Transfemoral Aortic Valve Implantation of Edwards SAPIEN XT Without Predilatation Is Feasible

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ABSTRACT

Background: Transcatheter aortic valve implantation (TAVI) without predilatation has fewer procedural steps and thereby potentially fewer complications. This has been demonstrated for the antegrade transapical access; however, whether TAVI can be safely performed without predilatation using the retrograde transfemoral route is unknown.

Hypothesis: We postulated that TAVI is feasible with a balloon-expandable device without predilatation using the retrograde transfemoral route.

Methods: Twenty-six consecutive patients with stenosis of the native aortic valve (AV) undergoing transfemoral TAVI with the Edwards SAPIEN XT prosthesis without predilatation were enrolled in this retrospective study and compared with 30 patients treated previously with predilatation.

Results: The procedure was successfully performed in all 26 patients, irrespective of the AV area and the extent of AV calcification. At baseline mean AV area, mean AV gradient, and median left ventricular ejection fraction were 0.7 ± 0.2 cm^2, 36.0 ± 17.3 mm Hg, and 55.0% (interquartile range [IQR], 35.0–60.0], respectively; prior to discharge these values were 1.7 ± 0.3 ($P < 0.001$), 9.8 ± 6.1 mm Hg ($P < 0.001$), and 57.5% (IQR, 38.7–60.0) ($P =$ not significant). Postdilatation was required in 3 patients due to aortic regurgitation $>2^\circ$; this was reduced by the procedure to $<2^\circ$ in all cases. Radiation dose and amount of contrast dye were significantly reduced in comparison with the predilatation group. No periprocedural neurological adverse events occurred. Mortality at 30 days was 0%.

Conclusions: TAVI without predilatation using the transfemoral Edwards SAPIEN XT valve is feasible and safe. Larger studies are required to further evaluate this approach.

Introduction

Transcatheter aortic valve implantation (TAVI) has evolved into standard procedure for elderly patients with aortic stenosis who are at higher surgical risk. The outcome of TAVI procedures has improved dramatically in the last decade.[1,2] Nonetheless, the complication rate is still rather high. Several complications can be attributed at least in part to balloon aortic valvuloplasty, which is typically performed prior to the valve implantation, especially with the balloon-expandable transfemoral Edwards SAPIEN prosthesis (Edwards Lifesciences Corp., Irvine, CA). The balloon valvuloplasty may cause (cerebro-) vascular embolic complications by detachment of debris from the calcified leaflets.[3,4] The conduction system, located in close proximity to the left ventricular outflow tract, can also be damaged by the mechanical irritation during balloon valvuloplasty.[5] Furthermore, balloon valvuloplasty bears the potential risk of annular tears or even ruptures. Finally, valvuloplasty requires an additional period of rapid pacing, which may have detrimental effects on the often-hypertrophied left ventricle. Therefore, it would be attractive to omit the balloon valvuloplasty prior to implantation of the balloon-expandable Edwards SAPIEN prosthesis in order to mitigate the inherent risk and further simplify the procedure. This method has been proposed for the self-expanding Medtronic (Minneapolis, MN) CoreValve prosthesis with promising data.[6] Likewise, it has been described for the transapical

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approach using the balloon-expandable Edwards SAPIEN valve.[7,8] The latter is also commonly used in a transfemoral delivery system. However, for the Edwards SAPIEN system, the transfemoral approach has been deemed to be unsuitable for a direct valve implantation without prior balloon valvuloplasty, due to concerns that the calcified native valve cannot be crossed in a retrograde manner. The purpose of the present study was therefore to evaluate the feasibility and safety of transfemoral implantation of an Edwards SAPIEN XT prosthesis without predilatation under real-life clinical conditions with an unselected all-comers patient cohort.

Methods

Patients

Patients were screened for suitability of TAVI with transthoracic and transesophageal echocardiography, coronary angiography, and multislice computed tomography of the aortic valve (AV) and aorta. Patient demographics, symptoms, and comorbidities were documented, and individual risk stratification was accomplished by calculating the logistic Euroscore and the Society of Thoracic Surgeons Predicted Risk of Mortality. The inclusion and exclusion criteria for this study are based on the guidelines of the European Society of Cardiology on valvular heart disease.[9] Furthermore, patients were excluded if the distance of the annular plane to the coronary ostia was below 8 mm or the annulus diameter was more than 27 mm. Apart from these contraindications, all patients within a prespecified 10-week period were consecutively enrolled to avoid selection bias. In addition, procedural and outcome data were compared with results from 30 patients treated in the comparable 10-week period before the enrollment of the non-predilatation group with a classical approach (eg, balloon valvuloplasty prior to valve implantation). The study was performed in accordance with the Helsinki Declaration.

Multislice Computed Tomography

Multislice computed tomography examinations were performed with a 64-slice dual source scanner (Siemens Medical Solutions, Erlangen, Germany). For the acquisition of contrast-enhanced scans Solutrast 370 (Iopamidol, 370 mg iodine/mL; Bracco Imaging Deutschland GmbH, Konstanz, Germany) was administered intravenously into an antecubital vein using 80 to 120 mL at 4 mL/s depending on body weight, scan time, and renal function, followed by a bolus of 50 mL isotonic saline at 4 mL/s. Scan acquisition and exposure parameters were as follows: pitch 0.2, rotation time 0.33 ms, tube current 120 kV with effective 320 to 400 mAs. Scan timing was coordinated by peak enhancement detection with the region of interest placed in the ascending aorta with a threshold of 120 Houndsfield units.

For reconstruction, a cardiac-gated B26f (smooth advanced) algorithm with slice thickness of 0.6 mm was used. Systole was identified according to maximum opening of the AV, which was between 30% and 40% in most cases, and diastole was determined at between the 70% and 80% phase of the cardiac cycle.

TAVI Procedure

The implantation of the valve was performed using standard methods with the exception of omitting the balloon valvuloplasty before advancing the Edwards SAPIEN XT prosthesis in the non-predilatation group. In brief, arterial sheathes (6 F) were bilaterally inserted. On 1 site the sheath was exchanged to the Edwards eSheath after insertion of a ProStar preclosure system (Abbott Laboratories, Green Oaks, IL). Retrograde crossing of the AV was accomplished by means of an Amplatz left catheter (Merit Medical OEM, South Jordan, UT) and a hydrophilic straight wire. The wire was exchanged for an Amplatz super-stiff wire, which was then used for the AV implantation. An angulation with a perpendicular view on the native aortic annulus was established using Dyna CT. In the predilatation group, the balloon valvuloplasty was performed using the standard techniques with the Edwards balloon. In both groups, the Edwards SAPIEN XT delivery system was then advanced to the descending aorta, and the final loading steps were performed with retraction of the balloon under the prosthesis. The aortic arch was crossed using the flexing tool of the delivery system. In the next step, the native valve was carefully crossed with the SAPIEN XT prosthesis, which was placed at the annular level. The pusher was then slowly removed, thereby taking care that the valve remained stable in the desired position. The final implantation of the valve was performed under a short period of rapid ventricular pacing by means of a transvenous pacing lead (200/min). During this period, a small amount of contrast dye was injected in the aortic root to facilitate positioning. The balloon was inflated slowly to allow minimal adjustment of the valve's position.

After implantation of the valve, its position and performance were assessed using transesophageal echocardiography and angiography with a root injection. In cases where aortic regurgitation $>1^{\circ}$ was observed, postballooning was performed.

Statistical Analysis

Continuous variables were assessed for normality by the Shapiro-Wilks test and accordingly were expressed as means $\pm$ standard deviation or as medians and interquartile range (IQR); categorical data were presented as values and percentages. Comparison of continuous data was achieved by using the Mann-Whitney signed rank test for paired data and the Mann-Whitney U test for unpaired data. For categorical data, the 2-sided Fisher exact test was applied. Correlation between discrete variables was assessed with a Pearson correlation coefficient. All statistical data were analyzed with SPSS version 18.0 (SPSS Inc., Chicago, IL).

Results

Patient Characteristics and Procedural Results

Patient baseline characteristics for both groups are summarized in Table 1. The procedure was successfully performed in all 26 patients with implantation of three 23-mm, fifteen 26-mm, and eight 29-mm SAPIEN XT valves.

Following the insertion of an extra-stiff wire into the left ventricle, the passage of the valve prosthesis through

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Table 1. Baseline Characteristics Including Comparison Between BAV vs Non-BAV Groups

Characteristics	All Patients, n = 56	Non-BAV, n = 26	BAV, n = 30	*P* Value
Age, y	81.9 ± 5.9	81.6 ± 6.5	82.2 ± 5.4	NS
Female gender	28 (50.0%)	11 (42.3%)	13 (43.3%)	NS
Logistic Euroscore, %	22.9 ± 11.1	24.6 ± 8.7	21.4 ± 12.1	NS
STS PROM, %	6.0 ± 2.9	5.8 ± 2.7	6.2 ± 3.1	NS
BMI	28.2 ± 4.7	28.6 ± 4.8	27.9 ± 4.6	NS
EF, % [IQR]	60.0 [46.3–63.8]	55.0 [35.0–60.0]	60.0 [53.8–65.0]	0.01
Pmean, mm Hg	42.8 ± 17.8	36.0 ± 17.3	48.5 ± 17.7	0.01
AVA, cm^2	0.7 ± 0.2	0.7 ± 0.2	0.6 ± 0.2	NS
GFR, mL/min	61.4 ± 23.7	58.7 ± 19.3	63.8 ± 26.9	NS
NYHA class 3 and 4	51 (91.1%)	23 (88.5%)	28 (93.3%)	NS
Hypertension	54 (96.4%)	25 (96.2%)	29 (96.7%)	NS
Diabetes	23 (41.1%)	10 (38.5%)	13 (43.3%)	NS
Hyperlipidemia	28 (50.0%)	10 (38.5%)	18 (60.0%)	NS
Prior stroke	9 (16.1%)	5 (19.2%)	4 (13.3%)	NS
Prior MI	7 (12.5%)	5 (19.2%)	2 (6.7%)	NS
Atrial fibrillation	23 (41.1%)	9 (34.6%)	14 (46.7%)	NS
CAD	34 (60.7%)	16 (61.5 %)	18 (60.0%)	NS
PVD	11 (19.6%)	8 (30.8%)	3 (10.0%)	0.09
CABG	10 (17.9%)	6 (23.1%)	4 (13.3%)	NS
COPD	10 (17.9%)	6 (23.1%)	4 (13.3%)	NS
Annulus	24.3 ± 1.8	24.6 ± 1.9	24.2 ± 1.8	NS
Ag-score [IQR]	2523 [1564–3319]	2464 [1480–3466]	2531 [1645–3277]	NS

Abbreviations: Ag-score, calcium score of the aortic valve; Annulus, effective systolic annulus diameter measured by multislice computed tomography; AVA, aortic valve area; BAV, balloon valvuloplasty; BMI, body mass index; CABG, coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; EF, ejection fraction; GFR, glomerular filtration rate; IQR, interquartile range; MI, myocardial infarction; NS, not significant; NYHA, New York Heart Association; Pmean, mean transvalvular gradient; PVD, peripheral vascular disease; STS PROM, Society of Thoracic Surgeons Score for Prediction of Mortality.

the AV was feasible without a remarkable increase in friction in all patients in the group without prior dilatation. This was completely independent of baseline AV area or extent of valve calcification as measured by the Agatston score.

The valve prosthesis was positioned within the aortic annulus, and a sufficient distance to coronary artery ostia was confirmed by aortic root angiography. During this potentially critical step, none of the patients developed any type of hemodynamic compromise. Valve deployment was uneventful in all patients thereafter, and final echocardiography and angiography demonstrated no incidence of malpositioning or coronary artery obstruction.

Postdilatation was required in 3 cases due to aortic regurgitation of $>2^{\circ}$. Postprocedurally, 13 patients had none or trace aortic regurgitation, 12 had 1°, and 1 patient had 2°.

At baseline, mean AV area, mean AV gradient, and median left ventricular ejection fraction were $0.7 \pm 0.2\,cm^2$ (range, 0.4–1.0), 36.0 ± 17.3 mm Hg, and 55.0% (IQR, 35.0–60.0], respectively; echocardiography prior to discharge yielded the following values for these parameters: $1.7 \pm 0.3\,cm^2$ ($P < 0.001$), 9.8 ± 6.1 mm Hg ($P < 0.001$), and 57.5% (IQR, 38.7–60.0) ($P =$ not significant).

Periprocedural complications according to the Valve Academic Research Consortium-2 criteria occurred in 6/26 (23.1%) cases. Two patients (7.6%) required new-onset pacemaker implantation due to third-degree atrioventricular block, and another 2 patients had major vascular complications. One patient developed pericardial tamponade (perforation of the venous pacemaker lead) and was punctured immediately with favorable outcome. Acute renal failure was observed in 1 patient who completely recovered with conservative treatment. Importantly, adverse neurological events occurred in none of the patients during the postoperative period until discharge. All patients were alive at the 30-day follow-up.

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Table 2. Correlation Between Aortic Valve Area or Calcification of the Aortic Valve and Procedural Parameters in the Study Population (Non-BAV, n = 26)

	R	*P* Value
AVA, procedural duration	0.02	NS
AVA, fluoroscopy time	0.13	NS
AVA, radiation dose	0.13	NS
AVA, contrast agent	0.10	NS
Ag-score, procedural duration	0.03	NS
Ag-score, fluoroscopy time	0.02	NS
Ag-score, radiation dose	0.11	NS
Ag-score, contrast agent	0.01	NS

Abbreviations: Ag-score, calcium score of the aortic valve; AVA, aortic valve area; BAV, balloon valvuloplasty.

There was no correlation between the area or extent of calcification of the AV and duration of the procedure, fluoroscopy time, radiation dose, or amount of contrast agent used (Table 2).

Comparison of Procedural Data

Additionally, a comparison of procedural data was made between the study population (non-balloon valvuloplasty [BAV]) and 30 consecutive patients who recently underwent transfemoral TAVI with preballooning prior to implantation of the Edwards SAPIEN XT prosthesis (BAV). The non-BAV group had a shorter median duration of the procedure, a difference that was of borderline significance (38.0 minutes [IQR, 28.0–55.75] vs 45.5 minutes [IQR, 36.3–65.8]; $P = 0.09$), an insignificantly decreased fluoroscopy time (9.2 minutes [IQR, 6.8–11.9] vs 10.4 minutes [IQR, 7.9–15.2]; $P = 0.17$), a reduced radiation dose (42.0 Gy cm^2 [IQR, 31.6–61.7] vs 56.6 Gy cm^2 [IQR, 34.9–112.5]; $P = 0.03$), and a lower amount of contrast agent administered (92.2 ± 20.5 mL vs 112 ± 31.0 mL; $P = 0.006$) as compared with the BAV group. The need for postdilatation and the rate of significant aortic regurgitation were not different between the groups (Table 3).

Discussion

Balloon aortic valvuloplasty is typically performed prior to implantation of transcatheter valves to facilitate the passage of the stenotic native valve with the device. However, balloon valvuloplasty is associated with some inherent risks, which could be reduced if this step were to be safely omitted. It has been shown that balloon valvuloplasty is unnecessary when using the antegrade transapical access with the balloon-expandable Edwards SAPIEN prosthesis[7] or when using the retrograde transfemoral approach using the self-expanding Medtronic CoreValve prosthesis.[2] The retrograde approach has thus far been deemed unsuitable for implantation of an Edwards SAPIEN XT valve without predilatation due to the concern about the ability to cross the stenotic native valve. A recent report, however, proposed that balloon valvuloplasty may be omitted in highly selected patients (low degree of calcification, symmetrical calcification, presence of preinterventional aortic regurgitation).[10]

In this study, we demonstrated the feasibility and safety of a retrograde transfemoral implantation of the balloon-expandable Edwards SAPIEN XT prosthesis independent of anatomic selection criteria on an all-comers basis. In particular, the critical step of crossing the stenotic AV with the crimped device and the positioning within the annulus did not result in any dislocation of the device or hemodynamic compromise. This suggests that the profile of the crimped device is low enough to ensure a sufficient blood flow into the systemic circulation. Of note, all of the procedures in our study were successful irrespective of the extent of AV calcification and AV area (Table 2), including valves with minimal areas of 0.4 cm^2, indicating the feasibility even in cases of critical aortic stenosis.

This approach may help to improve the intervention by reducing (1) the overall intervention time, (2) the need for radiation, (3) the risk of embolic complications such as stroke, (4) the risk of annular complications, (5) the need

Table 3. Procedural Data

	All Patients, n = 56	Non-BAV, n = 26	BAV, n = 30	*P* Value
Procedural duration, min [IQR]	41.0 [31.5–57.5]	38.0 [28.0–55.75]	45.5 [36.3–65.8]	0.09
Fluoroscopy time, min [IQR]	9.5 [7.2–12.7]	9.2 [6.8–11.9]	10.4 [7.9–15.2]	0.2
Radiation dose, Gy cm², [IQR]	47.7 [32.9–75.6]	42.0 [31.6–61.7]	56.6 [34.9–112.5]	0.03
Contrast agent, mL	102.9 ± 28.3	92.2 ± 20.5	112 ± 31.0	0.006
Predischarge EF, % [IQR]	60.0 [50.0–65.0]	57.5 [38.7–60.0]	62.0 [58.8–65.0]	0.002
Predischarge AVA, cm²	1.7 ± 0.3	1.7 ± 0.3	1.8 ± 0.4	NS
Predischarge Pmean, mm Hg	9.5 ± 3.5	9.8 ± 6.1	9.4 ± 3.5	NS
Postprocedural AR >2	0	0	0	NS
Postdilatation	6 (10.7%)	3 (11.5%)	3 (10.0%)	NS

Abbreviations: AR, aortic regurgitation; AVA, aortic valve area; BAV, balloon valvuloplasty; EF, ejection fraction; IQR, interquartile range; Pmean, mean transvalvular gradient.

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for periods of rapid ventricular pacing, and (6) the risk of conduction disorders.

We compared the intervention time and applied radiation doses of patients in our study with these parameters in patients who had been treated previously using the traditional balloon valvuloplasty technique. Although a proper statistical analysis cannot be performed given the nonrandomized character and low patient numbers, the data at least suggest that the theoretical considerations of reduced procedure time and radiation dose are valid. Likewise, the reduced 30-day mortality in the non-balloon valvuloplasty group may well be a coincidental finding (0% vs 10%). Nonetheless, this result is at least reassuring.

The absence of periprocedural strokes with the simplified technique presented here is also very promising. However, due to the small number of patients in our study, it does not allow us to speculate on whether TAVI without prior balloon valvuloplasty is additionally protective. This presumably beneficial effect needs to be investigated in an adequately sized trial.

Embolic or annular complications have often been described as inherent risks associated with cardiac interventions at the AV.[11] Although the rate of neurological events has already been significantly reduced by means of minimizing the rapid pacing-induced no-output periods,[12] the additional complete omission of a mechanical irritation of the calcified leaflets will definitely help to further reduce these potentially catastrophic complications. The same applies for the rare but deleterious complication of an annular rupture secondary to balloon valvuloplasty.

The justified concern that the stenotic and sometimes heavily calcified native valve cannot be crossed safely with the Edwards SAPIEN prosthesis certainly has to be taken into account. Once the SAPIEN prosthesis has left the sheath within the patient's body, it can no longer be retrieved. We therefore developed a bailout measure that would have been applied if we had encountered difficulties while crossing the native valve; we would have exchanged the 6 F arterial sheath on the contralateral groin for a 12 F sheath. In the next step, retrograde crossing of the AV would have been accomplished with a second wire, which then would be exchanged for a super-stiff wire. The balloon valvuloplasty would then have been performed using this second wire from the contralateral side. This approach, however, was not tested in our study as we did not experience any problems in crossing the native valve.

Conclusion

Our study demonstrates the safety and feasibility of a simplified implantation technique for the balloon-expandable SAPIEN XT prosthesis without prior balloon valvuloplasty. The omission of the balloon aortic valvuloplasty may contribute to an increased safety of the TAVI procedure due to shorter intervention time, reduced radiation dose, and the absence of a balloon valvuloplasty-inherent risk of complications.

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