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3

Which Valve to Who: Prosthetic Valve Selection for Aortic Valve Surgery

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1. Introduction

Harken et al. had performed the first aortic valve replacement in subcoronary position in 1960 (Harken, 1960). The "caged ball" valve used in this operation pioneered to the prosthetic valves and in the last 50 years many valve types were begun to be used. The early and long term results of the patients undergone aortic valve surgery do not depend not only the patient-related factors and the type of the surgery. The selected prosthetic valve is one of the most important factor affecting survival. According to the analysis of the multicenter randomized trials made by Hammermeister et al. involving the recent 15 years, more than one third of the deaths among the patients undergone aortic valve surgery were found to be related to the prosthetic valve (Hammermeister, 2000). The expectance from an ideal prosthetic valve is to correct the present valve pathology, to possess normal functions, to normalize patient's life standards or at least to improve it obviously, and to preserve this status during the patient's lifelong. Additionally, the implantation of the ideal prosthetic valve should be easy, the prosthetic valve should be replaced with low mortality and morbidity, should not cause a damage to the cardiovascular system, the hospitalization period should be short, the valve should be inexpensive (Rahimtoola, 2010). In spite of the whole developments in the prosthetic valve technology, the ideal prosthetic valve is not found yet, that's why the task of the surgeon is to select the prosthetic valve not depending on the nature of the disease but should be individualized to each patient.

Nowadays, the replacement alternatives for aortic valve replacement are mechanical valves, biological xenograft valves, homograft valves, autograft valves and valves implanted transapically or percutaneously which usage has increased in the recent years. Because of various advantages and disadvantages, these alternatives are prefered to each other. However, for the most appropriate valve choice, each patient should be evaluated individually. Additionally, improvements in the drug technology and risk preventing measures, due to the deceleration in the development of cardiovascular diseases, the age of the operated patients and the surviving period following the operation is increasing gradually. Cardiovascular diseases become the most important factor determining the life quality and surviving ratio in the elderly population. The main purpose of the aortic valve replacement is the improvement of life quality by prolonging the patient's life (Kolh, 2007;

Thourani, 2008). For that reason, by selecting the most appropriate valve for each patient, complications due to the valve can be decreased. Because the rate of the complications of the selected valve are affected by the age and comorbidities of the patients.

Traditionally, the most important criteria for the valve selection is the patient's age, but with the improvements in the production of prosthetic valves and fixation methods, different criteria began to come into prominence. Perforations due to the stress or dystrophic calcifications are hold to be responsible of the structural degeneration of the biological valves (Jameison, 1995). It was shown that the new generation bioprotheses are more durable and needed less reoperation in a long period (Silberman, 2008; Potter, 2005; Valfre, 2006). In addition, improvements achieved in the anticoagulant agents. The superiority of the biological valves would be limited by the technology providing patient's self-monitoring of international normalized ratio (INR) (Siebenhofer, 2004) and the development of new anticoagulant agents (Salam, 2004). These developments and innovations will be effective in the revision of the criteria in the selection of valve.

Generally, biological valves are preferred in the patients older than the age of 70 years. Besides the lower thromboembolic and hemorragic complications incidence at that age, durability of biological valves is enough for the survival of patients following aortic valve replacement (Cosgrove, 1995; Langley, 1999; Masters, 2004). Additionally, the usage of chronic anticoagulation therapy for the biological valves is not necessary as is in the mechanical valves. Generally, the mechanical valves which are more durable than the biological valves are chosen in the patients younger than the age of 60 years, because of their expected longer survival. At that age an early calcification due to the increase of the collagen degeneration and increased calcium turnover was seen in the biological valves (Gross, 1998). However, the selection of prosthetic valve is more difficult between the age 60 and 70 years. The selection of the valve can be easier by paying attention to co-morbidities. Biological valves are preferred in the patients with coronary heart disease because of the decrease in their expected survival. Additionally, generating less turbulence flow by biological valves increases the coronary by-pass graft flow (Hassanein, 2007). When a comparison is made between the biological valves, stentless biological valves are seen more advantageous in terms of coronary flow reserves. Stentless biological valves are an appropriate choice in the patients with left ventricular dysfunction in terms of postoperative recovery (Bakhtiary, 2006).

In some patients, the decision of the valve selection is unrelated to the age. Young female patients planning to become pregnant is a special patient group. In these patients, with the avoidance of an anticoagulation therapy during the pregnancy via biological valve replacement (De Santo, 2005), in experienced centers Ross procedure is offered as an alternative therapy (Bonow, 2008). Additionally, it is suggested that not only the mechanical prosthetic valves or anticoagulant agent usage, but at the same time the acceleration of the structural degeneration of biological valves is an important issue needed to be avoided during the pregnancy (Jamieson, 1988).

The pulmonary autograft procedure in patient with aortic valve disease is an alternative to the prosthetic valves and the aortic allograft. This technique was introduced in 1967 by Donald Ross (Ross, 1967). The benefits of the Ross procedure are the superior durability of the pulmonary autograft when compared to biological valves in the aortic position, the growth potential of the autograft, and avoidance of prolonged anticoagulation (Akhyari, 2009). Hence, this procedure is primarily used in young or growing patients.

Additionally, some factors provide making a decision on the valve selection regardless of the patient's age. In case of previous thromboembolism history, chronic atrial fibrillation, low ejection fraction, previously implanted valve type and intracardiac thrombus, the selection of the valve is made regardless of the patient's age. The replacement of mechanical prosthetic valves is not appropriate in the patients with low sociocultural level, exposed to frequent traumas due to occupational reasons, predisposed to bleeding, unwilling to use or is contraindicated to use anticoagulants. Biological valve options are good alternatives in these patients. In patients with small ventricle, when mitral valve replacement and aortic valve replacement are needed to be done together, and the usage of mechanical prosthesis is not appropriate due to their high profile, biological valves have to be selected for replacement.

These prosthetic valves are similar according to the perioperative mortality and immediate and long term survival (Silberman, 2008). These similar results have been shown not only for the elderly patients but also for middle aged patients (Carrier, 2001; Khan, 2001). But, during the biological valve replacement cardiopulmonary bypass time and ischemic time are longer than in those with mechanical valve replacement (Silberman, 2008) and especially stentless biologic valve implantation is more difficult in technical aspect. Thus, surgical experience and how the patients will be affected from the longer operation time are the other factors should be considered. The fact that stentless biological valves have hemodynamic advantages (Silberman, 2001), possibility of a replacement of larger sized prosthesis (Del Rizzo, 1994), better durability (Bach, 2005) and long term survival ratios (Albertucci, 1994; Westaby, 2000) in comparison with the stented biological valves, provides their preference in the young patients. The advantages of Ross procedure with respect to postoperative survival, life quality and reoperation requirement in adult patients undergone homograft and autograft aortic root replacement will provide it becoming widespread (Hammermeister, 2000; Stassano, 2009; El-Hamamsy, 2010).

Transcatheter aortic valve implantation (TAVI) recently developed and commonly used in some centers as a good alternative technique for the patients in whom the aortic valve replacement is with high risk (Cribier, 2006; Webb, 2007; Walther, 2007, Rode's-Cabau, 2010). In these patients, surgeon has to choose optimal valve and obtain the largest prosthetic valve area. TAVI has excellent hemodynamic performance. In the patients who had myocardial dysfunction, apoptosis of the cardiomyocites triggered by the ischemia, oxidative stress and inflammatory injury during the open heart surgery, could retard the postoperative recovery and improvement of myocardial functions (Anselmi, 2004, Vahasilta, 2005). In these risky patients, TAVI could protect the myocardial functions and LVEF can be increased after the intervention (Webb, 2007; Bauer, 2004; Clavel, 2009).

It was offered to choose mechanical valves in patients having chronic renal disease because of earlier degeneration by rapid calcification of biological valves. But, in ACC/AHA guideline updated in 2006, there is no recommendation for the choice of prosthetic valve type for these patients. Probably, this revision depends on new studies claimed similar results for both mechanical and biological prosthetic valve types for the patients on dialysis (Lucke, 1997; Kaplon, 2000; Herzog, 2002; Brinkman, 2002; Bonow, 2006). After these results, the criteria for the choice of valve type in the patients on dialysis shifted as those in patients without on dialysis. With holding intact parathormon, calcium, and phosphor levels at optimal levels, not only early degeneration of biological valves can be prevented but also the survival the patients on dialysis can be increased (Kazama, 2007; Kimata, 2007; Nakai, 2008). Degeneration of new generation biological valves has decreased in dialysis patients as in those non-dialysis patients with the technological improvements (Brinkman, 2002).

Because of the high mortality ratio after aortic valve replacement, measures should be taken for the prevention of infective endocarditis. Although, infective endocarditis risk after mechanical and biological valve replacement is similar in both prosthetic valve types, in case of a need for aortic valve replacement in a patient with infective endocarditis, allografts have advantages with respect to resistance to active endocarditis. But it is difficult to obtain allografts at any time and the valve durability depends on donor age, time after explantation from donor, and host immunologic response (Yacoup, 1995; Takkenberg 2002).

There are few prospective, randomized studies comparing the valve types used in aortic valve replacement. Besides, the valve types compared in these studies are limited. Large studies comparing all the prosthetic valves the autografts, mechanic valves, xenograft tissue valves will be helpful for the optimal prosthetic valve choice.

Because, the increase of durability for new generation biological valves and the decrease of the elective operations risk by the improvements of surgical techniques, the biological valves will be used widespread in the younger patients (Silberman, 2008; Bonow, 2006). We have to present this option to patients. Thus, the patients could join the decision process for the choice of the prosthetic valve type. Additionally, the patient's should learn the frequency of coagulation monitorization, the possibility for disturbed mechanical valve sound, hemorrhagic complications by using mechanical valve and reoperation caused by the structural degeneration for the biological valves.

In the patients planning to undergo aortic valve replacement, not only the patient's age but also patient's life expectancy, coagulopathy, life-style, occupation, comorbidities, anticoagulant therapy contraindication, surgeon's experience should be reviewed for the choice of the most appropriate prosthetic valve type for each person (Silberman, 2008). In this way, the best survival and improved life quality can be offered to the patient.

The factors should be kept in mind which will be given in details below:

- Patient's age
- Comorbidities
  - Chronic atrial fibrillation
  - Chronic renal failure
  - Malignancies
  - Small aortic annulus
  - Other valve diseases
  - Aortic dilatation
- Active infective endocarditis
- Young women
- Pregnancy
- Redo valve surgery

2. Patient's age

Biologic or mechanical aortic valve prostheses have been widely used in patients with aortic valve disease. The choice of prostheses remains controversial due to the higher rate of structural dysfunction with bioprosthesis and due to the risk of thromboembolism or hemorrhage releated to the anticoagulation treatment of a mechanical prosthesis. The elderly population is increasing due to increase in the human life span. Thus cardiac surgery is increasing in the elderly. In elderly patients with aortic valve replacement, early and long-

term results have significantly improved due to technical optimization, better myocardial protection and postoperative management. In studies, the term elderly is often used to describe different population. Some researchers define elderly population as older than 70 years (Tseng, 1997), whereas others define elderly as being older than 65 years (Florath, 2005). Structural failure of bioprostheses are strongly related to the patient's age at valve insertion (Akins, 1998). Bioprostheses have a significantly higher rate of reoperation. Freedom from reoperation for bioprostheses is >95% at 5 years, >90% at 10 years, but <70% at 15 years. However freedom from reoperation for mechanical valves is >95% at 5 years and >90% at 15 years (Desai, 2008). Many cardiac surgeons opt patient age 70 years or older as a routine age for insertion of bioprostheses. Several studies have compared stentless and stented aortic valve bioprosthesis. Stentless aortic bioprostheses were shown to be hemodynamically superior to stented aortic bioprostheses (Borger, 2005; Walther 1999). Stentless aortic bioprostheses provide a larger effective orifice area and lower transvalvular gradients postoperatively because of the absence of a sewing ring and stent. However the implantation of the stentless valve is more difficult and is generally associated with longer myocardial ischemic time and may therefore have a higher perioperative complication rates (Borger, 2005). Choice of mechanical aortic prostheses in elderly patients is often due to different factors, including the use of anticoagulation for other diseases, less need of reoperation and preference of the patient or surgeon. In patients younger than 60 years of age, mechanical prosthesis is recommended because of prosthesis durability (Emery, 2005; Carrier, 2001). In the age between 60 and 70 years, other individual factors have to be taken into account.

Transcatheter aortic valve implantation has become a clinical reality, applied to high-risk patients who are elderly or not operative candidates. TAVI has been developed as an endovascular alternative to surgical aortic valve replacement. This technique is performed with transfemoral or transapical routes. Successful implantation rate has been found between 85% and 100% (Al-Attar, 2009; Johansson, 2011).

Homografts and autologous pulmonary valves are good alternatives for infants and childhood patients. In this method advantages like the growing ability, perfect durability, avoidance of prolonged anticoagulation, excellent hemodynamic performance, low transvalvar pressure gradient, large effective orifice area of pulmonary autologous valve are shown (Alsoufi, 2009; Gatzoulis, 1999). Complications like neoaortic failure seen in the postoperative period has decreased following the improvements in the implantation techniques of autologous pulmonary valves (David, 2000; Takkenberg, 2006), and pulmonary allograft stenosis has decreased due to appropriate usage of anti-inflammatory agents (Carr-White, 2001; Raanani, 2000). For that reason while the usage of aortic route replacement and Ross procedure are getting widespread, on the other hand it is suggested that in case of usage of pulmonary autograft the operation is complex and while during the repair of one valve pathology, two valves are jeopardized (Alexiou, 2000). It is suggested that in the childhood, metallic valves are good alternatives to Ross procedure because of their quite easier implantation, their perfect durability and hemodynamic performance (Alexiou, 2000). In the literature, late period thromboembolism and hemorrhagic complications following mechanical valve replacement in the childhood are reported in a quite low rates (Ibrahim, 1994; Champsaur, 1997; Mazzitelli, 1998; Lupinetti, 1997). The most important disadvantage of the mechanical valves in the childhood is the requirement of replacement of them with bigger size later. However, in a great majority of the childhood patients adult sized mechanical valve replacement is possible with aortoplasty technique

(Nicks, 1970). Thus, it is suggested that in this age group mechanical prosthetic valves are good alternatives of biological ones. Another alternative to Ross procedure are allografts. Allograft aortic valves do not vary in the early and late period due to hemodynamic respect (Lupinetti, 2003).

3. Comorbidities

Atrial fibrillation is the most common arrhythmia in patients undergoing aortic valve surgery (Ngaage, 2006). Many studies show that atrial fibrillation is a risk factor for decreased long-term survival (Vidaillet, 2002; Stewart, 2002). Loss of synchronous atrioventricular contraction results in ventricular dysfunction or congestive heart failure. The Framingham Study shows that stasis of blood flow in the left atrium, three- to five fold increases risk of stroke in a patient with atrial fibrillation (Wolf, 1991). Currently, acetylsalicylic acid and warfarin are approved antithrombotic agents for stroke prevention in patients with atrial fibrillation. However randomized trials are shown that antiplatelet agents are less effective than anticoagulant agents (Hart, 1999). It seems that first choice is mechanical aortic valve because of the need anticoagulant therapy in patients with chronic atrial fibrillation undergoing aortic valve surgery. Nevertheless an old patient more than 60 to 65 years who has atrial fibrillation may be preferable to insert a biologic aortic valve due to an increased risk of bleeding with anticoagulant therapy (Rahimtoola, 2003). If bleeding obliges discontinuing anticoagulant therapy, then this is a risk of thrombosis in patient with mechanical aortic valve.

Patients with chronic renal failure have a poor long-term survival secondary to their underlying renal disease. Four-year survival of patients on hemodialysis or peritoneal dialysis, regardless of whether they undergo valve replacement, is approximately 40% (Brinkman, 2002). Chronic renal failure is also a significant risk factor for increased morbidity and mortality in patients undergoing cardiac surgery (Kogan, 2008). Chronic uremia, hypertension, hyperlipidemia and increased calcium phosphate product associated with secondary hyperparathyroidism predispose to cardiac valvular abnormalities in patients with chronic renal failure. Early studies on biologic valve implantation in these patients show accelerated calcification of bioprosthetic valves (Lamberti, 1978; Monson, 1980). Therefore, mechanical valves were recommended by the ACC/AHA in patient with chronic renal failure and the guideline considered the use of biologic valves potentially harmful. (Bonow, 1998). However, current studies demonstrated that no significant survival difference between mechanical and bilologic valves (Brinkman, 2002; Thourani, 2011). Furthermore, several studies recommend biological valve instead of mechanical valve in patients on chronic dialysis (Lucke, 1997). Chronic renal failure is a known major risk factor for bleeding in patients with anticoagulant therapy (Lanefeld, 1989). These patients have also a increased risk of endocarditis due to frequent vascular access and impaired immunity (Chan, 2006). The type of aortic valve chosen for these patients should be individualized to the age of the patient and expected long-term survival. Older and patients with relative short life expectancy should be considered as candidates for biological aortic valve.

Malignant tumors is another comorbidity in patients undergoing aortic valve replacement. Currently there is no specific study investigating effects of the type of aortic valve prostheses on survival in these patients. However analyses revealed that the presence of a malignant tumor was an independent risk factor on survival after cardiac surgery (Mistiaen,

2004). Life expectancy of the patient who has malignancy has to be considered on decision for choice of prosthetic aortic valve. Biological aortic valve may be a good choice if life expectancy is about five years or less in patients with malignancy (Rahimtoola, 2010).

Aortic valve replacement is an effective therapy for patients with aortic valve pathologies, however, transvalvular gradient is almost always higher than the physiologic gradients of the aortic valve. This gradient is related to the valve size and body surface area. Severe patient-prosthesis mismatch have been found to be associated with increased early and late mortality (Rao, 2000). Aortic root enlargement procedures are an option in patients with small aortic root. However, these techniques have been found to be associated with prolonged myocardial ischemia and perioperative bleeding which is frequently seen in the elderly patients (Kunihara, 2006). Stentless biologic aortic valves or homografts seem like good choice for patients with small aortic root size at risk for patients-prosthesis mismatch (Bonow 2008). Subcoronary implantation of stentless bioprostheses has been associated with residual transvalvular gradients (Milano, 2001). Kunihara and colleagues showed that full aortic root replacement using a stentless aortic bioprostheses may be advantageous in patients with small aortic root (Kunihara, 2006). Transcatheter aortic valve implantation may be an alternative to prevent patient-prosthesis mismatch in high-risk patients (Jilaihawi, 2010). Moderate patient-prosthesis mismatch is generally well tolerated in elderly patients who have small aortic root (Takaseya, 2007). However, the effect of patient-prosthesis mismatch is more important in younger patients. New generation mechanical aortic valve which design to increase orifice area by modifying the outside geometry of the orifice housing may be an option in younger patients with small aortic root (Bach, 2002). Additionally, mechanical aortic valves which can be implanted supraannular position may be preferable in younger patients with small aortic root (Roedler, 2008). Pulmonic valve autotransplantation may be preferred to prevent patient-prosthesis mismatch and allow growth of the autograft in children (Bonow 2008). Root enlargement techniques should be considered in younger patients when a severe patient-prosthesis mismatch can not be avoided with these models of prostheses.

Whether bioprosthesis or mechanical valve in simultaneous aortic and mitral valve surgery will be associated with a better result remains under debate. There is no specific recommendation for surgical strategy of multiple valve disease in ACC/AHA practice guideline (Bonow, 2008). Caus and colleagues reported that the rate of reoperative mortality was significantly higher in patients >65 years who had double valve replacement (Caus, 1999). Hence, some surgeons recommend mechanical valves for the majority of patients in double valve replacement (Urban, 2011). However, a cohort study of 1057 patients showed that biologic valves have the best in-hospital and long-term survival in patient ≥70 years undergoing concomitant aortic and mitral valve replacement (Leavitt, 2009).

Composite graft replacement of the aortic root is a favored technique in dilatation of the ascending aorta associated with aortic valve pathologies. It is more complex than isolated aortic valve replacement. Replacement of the aortic valve and the ascending aorta with a conduit consisting of a mechanical valve and a dacron tube is generally preferred procedure. This technique has been described by Bentall and Debono in 1968 (Bentall H, 1968) and it has led to increased life expectancy for patients with Marfan syndrome. In spite of initial mortality risk is higher, long term survival has been found similar to aortic valve replacement in patients with composite mechanical valve-graft conduit aortic root replacement (Kalkat, 2007). Homografts and conduits consisting of a stented or stentless xenograft valve may be the choice especially in elderly or in patients with endocarditis.

Other option is pulmonary autograft for aortic root replacement. In the study of Akhyari and colleagues, pulmonary autograft had no advantages over composite grafts regarding mid-term morbidity and mortality in aortic position (Akhyari, 2009).

4. Active infective endocarditis

Despite advances in the diagnosis and antibiotic treatment of infective endocarditis, aortic valve endocarditis is most commonly treated surgically by valve replacement in combination with antibiotics. For patients with aortic valve endocarditis, the choice of valve between bioprostheses, homografts and mechanical prostheses remains controversial. According to the ACC/AHA guidelines for management of patients with heart valve disease, valve repair should be preferred because of the risk of infection of prosthetic materials in patients with native valve endocarditis (Bonow, 2006). There is no specific recommendation for use of particular valve prosthesis. In a randomized study, patients with aortic valve endocarditis recieving bioprostheses have been found lower 5-year survival rate than patients recieving mechanical valves and it has been found no difference between patients receiving homografts and mechanical valves (Nguyen, 2010). Wos and colleagues showed that the risk of recurrent endocarditis was higher with bioprostheses than with mechanical valves (Wos, 1996). Guerra et al also found that the risk of endocarditis reinfection is very low with mechanical valves (Guerra, 2001). Homograft seems to be good choice in severe destructive prosthetic (Musci, 2010) or native (Klieverik, 2009) valve endocarditis with aorto-ventricular dehiscence caused by abscess. Petterson et al reported that the Ross operation is an attractive option in patients with aortic valve endocarditis in all age (Petterson, 1998).

5. Prosthetic valve choice in prengnancy

Native valve diseases and prosthetic valve disfunction are still the most important surgical indications in pregnant women requiring heart surgery (Weiss, 1998). Aortic valve diseases can become more symptomatic during pregnancy. A serious aortic stenosis is seen relatively rare in pregnancy. While transvalvular gradient is below 50 mmHg the possibility of heart failure during the pregnancy and delivery is low (Oakley, 2003). In case of aortic stenosis, fetal prognosis due to growth retardation, early delivery or low birth weight is deteriorated (Hameed, 2001; Malhotra 2004). For that reason, in case of asypmtomatic aortic stenosis, with an intervention before pregnancy the becoming the situation more complex can be prevented. As long as left ventricular sistolic function is not impaired aortic insufficiency can be well tolerated during pregnancy. On the other hand severe heart insufficiency can develop in patients with acute aortic failure or low EF (Oakley, 2003). There is not enough experience about the implementation of balloon aortic valvuloplasty during pregnancy. Furthermore, a permanent solution is not provided with this approach (Siu, 1997). However, these approaches can be used as a bridge before the delivery because of the maternal and fetal mortality risk due to serious aortic stenosis and if it is required, a surgical intervention can be applied after the delivery.

It was reported that in case of a development of a valve trombosis during pregnancy in patients with a previous mechanical valve replacement a replacement can be prevented with the addition of trombolytic treatment. However, it has to be known that some complications can be seen with the trombolytic treatment, the success rate is limited, recurrences can be

seen after the treatment (Elkayam2005; Roudaut 2003). As the data about this topic is limited the complication rates seen in nonpregnant patients can be taken into consideration. A surgical treatment during pregnancy can be required in patients without benefits despite medical treatments and percutaneous approaches. Although the maternal mortality is below 3% for pregnant patients undergoing CPB with aortic valve replacement, fetal loss reaches 20% (Pomini 1996). Some strategies like avoiding hypotermia, providing enough perfusion pressure are recommended in order to decrease these adverse effects of CPB. Besides that, because of the effects of cardioplegia usage like hemodilution and hyperkalemia, recently some valve operation in beating heart also are reported (Tehrani 2004). The choice of valve type for valve replacement in pregnancy is similar to the choice criteria in young women patients. In a similar way it is difficult to make a decision about the valve choice because of the degeneration risk of the biological valves in young women and the requirement of anticoagulation for the mechanical valves, the fact that the trombosis of the mechanical valves during pregnancy can be a cause of mortality, and the limited data about how the homografts are influenced during pregnancy. However, the participation of the patient in the decision process has to be provided by discussing with the pregnant patient and informating her for all of the possible complications and frequencies. During the decision besides the current pregnancy, the expectation of a new pregnacy in future is also important (Elkayam2005). On the contrary to the results of the previous studies, recent studies have demonstrated that pregnancy does not cause a deterioration or calcification in biological valves (Reimold 2003).

6. Prosthetic valve choice in young women

Especially in the developing countries valve diseases requiring a surical intervention is seen frequently in young age group due to the fact that rheumatic valve diseases are not very uncommon. Although the valve repairement is the most ideal treatment method in young age group, in case of a serious impaired structure of the valve a repairement is not always possible. In that situation valve replacement is needed. A prothesis choice is still a controverisal issue in young patients needing prosthetic valve replacement (Solymar 1991; Trimn 2007). The reason is that all of the chosed prosthetic valves have their own advantages and disadvantages. That's why the decision has to be made according to the most suitable valve alternative for the patients' characteristics. The patient has to be informed about the advantages and disadvantages of the valve types in terms of possible complications. Thereafter, the patient has to be involved in the decision process. Young women have a different situation among the patients undergoing valve surgery because of the pregnancy possibility. The fact that the bioprothesis used in young age can be exposed to early degeneration because of the rapid body metabolism or the requirement of anticoagulants in patients with preference of mechanical prosthetic valves are situations which have to be evaluated seperately. As the valve lesion present before pregnancy will become more pronounced with the pregnancy, patients can undergo a comfortable period during the pregnancy with the intervention to the valve lesion in that period. In these approaches, along with the medical treatment support, when required, balloon-plasty is the first preference. By postponding of the sugical interventions during the pregnancy, maternal and fatal risk due to the surgery is tried to be prevented. Yet if there is no benefit although the applied medical treatment and percutaneous intervention, valve repairment or valve replacement is applied surgically. The main difficulty in that stage is the choice of the valve type which will be used.

The biological grafts include heterografts, homografts and autografts. Among these prothesis, maximal clinical data exists about the porcine heterografts. Biological valves undergo some degeneration in every age and for that reason their long-term durability is influenced which results in a higher rate of valve reoperation (Brais 1985; Jamieson 2003; Gross 1998). In young patients this degeneration is seen more frequently because of the increased calcium turnover, fatigue-induced lesions and collagen degeneration, and discrete immunologic reaction (Berrebi 2001; Gross 1998; Salazar 1999; Badduke 1991; Sbarouni 1994). Additionally, in some studies it was suggested that the usage of biological valves in early periods results in increased rate of degeneration in pregnancy. Besides that, there are also studies demonstrating that the biological valves are not damaged during pregnancy due to the developments in the fixation technics of the first generation biological valves and the valve production technology (Jamieson 1995; North 1999; Salazar 1999). Interestingly, in a study showing that bioprosthesis are more rapidly degenerated during pregnancy, the survey rate of the patients with mechanical valves were found to be lower than those with biological valves (Robyn 1999). These rates were reported to be influenced by the pregnancy rate after the biological valve replacement (Lee 1994). The controversial results in different studies can be influenced by some factors like the inclusion of non-homogeneous populations, disregard of the age of patients, the time period between prosthesis implantation and gestation, and the condition of the prothesis before pregnancy, which avoids the correct evaluation of the data. Additionally, data about long-term follow up, especially in case of repeated pregnancies, is also unsufficient. Althougt there is no consensus about the influence of the pregnancy on biological valve degeneration, this possibility has to be told to the potential pregnant patient. The reason is that re-replacement is needed for the patients with degenerated biological valves. Especially the risks of such operations during pregnancy in terms of maternal and fetal prognosis has to be denoted. Fifty percent of the patients who undergone biological valve replacement in young age require a reoperation 10 years later. It means that almost all of these patients will undergo at least one re-operation during their life period (Elkayam 2005). The mortality rate following such a re-operation is reported as 3.8-8.7% (Jamieson 1995; Badduke 1991). Shaer et al. showed in their 18 years follow-up study that pregnancy has no additive contribution to the structural degeneration of biological valves. The importance of that study is that all of the patients included in the study have similar characteristic features (Fayez 2005). In studies comparing two different type heterografts used in young patients (Hancock and Carpentier-Edwards porcine bioprostheses), a structural valve deterioration in a rate of 50-70% in 10 years follow-up was demonstrated (Yum 1995; Jamieson 1988). Similarly, North et al. reported that structural valve deterioration in 10 years follow-up can be seen in high rates as 82% [preg9/5]. As it is seen the valve choice influences not only the possible complications but also the patient's survival. In a recent study about the usage of the last generation biological valves in young patients, it was shown that the valve degeneration is quite low and survival rates are distinctly high. These good results are suggested to be due to the usage of new fixation technics and the development of agents used for anti-mineralization (Carpentier 1995).

The biological valves are less thrombogenic than the mechanical valves. For that reason anticoagulation is not needed. However, tromboembolic complications due to biological valves, although rarely, are seen. They can be seen especially in the first days following valve replacement before the development of an endothelization. The annual tromboembolism risk following biological valve replacement is 0.7% (North 1999).

Patients using mechanical valves can feel uncomfortable because of the valve sounds, are more frequently asked to come for outpatient visits and need more closed monitorization with blood tests. Besides that, the mechanical prosthetic valves are not degenerated by time. The usage of anticoagulants is essential. Some physiological changes are seen with pregnancy. Fibrinogen level can increase and reach to two folds levels than normally. As factors VII, VIII, IX, and XII are increasing in the third trimestre, antritrombin II level is decreasing. Duration of pregnancy, body composition and rapid fluid shifts were demonstrated as factors influencing the coagulation system. Blood volume, viscosity, intraabdominal pressure increase and venous compression also increases (Al-Lawati AA, 2002). As there is a presence of naturally hypercoagulable state the dose of the anticoagulant treatment should be kept higher. The rate of mechanical valve trombosis reaches 14% because of this hypercoagulable state (Abbas, 2005). A maternal mortality rate of 10% is seen in these patients (Weiss BM, 1998). On the other hand, complications due to high dose anticoagulants is seen more frequently too. The superiority of the biological valves was emphasized in the retrospective evaluations of the first generation mechanicalal valves in order to avoid the complications due to high dose anticoagulants (Jamieson, 1993; Cannegieter, 1994). However, the tendency to trombosis of the mechanicalal prosthetic valves in that period was higher.

With the development of a new generation of mechanical valves, optimal anticoagulation doses were provided too. However, the usage of anticoagulants during pregnancy is still a controversial issue. Actually, as a common practice, after heparin usage in the first tremestre, warfarin treatment is used up to the expected delivery time, and then heparin is used instead again. Although there are centers accepting this procedure reliable, this subject is still a controversial subject because of the present complications (Salazar, 1996; Ismail, 1986; Pavankumar; 1988). For that reason there is no distinct concensus about the ideal anticoagulant treatment in terms of maternal and fetal prognosis. Warfarin is a good anticoagulant. But as it can pass placenta, fetal malformation, fetal loss and peripartum haemorrage can be seen in the organogenesis stage. These effects of warfarin were shown to be dose dependent [Oakley, 2003; Hanania, 2001). Although it is shown that when a 5 mg dose was not exceeded it is not a cause of embriopathy, it is known that it increases the rates of abortus. For that reason it is suggested that the embriopathy rates seen in the live births is relatively lower. Especially because of embriopathy occurring with warfarin usage between 6 and 12 weeks, a shifting heparin treatment is offered in this period (Iturbe-Alessio; 1986). As heparin is a large molecule and can not pass the placenta, negative effects on fetus is not expected. Additionally, heparin was not found to be associated with bleeding during the peripartum period (Noller, 1982; Iturbe-Alessio; 1986). For that reason warfarin treatment should be replaced with heparin treatment in the post 36 week period. A mortality rate of 1-4% is seen in the pregnant patients with mechanicalal prosthetic valves, which is more commonly due to valve thrombosis (Chan, 2000; Elkayam, 2005) The usage of heparin during pregnancy was shown to be a cause of maternal tromboemboli states like occlusive prosthetic thrombosis, including fatal events (Sbarouni, 1994; Hanania, 1994; Salazar, 1996; Oakley, 2003). The usage of low molecule weight heparins is not recommended in the pregnancy period because of the difficulty in their monitorization and titration, and their close relationship with the tromboembolic events (Iturbe-Alessio, 1986; Salazar, 1996; Meschengieser 1999). Although under current conditions warfarin seems to be more appropriate treatment method because of the reduction in maternal complications, most female patients, when they are informed, do not want to use this drug because of its fetal

effects. Moreover, even in the second trimestre, they do not want to stop heparin and go on with heparin treatment (Evans, 1997; Yinon, 2009)

Yinon et al. evaluated the usage of low molecule weight heparin and aspirin in patients with mechanicalal prosthetic valve replacement who do not want to use warfarin during pregnancy because of its embriopathy risk. The study reported that even in patients followed-up with carefull monitorization the rate of the maternal cardiac and fetal complications is high and bleeding is seen (Yinon, 2009). Additionally, non-cardiac complication rates like postpartum bleeding was found to be as high as 13%, which is higher than it is reported in the previous studies.

In order to avoid these possible complications the effect of the anticoagulation therapy during pregnancy has to be closely monitorized. It is important to identify the most important strategy by transition between warfarin and heparin in the distinct periods of pregnancy.

Homografts can be an alternative for the young women at childbearing age. There is no evident data about the possible complications of this valve not needing an anticoagulation and its generation during pregnancy (Yacoub, 1995; Waszyrowski, 1997). However, some studies in the literature gave an idea. Robyn et al. showed that less degeneration is seen after the usage of homograft in comparison with biological prosthetic valve users and less requirement of reoperation is needed (Robyn 1999). Similarly, North et al. reported in a recent study that homografts are more resistant in comparison with bioprosthetic valves in 10 years follow-up and structural valve detorioration is developed more infrequently (72% vs. 18%) (North 1999). It was shown that there was less structural failure requiring reoperation in homografts in comparison with biological grafts (Yum, 1995; Jamieson, 1988). Studies evaluating the effects of pregnancy on homografts are even more limited. Sadler et al. reported that 94% live births had eventuated in patients followed-up following homograft valve replacement and only in two patients a heart failure developed during pregnancy (Sadler, 2000). Although there are studies supporting these results, data about how the homograft are effected during pregnancy is still limited (Dyke, 2003). Prospective studies in future can suggest homografts as appropriate alternatives in young women.

Especially for young women who wants to get pregnant Ross procedure can be a good alternative because its perfect valve hemodynamics and not being thrombogenic [Al-Halees, 2002). However this opertaion is difficult in terms of technical aspect and as the operative mortality is reported as 2-13% in different studies it has to be performed in experienced centres (Rahimtoola, 2003; Takkenberg, 2002; Schmidtke 2003). Additionally, the effects of pregnancy on Ross procedure in not clear, as for homografts (Schmidtke, 2003; Dore,1997; Martin, 2003). Dore and Somerville (Dore,1997) reported in their study made with small number of patients that serious complications like mortality, trombo-embolic event or bleeding was not observed in patients who underwent Ross procedure. But, as there is not enough data for this surgical technique, its usage in young women who have potential for becoming pregnant is not still widespread.

As a conclusion, the optimal prosthetic cardiac valve for the women at childbearing age is still a controversial subject. The reason is that there is no consensus about the effects of anticoagulants and side effects in the research studies. The degenerative effects of biological valves on pregnancy is not clearly known. There are studies showing the effects of trombolytic studies even in trombosis of mechanicalal prosthetic valves. The reoperation carried out after the degeneration of biological valves was reported to be more safely performed. As it is seen, these study results give different messages. For that reason, in a

process of making a choice for the prosthetic valve, a comparison should be made according to the degeneration risk of biological valves, tromboemboli due to mechanicalal prosthetic valves and bleeding complications due to anticoagulants. In summary, every patient has to be evaluated individually in order to make a desicion what is the best for her or him. (Mihaljevic, 2005). All of these results should be shared with the patient before the operation.

6.1 A valve selection for the reoperation

Sometimes a valve replacement because of valvular or non-valvular reasons is needed to be performed again. A valve replacement is made because of different reasons like the valve degeneration, calcification or valve thrombosis of the previously replaced prosthetic valve, endocarditis, dehicence, or pannus formation. In that situation, the selection of the prosthetic valve needed for the replacement should be made according to the individual characteristics. When in case of active prosthetic valve endocarditis tissue valve more resistant to infection is selected, age factor should be taken into consideration too. Especially a rapid degeneration in a patient with previously selected biological valve can be a cautionary signal that this situation can be eventuated again. A comprehensive information about the both prosthetic valve types should be given to the patient before the reoperation. Thereafter, the final decision about the valve choice should be taken together with the patient.

Recently developed percutaneous aortic valve replacement can also be appropriate alternative for the reoperation. Especially it is an appropriate alternative for the patients in whom the reoperation is riskly because of comorbid situations (Fusari, 2009). With this new approach called as "valve-in-valve", trans-catheter stent valve is implanted percutaneously in the degenerated biological valve. The early results of this tecnique are promissing, but the long period results are not still known [Gotzmann, 2011, Fusari, 2009, Ye, 2007). At the same time, it should not be forgotten that complications like occlusion of the coronary ostiums, endocarditis, embolization of the prosthesis, iatrogenic aortic dissection can be seen (Tay, 2011; Kukucka, 2011; Carnero-Alcázar 2010).

7. References

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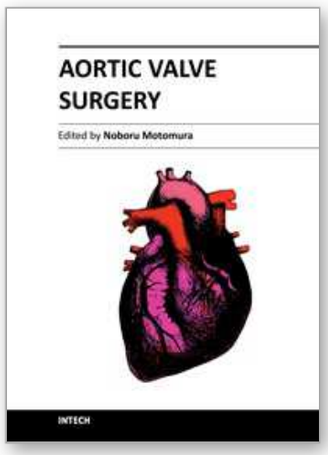
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The aortic valve is located at the center of the heart. It is the core of cardiac anatomy and aortic valve surgery has led the field of cardiac surgery. This book describes all aspects of aortic valve surgery and it will help clarify daily questions regarding the clinical practice in aortic valve surgery, as well as induce inspiration and new insights into this field.

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