



Mini-Review Article

Transcatheter Aortic Valve Implantation in Heart Failure Patients with Non-Severe Aortic Valve Stenosis

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Abstract

Introduction: aortic stenosis (AS) increases the afterload on the left ventricle, leading to structural changes in the heart muscle and gradual progression to heart failure (HF). The clinical guidelines recommend aortic valve replacement (surgical or transcatheter) in patients with HF and severe AS. The evidence on the benefits of Transcatheter aortic valve implantation (TAVI) for patients with less-than-severe AS and HF is still controversial and inconclusive. **Methods:** the literature was systematically searched on three different scientific databases (PUBMED, Google Scholar, EMBASE) using different combinations of search words (heart failure, non-severe aortic stenosis, less-than-severe aortic stenosis, mild to moderate aortic stenosis, TAVI, TAVR). **Results:** in heart failure patients, observational studies showed a significant reduction in mortality using TAVI to manage non-severe aortic stenosis compared to medical treatment. However, evidence from randomized controlled trials is still lacking. **Conclusion:** HF increases the surgical risk of AS patients; therefore, TAVI represents a safer option. The preliminary results indicated the benefit of TAVI in managing AS in HF patients, even if the AS did not reach the severe stage.

Keywords: TAVI; TAVR; Heart Failure; Aortic Stenosis; Surgical Aortic; Valve Replacement.

1. Introduction

It is well known that aortic valve stenosis (AS) and heart failure (HF) are two counterparts that can affect each other. Studies have shown that patients with HF are at higher risk of death and repeated hospitalizations in the presence of AS [1, 2]. The prevalence of AS varies across different parts of the world. The estimated prevalence of degenerative calcific AS in Western countries is 12.4% [3]. Causes of AS include congenital causes (e.g., Unicuspid and Bicuspid aortic valves), acquired causes (e.g., degenerative calcification, rheumatic fever, and radiation therapy to the mediastinum) [4]. Calcific aortic valve age-related degeneration is the commonest cause in Western countries [3].

The histopathological studies indicated that AS causes mitochondrial dysfunction due to the high energy demands to overcome the increased afterload, followed by capillary damage and cell death [5, 6]. Anatomically, such cellular-level changes lead to adverse remodeling effects in the form of concentric left ventricular hypertrophy, interstitial fibrosis, diastolic dysfunction, left atrial dilatation, and increased pulmonary artery pressure [7]. These pathological effects do not differ in moderate and severe AS [8].

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1.1. HF Continuum in the Presence of AS

AS and HF are two disease entities that can interact and potentiate each other. In the early stages of AS, patients develop symptoms of heart failure with preserved ejection fraction (HFpEF) because of the high afterload on the left ventricle (LV) [7]. However, with the progression of the disease, the LV functions start to deteriorate, and the patients begin to develop a drop in the left ventricular function with a reduction of the transvalvular gradients forming low flow, low gradient AS [9].

In cases of severe aortic stenosis and preserved LV function, the calculated aortic valve area (AVA) should be less than 1 cm², and the mean of the systolic pressure gradient between the LV and the aorta is more the 40 mmHg. In the low flow low gradient AS, the LV function drops significantly so that the mean pressure gradient drops below 40 mmHg, but the calculated AVA remains <1 cm² [10].

1.2. Diagnosis of AS in the Presence of HF

A dobutamine stress echocardiography is crucial in cases of low flow, low gradient AS to differentiate between true and false stenosis (or pseudo-stenosis). In true AS, the transvalvular gradients increase without changing the calculated valve area. Aortic pseudo-stenosis is diagnosed when the transvalvular gradients only mildly increase, with an increase in the aortic valve area of 0.2 cm² or more [9].

1.3. What is Transcatheter Aortic Valve Implantation (TAVI)?

TAVI is a percutaneous modality of insertion of a stented tissue aortic bioprosthesis (made of bovine or porcine pericardium) within the native aortic valve. The procedure is now well-validated in managing severe AS in patients with multiple comorbidities and fragility at increased mortality risk during surgical replacement [11]. The valve used in TAVI can either be balloon expandable (e.g., Sapien valve) or self-expandable (e.g., Corevalve) [11].

The device implantation is largely a safe procedure; nonetheless, some complications can happen. The complications are summarized in Table 1 [12]. The number of TAVI procedures is increasing, and the option is getting more popular even in patients with aortic valve incompetence indicated for aortic valve replacement [13].

Table 1. Complications of TAVI

Cardiac complications	Valvular complications	Vascular complications	Systemic complications
	<i>Device:</i>		
a) Conduction blocks	a) Device dislodgement and embolization.	a) Damage to the aortic ring.	a) Stroke
b) Pericardial effusion and cardiac tamponade	b) Device infection.	b) Coronary occlusion.	b) Acute kidney injury
c) Arrhythmia	c) Paravalvular regurgitation.	c) Aortic dissection.	
d) Cardiogenic shock	d) Structure valve failure.	d) Vascular access complications, such as arterial dissection, arterial perforation and retroperitoneal hemorrhage, and pseudoaneurysm formation	
	<i>Mitral valve:</i>		
	Injury to the mitral valve		

1.4. The Benefits of Aortic Valve Replacement in HF Patients with Severe AS

There is robust evidence of the benefits of management of severe AS in HF patients. In severe AS patients with symptomatic HF, pulmonary hypertension, left ventricular dilatation, or dysfunction should be considered for aortic valve replacement (either surgical aortic valve replacement (SAVR) or TAVI) after a heart team discussion [14]. The management of non-severe AS in HF patients is still controversial, and there is no clear consensus on aortic valve intervention in those patients [6]. This article will review the latest data on the benefits of aortic valve intervention via TAVI in symptomatic HF patients and less-than-severe aortic stenosis.

2. Methodology

We ran a systematic search on the largest three medical databases (PUBMED, Google Scholar, EMBASE) using different combinations of the search words (heart failure, non-severe aortic stenosis, less-than-severe aortic stenosis, mild to moderate aortic stenosis, TAVI, TAVR). We included the observational studies (cross-sectional, case-control, cohort) and the randomized controlled trials. We excluded the case reports, case series, narrative reviews, and reports not written in English. Our search revealed four cohort studies and one recruiting randomized controlled trial. The search methodology is summarized in Figure 1 [15].

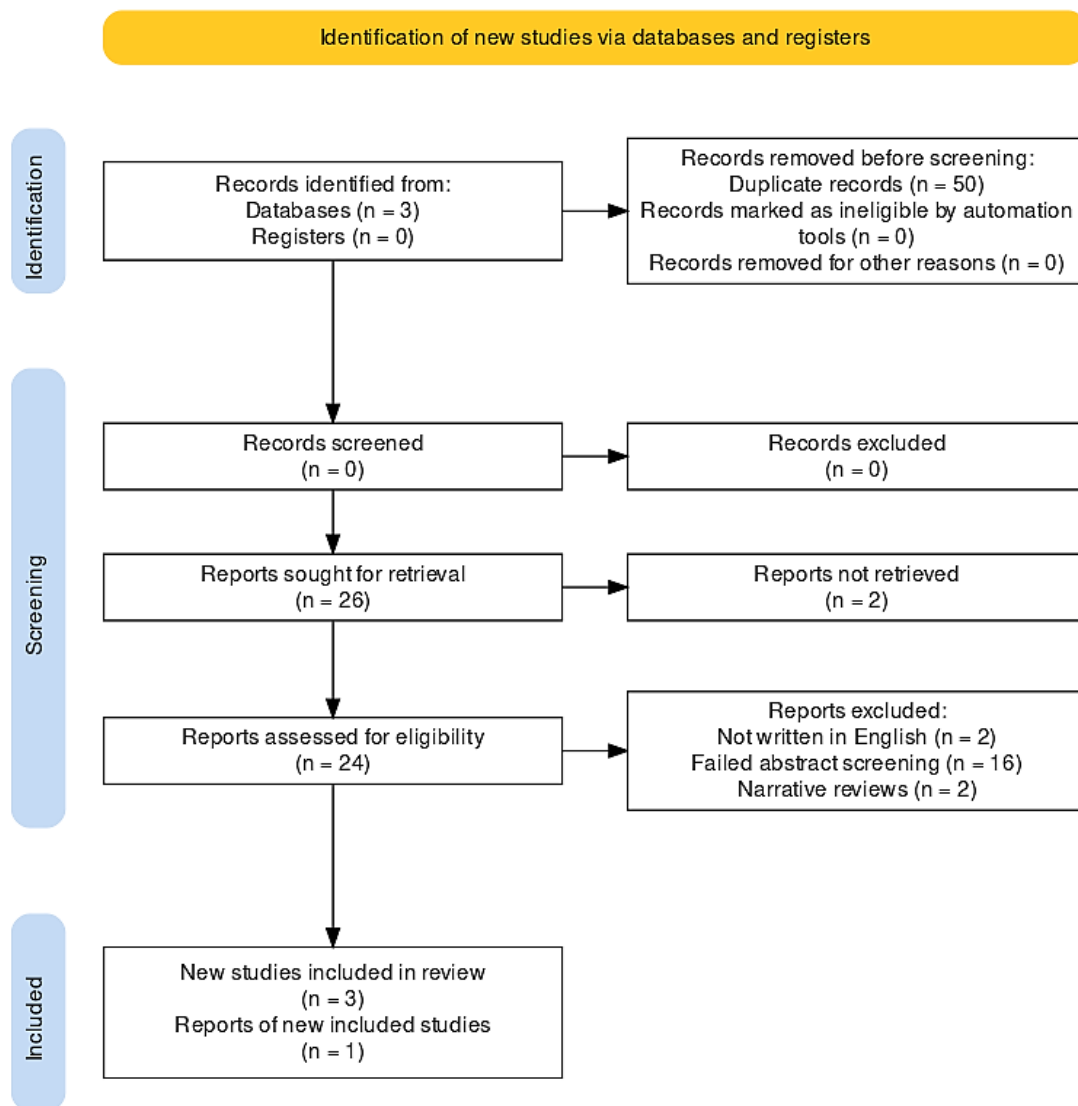


Figure 1. PRISMA diagram summarizing the methodology of the report

3. Review

3.1. Management of Non-Severe Aortic Stenosis in Heart Failure Patients

In symptomatic HF patients, the management of less-than-severe AS is a controversial area of research. Three observational studies have shown improved survival in moderate AS patients managed with TAVI compared to medical treatment [16–18] (Figure 2).

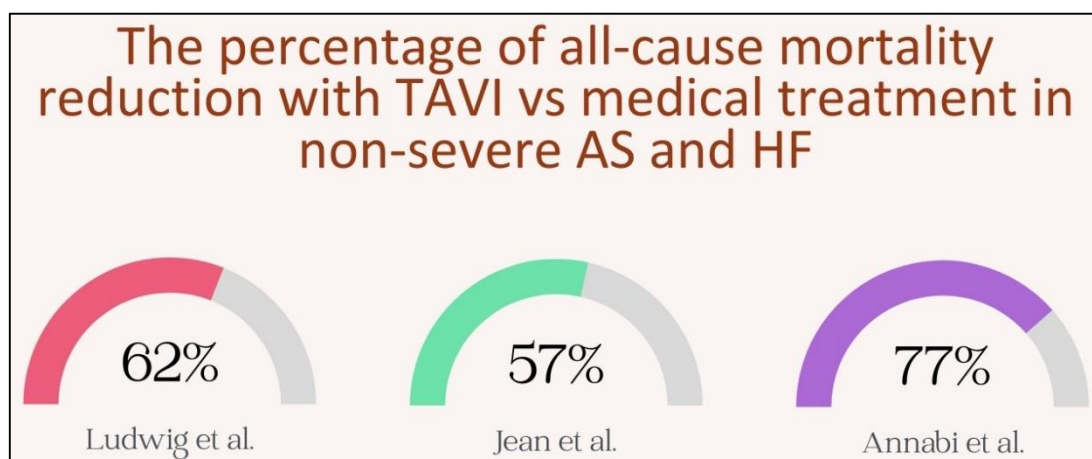


Figure 2. All-cause mortality reduction in TAVI vs. medical treatment in HF patients with non-severe AS

Ludwig et al. [16] included 308 propensity score-matched patients with non-severe AS (AVA>1.0 cm²) and LVEF<50% in a retrospective cohort study. Half of the patients underwent TAVI, and the other half remained on medical treatment. The study group showed a 62% relative risk reduction in all-cause mortality and a 72% relative risk reduction (RRR) in cardiovascular mortality in the patients managed with TAVI.

Jean et al. [17] ran a retrospective cohort study on 262 patients with reduced LV systolic function (LVEF<50%) and moderate AS (AVA >1.0 and <1.5 cm²; and peak aortic jet velocity >2 and <4 m/s, at rest or after dobutamine stress echocardiography) and a matched group of patients with the same LVEF range but no AS. The study showed a three-fold increase in mortality and 2.3 fold increase in the composite endpoint of heart failure hospitalization and mortality in the group with LV systolic dysfunction and moderate AS. 6% of the latter group underwent TAVI, which significantly improved the mortality (RRR=57%, p=0.05).

In the TOPAS study, Annabi et al. [18] studied 481 patients with low flow low gradient AS, 28% of which had non-severe AS on further testing. The mean of LVEF was 38%. Compared to those who were allocated to conservative medical management, there was a 77% RRR (p<0.001) and 49% RRR (p= 0.007) in all-cause mortality in non-severe AS patients managed with transfemoral or alternative-access TAVI, respectively.

The TAVR UNLOAD is a randomized controlled trial that compares TAVI plus optimum HF medical treatment to optimum HF treatment alone in patients with moderate AS and reduced ejection fraction. The study is currently recruiting, and the results are expected to be released by 2024 [19]. The clinical guidelines on managing valvular heart disease did not give a clear recommendation on treating non-severe AS in patients with HF [14, 20].

4. Conclusion

AS has deleterious effects on patients with HF. The management of non-severe AS is not clearly defined for patients with HF. HF patients with AS usually have a high surgical risk; therefore, TAVI represents a safer alternative to improve the symptoms and survival. In addition to its mortality benefits in cases of severe AS, our review hypothesizes that TAVI can reduce mortality in patients with non-severe AS and HF based on the results of the available observational studies. The results of the ongoing randomized controlled trial are awaited to give clear guidance on the management of non-severe AS in HF patients.

5. Declarations

5.1. Data Availability Statement

Data sharing is not applicable to this article.

5.2. Funding

The author received no financial support for the research, authorship, and/or publication of this article.

5.3. Institutional Review Board Statement

Not applicable.

5.4. Informed Consent Statement

Not applicable.

5.5. Declaration of Competing Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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