Direct Aortic Access for Transcatheter Self-Expanding Aortic Bioprosthetic Valves Implantation

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Background. **Transcatheter aortic valve implantation (TAVI) has been designed to treat elderly patients with severe aortic stenosis at high risk for operation; however, these patients are also often affected by severe iliac-femoral arteriopathy that prohibits the transfemoral approach.**

Methods. **From May 2008 to January 2012, 400 patients were evaluated for TAVI at our center; of these, 141 patients (64 men; mean age 81.3 ± 8 years) with severe symptomatic aortic stenosis and no reasonable surgical option due to excessive risk were eligible for CoreValve (137 patients; Medtronic Inc, MN) or Sapien (Edwards Lifesciences, CA) implantation. Twenty-five patients (all affected by severe peripheral vasculopathy, including five re-do procedures), with a mean The Society of Thoracic Surgeons mortality score 11% ± 6%, underwent CoreValve implantation directly from the ascending aorta through a right anterior minithoracotomy. This case series was reviewed to evaluate the clinical outcomes of these patients. A combined team of cardiologists, cardiac surgeons with expertise in hybrid procedures, and anesthetists performed all the procedures.**

Results. **In all patients after valve deployment, the mean aortic gradient immediately dropped to 5 mm Hg or less, and the angiographic grade aortic insufficiency was 1 or less in 22 patients. One patient was converted to the transfemoral approach due to an extremely fragile aortic wall, but the patient died of abdominal aorta aneurysm rupture on postoperative day 1. Procedural success was obtained in the remaining 24 patients. A left ventricle tear in 1 patient was successfully surgically treated. Four patients required a permanent pacemaker implantation. Thirty-day mortality was 8% (2 patients). All discharged patients improved their New York Heart Association functional class and functional capacity, and echocardiograms demonstrated good valve performance up to 2 years (mean valve gradient, 9 mm Hg). During follow-up, 1 patient died of cachexia and another of bone marrow aplasia.**

Conclusions. **TAVI with the direct aortic approach is safe and feasible, offering a new attractive option to treat selected high-risk patients with severe aortic stenosis and peripheral vasculopathy, including those requiring a re-do procedure, and has emerged as a valuable alternative route to transapical access.**

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Severe aortic stenosis (AS) is the most frequent form of valvular heart disease in Western countries, and with the growing elderly population, symptomatic aortic stenosis has become an increasing health problem [1]. Aortic valve replacement (AVR) is the standard treatment for these patients [2] and can be performed with acceptable mortality in elderly patients. However, the mortality rate associated with AVR increases substantially if multiple comorbidities, such as left ventricular dysfunction, previous cardiac operations, chronic obstructive pulmonary disease, liver or renal failure, and diffuse atherosclerosis are present [3].

Transcatheter aortic valve implantation (TAVI) has been designed to treat this group of elderly, symptomatic aortic stenosis patients at high risk for operation. The procedure may be performed from the femoral artery [4, 5], from a transapical approach [6], or the axillary artery [7] and has rapidly gained credibility. Since the first-in-man procedure in 2002 [8], several technologic improvements have been achieved on both available devices, the balloon-expandable Edwards-Sapien prosthesis (Edwards Lifesciences, Irvine, CA) and the self-expandable CoreValve Revalving prosthesis (Medtronic Inc, Minneapolis, MN), as well as in procedural management and access, leading to increased TAVI success rates [4, 5, 7].

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Because of the large device size of current generation systems, the transfemoral approach requires favorable ileofemoral arterial anatomy. This approach is contraindicated in patients with excessive atherosclerosis, calcifications, or tortuosity of ileofemoral arteries and should be considered cautiously in patients with an aneurysm of the abdominal aorta. To treat these patients, a transsubclavian approach with the CoreValve Revalving prosthesis or transapical access with the Ascendra (Edwards Lifesciences) transapical catheter and the Edwards-Sapien valve is preferred. However, this last approach is demanding because it requires direct left ventricle (LV) apex surgical exposure, which can be structurally friable in elderly patients and in patients with severe hypertrophy. Moreover, the transapical approach requires a dedicated antegrade delivery system.

A few CoreValve implantations directly from the ascending aorta with the standard retrograde delivery system have recently been described in patients with contraindications to the femoral or subclavian approach [9, 10]. In the present report we describe the procedural and short-term results of our initial experience of CoreValve transaortic implantation through a right anterior minithoracotomy.

Material and Methods

From May 2008 to January 2012, 400 patients affected by severe, symptomatic aortic stenosis and no reasonable surgical options or considered high risks for operation were evaluated for TAVI at our center. The screening protocol included transthoracic echocardiogram, complete left heart catheterization, and coronary angiography, with angiography of the iliac and femoral arteries and chest and aortic-iliac-femoral computed tomography scan. Of these, 141 patients (64 men), with a mean age 81.3 ± 8 years, were eligible for the CoreValve (138 patients) or Edwards-Sapien implantation. Acceptance for the procedure required consensus by a team composed of a cardiac surgeon, an interventional cardiologist, the referring cardiologist, and a cardiac anesthesiologist. Written informed consent was obtained in all patients, and the local ethics committee approved the procedures.

We excluded 32 patients (20 men), mean age 80.1 ± 8 years, from the transfemoral approach due to iliac-femoral arteriopathy, small size, excessive tortuosity, calcification, or an abdominal aortic aneurysm. Six of these patients underwent CoreValve implantation through the left axillary artery, 1 underwent anterograde transapical Edwards-Sapien valve implantation, and in 25 patients, a CoreValve implantation was performed directly from the ascending aorta through a right anterior minithoracotomy. The direct aortic CoreValve patients' characteristics are reported in Table 1.

The current third-generation CoreValve Revalving system with the standard retrograde delivery system was used in all patients. The CoreValve System consists of three unique components: a self-expanding support frame with a trileaflet porcine pericardial tissue valve, an 18F catheter delivery system, and a disposable loading system; details have been described previously [5, 11]. The procedures were performed by the cardiovascular team composed of interventional cardiologists, cardiac surgeons with expertise in hybrid procedures, and cardiac anesthesiologists.

Table 1. Baseline Patient Characteristics at Implant

Variables	Mean ± SD or No. (%) (N = 25)
Age, years	79.9 ± 7.9
Society of Thoracic Surgeons score	
Mortality, %	11.2 ± 6.1
Mortality and morbidity, %	41.3 ± 11.2
EuroSCORE II	12.6 ± 11.7
Body surface area, m^2	1.7 ± 0.3
Creatinine clearance, mL/min	37.2 ± 15.1
Left ventricular ejection fraction	0.576 ± 0.099
Transaortic gradient, mm Hg	
Peak	90.3 ± 22.9
Mean	55.3 ± 15.3
Aortic valve area, cm^2	0.6 ± 0.1
Female sex	11 (44)
NYHA class ≥ III	19 (76)
Hypertension	24 (96)
Diabetes mellitus	6 (24)
Peripheral artery disease	21 (84)
Pulmonary hypertension ≥ 60 mm Hg	5 (20)
Carotid artery disease	12 (48)
Prior cerebrovascular accident	3 (12)
Severe chronic pulmonary disease	11 (44)
Severe renal impairment	19 (76)
Coronary artery disease	14 (56)
Prior myocardial infarction	5 (20)
Prior procedures	
Percutaneous coronary intervention	8 (32)
Coronary artery bypass grafting	5 (20)
Aortic valve replacement	1 (4)
Mitral valve replacement	1 (4)
Pacemaker implant	7 (28)
Atrial fibrillation	9 (36)
Porcelain aorta	3 (12)

EuroSCORE = European System for Cardiac Operative Risk Evaluation; NYHA = New York Heart Association; SD = standard deviation.

Operative Technique

All patients received acetylsalicylic acid (100 mg) before the procedure and lifelong thereafter. Clopidogrel (75mg) was started the day after the procedure and continued for 3 months. Standard antibiotic prophylaxis was started before the procedure and continued for 3 days.

The patients were prepared as for a conventional aortic valve replacement. The intervention was performed under general anesthesia and mechanical ventilation. A double-lumen endotracheal tube was used for single left-lung ventilation. Defibrillator pads were properly

placed across the chest wall. Unfractionated heparin (100 IU/kg) was administered during the procedure to achieve an activated clotting time of 200 to 250 seconds for the duration of the procedure and reversed with protamine at the end of the procedure.

A temporary pacing lead was advanced in the right ventricle through the right jugular vein or the femoral vein, in patients without permanent pacemaker, to treat possible postprocedure atrioventricular block. A 6F pigtail catheter was inserted for hemodynamic monitoring and landmark aortic angiography through the right radial artery or the best femoral artery.

The procedure was performed through a 5-cm incision in the second intercostal space. The right anterior minithoracotomy was made such that the medial angle of incision was positioned just before the projection of the right internal mammary artery 1.5 to 2 cm laterally to the sternal edge. A soft-tissue retractor or a small rib retractor, or both, were used to open and expose the working field. The ascending aorta was than evaluated by gentle palpation to find a safe entry site.

A basal ascending aorta aortography, using a graduated pigtail, was performed to measure the distance between the aortic annulus and the selected entry site in the ascending aorta (Fig 1). To safely perform the CoreValve implantation, more than 6 cm is needed because the CoreValve is 5.5 cm in height. At the entry site, 2 aortic purse-string sutures for direct aortic access were placed in a standard fashion (Fig 2).

Ascending aortic cannulation was performed with the Seldinger technique through the double purse-string sutures. A 6F sheath was then inserted into the ascending aorta. A 0.035 straight-tipped guidewire was placed in the LV using a left Amplatz (Boston Scientific, Natick, MA) catheter, then a Cook 30-cm Check-Flo Performer 18F introducer (William Cook Europe, Bjaeverskov, Denmark) was inserted over an Amplatz super stiff guide-

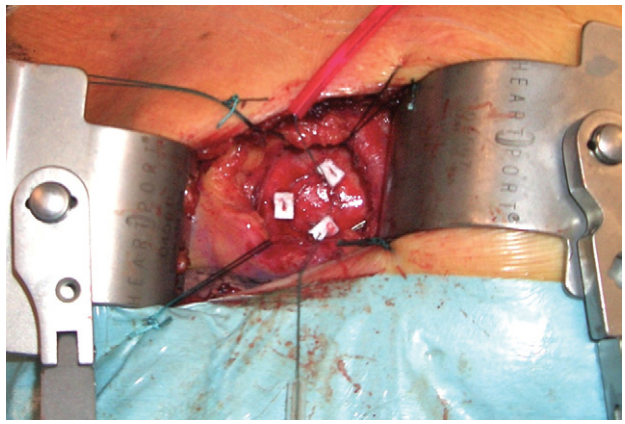

Fig 2. Operative photograph shows ascending aorta exposure through the right minithoracotomy and standard aortic purse-string sutures for direct aortic access.

wire, and the native aortic valve was predilated with a Nucleus balloon (NuMED, Inc, Hopkinton, NY) under rapid pacing in all patients with native calcified aortic valve. A CoreValve bioprosthesis was then carefully introduced and retrogradely implanted under angiographic and fluoroscopic guidance over the super-stiff wire, with immediate improvement of the hemodynamic status in all patients.

Immediately after CoreValve deployment, ascending aorta angiography was performed to assess the patency of the coronary arteries and coronary grafts as well as the presence and location of paravalvular leak (Fig 3). The purse-string sutures were knotted, and the access site insertion was reinforced with pledgeted polypropylene sutures, if necessary. After placement of a 26F round

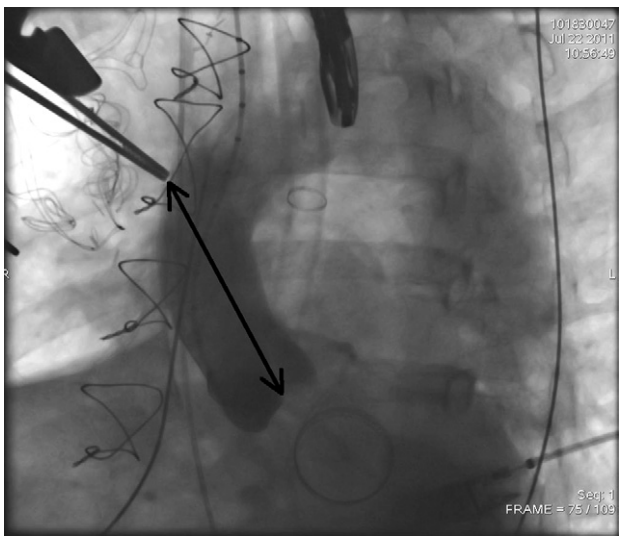

Fig 1. Angiography is used to evaluate the distance between the aortic annulus and the entry site in the ascending aorta (forceps tips).

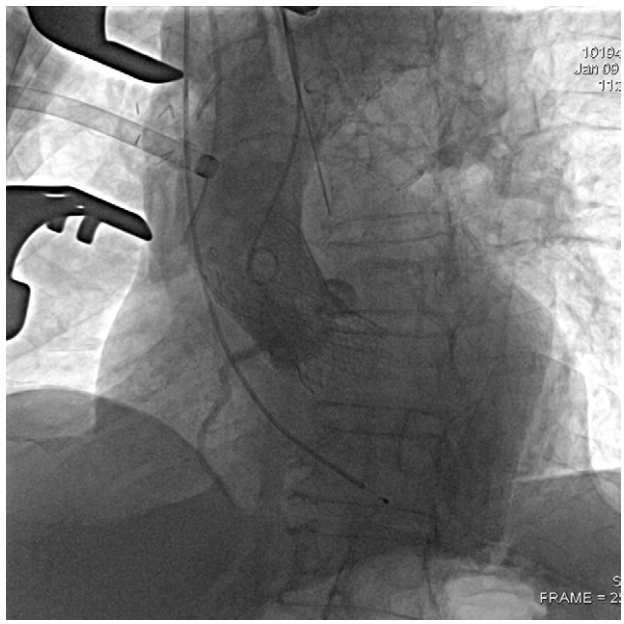

Fig 3. Coronary flow and eventual paravalvular leak are evaluated with a final aortography.

fluted chest spiral drain (Redax S.r.l., Mirandola, Italy), the minithoracotomy incision was closed in anatomic layers, with particular attention to the medial angle of incision, because the right internal mammary artery should be routinely checked for any lesion. The skin was approximated in a traditional manner with intradermic absorbable sutures.

Statistical Analysis

Incidence rates of events are reported by providing the number and percentage of patients experiencing the event. Continuous data are reported through the mean ± standard deviation or median and the range of values observed.

Results

According to the consensus report of the Valve Academic Research Consortium (VARC) [12], procedural success was defined by the combination of three end points: (1) successful vascular access, delivery, and deployment of the device, and successful retrieval of the delivery system; (2) correct position of the device in the proper anatomic location; and (3) normal performance of the prosthetic heart valve, with an aortic valve area of 1.2 cm^2, a mean aortic valve gradient of less than 20 mm Hg or peak velocity of less than 3 m/s, without moderate or severe prosthetic valve regurgitation, and only one valve implanted in the proper anatomic location.

Operative outcome was represented by any event occurring during the procedure and within the subsequent 24 hours. Any event occurring within 30 days from the procedure was considered as being procedure-related [12, 13]. Events collected were death, neurologic event, myocardial infarction, ventricular perforation, cardiac tamponade, aortic dissection, vascular access complication, infections, and contrast-induced nephropathy.

Procedural success was obtained in 24 patients. In patient 3, an 85-year-old woman with a non-Hodgkin lymphoma treated with cyclophosphamide, Doxorubicin, vincristine, and prednisone chemotherapy, bleeding from the pericardium, with signs of cardiac tamponade, was evident after the thoracotomy was performed. We decided to perform a median sternotomy, and a right ventricle laceration was evident. After direct-patch suturing of the right ventricle, an extremely fragile aortic wall was evident when the ascending aorta purse-string sutures were inserted. Despite the presence of an abdominal aortic aneurysm, considering the extremely fragile aortic wall, we decided to perform a standard femoral approach. A CoreValve was successfully implanted, but because of femoral extravasation, the placement of a Viabahn (W.L. Gore and Associates, Flagstaff, AZ) 7- × 10-cm covered stent was needed. The patient died of abdominal aortic aneurysm rupture on postoperative day 1.

Patient 8, an 83-year-old woman, experienced a LV tear during valve implantation. We decide to perform a median sternotomy immediately after valve deployment, and LV laceration was evident. Immediate instauration of cardiopulmonary bypass was performed with a two-stage cavoatrial cannula and standard ascending aorta cannulation, with no interference between the upper portion of the CoreValve frame and the aortic cannula (Fig 3). With LV decompression, a successful direct suture of the LV tear was performed. Prolonged hemostasis was needed and achieved with the use of a patch sponge coated with a dry layer of the human coagulation factors fibrinogen and thrombin (TachoSil; Nycomed, Glattpark-Opfikon, Switzerland). The patient required multiple transfusions but had an uneventful postoperative course and was discharged home from the hospital after 17 days.

Five patients were redo procedures at TAVI implantation, having undergone previous coronary artery bypass grafting (CABG). In addition, 2 patients previously underwent combined valve replacement. Patient 14 underwent CABG plus aortic valve replacement for severe aortic stenosis with a Sorin Solo No. 21 stentless valve (Sorin, Saluggia VC, Italy) 7 years before the transcatheter procedure. Owing to stentless valve degeneration causing severe aortic stenosis (mean transvalvular gradient, 65 mm Hg), the patient underwent a No. 26 CoreValve implantation. Patient 20 underwent CABG and mitral valve replacement with an On-X No. 25 bileaflet mechanical valve 7 years before the TAVI procedure. A successful No. 26 CoreValve implantation was performed, with no deformation of the nitinol tubing of the CoreValve and no distortion or malfunction of the mechanical valve.

Patient 23 was a 63-year-old man affected by severe aortic regurgitation caused by aortic endocarditis (*Streptococcus viridans*) complicated by a thromboembolic pulmonary event. He was excluded from conventional aortic valve replacement because of severe hepatic cirrhosis (Child-Pugh C, Meld 16), secondary to hepatitis C virus infection and alcoholic liver disease, with episodes of portosystemic encephalopathy and portal hypertension. The patient had an aortic annulus perimeter of 93 mm (28.2 × 29.3 mm), but considering that no other option was possible to allow enlisting the patient for liver transplantation, a No. 31 CoreValve implantation was performed, with grade 2 residual aortic insufficiency. The patient died of sudden death on postoperative day 13.

In all patients after valve deployment, the mean aortic gradient immediately dropped to 5 mm Hg or lower. Five patients had angiographic grade 1 aortic insufficiency. Procedural details are reported in Table 2. All patients, except the patient who died, were extubated in the hybrid operating room or in the intensive care unit within the first 24 hours. Postprocedural complete atrioventricular block developed in 4 patients, and permanent pacemaker implantation was required. No other complications occurred during the hospitalization. All patients were asymptomatic at discharge, with good prosthesis function, as assessed by echocardiography, after a median hospitalization of 10 days (range, 6 to 28 days). The mean transvalvular aortic pressure gradient at discharge was 10 mm Hg.

During a mean follow-up of 9.1 ± 6.6 months, all patients experienced New York Heart Association func-

Table 2. Procedural Details and Complications

Variables	Mean ± SD or No. (%) (N = 25)
Implant time, min	150 ± 90
Fluoroscopy time, min	19.1 ± 6.4
Radiation dose/area product, Gy cm^2	155 ± 90
Peak transaortic gradient, mmHg	3.4 ± 5.1
CoreValve size	
26 mm	12 (48)
29 mm	10 (40)
31 mm	3 (12)
Valve-in-valve	0 (0)
Procedural success	24 (96)
Low implantation	1 (4)
New pacemaker	4 (16)
Transfusion ≥ 3 units packed cells	2 (8)
Mortality rate	
Procedural	0 (0)
30 days	2 (8)
Myocardial infarction	0 (0)
Neurologic event (stroke/TIA)	0 (0)
Acute kidney injury	1 (4)
Vascular complications	0 (0)
Ventricular perforation	1 (4)
Normal prosthetic valve performance	25 (100)

TIA = transient ischemic attack; SD = standard deviation.

tional class improvement and returned to a normal life, limited only by their previous medical conditions. One patient underwent right thoracoscopic decortication 35 days after the procedure. One patient experienced severe idiopathic bone marrow aplasia 1 month after CoreValve implantation, was treated with recurrent platelets and blood transfusions, but died 4 months after the procedure. One patient died of cachexia 8 months after implantation. All patients underwent regular echocardiographic follow-up controls that demonstrated normal prosthesis performance, with an average mean transvalvular aortic pressure gradient of 9.9 ± 5.9 mm Hg at 6 months and only trivial paravalvular leak (Table 3).

Comment

From the first case of a successful percutaneous implantation of an aortic bioprosthesis in April 2002 done through the femoral vein with an antegrade (transseptal) access [8], several technical approaches have been applied, such as the retrograde approach through the femoral arteries [4, 5], the anterograde transapical approach through a left minithoracotomy [6], or most recently, the subclavian approach [7, 14]. The antegrade transvenous approach [8, 15] theoretically appears more suitable to introduce the large delivery systems, reducing the risk of vascular complications. However, the technique was challenging due to the need for a transseptal puncture, and the guidewire interaction with the mitral valve and subvalvular apparatus contributed to poorly tolerated acute mitral insufficiency, and for these reasons, this approach has been abandoned [4, 16]. Significant technical and prosthetic modifications followed to solve the previously encountered limitations, with the aim to transform the retrograde approach through the femoral arteries to the preferred access site for TAVI because of lower invasiveness and nonsurgical access.

Owing to the improvements of the interventional techniques, such as the crossover technique for percutaneous closure of the common femoral artery at low pressure (by occlusion balloon inflation in the proximal iliac), as well as a thorough preinterventional screening, the incidence of major vascular complications has declined significantly within a relatively short period of time [17]. Vascular complications are frequent, however, and are currently still reported in up to 32% of percutaneous transfemoral TAVI cases [18] and necessitate endovascular or surgical treatment, as shown in the Sapien Aortic Bioprosthesis European Outcome (SOURCE) Registry [19] and also in the more recent Placement of Aortic Transcatheter Valves (PARTNER) trial [20, 21]. There is a significant association between vascular complications and 30-day and long-term mortality. This is hardly surprising considering the known overlap of etiology and risk factors for atherosclerotic vascular disease and aortic stenosis, the patient selection criteria of advance age combined with severe generalized atherosclerotic disease, porcelain aorta, or previous cardiac operation, and considering the need to insert and maneuver semirigid, large-bore sheaths and delivery catheters through the vasculature that is often atherosclerotic, tortuous, and thus prone to injury in the elderly patients who are currently referred for TAVI. The femoral approach is therefore contraindicated in patients with excessive atherosclerosis, calcifications, or tortuosity of femoral or iliac

Table 3. Echocardiographic Valve Evaluation at Follow-Up

Variable	3 Months	6 Months	12 Months	18 Months
LV ejection fraction	0.612 ± 0.087	0.637 ± 0.054	0.645 ± 0.035	65.3 ± 0.025
Mean aortic gradient (mmHg)	10.1 ± 3.8	9.9 ± 5.9	11.9 ± 4.9	12.3 ± 5.2
Aortic insufficiency[a]	0.8 ± 0.8	0.8 ± 0.5	0.8 ± 0.3	0.5 ± 0.5
Patients, No.	20	17	7	4

[a] Units for Aortic insufficiency are based on four different degree of AI (0: no AI; 1: mild; 2: mild-moderate; 3: moderate; 4: severe.)

LV = left ventricle.

arteries and should be considered cautiously in patients with an aneurysm of the abdominal aorta.

A transsubclavian retrograde approach could represent an intriguing alternative for TAVI in patients with coexistent severe iliac-femoral arteriopathy, considering that the axillary artery is easily accessible after surgical cutdown and that the procedure should be performed with local anesthetic and mild sedation and has shown excellent results [7, 14, 22, 23]. However the axillary is fragile, and patients are not eligible for the subclavian approach in case of vessel diameter of less than 6 mm, heavy calcification, excessive tortuosity, or tight subclavian stenosis not amenable to percutaneous balloon angioplasty [7]. Moreover, the subclavian approach has to be considered cautiously in patients with patent left internal mammary artery graft.

Otherwise, TAVI implantation in patients with a contraindication to femoral access may be performed through a transapical approach, which is widely and successfully performed using the Edwards-Sapien valve [6, 16, 21]. This approach allows the introduction of the Ascendra Transapical Delivery System directly through the apex of the LV without theoretic sheath diameter limitation. However the transapical valve implantation has some peculiar technical limitations, as in the case of severe septal hypertrophy, calcifications of the apex, previous LV patch operation, and calcified pericardium. This approach has also some potential and unique complications, including the occurrence of significant incidence of bleeding from the apical puncture site, myocardial tears requiring further surgical repair, possible accidental damage of a coronary artery during apical repair, and mitral or aortic trauma that could occur from misdirected stiff catheters. Some long-term complications have also been described, such as the development of LV apical false aneurysm, arrhythmias, and echocardiographic hypokinesia or akinesia of the LV apex [6, 24, 25, 26].

The analysis of the Trans-Apical surgical Delivery of the Cribier-Edwards Aortic Bioprothesis Clinical Feasibility (TRAVERCE) [27] data and data from large series of high-risk patients treated with the transapical approach [28], including the results of the PARTNER trial [21], demonstrate worse clinical outcomes associated with the transapical approach. This reflects the complexity of the technique and the importance of appropriate patient selection.

In this scenario, other authors have also recently reported a new alternative to femoral, transapical, and subclavian access—a direct aortic access [9, 10]—that could represent an intriguing alternative for TAVI in high-risk aortic patients with associated severe iliac-femoral arteriopathy.

In our center, we moved from considering the axillary access as the first alternative option for TAVI patients with challenging femoral arteries to considering direct aortic access as the best alternative in these patients. We opted in all operations to enter through a right anterior minithoracotomy, as is routinely used for minimally invasive aortic valve replacement [29], rather than by performing a ministernotomy. The advantage of performing implantation through a right anterior minithoracotomy is more evident in redo patients, in whom a repeat sternotomy, even if partial, is a challenging procedure; indeed, right thoracotomy requires only limited dissection at the entry site on the ascending aorta and is also feasible in patients with patent venous grafts with a proximal anastomosis on the ascending aorta [30].

Another advantage of the right thoracotomy is the better angulation toward the aortic annulus achieved from the right side. The principal advantages of TAVI through a direct aortic approach compared with peripheral arterial approaches are the 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. These undoubtedly facilitate more accurate device delivery, which is particularly useful in patients with complex anatomic or pathophysiologic situations, including horizontal ascending aorta, annular sizes that are borderline to their suitability for current device sizes, TAVI within previous bioprosthetic valves, and aortic regurgitation. The principal challenge to device delivery can be the final release of the device owing to the length of the stent. We believe that preoperative angiography and computed tomography scan is mandatory to evaluate not only the presence and location of ascending aorta calcification but also the height of the proximal anastomoses of coronary grafts in patients who have previously undergone CABG.

Our results, where only 2 patients died at 30 days, are very encouraging considering that all 25 patients were deemed not to be suitable for a transfemoral approach and, in most cases, a subclavian approach. As such, they represent a higher-risk subgroup within the TAVI patient population. The direct aortic approach also has the advantage of overcoming challenging vascular disease in the aorta, iliac, and femoral arteries, and avoids the risk of dislodging atherosclerotic plaque during valve passage through the aorta that may cause particulate embolization and subsequent stroke. None of our patients experienced a neurologic event or surgical wound infections. All patients were discharged in good condition and stable hemodynamic compensation within 2 weeks after valve implant. During the follow-up period, all patients improved their New York Heart Association functional class and capacity, and echocardiograms demonstrated good valve performance at 2 years. Our initial experience emphasized that a multidisciplinary approach is necessary to offer the safest conditions and care for patients.

Considering that the best access is the one that minimizes the risk to the procedure and offers the best recovery for the patient, TAVI by the direct aortic retrograde approach is safe and feasible in high-risk patients with symptomatic aortic stenosis and coexisting peripheral vasculopathy as well as in redo patients with patent ascending aorta coronary grafts or severe calcifications of the ascending aorta. Direct aortic deployment of TAVI may overcome the inherent shortcomings associated with the implantation of the self-expanding CoreValve aortic prosthesis and will allow us to extend the current

indications, increasing the percentage of patients eligible for TAVI. In our opinion, the direct aortic approach is a viable alternative to the standard transapical technique.

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