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MINI REVIEW

Transcatheter aortic valve implantation: Miracle of heart surgery

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Abstract

Patients with severe aortic stenosis (AS) who are ineligible for surgery due to technical/anatomical complications or significant surgical risk can now get transcatheter aortic valve implantation (TAVI), a fast-developing therapeutic option. When practical, the transfemoral technique is the preferred TAVI delivery method. Transaortic, trans-subclavian, and transapical access are other non-transfemoral access possibilities. The transcarotid, transcaval, and antegrade aortic methods are also viable, although they are only available to experienced surgeons and medical facilities. It is essential to thoroughly evaluate the patient's atherosclerotic load and location, arterial size and tortuosity, and the presence of mural thrombus due to the unique characteristics of each vascular approach created for TAVI delivery. Several clinical trials are presently being conducted, and in the near future, it is anticipated that the indications for these methods will be clarified and expanded to a wider range of TAVI candidates.

Keywords: Aortic stenosis, transcatheter aortic valve implantation, vascular.

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Introduction

The most frequent reason for obstruction of the left ventricular outflow tract is aortic stenosis (AS), which is brought on by increasing the calcification of the valve. When intermediate AS is present, the likelihood of severe AS developing is high. For patients with severe AS symptoms, surgical aortic valve replacement has traditionally been the recommended course of action (1). Before, patients who were deemed to be at high risk for surgery could only get palliative treatments like diuretics and balloon valvuloplasty, which had little impact on long-term outcomes. Transcatheter aortic valve replacement (TAVI) has been a lifesaver for individuals deemed inoperable, improving symptoms and reducing mortality by a statistically significant amount (2,3).

H. R. Anderson, a Danish researcher, initially proposed the notion of transcatheter balloon-expandable valves in the 1980s and started testing them on pigs. On an inoperable patient in 2002, Dr. Alain Cribier carried out the first

successful percutaneous aortic valve replacement. 2011 saw the first approval of TAVI for use in individuals with severe AS and high risk. The FDA approved TAVI in 2012 for individuals who posed a high surgical risk. The "valve-in-valve" technique for failed surgical bioprosthetic valves was added to the indication in 2015. The FDA approved the use of TAVI valves in 2016 for patients with severe AS who were at intermediate risk. After the PARTNER-3 trial results were released in 2019, the FDA further increased the indication for TAVI valves to cover low-risk patients (4).

leaves the heart. Due to its semi-lunar shape, it is also known as the aortic semilunar. Making sure that oxygen-rich blood does not return to the left ventricle is the responsibility of the left ventricle and the aorta. The three membranes (cusps) that make up the aortic valve typically consist primarily of collagen. The valve is mounted on a muscle ring and attached to the heart wall (5).

The aortic valve is normally assessed by transthoracic echocardiography, however, other imaging modalities like transesophageal echocardiography and CT are also frequently employed. When an aortic valve opens to an area of less than 1.0 cm^2, it is deemed to be highly stenotic (6). The most prevalent type of severe AS, known as high gradient AS is characterized by a mean gradient of less than 4 mmHg and an aortic jet velocity of greater than 4 m/s across the valve. A less frequent variation of severe AS is low flow, low gradient severe AS. Small ventricular volumes attributable to left ventricular hypertrophy or systolic dysfunction with lower ejection fraction are the causes of poor flow rate across the valve in this population of individuals (with normal LVEF). Low flow is indicated by a stroke volume index of 35 mL/m2 when the LVEF is normal. Dobutamine stress echocardiograms are performed on patients with poor flow and reduced LVEF to distinguish between true severe stenosis and pseudostenosis (inadequate valve cusp opening caused by low cardiac output causing an artefactually low value) (6,7).

Indications

The following conditions call for surgical or transcatheter aortic valve replacement (8):

. Symptoms of severe high-gradient AS (class I recommendation, level B evidence)

. Patients who are asymptomatic with severe AS and LVEF under 50 (class I recommendation, level B evidence)

. When undergoing further heart surgery, severe AS (class I recommendation, level B evidence)

. Severe AS symptoms without symptoms, little surgical risk (class IIa recommendation, level B evidence)

. Exhibiting severe low-flow/low-gradient AS symptoms (class IIa recommendation, level B evidence)

. Moderate AS and having additional heart operations (class IIa recommendation, level C evidence)

The following uses of TAVI are authorized (8):

. Patients with severe AS and low to prohibitive surgical risk who undergo valve-in-valve procedures after failing bioprosthetic valves

Contraindications

The life expectancy of fewer than 12 months due to something other than heart disease, myocardial infarction within the last 30 days, congenital unicuspid, bicuspid, or noncalcified valve, hypertrophic cardiomyopathy, short distance between the annulus and coronary ostium, need for emergency surgery, left ventricular ejection fraction of less than 20%, severe pulmonary hypertension with right ventricular dysfunction, echocardiographic evidence of intracardiac mass, thrombus, or vegetation (9).

Before undergoing TAVI, an interprofessional heart team evaluates patients and performs extensive evaluation and pre-procedural testing to determine candidacy. Cardiologists, cardiothoracic surgeons, and anesthesiologists make up the heart team. Transesophageal echocardiography, in addition to transthoracic echocardiography, is frequently used to improve visualization of aortic valve anatomy (10).

CTA of the chest, abdomen, and pelvis is also performed to ensure accurate measurement of the aortic annulus for valve size determination. CTA is also necessary for visualizing the vascular anatomy and determining the best approach to take. Before deciding on a surgical or transcatheter approach, a left heart catheterization is commonly performed to provide invasive hemodynamic measurements as well as rule out any coexisting coronary artery disease (CAD) that may be contributing to symptoms or may require revascularization (11). The need for concurrent coronary artery bypass grafting may influence the decision to pursue surgical aortic valve replacement. Revascularization of stable CAD prior to/during TAVI was previously debated, but data published in 2019 revealed that revascularization in conjunction with TAVI did not provide additional clinical benefit and did not improve important clinical outcomes (risk of MI, stroke, or death at 30 days) (10-12).

Usually, the surgery is carried out in a hybrid room that has both an operating room and a cath lab. Anesthesiologists, cardiac surgeons, and interventional cardiologists make up the team.

Transesophageal echocardiography (TEE) guidance and fluoroscopy are occasionally used during the surgery under direct visualization. The transfemoral technique is the preferred and least invasive method. If practical, a different, frequently more invasive procedure may need to be used (subclavian, apical, trans-aortic) (Figure 1) (13-15).

Conclusions

Life-saving aortic valve replacement. Leaky (aortic insufficiency) or partially occluded aortic valves are common (aortic stenosis). Treatments include sternotomy, minimally invasive heart surgery, and transcatheter aortic valve replacement. Patients with high surgical risk could only undergo palliative therapy like diuretics and balloon valvuloplasty before. TAVI has helped inoperable patients by decreasing symptoms and reducing death.

Conflict of interest:

The authors report no conflict of interest.

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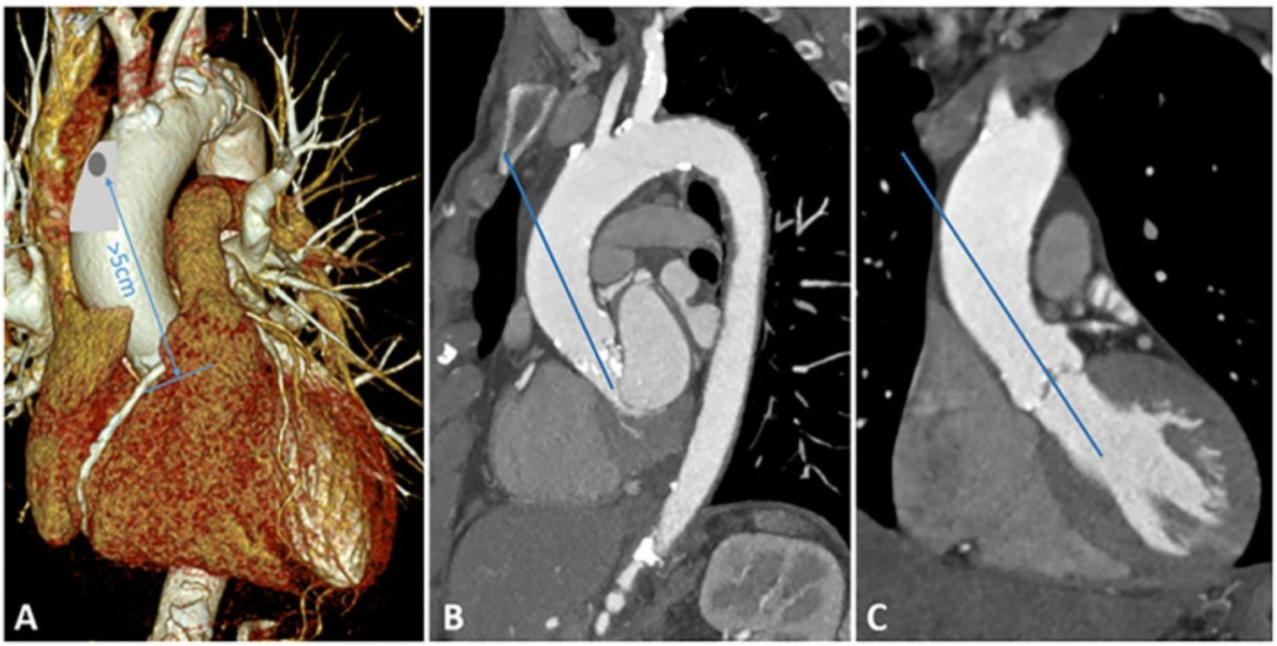

Figure 1: Preoperative multislice computed tomography scan. **(A)** 3D reconstruction of the aortic arch, appropriate location for aortic puncture is highlighted in gray. The distance between the puncture and the aortic annulus should be at least 5 cm. **(B)** Sagittal plane of the aortic arch. **(C** Coronary**)** plane of the ascending aorta (14).

Ethical approval:

No need for reviews.

Contributions

Research concept and design: **HAT**
Data analysis and interpretation: **HAT**
Collection and/or assembly of data: **HAT**
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