Review article

Transcatheter versus conventional surgery in patients with aortic stenosis requiring valve replacement

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Cirugía transcatéter contra convencional en pacientes con estenosis aórtica que requieren reemplazo de válvula

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Abstract
Aortic stenosis is a condition that restricts blood flow from the left ventricle through the aortic valve and is associated with high mortality, reaching up to 75 % within the first three years if left untreated. The definitive management consists of aortic valve replacement, traditionally performed with conventional surgery and more recently, via transcatheter approach. This narrative review aims to compare transcatheter aortic valve replacement and surgical aortic valve replacement in patients with aortic stenosis, analyzing published evidence regarding their advantages, limitations, complications, reintervention rate and mortality. To this end, a literature search was conducted in PubMed, Scielo, and Google Scholar, including studies based on methodologic design, levels of evidence and clinical relevance, among them, meta-analyses, randomized clinical trials, clinical guidelines and narrative reviews in Spanish, English, and Portuguese, from both primary and secondary sources between 2015 and 2025. Evidence suggests that surgical aortic valve replacement provides greater durability and lower reintervention rates, while transcatheter aortic valve replacement offers important advantages in high-risk patients, such as lower short-term mortality and shorter hospital stays. Therefore, a comprehensive clinical assessment is essential to optimize the therapeutic decision-making.

Keywords
Aortic Valve Stenosis, Aortic Valve Insufficiency, Transcatheter Aortic Valve Replacement, Heart Failure.

Resumen
La estenosis aórtica es una enfermedad valvular caracterizada por la obstrucción del flujo sanguíneo desde el ventrículo izquierdo hacia la aorta, asociada a una elevada mortalidad que puede alcanzar el 75 % en los tres primeros años sin intervención quirúrgica. El tratamiento definitivo incluye el reemplazo quirúrgico de la válvula aórtica y el reemplazo valvular aórtico transcatéter. Esta revisión narrativa analiza la evidencia comparativa entre ambos abordajes en pacientes con estenosis aórtica que requieren sustitución valvular, considerando sus beneficios, limitaciones, complicaciones, tasas de reintervención y mortalidad. Se realizó una búsqueda bibliográfica en PubMed, SciELO y Google Académico, incluyendo metaanálisis, ensayos clínicos aleatorizados, guías clínicas y revisiones narrativas en español, inglés y portugués, publicados entre 2015 y 2025. La evidencia disponible indica que el reemplazo quirúrgico ofrece mayor durabilidad y menor tasa de reintervención; mientras que, el abordaje transcatéter se asocia con menor mortalidad a corto plazo, recuperación más rápida y reducción de la estancia hospitalaria, especialmente en pacientes de alto riesgo quirúrgico, por tanto, la selección del procedimiento debe basarse en una evaluación clínica integral y multidisciplinaria que optimice los resultados y minimice las complicaciones.

Palabras clave
Estenosis de la Válvula Aórtica, Insuficiencia de la Válvula Aórtica, Reemplazo de la Válvula Aórtica Transcatéter, Insuficiencia Cardíaca.

Introduction

Aortic stenosis (AS) is a valvular heart disease that restricts blood flow from the left ventricle through the aortic valve. It occurs when the valve opening area is < 2 cm^2 and the velocity is < 2 m/s,[1] causing pressure overload (afterload) with concentric hypertrophy and progressive diastolic dysfunction. Following these events, adaptive remodeling called ventricular hypertrophy occurs to compensate for cardiac output, leading to heart failure.[2]

The etiology of AS may result from rheumatic sequelae, a congenital bicuspid valve, or in most cases due to senile calcification.[3]

Worldwide, AS affects around 4 to 7 % of the population over 65 years of age and has a progressively increasing mortality rate, reaching 75 % of symptomatic patients without surgical intervention within three years; this represents a public health problem given the trend toward an aging population.[4] The incidence in Europe is five per thousand inhabitants per year, and it is estimated that the number of older adults requiring treatment will double by 2050.[5]

Echocardiography is the non-invasive imaging study used to diagnose aortic stenosis. In conjunction with Doppler, it allows the level of obstruction (subvalvular, valvular, or supravalvular) to be determined. It is essential to perform standardized measurements to reduce the margin of error and integrate it into the patient's clinical context.[6,7]

About 50 % of patients are asymptomatic at the time of diagnosis, and when initial symptoms appear, they can be confused with the unconscious adaptation of daily activities in older adults.[8]

Currently, there is no medical therapy available that has an impact on preventing or reducing the rate of progression of AS. Once symptoms appear, survival is reduced exponentially unless the valve is replaced.[9] Treatment options include conventional balloon valvuloplasty therapy, which temporarily relieves symptoms; and aortic valve replacement, indicated in patients with severe symptomatic AS and severe asymptomatic AS with reduced left ventricular ejection fraction.[10]

The first aortic valve replacement as a therapeutic approach for AS was performed in 1960 by surgeon Dwight Harken in Boston.[11] Over the years, new types of prostheses and approaches have emerged.[12] Currently, aortic valve replacement (AVR) is performed in two ways: transcatheter or conventional surgery.[13]

According to Maluenda *et al.*, patients who underwent AVR at a hospital in Chile generated an approximate cost of US$33 500 compared to US$7027 generated for patients who did not undergo surgery. however, the group that did not undergo surgery had a higher number of deaths and hospitalizations, suggesting a high cost-effectiveness of AVR compared to conservative therapy based on strategies focused on symptoms and complications.[14] It has been shown that, in asymptomatic patients with AS, the incidence of adverse outcomes is lower when the aortic valve is replaced early.[15]

Duffy M *et al.*, demonstrated an improvement in symptoms and quality of life in low- and high- risk patients undergoing transcatheter aortic valve replacement (TAVR) and surgical aortic valve replacement (SAVR), which translates into a positive short- and long-term effect.[16]

Limited access to technologies such as TAVR and the scarcity of publications in Latin America reflect a significant gap in the care of patients with severe aortic stenosis. In response to this problem, a search of primary and secondary sources in databases such as PubMed, Scielo, and Google Scholar was conducted using the terms MeSH (Medical Subject Headings) and DeCS (Descriptors in Health Sciences) (aortic valve stenosis, aortic valve sufficiency, transcatheter aortic valve replacement, heart failure). Studies were included based on their methodological design, level of evidence, and clinical relevance, including meta-analyses, randomized clinical trials, clinical guidelines, and narrative reviews published between 2015 and March 2025 in Spanish, English, and Portuguese, with the aim of analyzing TAVR versus SAVR in patients with aortic stenosis requiring aortic valve replacement.

Discussion

Overview of TAVR and SAVR in patients with aortic stenosis

Conservative management allows for a certain degree of hemodynamic stability to be achieved after the onset of symptoms, mainly through the use of loop diuretics as the basis of medical therapy. However, valve replacement is the only definitive therapy.[17]

The guidelines of the American Heart Association (AHA) and the American College of Cardiology (ACC) classify patients with AS based on the presence of symptoms, and anatomical and hemodynamic considerations, as shown in Table 1. Regarding the classification of gradients, a low gradient is defined as a transvalvular pressure of less than 40 mmHg, and a high gradient as a transvalvular pressure of more than 40 mmHg. In patients with severe AS from stage D1 onwards, aortic valve replacement is indicated.[18-20]

SAVR and TAVR are the two forms of aortic valve replacement. The transcatheter approach was used only in patients with high surgical risk, but it is now used in patients with low or moderate surgical risk.[21]

The choice of valve type must be individualized. There are Bioprosthetic valves made from allografts or xenografts do not elict an immune response but have a limited lifespan due to inevitable calcification; these can

be implanted via SAVR. On the other hand, mechanical valves can be implanted through both routes, with a useful life of approximately 25 years, but it is essential to establish permanent antithrombotic therapy.[22] These drawbacks have led to modifications aimed at increasing biocompatibility and reducing thrombogenicity. Tissue engineering is a promising area of research, as it offers the possibility of developing a valve capable of remodeling over time, ensuring long-term durability and functionality.[23]

Given the need to find the ideal valve, the Ross procedure was introduced in the 1960s. Ross-SAVR involves excising the pulmonary valve to perform an autograft and replace the aortic valve, and then performing a homograft of the pulmonary valve. This technique offers long-term advantages, mainly in young patients, due to its durability. In addition, according to Yokoyama *et al.*, patients who undergo this procedure have lower rates of mortality, pacemaker placement, reoperation, and endocarditis.[24]

For transcatheter replacement, the femoral route is the most common access site and can often be performed under sedation and anesthetic monitoring, as well as under general anesthesia depending on complexity, alternative access, or patient condition, which facilitates recovery, reduces the length of hospital stay, and offers better clinical results. To perform the procedure, the required arterial diameter depends on the profile of the delivery system and the degree of iliofemoral calcification. Ten to 20 % of patients do not meet this criterion and therefore require alternative routes of access, including transcarotid, axillary/subclavian, transapical, transaortic, suprasternal-brachiocephalic, and transvenous.[25]

Before TAVR, a CT angiogram and a reconstruction program are required to measure the aortic annulus, which will determine the size of the prosthesis, the diameters of the delivery devices, and the necessary diameter of the access site. The pathway must also be evaluated to identify thrombi, angulations, and calcifications that could hinder the technique. The procedure is guided by a guide catheter to the aortic root, through which the prosthetic valve is deployed.[26]

In 2011, following clinical trials that established the efficacy and benefits of TAVR, the US Food and Drug Administration (FDA) approved the procedure in patients with severe AS who were not candidates for SAVR.[27] In 2019, the FDA approved the procedure for low- surgical-risk patients based on two randomized clinical studies.[28]

In Latin America, the first TAVR procedures were performed in Brazil and Colombia in 2008. In 2015, a questionnaire was conducted through a website, which included 250 centers performing the procedures, of which 11.6 % were in Latin America. The number of procedures performed in 2020 had doubled compared to 2015; on the other hand, patients who underwent surgery in 2015 were classified as high surgical risk, while in 2020, patients with intermediate and low risk were included.[29]

Table 1. Classification of AS

Stage A (at risk of AS)	Valvular abnormalities without symptoms or hemodynamic alterations
Stage B (progressive EA)	Moderate calcification or fibrosis, with a maximum aortic velocity (Vmax) of 2-3.9 m/s and no significant symptoms
Stage C (severe asymptomatic EA)	Severe calcification or fibrosis, with severely reduced valve opening, Vmax ≥ 4 m/s, aortic valve opening ≤ 1 cm^2 and high gradient; left ventricular diastolic dysfunction may be present (stage C2, LVEF < 50 %)
Stage D (Severe symptomatic EA)	Severe symptoms such as dyspnea, angina, presyncope, syncope, heart failure; depending on hemodynamic characteristics, it is subdivided into: a. Stage D1 (high-gradient AE): severe calcification or fibrosis, severely reduced valve opening, Vmax ≥ 4 m/s, aortic valve opening ≤ 1 cm^2, left ventricular diastolic dysfunction, left ventricular hypertrophy, pulmonary hypertension may be present b. Stage D2 (low-gradient EA): severe calcification or fibrosis, with severe reduction in valve movement, Vmax < 4 m/s, valve opening ≤ 1 cm^2, left ventricular diastolic dysfunction, left ventricular hypertrophy, LVEF < 50 % c. Stage D3 (low-gradient EA with normal left ventricular ejection fraction [LVEF]): severe calcification or fibrosis, with severe reduction in valve motion, Vmax < 4 m/s, valve opening ≤ 1 cm^2, thickening of the left ventricular walls, small left ventricular chamber with low systolic volume, restrictive diastolic filling, LVEF ≥ 50 %

Source: Adapted from Otto, *et al.* Guideline for the Management of Patients With Valvular Heart **Disease:** A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 143,5:e,2021.

The recommendations of the ACC/AHA Clinical Guidelines for the Management of Patients with Heart Valve Disease in 2020 compare SAVR with TAVR (Table 2).

Postoperative complications and mortality

Patients with severe AS who retain left ventricular function and are asymptomatic have a survival rate similar to patients of the same age who do not have the condition, with an associated risk of sudden death < 1 % per year;[30] However, once symptoms appear, it gradually progress to heart failure and sudden death in untreated patients in advanced stages of the disease.[31]

Survival in adults over 60 years of age who undergo AVR is similar to that of adults without AS who do not require intervention, unlike young patients undergoing AVR, in whom the expected survival for their age is considerably lower than in the population without AS. This is compounded by the uncertain risk of reintervention, which makes it difficult to choose this age group for this procedure.[32]

Mistry *et al.*, reported that patients undergoing TAVR under local anesthesia had a shorter hospital stay than the group undergoing surgery under general anesthesia; however, there were no significant differences in terms of short-term complications.[33]

The PERIGON (PERIcardial SurGical AOrtic Valve ReplacemeNt) clinical study evaluated the safety and efficacy of the Avalus bioprosthesis in patients undergoing SAVR. At the start of the study, the mean age of patients was 70.2 ± 9.0 years; 75.1 % were male. The five year follow-up determined the predicted mortality risk to be 2.0 ± 1.4 % and the overall survival rate to be 88.1 %. In turn, the event rates were 5.6 % for thromboembolism, 4.4 % for endocarditis, 0.2 % for major paravalvular leak, and 3.2 % for reoperation. No cases of structural valve deterioration were reported.[34] These findings support the Avalus bioprosthesis as a safe and effective option in patients who are candidates for SAVR; however, the absence of a control cohort limits the comparison of its clinical results with other bioprostheses or TAVR.

Table 2. Recommendations from the ACC/AHA 2020 Clinical Practice Guidelines for the Management of Patients with Heart Valve Disease

	SAVR	TAVR
Access route	Open access via sternotomy (conventional surgery)	Transcatheter (femoral, transcarotid, axillary/subclavian, transapical, transaortic, suprasternal-brachiocephalic, transcava)
Indication	Aortic valve replacement is indicated in adults with AS classified as D1. In patients classified as stage C1 (who will undergo cardiac surgery for other indications) and stage C2 (according to type B evidence)	
Determining factors for the type of technique to be used	• Useful in young patients (due to the durability of mechanical valves)	• Anatomy suitable for the type of access. • Patients of any age in whom anticoagulants are contraindicated
Type of valve according to technique	• Mechanical (ideal for patients under 50 years of age). • Bioprostheses (ideal for patients over 65 years of age)	• Bioprosthesis (ideal for patients over 65 years of age)
Advantages	• Greater valve durability	• Less invasive procedure. • Lower risk of thrombogenicity, bleeding, atrial fibrillation, and stroke (in the short term)
Disadvantages	• More invasive surgery • Higher complication and mortality rates • Higher risk of thrombogenicity requiring antithrombotic strategy • Risk of reoperation in young patients	• Shorter valve durability • High risk of permanent pacemaker use • Higher risk of stroke in the medium and long term

Source: Adapted from Otto, *et al.* Guideline for the Management of Patients With Valvular Heart **Disease:** A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 143,5:e,2021.

Thieme *et al.*, compiled data from 689 patients who underwent TAVR at a hospital in Germany between 2017 and 2020, reporting a vascular complication rate of 2.7 %. Common femoral artery aneurysm, dissection, and severe bleeding were some of the vascular complications reported.[35] These results suggest evaluating the type of closure at the end of the TAVR procedure to reduce adverse vascular events.

Lou *et al.*, showed that patients with low surgical risk who underwent TAVR had lower all- cause mortality at one year than those who underwent SAVR (OR: 0.66, 95 % CI: [0.46, 0.96], p = < 0.05); however, at two years, mortality tended to be lower in patients undergoing SAVR, although the difference was not statistically significant (OR: 0.89, 95 % CI: [0.61, 1.30], p = > 0.10). In terms of complications, SAVR had a higher incidence of bleeding at 30-day follow-up (OR: 0.34, 95 % CI: [0.18, 0.64], p < 0.01), while the rate of atrial fibrillation and acute renal failure was reduced by 51 % and 80 %, respectively, for TAVR compared to SAVR. Both approaches had similar incidences of acute myocardial infarction and stroke (6.8 % and 8.1 %, respectively, p > 0.05) at two years.[36] This suggests that TAVR has a superior safety profile in the immediate postoperative period.

The prevalence of permanent pacemaker uses increases from 9 % to 36 % after TAVR, due to the position of the aortic valve in relation to the cardiac conduction system.[37] Ito *et al.*, reported in their study that in patients with moderate to severe aortic stenosis undergoing TAVR, the rate of permanent pacemaker implantation was significantly higher than in the group undergoing SAVR (2.3 % vs. 30.5 %, p < 0.05).[38] Both studies show a higher incidence of pacemaker implantation after TAVR, highlighting the importance of strict follow-up for early detection and effective management of conduction system complications.

Madhavan *et al.*, compared TAVR with SAVR at five years post-intervention and reported a similar rate of all-cause mortality (39.2 % vs. 41.4 %).[39] The NOTION (The Nordic Aortic Valve Intervention) clinical study, at eight years post-intervention, demonstrated similar estimated risks for all-cause mortality (51.8 % vs. 52.6 %), stroke (8.3 % vs. 9.1 %), and myocardial infarction (6.2 % vs. 3.8 %).[40] The findings show similar mortality and complication rates between the SAVR and TAVR groups, indicating comparable medium- and long-term efficacy.

Since the approval of TAVR in 2011, data from 276 316 patients undergoing the procedure in the US through 2019 were collected and submitted to the Transcatheter Valve Therapy Registry. In 2019, 72 991 TAVR procedures were performed, reflecting a decrease in mortality and various complications (p < 0.01) over the years.[41]

Reoperations in patients undergoing aortic valve replacement

Currently, in patients who have undergone surgery and experience recurrent AS, valve reintervention is the only way to prevent further deterioration of the valve.[42] The most common cause of SAVR reintervention is endocarditis, while in TAVR it is paravalvular regurgitation.[43]

Van Mieghem *et al.*, reported a reintervention rate of 1.9 % and 3.5 % at five years in patients undergoing SAVR and TAVR, respectively, included in the SURTAVI (Surgical Versus Transcatheter Aortic Valve Implantation) clinical trial.[44] Meanwhile, Horsted *et al.*, compared ten-year clinical outcomes in patients undergoing SAVR and TAVR as part of the NOTION clinical study, which found that the mild risk of structural deterioration of the aortic valve was lower in SAVR than in TAVR (5.0 % vs. 18.0 %); while the moderate to severe risk (20.8 % vs. 15.4 %) and severe risk (10.0 % vs. 1.5 %) were lower in the TAVR group. However, there were no significant differences in the reoperation rate (SAVR 2.2 % vs. TAVR 4.3 %).[45]

A study conducted in France compared 30-day clinical outcomes between patients reoperated for SAVR and TAVR. The SAVR reoperation group had a higher incidence of cardiovascular deaths (6.6 % vs. 2.9 %) and atrial fibrillation (4.0 % vs. 0.6 %). The group reoperated for TAVR had a higher incidence of permanent pacemaker placement (4.6 % vs. 16.7 %). There were no significant differences in the incidence of myocardial infarction (0.4 % vs. 0.1 %) and bleeding (4.7 % vs. 4.0 %).[46]

Latif *et al.*, in their meta-analysis, reported that in the group reoperated for SAVR, the incidence of stroke (3.5 % vs. 2.1 %), bleeding (30.0 % vs. 13.7 %), and acute kidney injury (20.6 % vs. 17.2 %) was higher than that in the group reoperated for TAVR. TAVR had a shorter duration, an average of 170, minutes less (95 % CI: [−249.37, −92.53], $p \leq 0.01$) and a shorter hospital stay of approximately 3.6 days (95 % CI: [−5.43 −1.95], $p \leq 0.01$).[47]

Formica *et al.* reported that the incidence of all-cause mortality at one year was higher in patients undergoing SAVR reoperation compared to those undergoing TAVR reoperation (12.9 % vs. 9.9 %); however, the five-year incidence was lower in patients undergoing SAVR reoperation (25.4 % vs. 27.6 %).[48] Similarly, Hecht *et al.*, reported

that the 30-day mortality rate was higher in patients undergoing SAVR reoperation (8.7 % vs. 2.5 %), while at eight years, it was lower than in patients undergoing TAVR reoperation (24.2 % vs. 50.1 %).[49]

In certa*in situ*ations, a third valve replacement may be required, so it is recommended to implement a hybrid strategy that integrates both approaches. However, the risk of a new intervention in older adult patients with comorbidities must be taken into account, and the decision must be individualized.[50]

Conclusion

Surgical aortic valve replacement has been the treatment of choice for decades in patients with low surgical risk, characterized by a lower reoperation rate and greater valve durability, but with a more complex postoperative recovery.

Transcatheter aortic valve replacement is an innovative therapeutic alternative in patients with high surgical risk, associated with lower 30 day mortality and reduced hospital stay. However, its main limitation remains the higher incidence of permanent pacemaker requirements, as well as greater valve deterioration compared to other therapeutic options.

Mechanical valves have greater durability and require the use of permanent antithrombotic therapy, unlike bioprosthetic valves, which do not require permanent medication but have less durability. However, these can only be placed surgically. A comprehensive clinical assessment based on factors such as age, life expectancy, comorbidities, anatomy, and valve physiology is essential for choosing the technique. This should include an evaluation of the benefits and risks of both procedures, to achieve a better therapeutic outcome and a better quality of life.

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