeneration was 78% and 55% at 10 and 16 years respectively (4). Interestingly, while initially reported as aortic valve *replacement* , it was later labelled as aortic valve*reconstruction* by the group. Bicuspid aortic valve was a contraindication.

Dr Ozaki's technique of "aortic valve reconstruction" (5) is based on recreating the three leaflets and commissures, rather than extending the leaflet and commissural heights to increase coaptation. The leaflets are completely excised and replaced with three separate pieces of autologous glutaraldehyde-fixed pericardium. New leaflets are sutured directly to the annulus. Even bicuspid valves are repaired in a tri-leaflet fashion by creating a new commissure. While he has demonstrated excellent midterm results, the mean age of the patients was 71 years. Even though this procedure can be done minimally invasively (6), this is the age group in which transcatheter aortic valve implantation has become the procedure of choice in the western world. Ozaki procedure is therefore unlikely to see widespread use in this older patient population.

However, in the developing world, where millions of patients still suffer from rheumatic valvular disease and up to 12-13 million patients suffer from rheumatic aortic valve disease (7), this procedure has tremendous potential. There have been reports of its successful use in Brazil, Russia and Vietnam (6-9) for instance, where the population has been relatively younger. In this issue of *Journal of Cardiac Surgery,* Ngo et al (10) from Vietnam, presents their experience with Ozaki procedure in 72 patients with a mean age of 53 years and mean follow-up of 26 months. Two patients required conversion to prosthetic valve replacement due to coronary obstruction with reconstructed leaflets. There was one 30-day mortality due to cardiac tamponade from bleeding and another two died due to pseudoaneurysm rupture resulting from mediastinitis. In the follow-up period, two patients required reoperation for infected endocarditis. Only one patient had moderate regurgitation immediately following surgery and should be considered a failure of the operation. None of the other complications can be attributed to the procedure itself. These results are comparable to those of others (6-9).

When Dr Ozaki presented his initial series of patients, the concern was reproducibility. However, with the creation of "AVNeo" system, which uses standardized sizing templates for the autologous pericardium based on inter-commissural distance and coaptation heights, this procedure has become quite reproducible. This work by Nguyen et al, is a testament to the reliability and reproducibility of the Ozaki procedure or Neo-cuspidization as it is also called.

Another potential use of this procedure is in the pediatric population. Since its approval by Food and Drug Administration approval in 2014, it has also been used in pediatric patients (11). By not restricting the aortic root, this procedure allows the aortic root to grow with age. Since 2015, pediatric sizers 13 mm and 15 mm have also been available in addition to the adult sizes 17 to 31 mm.

One issue that still remains unresolved is the fate of the autologous pericardial leaflets over long term. Dr Duran's report of 92 patients (5) remains the most pertinent report on the use of autologous pericardium in a young population. The mean age of patients in that series was 30 years and it had a mean follow up of 10 years. The group had a survival of a 85% over a 10 year follow-up. Ozaki procedure has not been tested in such a young population yet.

One final consideration is the choice of material for leaflet reconstruction. Much research is being conducted on the use of synthetic materials such as polyurethanes and nanocomposite polymers, as well as carbon fibers for use in prosthetic valves. These materials have shown promising results (12-14) in vitro in terms of their durability, resistance to thrombosis and ability to encourage endothelialization. It would be logical to use some of these materials in making individual leaflets that can be kept on the shelves and used when needed, instead of autologous pericardium. It would save time as well as be amenable to minimally invasive approaches. I hope someone picks up on this line of research, with the hope of having artificial leaflets of all different sizes on the shelf for use in the young adult population.

In conclusion, this procedure is a useful tool in the surgeon's armamentarium, but its most beneficial use will be in a younger population under the age of 50 years, where it still has to demonstrate long-term freedom from structural valve degeneration. More centers need to report even longer-term outcomes in a young adult and pediatric population to clearly define its role in the treatment of aortic valve disease. Use of synthetic leaflets as an alternative to autologous pericardium would be a reasonable line of future investigation but does not seem to be the focus of any published literature yet. At present this procedure can be best described

as what my friend and mentor, Dr John Charles Alexander loves to quote, "Close, but no cigar."

REFERENCES:

1. Yacoub M, Khaghani A, Dhalla N, et al. Aortic valve replacement using unstented dura or calf pericardium: early and medium term results. In: Bodnar E, Yacoub M, Eds. *Biological and bioprosthetic valves.*New York: Yorke Medical Books, 1986:684-90
2. Batista RJV, Dobrianskij A, Comazi M, et al. Clinical experience with stentless pericardial aortic monopathy for aortic valve replacement.*J Thorac Cardiovasc Surg* 1987;99:113-8
3. Duran CMG, Gometza B, Kumar N, Gallo R and Martin-Duran R. Aortic valve replacement with freehand autologous pericardium. *J Thorac Cardiovasc Surg* 1995;110:511-6
4. Halees Z, Shahid MA, Sanei AA, Sallehuddin A and Duran C. Up to 16 years follow-up of aortic valve reconstruction with pericardium: a stentless readily available cheap valve? *Eur J Cardiothorac Surg* 2005;28(2):200-5
5. Ozaki S, Kawase I, Yamashita H, Uchida S, et al. Aortic valve reconstruction using self-developed aortic valve plasty system in aortic valve disease. *Interact CardioVasc Thorac Surg*2011;12:550-3
6. Nguyen DH, Vo AT, Le KM, et al. Minimally invasive Ozaki procedure in aortic valve disease: Preliminary results. *Innovations (Phila)*2018;13(5):332-7
7. Coffey S, Robert-Thomson R, Brown A, et al. Global epidemiology of valvular heart disease. *Nature Rev Cardiol* 2021;18:853-64
8. Ozaki S, Kawase I, Yamashita H, et al. Midterm outcomes after aortic valve neocuspidization with glutaraldehyde-treated autologous pericardium. *J Thorac Cardiovasc Surg* 2018;15(6):2379-87
9. Krane M, Boehm J, Prinzing A, et al. Excellent hemodynamic performance after aortic valve neocuspidization using autologous pericardium.*Ann Thorac Surg* 2021;111:126-33
10. Ngo TH, Nguyen CHG, Do DT et al. Aortic valve reconstruction surgry using autologous pericardium: The experience in Vietnam. *J Cardiac Surg* . . . . . .
11. Baird CS, Marathe SP and del Nido PJ. Aortic valve neo-cuspidation using the Ozaki technique for acquired and congenital disease: where does this procedure currently stand? *Ind J Thorac Cardiovasc Surg* 2020;36(1):S113-22
12. Ovcharenko EA, Seifalian A, Rezvova MA, et al. A new nanocomposite copolymer based on functionalised graphene oxide for development of heart valves. www.nature.com/scientificreports/ 2020;10:5271, https://doi.org/10.1038/s41598-020-62122-8 , Accessed January 16, 2022
13. Alves P, ardoso R, Correia TR, et al. Surface modification of polyurethane films by plasma and ultraviolet light to improve haemocompatibility for artificial heart valves. *Colloids and Surfaces B: Biointerfaces* 2014;113:25-32
14. Tseng Y-T, Grace NF, Aguib H, et al. Biocompatibility and application of carbon fibers in heart valve tissue engineering. *Front Cardiovasc Med* 8:793898

doi: 10.3389/fcvm.2021.793898. Accessed January 14, 2022.