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Contemporary surgical or percutaneous management of severe aortic stenosis in the elderly

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Aims To assess patient characteristics, therapeutic options, and their results in patients referred to a tertiary centre with on-site capabilities for surgical and percutaneous valvular interventions for the management of severe symptomatic aortic stenosis (AS).

Methods and results Sixty-six consecutive patients >70 years (83 ± 6 years) were referred for severe AS. Their mortality risk predicted by the logistic European System for Cardiac Operative Risk Evaluation and the Society of Thoracic Surgeons-Predicted Risk of Mortality scores were on average 20 ± 14% and 17 ± 7%, respectively. Thirty-nine patients (59%) were considered at high-risk for surgery or inoperable after multidisciplinary evaluation: 12 (31%) underwent a transfemoral aortic valve implantation and 27 were considered unsuitable and treated medically ($n = 16$) or with valvuloplasty ($n = 7$), or were re-directed towards surgery ($n = 4$). The 27 other patients underwent valve replacement. In-hospital mortality was 9% (6 of 66). There were three hospital deaths in patients treated percutaneously, two in those treated medically, and one after surgery. At 6 months, 10% (6 of 60) of the survivors died: two after valvuloplasty and four after medical treatment.

Conclusion A large proportion of elderly patients referred for management of severe AS have a high-risk profile. The availability of percutaneous valvular interventions increases the number of those who are offered interventions.

Keywords Aortic stenosis • Valve replacement • Percutaneous valve implantation • Risk evaluation • Elderly

Introduction

Surgical aortic valve replacement (AVR) is the only effective therapy for severe symptomatic aortic stenosis (AS). However, because of age and the presence of comorbidities, a large proportion of patients who are operated on have a high surgical risk, and many others are not even referred for surgery.[1,2] For the last few years, a percutaneous aortic valve implantation (AVI) technique has been in development.[3–9] However, the feasibility, indications, and outcomes of this technique with respect to surgery are not yet established and are currently being evaluated. Thus, the aim of this prospective study was to assess patient characteristics, therapeutic options, and their results in patients referred to a tertiary centre with on-site capabilities for the surgical and percutaneous valvular interventions for the management of severe AS.

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Methods

Patients

From October 2006 to April 2007, 66 consecutive patients >70 years were referred to the cardiology department for the management of severe symptomatic AS. Preoperative screening included clinical evaluation, transthoracic echocardiography, coronary, and femoro-iliac angiography. Later, a team of cardiologists, cardiac surgeons, and anaesthesiologists evaluated the risk profile of the patients on the basis of these evaluations combined with the use of the logistic European System for Cardiac Operative Risk Evaluation (EuroSCORE) and the Society of Thoracic Surgeons Predicted Risk of Mortality (STS-PROM) scores.

Patients with high-risk features or contraindications for surgery were considered for percutaneous AVI (PAVI). Patients retained were included in the multicentric international REVIVE (Registry of EndoVascular Implantation of Valves in Europe) trial. *Table 1* lists the high-risk criteria necessary to include patients in the study. The main contraindications for PAVI were: (i) left main stenosis ≥70%, as assessed by coronary angiogram; (ii) aortic annulus diameter <18 mm or >25 mm, as measured from the echocardiographic parasternal long-axis view at the level of the leaflet attachment; (iii) iliofemoral disease or diameters <8 or 9 mm, according to the diameter of the sheath (22 or 24F), as obtained by conventional angiography and computed tomography; (iv) any condition that made the quality or duration of life unlikely, despite AVR. With the presence of contraindications to PAVI, patients were considered for medical management, or balloon aortic valvuloplasty (BAV), or re-considered for AVR.

Patients without high-risk features underwent conventional AVR.

Percutaneous aortic valve implantation

Procedures were performed in a catheterization laboratory, by the retrograde femoral approach, under general anaesthetic, with fluoroscopic and transoesophageal echocardiographic guidance. Arterial femoral access was obtained percutaneously. The technical aspects of prosthetic valve implantation have been published previously.[3–7] A percutaneous sheath (22F or 24F) was carefully inserted in the femoral artery. After retrograde crossing of the aortic valve and predilation with conventional BAV, the balloon-mounted valve (Edwards-Sapien, Edwards Lifesciences Inc., Irvine, CA, USA) was passed through the aorta and positioned within the native aortic annulus. Transient partial standstill was induced with right ventricular burst pacing to minimize transvalvular flow. The delivery balloon was inflated to expand and the valved stent was implanted. The femoral access site was closed surgically.

Table 1 Inclusion criteria for percutaneous aortic valve implantation using the retrograde femoral approach in the REVIVE (Registry of EndoVascular Implantation of Valves in Europe) study

Age >70 years
Severe aortic stenosis from degenerative origin
Symptomatic
Valve area <0.7 cm^2
Surgical mortality predicted by the logistic EuroSCORE >20%
Alternative criteria
Porcelain aorta
Radiation of the sternum or chest deformities precluding an open chest surgery
Severe chronic obstructive pulmonary disease
Patients referred for surgery and rejected by the surgeon
Adequate diameters
Aortic annulus >18 mm and ≤25 mm
Femoro-iliac axes >8 mm or 9 mm

Aortic valve replacement

The operation was performed conventionally, through sternotomy with extracorporeal circulation. Bioprosthesis was the preferred valve substitute. Combined coronary artery bypass grafting (CABG) was done when necessary.

In-hospital follow-up

Clinical follow-up and transthoracic echocardiograms were obtained before discharge. All adverse events were prospectively recorded.

Six-month follow-up

Clinical follow-up was obtained at 6 months in all hospital survivors ($n = 60$) by medical visits or phone calls.

Statistical analysis

Data were expressed as mean ± SD. The non-parametric Kruskal–Wallis test was used to compare continuous variables from the three groups (PAVI, contraindication to PAVI, AVR) and categorical variables were compared by the Fisher exact test. Predicted mortality rates using surgical mortality risk scores (EuroSCORE and STS-PROM) were compared using the Wilcoxon test and the Spearman correlation. A *P*-value <0.05 was considered to indicate a statistically significant difference. Statistical analysis was performed using statistical software Statistica version 5.0, Statsoft Inc., Tulsa, OK, USA.

Results

Patients

The population studied consisted of 66 consecutive patients >70 years who were referred for management of severe symptomatic AS. Mean age was 83 ± 6 years (range: 71–96 years). Most of the patients were in NYHA class III or IV (78%). Thirty-seven patients (56%) had ≥2 comorbidities.

Multidisciplinary consensus considered that 59% (39/66) of the cohort were at high-risk. All of them had a mortality predicted by the logistic EuroSCORE >20%, in accordance to the protocol, or had a contraindication to surgery. Main differences in baseline clinical and haemodynamic characteristics between groups are detailed in *Tables 2 and 3*. The study flow is shown in *Figure 1*. All the patients with low-risk features (27/66) underwent AVR. Of the 39 patients with high-risk features, 12 were proposed for PAVI, while the rest 27 presented a contraindication to it. Overall predicted surgical mortality tended to be higher using the logistic EuroSCORE than the STS-PROM (respectively, 20 ± 14 vs. 17 ± 7%; $P = 0.08$). There was a good correlation between EuroSCORE and STS-PROM scores ($r = 0.78$, $P < 0.0001$; *Figure 2*). In the high-risk group, the variability of scores increased, and the mortality predicted by the logistic EuroSCORE was significantly higher than the one predicted by the STS-PROM.

Table 2 Baseline clinical characteristics of 66 patients >70 years with severe aortic stenosis

	PAVI (*n* = 12)	Contraindication to PAVI (*n* = 27)	AVR (*n* = 27)	Overall (*n* = 66)	*P*
Age (years, mean ± SD)	85 ± 6	84 ± 7	81 ± 5	83 ± 6	0.03
70–80	2 (17)	8(30)	11 (41)	21 (32)	
80–90	7 (58)	13 (48)	14 (52)	34 (51)	
>90	3 (25)	6 (22)	2 (7)	11 (17)	
Female sex	4 (33)	11 (41)	13 (48)	28 (42)	0.85
NYHA class					
I	0	0	3 (11)	3 (4)	0.21
II	0	3 (11)	8 (30)	12 (18)	0.06
III	3 (25)	20 (74)	9 (33)	32 (48)	0.002
IV	9 (75)	4 (15)	7 (26)	20 (30)	0.001
Diabetes	1 (8)	7 (26)	7 (26)	15 (22)	0.5
Coronary artery disease	4 (33)	18/20 (90)[a]	17 (63)	39/59 (66)	0.02
Previous MI	0 (0)	5 (18)	1 (4)	6 (9)	
Previous PCI	2 (17)	5 (19)	6 (22)	13 (20)	
Previous CABG	3 (25)	9 (33)	2 (7)	14 (21)	
Previous stroke/TIA	1 (8)	7 (26)	2 (7)	9 (14)	0.26
Renal failure	1 (8)	17 (63)	5 (19)	23(35)	<0.001
Severe COPD	3 (25)	5 (18)	3 (10)	11 (17)	0.47
Previous cancer	5 (42)	3 (11)	6 (20)	14 (20)	0.8
Porcelain aorta	1 (8)	2 (7)	0 (0)	3 (5)	0.4
Other severe comorbidities	4 (33)	5 (18)	7 (26)	16 (24)	0.47
≥2 comorbidities	6 (50)	18 (67)	13 (48)	37 (56)	0.39
Logistic EuroSCORE (%)[b]					
Mean ± SD	31.1 ± 14.4	24.0 ± 13.8	10.4 ± 4.8	19.7 ± 13.7	<0.0001
Range	15–59	5–50	4–21	4–59	
STS-PROM (%)[b]					
Mean ± SD	18.8 ± 4.3*	20.3 ± 8.7*	12.1 ± 4.2	16.5 ± 7.3	<0.0001
Range	13–26	6–36	5–27	5–36	

Values are expressed as *n* (%) unless otherwise stated. AVR, aortic valve replacement; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; MI, myocardial infarction; NYHA, New York Heart Association; PAVI, percutaneous aortic valve implantation; TIA, transient ischaemic attack; PCI, percutaneous coronary intervention; SD, standard deviation; STS-PROM, Society of Thoracic Surgeons Predicted Risk of Mortality.
[a]Coronary status was known in 20 of 27 patients.
[b]Predicted 30-day surgical mortality.
*$P < 0.05$ compared with EuroSCORE.

Table 3 Baseline haemodynamic and echocardiographic characteristics in 66 patients >70 years with severe aortic stenosis

	PAVI (*n* = 12)	Contraindication to PAVI (*n* = 27)	AVR (*n* = 27)	Overall (*n* = 66)	*P*
Aortic valve area (mean ± SD)					
cm^2	0.5 ± 0.1	0.6 ± 0.2	0.7 ± 0.2	0.6 ± 0.2	0.2
cm^2/m^2	0.3 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.01
Mean gradient (mmHg, mean ± SD)	50 ± 19	46 ± 12	48 ± 13	47 ± 14	0.8
LVEF (%, mean ± SD)	47 ± 16	50 ± 13	56 ± 16	52 ± 15	0.07
≥50%	7 (58)	14 (52)	20 (75)	41 (62)	
30–50%	2 (17)	11 (41)	5 (18)	18 (27)	
≤30%	3 (25)	2 (7)	2 (7)	7 (11)	
Pulmonary hypertension ≥ 60 mmHg	4 (33)	2 (7)	0 (0)	6 (9)	0.03

Values are expressed as *n* (%) unless otherwise stated.
AVR, aortic valve replacement; PAVI, percutaneous aortic valve implantation; LVEF, left ventricular ejection fraction; SD, standard deviation.

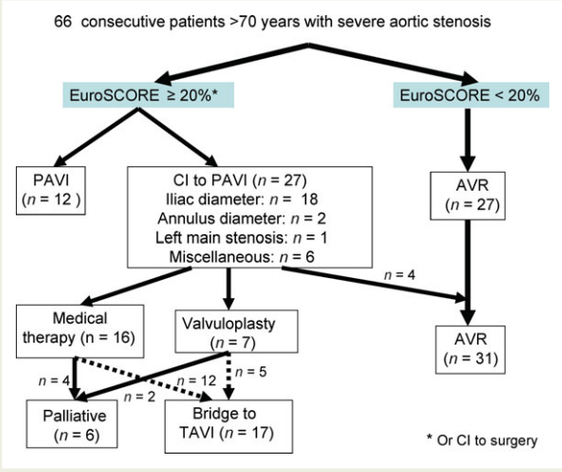

Figure 1 Flow chart of 66 consecutive patients >70 years referred for treatment of severe symptomatic aortic stenosis. AVR, aortic valve replacement; CI, contraindication; PAVI, percutaneous aortic valve implantation; TAVI, transventricular aortic valve implantation.

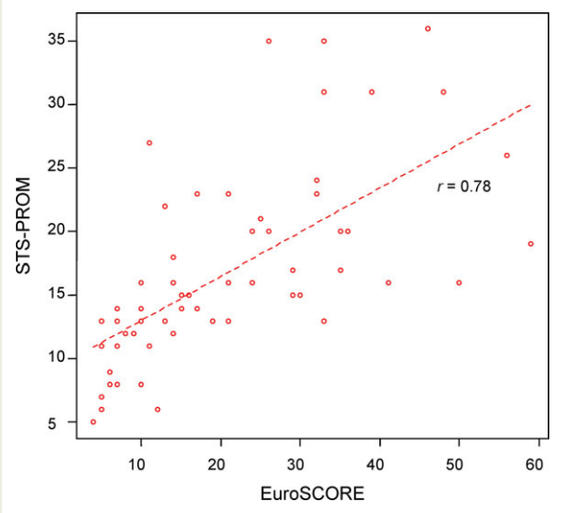

Figure 2 Correlations between the European System for Cardiac Operative Risk Evaluation (EuroSCORE) and the Society of Thoracic Surgeons-Predicted Risk of Mortality (STS-PROM) scores in 66 patients >70 years referred for treatment of severe symptomatic aortic stenosis. *r* denotes Spearman coefficient correlation.

Outcome after percutaneous aortic valve implantation

The valve was implanted in the correct position in 10 patients (83%). Valve implantation was not successful in two patients. Reasons for failure included inability to pass iliac artery and hemopericardium in one patient because of perforation of the left ventricle by the wire, leading to intraprocedural death in a 94-year-old woman. In another case, a rescue 'prosthesis-in-prosthesis' implantation was needed for haemodynamic compromise because of severe intravalvular leak after placement of the first prosthesis. Otherwise, a grade 3 paravalvular leak was noted in one patient, with no immediate haemodynamic consequence. All other patients had no, or ≤grade 2 aortic regurgitation. Outcome events are listed in *Table 4*. Two patients suffered iliac injury requiring vascular grafting. There were two post-procedural deaths: one occurred 4 days after the procedure and was the consequence of major vascular surgery after iliac injury, the other occurred 24 h after the procedure in an 85-year-old man with the highest EuroSCORE among the series (59%), but remained unexplained.

Table 4 Hospital outcomes after percutaneous aortic valve implantation in 12 high-risk patients

Characteristics	*n* (%)
Successful valve implantation	10 (83)
Femoral approach	
Percutaneous	11 (92)
Surgical exposure	1 (8)
Aortic valve area (mean ± SD)	
cm^2	1.7 ± 0.5
cm^2/m^2	0.9 ± 0.3
Mean gradient (mmHg, mean ± SD)	11 ± 3
Paravalvular AR	
Grade 0–I	6 (60)
Grade II	3 (30)
Grade III	1 (10)
Major vascular complications	2 (17)
Stroke	0
Myocardial infarction	0
Tamponade	1 (8)
Heart block	1 (8)
Emergent cardiac surgery	0
Transfusion	2 (17)
Procedure duration (h, mean ± SD)	2.9 ± 1.2
In-hospital death	3 (25)
Per-procedure	1 (8)
After procedure	2 (17)
Duration of hospital stay (days, mean ± SD)[a]	17 ± 8

Values are expressed as *n* (%) unless otherwise stated. AR, aortic regurgitation; SD, standard deviation.
[a]From procedure to discharge.

Outcome in patients with contraindications to percutaneous aortic valve implantation

The 27 patients with both a high surgical risk and contraindications to PAVI were divided into three groups (*Figure 1*). (i) Sixteen patients (59%) were treated medically. In 12 cases, medical

Table 5 Hospital outcomes after aortic valve replacement in 31 patients

Characteristics	Low-risk patients ($n = 27$)	High-risk patients ($n = 4$)	Overall ($n = 31$)
Prosthesis			
Bioprosthesis	26 (96)	4 (100)	30 (97)
Mechanical	1 (4)	0	1 (3)
Aortic valve replacement			
+ CABG	9 (33)	2 (50)	11 (35)
+ Mitral valve replacement	1 (4)	0	1 (3)
Myocardial infarction	0	0	0
Cerebral ischaemic event	0	0	0
Heart block	3 (11)	1 (25)	4 (13)
Tamponade	2 (7)	0	2 (6)
Mediastinitis	0	0	0
In-hospital death	1 (4)	0	1 (3)
Duration of hospital stay (mean ± SD)[a]	15 ± 6	22 ± 6*	16 ± 7

Values are expressed as *n* (%) unless otherwise stated. CABG, coronary artery bypass grafting.
[a]From procedure to discharge.
*$P = 0.04$.

Table 6 Six-month outcomes in 60 hospital survivors after treatment of severe aortic stenosis by percutaneous aortic valve implantation, balloon aortic valvuloplasty, medical therapy, or surgical aortic valve replacement

	PAVI ($n = 9$)	BAV ($n = 7$)	Medical therapy ($n = 14$)	AVR ($n = 30$)
Death	0	2 (29)	4 (29)	0
Hospitalization				
CHF	2 (22)	1 (14)	5 (36)	2 (7)
Other cause	3 (33)	0	1 (7)	7 (23)
NYHA class				
I	2 (22)	0	0	12 (40)
II	5 (56)	2 (40)	2 (20)	14 (47)
III	2 (22)	1 (20)	7 (70)	3 (10)
IV	0	2 (40)	1 (10)	1 (3)

Values are expressed as *n* (%) unless otherwise stated. PAVI, percutaneous aortic valve implantation; AVR, aortic valve replacement; BAV, balloon aortic valvuloplasty; CHF, congestive heart failure; NYHA, New York Heart Association.

treatment was applied to patients with stable haemodynamic condition, in view of future AVI using the transventricular approach. One patient refused the percutaneous intervention and died in-hospital. Three other patients were considered too frail to undergo any invasive procedure; one of them died in-hospital. (ii) Seven patients (26%) were treated with BAV because of immediate haemodynamic compromise, as a bridge to transventricular AVI (TAVI) in five patients, and symptomatic treatment in two patients. The aortic valve area (AVA) increased from 0.6 ± 0.1 cm^2 before, to 0.8 ± 0.1 cm^2 after BAV, the mean gradient decreased from 44 ± 6 to 26 ± 3 mmHg and the pulmonary artery systolic pressure from 56 ± 3 to 38 ± 7 mmHg. There were neither major non-fatal complications nor in-hospital deaths in this group. (iii) Four patients (15%) were redirected towards AVR, because the surgical risk was considered high, but not prohibitive. Two of them had severe coronary heart disease and underwent a combined CABG. All patients had an uneventful recovery.

Outcome after aortic valve replacement

Thirty-one patients underwent AVR (27 patients with low-risk features, and four with high-risk features). Only one mechanical prosthesis was implanted in a 72-year-old patient, on his request. Eleven patients (35%) had a combined CABG and one patient (4%) also necessitated a mitral valve replacement. In-hospital outcome is detailed in *Table 5*. There was one post-operative death (3%).

Six-month outcomes

Outcomes at 6 months are shown in *Table 6*. There were no deaths in patients treated by AVR or PAVI. Twenty-nine percent of the patients died after medical treatment (2/7) or BAV (4/14). In survivors, 78% (7/9) of the patients treated by PAVI and 87% (26/30) of those treated by AVR were in NYHA classes I or II, while 60% (3/5) of the patients treated by BAV and 80% (9/10) of those treated medically remained in classes III or IV.

Discussion

To our knowledge, this is the first prospective study detailing the clinical characteristics and management of elderly patients referred for severe and symptomatic AS in a centre with on-site capabilities for cardiac surgery and percutaneous valve interventions. Our study indicates that a large proportion of these patients have high-risk features, and that a tailored treatment strategy using PAVI or surgical AVR may increase the number of those who can receive an effective treatment.

There are no explicit restrictions for AVR related to age itself according to guidelines on treatment of severe symptomatic AS.[10,11] However, comorbidities are frequent in the elderly with AS, and decision-making for intervention is often difficult in old patients in whom it may not be obvious whether the benefit of surgery, when compared with spontaneous outcome, outweighs the risk of intervention. The decision should also take into account the patient's life expectancy and quality of life regardless of AS.[10–13] This analysis is particularly difficult in the elderly given the heterogeneity of operative risk and spontaneous prognosis.

High-risk features in elderly patients with severe aortic stenosis

Recent surgical registries consistently observed that overall mortality after AVR is low, around 3%.[1] However, they also showed that the risk is doubled if AVR is combined with CABG.[14] Moreover, in the Euro Heart Survey, the risk increased up to 25% in a large subset of patients, and 32% of patients with severe, symptomatic single valve disease were not referred for intervention.[1] Thus, the question of the accurate risk evaluation for AVR is essential to select the best strategy. Several variables have been isolated as independent predictors of early mortality after AVR and have been included in various predictive risk scores, most important of which are the EuroSCORE, the STS-PROM, and the Ambler's score.[15] All of these scores suffer limitations. However, they are helpful and should be routinely used as an adjunct to multidisciplinary clinical evaluation. A recent study by Dewey *et al.*[16] suggested that the EuroSCORE overestimated the mortality and that the STS-PROM was the most reliable model for identifying the highest risk patients. The present series confirms the overall expected high risk of mortality in this aged population. It also shows that the mortality risks predicted by the logistic EuroSCORE and STS-PROM scores are closer in low-risk than in high-risk groups, with a trend towards a higher predicted mortality with the EuroSCORE.

Among elderly patients referred for AVR in our study, more than 50% were considered at high-risk. This large proportion probably reflects a selection bias towards a high-risk population, as patients were specifically referred to an institution offering comprehensive resources for surgical and percutaneous valvular interventions, and may not be generalized to the population more usually referred for AVR.

Therapeutic options in patients with high-risk features and severe aortic stenosis

Percutaneous aortic valve implantation

Since the first French feasibility studies, two different prostheses have been used: the Edwards-Sapien balloon-expandable prosthesis and the CoreValve (CoreValve Inc., Irvine, CA, USA) self-expandable prosthesis.[3,4,8,9] In parallel, a minimally invasive TAVI has been developed to overcome the limitations inherent to the retrograde approach. Preliminary data are encouraging.[17–19]

The present study confirms the excellent haemodynamic performances of the balloon-expandable prosthesis. However, post-implantation aortic regurgitation occurred in nearly half of the patients. Although it was rarely more than mild and had no significant haemodynamic consequences, it remains a cause for concern. Despite the good immediate haemodynamic results of the prosthesis, early mortality was high in this group (3/12). This may reflect the severe risk profile of the patients, and may also be related to the learning curve demonstrated by Webb.[7] This also underlines the necessity to improve the evaluation and the selection of patients. Improvements in patient selection, technique, and equipment will improve clinical outcomes of PAVI in the future. However, there were no late deaths, and improvement in functional condition was observed in 78% of the patients.

Among the large proportion (59%) of the patients in the cohort who were proposed for PAVI, only one-third was actually suitable for the technique. Consistent with previous observations, the main exclusion criterion was by far related to the anatomy and the diameters of iliofemoral axes, too small or diseased to accommodate arterial sheaths. The present study took place in a transition period, as the TAVI technique was not available in our institution. Thus, patients contraindicated for anatomical reasons were postponed in the view of future transventricular approach.

Finally, despite the excellent immediate performances of the currently available prostheses, questions regarding their long-term durability remain unanswered. Thus, these transcatheter procedures cannot be recommended for younger patients who are candidates for surgical AVR.

Medical therapy

Among the 39 patients with high-risk features, only three (8%) were considered too frail to undergo either a percutaneous intervention or AVR, and were treated medically. This may be explained by the fact that patients were specifically referred to a tertiary centre for invasive management of severe AS. Thus, few of them had severe comorbidities that clearly limited their short-term life expectancy. No medical therapy has been shown to improve the prognosis of AS. However, the main purpose of treatment in this context is to improve symptoms rather than to increase the duration of life.

Balloon aortic valvuloplasty

Despite frequent functional improvement after BAV, there is only a limited and transient improvement in valve function. More importantly, BAV did not improve survival when compared with natural history. This explains why guidelines restrict BAV to situations in which it is used as a bridge for subsequent AVR, and why it has been nearly abandoned during the last decades.[1,10,11]

BAV was performed as a bridge to TAVI in five patients who were judged to be at very high risk for surgery and clinically unstable with poor immediate prognosis, as suggested by the guidelines. This option is questionable, but appeared to be the only solution to overcome the temporary inability to achieve an effective and durable treatment.[20]

Aortic valve replacement in elderly patients with severe aortic stenosis

A number of contemporary series have reported that AVR can be performed in the elderly, even in octo- and nonagenarians, with operative mortality rates of around 10%.[21,22] However, these series were likely to include selected patients. Like mortality, operative morbidity is higher than in younger patients, particularly, with regard to the frequency of stroke. Significant coronary artery disease is present in approximately half of the patients with AS after the age of 75 and requires combined CABG, which increases operative mortality. Previous studies drew attention to the considerable heterogeneity of operative risk in the elderly.

This study shows that careful clinical evaluation combined with the use of risk scoring enables an adequate selection of low-risk elderly patients who are suitable candidates for AVR, with excellent outcomes. It also points out that the team approach may

lead to reconsider surgery in some patients who were primarily considered as non-candidates for surgery. A bioprosthesis is the substitute of choice in the elderly, contributing to the absence of constraints directly related to valve surgery. The results of AVR were satisfactory, with only one hospital death, a low rate of post-operative non-fatal major complications, and favourable mid-term outcome. Although the question of the risk/benefit ratio of surgery when compared with percutaneous approaches remains to be answered in high-risk subsets, these results underline that contemporary surgery keeps a dominant place in the treatment of severe AS in elderly populations.

Study limitations

This study reflects an initial single-centre experience, on a relatively small number of patients. However, it is the first prospective report of a homogeneous strategy including PAVI and surgical AVR in a 'real-life', non-selected elderly population with severe AS. Although patients were consecutive, they were referred to a tertiary centre with on-site capabilities for percutaneous valve interventions. Thus, there was a possible selection bias towards a higher risk profile. On the other hand, the characteristics more usually encountered in patients with AS and referred for AVR in other centres probably underestimate the overall risk profile of the population with AS, as many high-risk patients are not referred to hospitals. The present study took place in a transition period, at the beginning of our learning curve. Its conclusion may be altered by the substantial innovation in hardware and equipment that took place during the last few months, and by the availability of the transventricular approach. Finally, it is not sure whether prognostic observations made in younger patients can, or cannot be extended to older patients, and much remains to be learned about the natural history of AS in the elderly and very elderly.

Future directions and conclusion

The availability of less-invasive techniques, combined with lengthened life spans, is likely to increase the referral of elderly with AS with a high-risk profile. This challenging perspective stresses the need for a thorough evaluation of new techniques, and long-term studies as well as randomized trials are required. The Placement of AoRTic TraNscathetER valves (PARTNER) multicentre trials are currently ongoing in Europe (PARTNER-EU) and in the United States (PARTNER-US). It will also be necessary to improve the knowledge of the natural history of AS in the elderly and its determinants. The predictive value of multivariate predictive scores should be improved to guide the individual choice between AVR, transfemoral or TAVI, or abstention. It remains that the final therapeutic decision should rely on clinical judgment based on a team approach. This will be mandatory to individualize decision-making according to the expected risks and benefits of the different treatments and the wishes of the informed patient. In the present series, the availability of PAVI and thorough reconsideration of AVR increased the number of patients benefiting from an effective treatment of their AS.

Conflict of interest: none declared.

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