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REVIEW ARTICLES

Selection of Prosthesis in Aortic Valve Surgery: Short Review and Trend in our Practice in 10 Years

Selman Dumani*, Ermal Likaj, Laureta Dibra, Devis Pellumbi, Adelina Musliu, Fjoralba Qejvani Altin Veshti

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Abstract

Introduction: In our country, the predominant condition treated in aortic valve surgery in its early stages was aortic valve disease of rheumatic origin, primarily in patients under the age of 60. In recent decades, due to lifestyle changes, increased average lifespan, and a shift in surgical treatment concepts among the elderly, there has been a noticeable trend towards atherosclerotic aortic valve disease treated surgically. This condition poses challenges in selecting the type of prosthesis for surgical replacement—either bioprosthetic or mechanical. The replacement of the aortic valve, aside from its undeniable benefits for patients, also introduces various complications, such as bleeding related to anticoagulation, thromboembolism, prosthetic endocarditis, and structural degeneration of the prosthesis. These complications vary between the two main groups of prostheses: bioprosthetic and mechanical. In this context, we are confronted with the challenge of selecting the type of prosthesis suitable for each patient.

This paper presents current issues regarding selecting aortic valve prostheses, considering factors related to the prosthesis and the patient. We will also discuss the trends in prosthesis usage in our country over the past decade.

Materials and Methods: We reviewed the types of mechanical and bioprosthetic valves used over the past ten years at our clinic, the Cardiac Surgery Service of the University Hospital Center "Mother Teresa." We consulted articles, studies, and guidelines for managing heart valve diseases from European and American cardiology associations.

Conclusion: The choice of prosthesis for aortic valve replacement remains a current issue, involving considerations of patient-related and prosthesis-related factors. The decision is based on guidelines recommendations, surgical team judgment, and patient preference, following a detailed explanation of the benefits and risks associated with each type of prosthesis.

Keywords: aortic valve surgery, aortic valve, mechanical prosthesis, bioprosthetic prosthesis.

Introduction

According to the European Heart Survey, 28% of patients undergoing valve surgery have had previous valve surgery and are subjected to reintervention. Complications related to the prosthesis are a significant cause of reintervention. Hence, choosing a prosthesis during implantation and caring for patients with valve prostheses are crucial in preventing complications [1].

Aortic valve surgery is our country's most critical part of valve surgery. The predominant condition treated in aortic valve surgery in its early stages was aortic valve disease of rheumatic origin, primarily in patients under the age of 60. In recent decades, due to lifestyle changes, increased average lifespan, and a shift in surgical treatment concepts among the elderly, there has been a noticeable trend towards atherosclerotic aortic valve disease treated surgically. This condition poses challenges in selecting the type of prosthesis for surgical replacement—either bioprosthetic or mechanical. The replacement of the aortic valve, aside from its undeniable benefits for patients, also introduces various complications, such as bleeding related to anticoagulation, thromboembolism,

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* ***Corresponding author:***
Asc. Prof. Selman Dumani, MD, PhD
✉ *selmandumani@yahoo.co.uk*

Cardiac Surgery Service, University Hospital Center "Mother Theresa," Tirana, ALBANIA

prosthetic endocarditis, and structural degeneration of the prosthesis. These complications vary between the two main groups of prostheses: bioprosthetic and mechanical. In this context, we are confronted with the challenge of selecting the type of prosthesis suitable for each patient.

Materials and Methods:

We presented the mechanical and bioprosthetic valve types in numbers and percentages used over the past ten years at our clinic, the Cardiac Surgery Service of the University Hospital "Mother Teresa." We reviewed articles and studies on different types of valves and guidelines for managing heart valve diseases from European and American cardiology associations.

Results:

We reviewed patients operated on in our clinic from 2014 to 2023. The patients were analyzed in total and by year. From 2014 to 2023, we have seen a consistent growth of biological aortic prosthesis implantation compared to mechanical prosthesis. The graphic lines that show the use of the prosthesis intersect in 2021. In 2023, the number of biological aortic prostheses was higher than that of mechanical prostheses.

The overall trend of different studies and the guidelines recommendations favors biological prosthesis use.

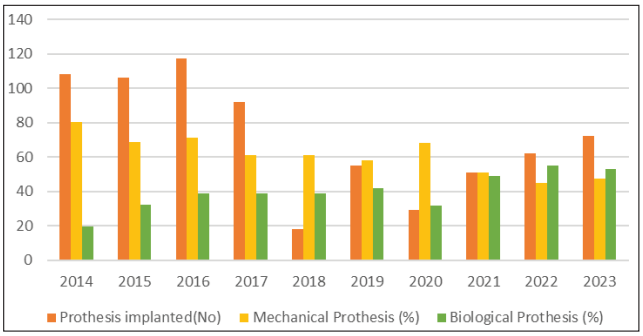

Table 1. Aortic valve prosthesis from 2014-2023

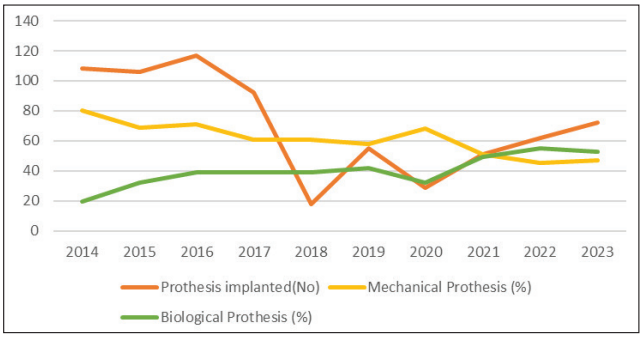

Table 2. Aortic valve prosthesis from 2014-2023

Discussion

Despite continuous improvement in the technology of manufacturing these artificial aortic valve prostheses, the so-called "ideal prosthesis" has not yet been achieved. This ideal prosthesis would have an excellent hemodynamic profile, durability without requiring anticoagulation, ease of implantation, and cost-effectiveness. In these conditions, despite the complications they entail, surgeons are mostly compelled to choose between standard bioprosthetic and

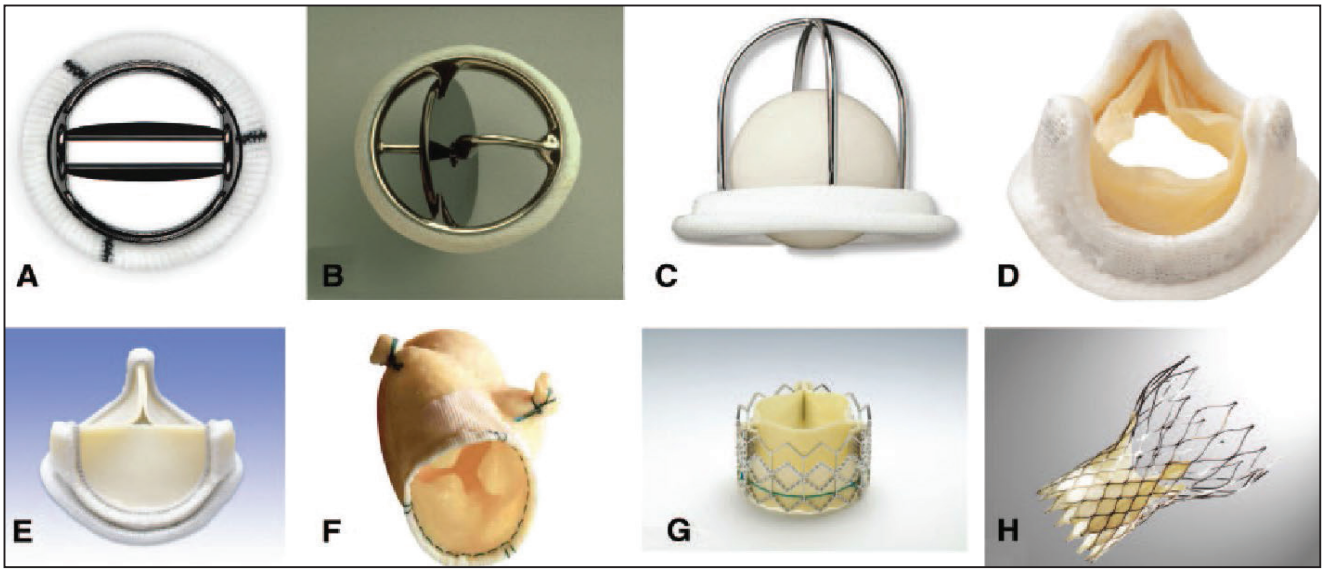

Figure 1. Different types of prosthetic valves.
A, Bileaflet mechanical valve (St Jude); B, monoleaflet mechanical valve (Medtronic Hall); C, caged ball valve (Starr-Edwards); D, stented porcine bioprosthesis (Medtronic Mosaic); E, stented pericardial bioprosthesis (Carpentier-Edwards Magna); F, stentless porcine bioprosthesis (Medtronic Freestyle); G, percutaneous bioprosthesis expanded over a balloon (Edwards Sapien); H, self-expandable percutaneous bioprosthesis (CoreValve). (Circulation2009; 119:1034-1048. Prosthetic Heart Valves: Selection of the Optimal Prosthesis and Long-Term Management. Philippe Pibarot and Jean G. Dumesnil)

mechanical prostheses. Figure 1 illustrates the various types of prostheses, generally highlighting the selection between single or double discs for mechanical and stented for bioprosthetic valves.

Factors influencing the choice of prosthesis are grouped into two categories: those related to the prosthesis and the patient [2, 3]. Regarding factors related to the prosthesis, the benefits and risks of each type of prosthesis are considered. Mechanical and biological prostheses have specific benefits and risks. Mechanical prostheses are durable, which is advantageous when selecting this type for implantation. However, complications, bleeding, and thromboembolism related to anticoagulation remain the most frequent.

On the other hand, biological prostheses do not require anticoagulation, but their main issue is structural degeneration, leading to reoperation [4, 5, 6, 7]. The Edinburgh Heart Valve Trial (EHVT) [8] and the Veterans Affairs Trial (VA) [9] are the most extensive randomized studies comparing mechanical and biological prostheses. Surgeons generally base their decisions on these studies. In these trials, 65 years is the limit for the type of prosthesis that should be used. Above this age, the risk of bleeding due to anticoagulation is significantly higher for mechanical prostheses than younger ones. In contrast, the likelihood of structural degeneration for biological prostheses increases notably under this age.

In our clinic, we primarily adhere to the guidelines of the European Society of Cardiology, considering the types of biological prostheses we have used. According to these guidelines, the upper age limit has been 65 years [10]. Over the years, there has been a trend towards lowering this age limit.

Bartus et al. [11], in a series of 9616 patients, concluded that in recent years, there has been a significant increase in the implantation of biological prostheses even in younger age groups than 65 years, with excellent outcomes in follow-up and lower probability of reintervention. Recent assessments [12,13] have shown the potential for more extended durability of modern biological prostheses and a global trend towards choosing this type for ages younger than 65. Biological prostheses manufactured with the latest technologies may last longer, thus compromising the primary reason for using mechanical prostheses, which is to prevent valve reinterventions. However, the same could also apply to mechanically improved prostheses [14], reducing the need for high international normalized ratio (INR) anticoagulation. It is also known that patients with excellent INR monitoring have a significantly lower probability of bleeding or thromboembolic events.

There is a clear increasing trend in the use of biological prostheses. Brown et al. analyzed the results for 108,687 patients undergoing isolated aortic valve surgery from 1997 to 2006. Year after year, there has been an increase in the use of biological prostheses (BP).

In 1997, BP was implanted in 43.6% of cases compared to 49.9% for mechanical prostheses (PM). By 2007, these numbers shifted significantly, with 78.4% of cases receiving BP and only 20.5% PM (p=0.000001) [15]. This trend is reflected in Table 3.

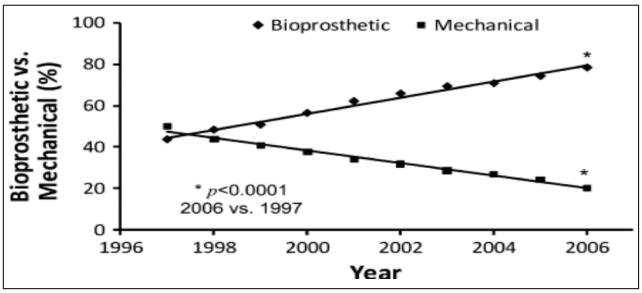

Table 3 Data according to Bioprosthetic vs Mechanical prosthesis (J Thorac Cardiovasc Surg 2009; 137:82-90. Brown et al.)

The trend towards increased use of biological prostheses is also reflected in the guidelines of the European Society of Cardiology for 2021, which lowered the age limit for implantation of mechanical prostheses to under 60 [16]. In addition, the American College of Cardiology lowers the age for mechanical prosthesis implantation even further to 50 [17].

In our country, biological prostheses are being used more than mechanical ones. The graphs above present (see results) data collected on the type of prostheses implanted for patients undergoing aortic valve surgery in our country during the period 2014-2023. There is a clear trend towards increased use of biological prostheses year after year.

Besides age, which remains a crucial factor, we must recognize other factors that do not necessarily change over time. Another significant factor after age is gender, mainly linked to physiological life stages, family planning, and pregnancy. Biological prostheses are recommended for women of childbearing age based on specific studies [18, 19] or general guidelines. Other important factors include the number of previous cardiac surgeries or the need for lifelong anticoagulation, where mechanical prostheses are recommended [19, 20, 21]. Shuli Silberman et al. [21] emphasize social and infrastructural factors that rigorously affect the ability or willingness to follow anticoagulation therapy. Recommendations lean towards choosing biological prostheses in conditions with difficulties adequately monitoring anticoagulation.

Under these circumstances, it seems reasonable to favor the choice of a biological prosthesis for patients who do not require lifelong anticoagulation, for patients over 60-65 years old, for women who wish to remain pregnant, and for patients with monitoring difficulties or contraindications to anticoagulation. On the other hand, mechanical prostheses should be reserved for younger patients, chronic users of anticoagulants, and patients who have undergone reinterventions. In guideline practices, decision-making always focuses more on the patient's own decision after understanding explanations regarding the benefits and risks of each type of prosthesis.

The decision to implant a mechanical or biological prosthesis has been a persistent challenge for patients and

surgeons. Despite having a longer lifespan, mechanical prostheses require lifelong anticoagulation to prevent complications such as thromboembolic events and hemorrhages. Conversely, biological prostheses do not require long-term anticoagulation but have a higher incidence of valve structural degeneration leading to reintervention. Balancing risks and benefits is a challenge that must be personalized for each patient.

Conclusions:

The choice of prosthesis in aortic valve replacement remains a current issue. The process considers factors related to the patient and the prosthesis. In recent decades, there has been an increase in the use of bioprosthetic valves compared to mechanical ones, even in our practice. The decision is based on guideline recommendations, the judgment of the surgical team, and the patient's preference after receiving comprehensive explanations regarding the benefits and risks associated with each type of prosthesis.

COI Statement: This paper has yet to be submitted in parallel, presented fully or partially at a meeting, podium, or congress, published, or submitted for consideration beforehand.

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