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iREVIEWS

FROM PICTURES TO PRACTICE PARADIGMS

Multidetector Computed Tomography in Transcatheter Aortic Valve Implantation

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Aortic stenosis is a common disorder. Aortic valve replacement is indicated in symptomatic patients with severe aortic stenosis, as the prognosis of untreated patients is poor. Nevertheless, many patients pose a prohibitively high surgical risk and are not candidates for surgical valve replacement. Transcatheter aortic valve implantation (TAVI) is a novel method to treat selected high-risk patients with aortic stenosis. Patient screening and anatomic measurements of the aortic root are of great importance to ensure procedural success and appropriate patient selection. Multidetector computed tomography (CT) is playing an increasingly important role in patient screening protocols before TAVI, provides detailed anatomic assessment of the aortic root and valve annulus, assesses the suitability of iliofemoral access, and determines appropriate coaxial angles to optimize the valve implantation procedure. Additionally, CT is providing a greater understanding of medium-term valve durability and integrity. This review outlines an evolving role for CT angiography in support of a TAVI program and describe step by step how CT can be used to enhance the procedure and provide a practical guide for the utilization of CT angiography in support of a transcatheter aortic valve program. (J Am Coll Cardiol Img 2011;4:416–29) © 2011 by the American College of Cardiology Foundation

Aortic stenosis is a common disorder that affects nearly 5% of persons >75 years of age (1). Aortic valve replacement is indicated for symptomatic patients with severe aortic stenosis, as the prognosis of untreated patients is poor (2). Nevertheless, many patients with symptomatic severe aortic stenosis do not undergo surgical valve replacement, which has been attributed to comorbidities (3). Transcatheter aortic valve implantation (TAVI) is a novel method to treat selected high-risk patients with aortic stenosis (4–7). As of early 2010, >15,000 procedures have been performed worldwide, mostly confined to patients at high surgical risk. Thus far, short- and medium-term outcomes have been encouraging (4,6,8).

Recently, the landmark PARTNER B (Placement of AoRTic TraNscathetER Valve) trial was published (9) in which 358 patients with aortic stenosis who were considered too high risk for

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standard surgery were randomly assigned to medical management (including balloon aortic valvuloplasty) versus TAVI. This multicenter study showed a 20% absolute reduction in 1-year all-cause mortality in the TAVI cohort as compared with the standard of care (30.7% vs. 50.7%, respectively; $p < 0.001$), establishing that transfemoral TAVI is superior to conservative therapy in this patient population of high-risk patients, and defining a new treatment option.

Procedural Overview and Background

Two TAVI systems have seen wide clinical application: the balloon-expandable Edwards Sapien valve (Edwards Lifesciences, Irvine, California), and the self-expandable CoreValve ReValving system (Medtronic, Minneapolis, Minnesota) (Figs. 1A and 1B). Both systems have been extensively described elsewhere (10–12). The native valve can be approached using a retrograde transarterial technique (generally using the femoral or subclavian arteries), or using an anterograde transapical technique. Balloon aortic valvuloplasty is initially performed to facilitate passage of the valve prosthesis through the stenotic native valve. Subsequently, the unexpanded valve is appropriately positioned within the native aortic valve. The Edwards Sapien valve (Edwards Lifesciences) is expanded by a balloon during burst ventricular pacing to minimize cardiac output and prevent migration of the valve during deployment. The CoreValve (Medtronic) is self-expanding and is generally deployed without pacing.

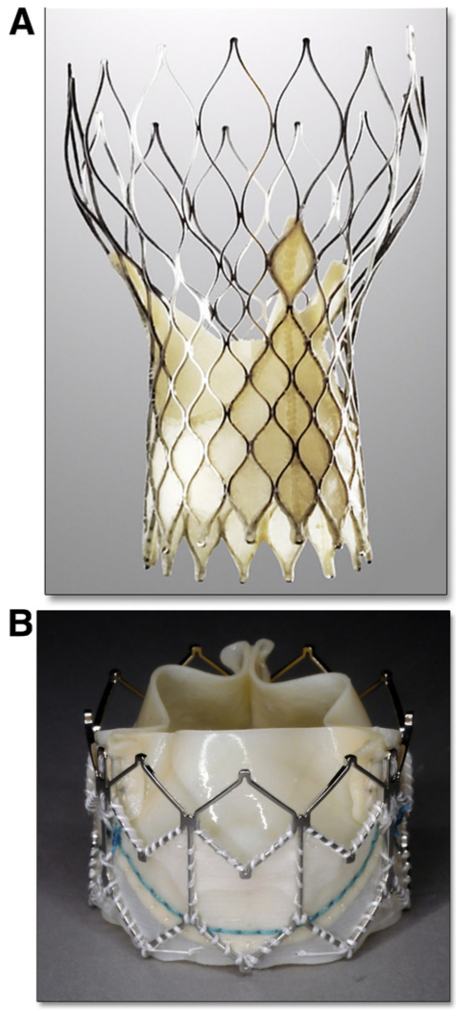

Figure 1. Edwards Sapien XT Valve and Medtronic CoreValve

(A) Edwards Sapien XT valve. The balloon expandable valve stent frame is composed of cobalt-chromium, with bovine pericardial leaflets. **(B)** Medtronic CoreValve. The self-expanding valve stent frame is composed of nitinol, with porcine pericardial leaflets.

Optimal positioning of the transcatheter aortic prosthesis is paramount to procedural success, as the goal is to displace the native valve leaflets and deploy within the native valve annulus. If valve deployment is too high, there is increased risk of aortic injury, paravalvular regurgitation, or embolization into the aorta (13). Conversely, if deployment is too low, there is increased risk of mitral valve dysfunction, heart block, paravalvular regurgitation, or embolization into the left ventricular cavity (14).

The relatively large delivery catheters currently required for valve implantation using the transfemoral route have been associated with attendant vascular complications, and limit the number of patients who are candidates for this technique. Recent technological efforts have culminated in significantly lower profile delivery systems requiring 18-F sheaths (outer diameter of approximately 7 mm), and include the Edwards NovaFlex and CoreValve third-generation devices. These smaller catheters may reduce vascular complications and expand patient eligibility for the procedure. Routine screening with multidetector computed tomography (MDCT) to determine the feasibility of the transfemoral approach permits identification of patients who may be candidates for these lower profile systems.

Whether a femoral, subclavian, or apical approach is used, accurate measurements of the aortic annulus are important in patient selection and proper implantation, as existing valves are designed for specific annular sizes. Unlike with surgical aortic valve replacement, where sizing occurs under direct visualization and using a sizing probe, aortic annulus measurements

ABBREVIATIONS AND ACRONYMS

CT = computed tomography

ECG = electrocardiography

LAO = left anterior oblique

MDCT = multidetector computed tomography

RAO = right anterior oblique

TAVI = transcatheter aortic valve implantation

TEE = transesophageal echocardiography

3D = 3-dimensional

TTE = transthoracic echocardiography

2D = 2-dimensional