Case Study

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Direct aortic transcatheter valve implantation in a porcelain aorta

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Abstract

Transcatheter aortic valve implantation has been designed to treat elderly patients with severe aortic stenosis at high risk for surgery, and is generally performed retrogradely with vascular access. However, in certain patients, this access is either not possible or deemed to carry a high risk of vascular injury. We report our experience of a direct aortic approach in a 78-year old man with severe aortic stenosis, excluded from standard aortic valve replacement due to a porcelain aorta, and affected by severe aortic, iliac-femoral, and subclavian arteriopathy, rendering the transfemoral or subclavian approach unemployable.

Keywords

Aortic valve stenosis, catheterization, heart valve prosthesis implantation

Introduction

Transcatheter aortic valve implantation (TAVI) has been designed to treat elderly patients with severe aortic stenosis at high risk for surgery or affected by severe diffuse ascending aortic calcification, so called porcelain aorta.[1,2] Since the first human procedure in 2002, the retrograde approach was the widely used. Both the transfemoral and subclavian approaches require peripheral arterial access and cannulation. In some patients, the peripheral vasculature is unfavorable because of small vessel size, severe atherosclerosis, tortuosity, or calcification, rendering either of these approaches contraindicated or carrying an increased risk of vascular complications. In patients with no suitable femoral or axillary access, alternative approaches have been described: the standardized transapical approach with the Edwards Sapien valve (Edwards Lifesciences, San Francisco, CA, USA), and a direct aortic approach utilizing the CoreValve (Medtronic, Inc., Minneapolis, MN, USA) bioprosthesis.[3,4]

Case report

A 78-year-old man was admitted to our department with pulmonary edema. He was affected by severe peripheral vasculopathy, carotid vasculopathy (right internal carotid artery stenosis 65%, left internal carotid artery 40%) and severe chronic obstructive pulmonary disease (forced expiratory volume in 1 s of 2.3 mL). Echocardiography revealed severe aortic stenosis (mean gradient 47 mm Hg, aortic valve area 0.6 cm^2, annulus 24 mm, maximal velocity 4.7 $m \cdot s^{-1}$), no aortic regurgitation, normal left ventricular function (ejection fraction 61%), and mild mitral regurgitation. The patient was evaluated for standard aortic valve replacement and underwent preoperative screening. Chest radiography revealed diffuse severe calcification of the ascending aorta, with complete demarcation of the ascending aorta, arch, and descending aorta (Figure 1). Coronary angiography showed normal coronary arteries, but aortography demonstrated severe diffuse vascular calcification of the entire thoracic aorta (Figure 2). To evaluate the extension of the calcification and the possibility of performing transcatheter aortic valve implantation, the patient underwent computed tomography which confirmed that the

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Figure 1. Chest radiograph revealing calcified demarcation of the ascending aorta, arch, and descending aorta.

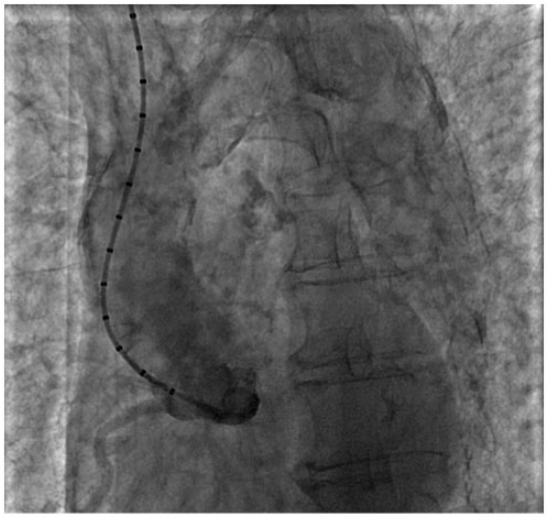

Figure 2. Aortography showing severe diffuse vascular calcification.

ascending aorta was virtually encased in calcium (Figure 3a) and the abdominal aorta, iliac, and femoral vessels were calcified, with a common femoral artery inner lumen <5 mm; the left subclavian artery was also heavily calcified and small in size. After the heart team's evaluation, a transcatheter aortic valve implantation was preferred due to the presence of a porcelain ascending aorta (logistic EuroSCORE 20.6, Society of Thoracic Surgeons' mortality score 4.7% and morbidity score 26.7%), but considering the severe peripheral and subclavian vasculopathy, a femoral or subclavian approach was excluded. After careful 3-dimensional computed tomography, a safe spot on the ascending aorta, without atherosclerotic calcific involvement, was found at 6 cm from the aortic annulus (Figure 3a), and a direct aortic approach was chosen, which is our first alternative access option if the transfemoral approach is not feasible or high-risk. We performed the procedure in our hybrid operating room, with the patient under general anesthesia with double-lumen endotracheal intubation. Through a right anterior minithoracotomy in the 2nd intercostal space, as previously described,[4] a successful direct aortic CoreValve no. 29 implantation was performed by a combined team of cardiologists, cardiac surgeons with expertise in hybrid procedures, and anesthetists (Figure 4). The patient had an uneventful postoperative course and was discharged from hospital on 5th postoperative day with normal valve function. At the 1-year follow-up, he was in New York Heart Association functional class I with normal valve function (mean gradient 6 mm Hg), a trivial paravalvular leak, and normal left ventricular function (ejection fraction 67%).

Discussion

Transcatheter aortic valve implantation has been designed to treat elderly patients with severe aortic stenosis at high risk for surgery. This population also includes those considered inoperable due to anatomical reasons such as severe diffuse ascending aortic calcification.[2] Peripheral arterial approaches for TAVI are less than ideal in certain patients, either because of a high risk of arterial injury or a relative lack of control of device delivery. Major vascular complications constitute one of the major determinants of adverse clinical outcomes in all TAVI registries, with an incidence currently reported in as many as 10% of percutaneous transfemoral TAVI cases.[5] The transapical approach using the Edwards Sapien valve is a well-recognized alternative, allowing valve deployment directly through the apex of the left ventricle. However, the transapical approach has some technical limitations and also some

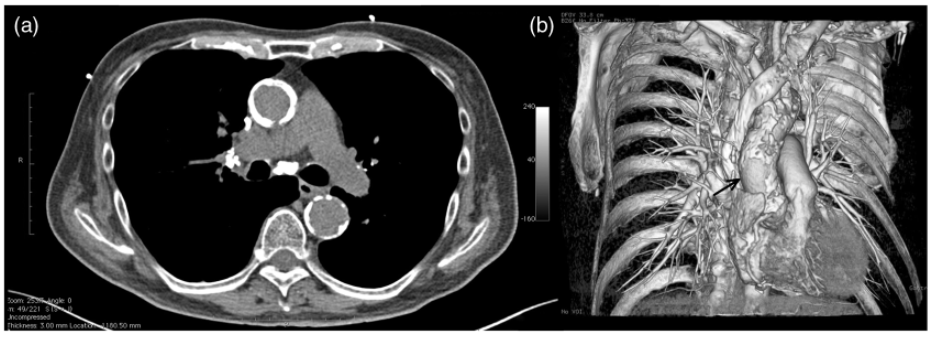

Figure 3. (a) Computed tomography confirmed severe diffuse vascular calcification and showed that the ascending aorta was virtually encased in calcium. (b) Three-dimensional computed tomography detected a safe spot (arrow) without calcification on the ascending aorta at 6 cm from the aortic annulus.

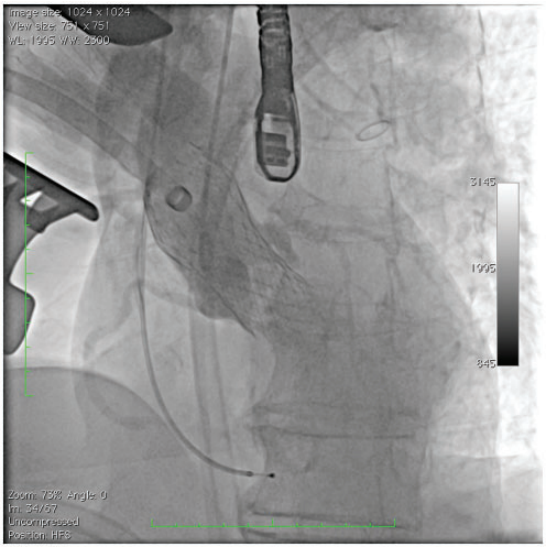

Figure 4. Direct aortic approach through a right-anterior thoracotomy, post-deployment angiography revealed normal CoreValve expansion, absence of a paravalvular leak, and normal coronary flow.

potential and unique complications related to left ventricular access, such as bleeding from the apical puncture site, myocardial tears, mitral trauma related to misdirected stiff catheters, and left ventricular apical false aneurysm during late follow-up.[6]

In this scenario, direct aortic access has recently been described as an alternative to femoral, transapical, and subclavian access, which provides an intriguing alternative for TAVI in high-risk patients with associated severe iliac-femoral arteriopathy.[7,8] The principal advantage of TAVI via direct aortic access is enhanced control of the delivery system and the ability to manipulate the delivery system so that it is truly coaxial to the plane of the aortic annulus. The principal challenge is the presence of severe calcification in the ascending aorta, and we believe that preoperative computed tomography is mandatory to determine the feasibility of the procedure. On the basis of 3-dimensional computed tomography reconstruction, it is possible to evaluate whether a safe spot on the ascending aorta is present. Our experience emphasizes the fact that a multidisciplinary approach is necessary to offer the safest conditions and care for patients, and that the direct aortic approach for transcatheter valve implantation may be feasible in patients with a porcelain aorta.

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Conflict of interest statement

G. Bruschi is consultant for Medtronic.

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