Tissue Heart Valve Replacement at BSMMU- Initial Experience with Two Cases

Rezwanul Hoque[1], Mostafa Nuruzzaman[2], Sabrina Sharmeen Husain[3],Md. Anwarul Islam[3], Magfur Rahman[3], Md. Aftabuddin[4]

[1]Associate Professor, [2]Consultant, Cardiac Anaesthesiology, [3]MS Student, [4]Professor & Chairman [4]Department of Cardiac Surgery, BSMMU, Dhaka

Abstract:

Research on prosthesis to replace diseased heart valves began almost simultaneously with mechanical valves which are durable but with inherent thromboembolic complication requiring life-long anticoagulant therapy and tissue valves which are more prone to structural failure but free from thromboembolic complication. Tissue valves are more useful in females of reproductive age desiring a child, male patients older than 60 years of age and female patients over 55 years of age, patients having chronic liver disease, history of stroke, bleeding disorder and in presence of infective endocarditis. Gluteraldehyde fixation at low pressure with removal of maximal amount of phospholipid have increased the durability of tissue valves in recent years. Considering the better quality of life with tissue valve the trend is shifting towards using it more frequently around the world. Recently two heart valve replacement operations using bovine perimount pericardial valve were done in the department of cardiac surgery, BSMMU, one in aortic position another in mitral position, both in females of reproductive age desiring children.The operations were technically demanding but the outcomes were uneventful. Tissue heart valve replacement is a safe procedure and can be useful in female of child bearing age desiring children.

Key Words: Tissue heart valve replacement, Aortic valve, Mitral valve, Bioprosthetic heart valves, Bovine perimount pericardial valve.

[BSMMU J 2010; 3(1): 27-30]

Introduction:

The first valve replacements that led to long term survivors were mechanical cage ball valves used by the Harken in the aortic position and Starr in the mitral position both in 1960.[1] The first biological valves used successfully were transplants from human cadavers, called homograft or allograft pioneered by Ross and Barratt-Boyes in 1962.[1] Successful use of autologous grafts began with the pulmonary autograft in 1967[1].

Mechanical valves are the most durable replacement alternative, designed to last a lifetime, for patients of all ages. A study by Lund et al. of 694 aortic valve implants documented 100% freedom from mechanical failures at 18 years[2]. A study by Remadi et al. of 440 mitral valve implants documented 100% freedom from structural dysfunction at 19 years[3].

The mechanical valve designs that have prevailed until today are the ball and cage valve, tilting disc valve, and the bileaflet valve. The use of pyrolitic carbon has reduced but could not completely remove the unavoidable thromboembolic complication. The use of warfarin continued with the risk of bleeding at higher dose and thromboembolic complication at lower dose. The teratogenic effect related to warfarin therapy prevents women of child bearing age to be implanted by mechanical valve. Apart from that, patients with recent history of stroke, having chronic liver disease and infective endocarditis can not be replaced by mechanical valves. Mechanical valve should be used if the need for anticoagulation is mandatory because of atrial fibrillation, mechanical valve in another position, renal failure requiring dialysis, or has a long life expectancy.[1] Mechanical valves should also be considered for double valve replacement, because the thromboembolic risk is not an additive with two valves but the risk of structural deterioration is additive[1].

The biological or tissue valve are of several types- an autograft (Pulmonary valve used to replace own aortic valve), homograft- harvested from cadaveric human donor, heterograft- harvested or manufactured from animal tissue.

The porcine stented valve was the first generation of porcine tissue valves. They have been available for more than 30 years. The valves are made from natural porcine

Address of Correspondence: Dr. Rezwanul Hoque Bulbul, Associate Professor (Cardiac Surgery), D-block, 5th Floor, Room No. 601, BSMMU, Shahbag, Dhaka- 1000, E-mail: drrhbulbul@yahoo.com

aortic valves, but may be used for aortic or mitral valve replacement. They are trimmed and then fixed in buffered glutaraldehyde at high pressure. The valves are mounted on flexible stents (frames). The bottom of the valve is covered with a seamless knitted polytetrafluoroethylene cloth. This material helps to facilitate the healing and ingrowths of tissue around the implanted valve. Freedom from structural deterioration at ten years ranges from about 60 to 90 percent for aortic position and from about 60 to 80 percent from the mitral position[1].

The porcine stentless valve is used for aortic valve replacement. The valve is made from a natural porcine aortic valve and is fixed in buffered glutaraldehyde solution at a low pressure. No stents or synthetic sewing rings are used. Therefore, these valves are very similar to the homograft valve. These valves are technically more difficult to implant but are useful in patients with small hypertrophied hearts.

The Carpentier-Edwards perimount pericardial bioprosthesis is made of bovine pericardial tissue (tissue from a cow heart) that has been preserved in a buffered glutaraldehyde solution and mounted on a flexible frame and a sewing ring of molded silicone rubber, which allows the surgeon to sew the valve to the patient. Both the frame and the sewing ring are covered with a knitted polytetrafluoroethylene (PTFE) cloth.

The Carpentier-Edwards Perimount Pericardial Bioprosthesis

The aortic pericardial bioprosthesis has been implanted internationally since 1981 and in the United States since 1991[4]. In 2000; Carpentier-Edwards released a perimount valve for the mitral position. The benefit of this valve is enhanced durability, which is related to the use of pericardium and the specific bioengineering involved in the valve design[4].

Sterilization methods used for homograft include chemical (ethylene oxide, beta propiolactone), radiation, and antibiotics, with antibiotics being favoured today. Preservation for a short time (months) is accomplished with nutrient storage of 4°C but cryopreservation, which allows for indefinite storage, greatly increases the availability of homograft. [1]Because of supply limitations with homograft, the most widely used valves are the partially manufactured heterograft valves. Bioprosthesis is a term Carpentier and Dubost introduced for a biological tissue that has been treated to render it nonviable[1]. Glutaraldehyde is used for fixing and preserving prosthetic heart valves because of three important biological actions: it sterilizes the tissue, renders it bio acceptable by destroying antigenicity, and stabilizes the molecular cross-links between the collagen fibers to enhance durability[1].

The main problems with bioprosthetic valves are structural failure from early calcification particularly in younger age group; Children exhibit the highest incidence of primary tissue failure because of increased uptake of calcium and high calcium metabolism. For children, tissue valve durability generally is limited to five years[5]. However, in some recent studies; researchers found that the 20- and 25-year survival rate in patients younger than age 50 did not differ between those who received tissue or mechanical devices. The findings show that at 20 years follow-up, the overall health risk of receiving a tissue valve is not greater than that of having a mechanical valve, even in young patients However; reoperation rates were significantly higher in patients receiving both aortic and mitral tissue valves[6, 7].

Second-generation tissue valves (that are glutaraldehyde fixed under low pressure) are considered more durable than first-generation tissue valves (that are glutaraldehyde fixed under high pressure)[8].

Case History: 1

A 20 year old recently married female was admitted into the department of cardiac surgery, on 23.04.2009 with a diagnosis of moderate stenosis of her congenital bicuspid aortic valve having peak pressure gradient of 56.4 mm of Hg. She was very much symptomatic with shortness of breath with mild exertion (NYHA- class EEE) though her left ventricular ejection fraction was 77%, much higher than expected. Her haematological, biochemical, coagulation profile and spirometric findings were normal. Her urine test was positive for pregnancy substantiated

by ultrasonography which revealed 10 weeks live pregnancy. Considering her symptoms and threat to her life if pregnancy was continued and appeal from her guardians to save her life by all means, a group of physicians including obstetrician ,cardiologist, and cardiac surgeon came to a consensus to terminate her pregnancy. Her pregnancy was terminated safely in the fetomaternal unit and after getting well she was transferred back to cardiac surgery. As the couple desired further pregnancy a decision to replace her diseased aortic valve by bioprosthetic tissue valve was taken. She was operated upon on 21.05.09 and her aortic valve was replaced by 21mm bovine perimount pericardial valve. She recovered uneventfully and was discharged home on 04.06.09 with an advice to take warfarin for 3 months. Follow up visit at one month and three months showed that she was completely free from her symptoms (NYHA- class I) and the prosthetic valve was working satisfactorily.

Case History: 2

Another 24 year old lady was admitted into the department of cardiac surgery on 08.06.2009 with history of progressive dyspnoea on exertion for last 2 years with a history of stroke with right hemiparesis 1 year back. Physical examination and diagnostic work up revealed grade 3+ mitral regurgitation with thickened anterior and posterior mitral leaflets having calcification at the tips. Her mitral valve area was 4.3 cm^2, peak pressure gradient across mitral valve was 13.6 mm of Hg and left ventricular ejection fraction was 63%. Her biochemical, haematological, coagulation profile was normal, however, lung function test revealed mild restrictive disease. She had history of rheumatic fever at her childhood and did not get proper penicillin prophylaxis.

She had one female child about 2 years old and she desired further pregnancy. Echocardiography did not show any left atrial thrombus. She was on sinus rhythm, so long term anticoagulation would not be needed and tissue valve was considered a better option than mechanical valve. Patient was prepared with regular chest physiotherapy, breathing exercise with incentive spirometry, diuretics, bronchodilators and a course of antibiotic therapy. Her mitral valve was replaced by 25 mm perimount bovine pericardial valve on 01.07.2009 and she recovered uneventfully.

Discussion:

The use of tissue valve to replace diseased heart valve is a new approach in the current practice of cardiac surgery in our country. Although few sporadic attempts to use tissue valves have been undertaken around the country these are the first two reported cases in Bangladesh. The main problem with tissue valve replacement was not only unavailability but the high initial expenses, higher chance of reoperation rate due to structural failure, more technically demanding surgeons of this country being less inclined to use tissue valves. But if the costs of anticoagulants and the regular check up of prothombin time are taken into consideration the overall cost at long term basis goes in favour of tissue valve. The main difference of implanting a tissue valve from a mechanical valve lies in the fact that it is non-rotatable, the sewing ring and the leaflets are very delicate, and particularly in mitral position the valve handles can not be removed before tying the knots and the assessment of valve function mainly relies on trans oesophageal echocardiography although the left ventricular cavity can be filled with saline to observe for proper cooptation of the three cusps and for any paravalvular leakage[9].

The main indication for using tissue valves in these cases were patients' desire for child. Recently a study in India involving 457 patients with bioprosthetic valve replacement show that their age ranged from 20 to 77 years (55.5 ±9.3 years), total of 559 bioproshesis were implanted, of this 200(49%) were mitral valve replacement, 154 (33.71%) were aortic valve replacement, 102(22.3%) were double valve replacement and one (2%) was tricuspid valve replacement. There were 11(2.4%) early and 3(0.7%) late deaths. Post-operative gradients across the valve prosthesis were low. Actuarial survival at 60 months was 95.1± 2.2%. The actuarial event free survival was 87.9±5.7% at 60 months. Advantages were freedom from thromboembolism (97.6%), infective endocarditis ((8%), haemorrhage (99.7%), paravalvular leak (99.3%), valve dysfunction (100%). Quality of life was satisfactory using standard world health organization questionnaire for quality of life[10].

The mechanical valve market is expected to continue to grow in the low single digits while tissue valve market is growing at mid-single digit rates. Global mechanical valve unit sales have declined significantly over the last five years due to growth of tissue valves[11].

Conclusion:

Tissue valves have limitations and advantages. In specific situation these are better alternatives than mechanical valves and in long term basis these are cost-effective. Quality of life should get precedence if reoperation for structural failure of tissue valve is not that much risky.

References:

1. Grunkemeier GL, Starr A, Rahimtoola SH. Clinical performance of prosthetic heart valves. In: Schlant RA, Alexander RW, eds. Hurst's The Heart. 9th ed. New York, NY: McGraw-Hill Publishing Co; 1998. p 1851-1866.
2. Lund 0, Nielsen SL, Arildsen H, Ilkjaer LB, Pilegaard HK. Standard aortic St. Jude valve at 18 years: performance profile and determinants of outcome. Ann Thorac Surg 2000; 69:1459-1465.
3. Remadi JP, Baron 0, Roussel C , Bizouarn P , Habasch Al, Despins P, et al. Isolated mitral valve replacement with St. Jude Medical prosthesis: long-term results: a follow-up of 19 years. Circ 2001; 103:1542-1545.
4. Sapirstein JS, Smith PK. The "ideal" replacement heart valve. Am Heart J 2001; 141: 856-860.
5. Jamieson WR Rosado LJ, Munro Al, Gerein AN, Burr LH, Miyagishima RT, et al. Carpentier-Edwards standard porcine bioprosthesis: primary tissue failure (structural valve deterioration) by age groups. Ann Thorac Surg 1988; 46: 155-162.
6. Khan SS, Trento A, DeRobertis M, Kass RM, Sandhu M, Czer LS,et al. Twenty-year comparison of tissue and mechanical valve replacement, J Thorac Cardiovasc Surg 2001;122:257-69.
7. Ruel M, Chan V, Bedard P, Kulik A, Ressler 1, Lam BK, et al. Very long term survival implications of heart valve replacement with tissue versus mechanical prosthesis in adults 60 years of age. Circulation. 2007; 116: 1-294-1-300
8. Broom ND, Thomson FJ. Influence of fixation conditions on the performance of glutaraldehyde-treated porcine aortic valves: towards a more scientific basis. Thorax. 1979; 34:166-176.
9. Kumar AS. Techniques in valvular heart surgery, 1st ed, New Delhi, CBS publishers & distributors; 2007:28-30.
10. Talwar S, Sharma AK, Kumar AS. Tissue valve implantation in India, indications, result and impact on quality of life. Ind J Thorac Cardiovasc Surg 2008; 24:10-14.
11. Worldwide Heart Valve Market Report: 2009 Edition, Global Mechanical Valves Market Share (2007-12E), Global Tissue Valves Market Share (2007-12E), available from Internet http://www.pharmaceutical-market-research.info/research/PMAAACIK-Worldwide-Heart-Valve-Market-Report—2009-Edition.shtml