Original Research

Transcatheter Aortic Valve Implantation: First Greek Experience

Konstantinos Spargias, Athanassios Manginas, Gregory Pavlides, Mazen Khoury, George Stavridis, Panagiota Rellia, Anna Smirli, Apostolos Thanopoulos, Marina Balanika, Spyros Polymeros, Sofia Thomopoulou, George Athanassopoulos, George Karatasakis, Renata Mastorakou, Stavroula Lacoumenta, Alkis Michalis, Petros Alivizatos, Dennis Cokkinos

Departments of Cardiology A', Cardiac Surgery A and B, Anaesthesiology and Radiology, Onassis Cardiac Surgery Centre, Athens, Greece

Key words:
Aortic valve stenosis, prosthetic aortic valve, SAPIEN, percutaneous valve repair.

Introduction: Percutaneous aortic valve replacement represents an alternative to conventional open-heart surgery for selected high-risk patients without the need for sternotomy, aortotomy, or cardiopulmonary bypass. We present the first Greek series of transcatheter prosthetic aortic valve implantation procedures, performed in our centre.

Methods: All 12 patients (age 81 ± 5 years) had severe, symptomatic, calcific aortic stenosis and were judged not to have a reasonable surgical option by a medical team including experienced cardiac surgeons. The patients' mean logistic EuroSCORE was 34 ± 15% (min 11%, max 61%). Eight (8) of them underwent transfemoral (SAPIEN, Edwards 23 mm valve in 7 and 26 mm in 1 patient) and 4 transapical (26 mm in 2 and 23 mm in 2 patients) prosthetic aortic valve implantation, all in the cardiac catheterisation laboratory under general anaesthesia.

Results: The procedural, in-hospital and 2-month (mean follow up 50 days, min 17, max 122 days) mortality was 0%. The length of hospital stay was 8 ± 2 days (min 5, max 12 days). The aortic valve area increased from 0.64 ± 0.14 cm^2 to 1.83 ± 0.14 cm^2 and the mean pressure gradient decreased from 57 ± 23 mmHg to 10 ± 3 mmHg post-implantation ($p<0.001$ for both). The patients' mean NYHA functional status improved from 2.8 ± 0.7 to 1.3 ± 0.5 at follow-up ($p<0.001$).

Conclusions: Our initial experience with transcatheter prosthetic aortic valve implantation demonstrates that it can be performed safely and with excellent short and mid-term clinical outcomes.

Manuscript received:
March 20, 2008;
Accepted:
July 28, 2008.

Address:
Konstantinos Spargias

Onassis Cardiac Surgery Centre
356 Syngrou Ave.
176 74 Athens, Greece
e-mail:
spargias@ocsc.gr

Calcific aortic stenosis is the most frequent expression of valvular heart disease in the western world, with increasing prevalence expected as the population ages. Three percent of all adults ≥75 years of age have moderate or severe aortic stenosis, and it is the leading indication for valve replacement in Europe and the United States.[1-3] Surgical aortic valve replacement can both reduce symptoms and extend life and it is the preferred treatment strategy for patients of all age groups.[1,2]

Nevertheless, many patients with severe aortic stenosis do not undergo surgery because of excessive risk, advanced age, or preference.[1-8] Prognosis with medical management is poor, and until recently percutaneous alternatives to surgery have been limited to balloon aortic valvuloplasty (BAV) with palliation that is modest and short-lived.[1,2,7-8]

Percutaneous valve implantation has been under active investigation by a number of groups for more than a decade,[9-13] but it was not until May and September 2007 that

the first two transcatheter aortic valves (ReValving system, CoreValve, and SAPIEN, Edwards) obtained preliminary approval for clinical use by the European Union authorities.

The current clinical indications for transcatheter aortic valve (TCV) implantation are well defined and are intended for high-risk patients who do not have a reasonable surgical option, as indicated by a calculated risk score (usually logistic EuroSCORE >20% or STS score >10%).[14-17] The mortality outcome with the transcatheter procedure in this population has been as low as one third of the calculated one.[15,17]

As of January 2008, approximately 700 procedures had been performed with the Edwards valve (with almost 550 of them during the investigational phase) and 500 procedures with the ReValving system of CoreValve. The performance of the transcatheter procedure has been restricted to selected centres that fulfil certain set-up and multidisciplinary training requirements.

Our hospital was the first to employ this novel procedure in Greece, and between November 14, 2007, and February 28, 2008, 12 patients underwent TCV implantation using the SAPIEN, Edwards valve. We describe our initial experience, focusing on patient selection, set-up requirements and clinical outcomes.

Methods

Valve prosthesis

The balloon-expandable prosthesis (SAPIEN, Edwards Lifesciences Inc., Irvine CA, USA) is a tubular, slotted, stainless steel stent with an attached bovine pericardial trileaflet valve (treated with the proprietary ThermaFix™ process) and fabric sealing cuff. Two sizes are currently available: 23 and 26 mm expanded diameter. The prosthetic stent valve is mechanically crimped onto a balloon catheter immediately before implantation.

Patient selection and screening

Indications

The current clinical indications for TCV implantation according to the SAPIEN valve approval are: 1. Severe, calcified, aortic valve stenosis with aortic valve area ≤0.8 cm^2 and/or mean pressure gradient ≥40 mm Hg and/or maximum flow velocity ≥4 m/s; and 2. Symptomatic patient with at least NYHA class II functional status; and 3. Calculated logistic Euro SCORE[18] >20% and/or STS score[19] >10%. To account for comorbid conditions that are not incorporated into the risk scores (such as porcelain aorta, severe obstructive airway disease, previous radiation therapy, severely incapacitating osteoarthritis) it is possible to accept a patient with a lower score if the cardiac surgeon estimates that the mortality risk exceeds 20%. Patient preference alone for a percutaneous procedure is not considered adequate if surgery is an option.

In our centre, apart from the treating cardiologist and cardiac surgeon who indicated patient suitability for TCV implantation, a team of senior cardiologists, cardiac surgeons and anaesthesiologists formally reviewed patients and reached a consensus that they fulfilled the approved criteria. We required that patients should have a reasonable life expectancy (above 1 year).

Echocardiographic assessment

Echocardiographic assessment of all patients was required at our centre before intervention. All patients had to fulfil the previously defined echocardiographic criteria of severe aortic stenosis. Particular attention was given to the measurement of the aortic valve annulus diameter. This was obtained in the parasternal long-axis view by placing the markers at the hinge points of the aortic valve leaflets to the valve annulus. The currently available SAPIEN valve sizes require an annulus diameter larger than 18 mm and smaller than 25 mm (18 to 21 mm annulus is suitable for the 23 mm diameter valve and 22 to 25 mm annulus is suitable for the 26 mm diameter valve). In borderline cases transoesophageal echocardiography was used for more accurate assessment.

Other important information sought was left ventricular ejection fraction and estimated systolic pulmonary artery pressure, both counting in the EuroSCORE calculation, as well as the degree of aortic and mitral valve insufficiencies, presence of basal interventricular septum hypertrophy and aortic root dilatation. When the position of the coronary ostia in the sinuses of Valsalva was low, an effort was made to better delineate their 3-dimensional relation to the calcified aortic valve leaflets with transoesophageal echocardiography.

Coronary angiography

All patients underwent coronary angiography before TCV implantation. Significant coronary artery disease was detected and treated percutaneously if indicated. It is generally desirable to avoid excessive ischaemia during the TCV procedure. This can be induced by the stress and haemodynamic effects of anaesthesia, multi-

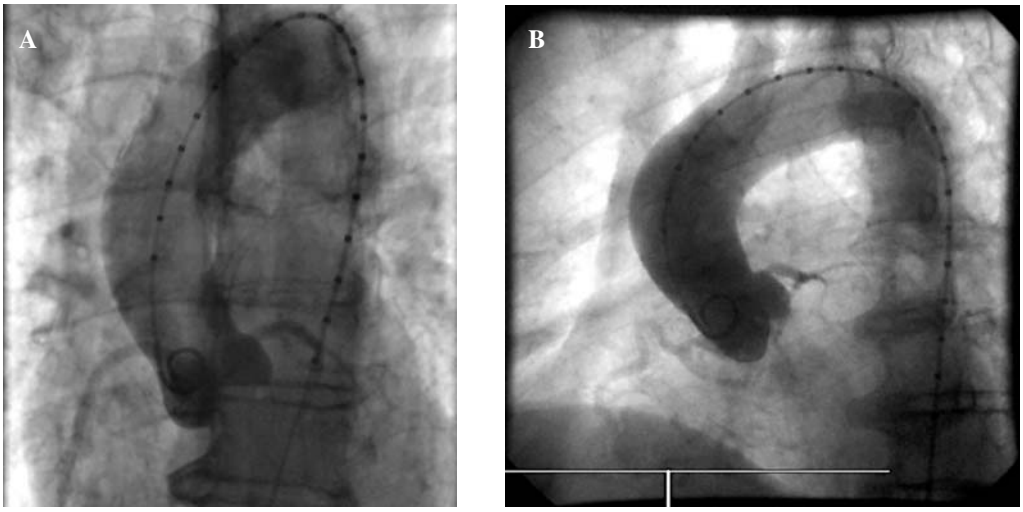

Figure 1. Aortographies demonstrating a vertical (A) and a horizontal (B) ascending aorta.

ple periods of rapid cardiac pacing, and a prolonged time of aortic insufficiency at the time of the prosthesis placement. Therefore, it is preferred to treat a significant coronary artery stenosis percutaneously before TCV implantation. Usage of bare metal stents is preferable in this high-risk elderly population, and the procedure should be done at least 15 days before the planned TCV implantation, to allow for complete stent endothelialisation. Coronary angiography can also help to better delineate the 3-dimensional relation of the coronary ostia to the calcified aortic valve leaflets.

Angiographic and other assessments

The decision regarding the optimal access for TCV implantation depends on a number of factors, the most important being peripheral artery suitability for valve delivery. Transfemoral aortic valve (TFV) implantation requires a minimum lumen diameter of the common femoral, external and common iliac artery to be used for the valve delivery (7 mm for the 23 mm diameter valve and 8 mm for the 26 mm diameter valve). In addition, significant tortuosity, atheroma and calcification in these arteries are considered independently of the minimum lumen diameter, since they may hinder TFV implantation. The other important factor in deciding on TFV implantation suitability is the aorta itself. The shape of the ascending aorta is crucial for the procedure's success. The more vertical the ascending aorta, the easier it is to advance the prosthesis across the stenosed aortic valve. A horizontal aorta makes this part of the procedure challenging and is associated with failures and complications. The descending and abdominal aorta should also be free of undulating tortuosity and atheroma.

All patients underwent screening (most of them at the time of coronary angiography) with ascending (Figure 1) and low abdominal aortography (Figure 2) using a pigtail catheter with multiple 1 cm markers (Aurous, COOK) for calibration and measurements. Particular care was taken to visualise the common femoral arteries at the level of the femoral head, the ideal arterial puncture site. CT scan angiography was obtained when additional information regarding periph-

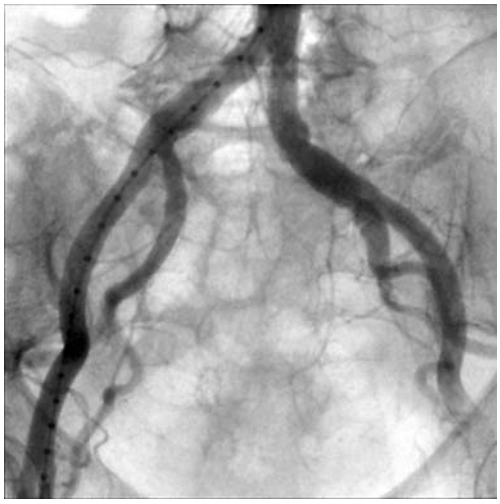

Figure 2. Abdominal aortography with full visualisation of the common and external iliac and common femoral arteries indented for transfemoral valve delivery. Note the 1 cm markers of the catheter used for calibration and minimal lumen diameter measurements.

eral artery atheroma and wall calcification was desirable.

Patients judged not to be candidates for TFV implantation were considered as candidates for transapical aortic valve (TAV) implantation.

Another important factor of concern regarding both TFV and TAV procedures is the 3-dimensional relation of the coronary artery ostia with the calcified aortic valve leaflets. A low position of the ostia in the sinuses of Valsalva jeopardises their patency following the expansion of the stented valve prosthesis, and it is not the stent itself that poses this threat but the native valve leaflets as they are pushed aside. As discussed previously, both transoesophageal echocardiography and coronary angiography can provide important information on this issue, but it is ascending aortography that first detects this unfavourable anatomy for TCV implantation. Cardiac CT scanning provides the most accurate assessment of the TCV implantation safety in the presence of low coronary ostia by measuring and comparing the distance from the leaflet hinge point to the coronary ostium and the length of the leaflet in front of the coronary ostium. If the latter is shorter than the former, the procedure can be done safely. Transoesophageal echocardiography can also be used for this matter, but the measurements obtained are less accurate because of the dynamic nature of the examination and the difficulty in finding and scanning the correct plane containing both the leaflet and the coronary os. Cardiac CT scanning is also the examination of choice for detecting and rating porcelain aorta, and for evaluating wall atheroma and lumen dimensions of the entire thoracic aorta.

BAV experience

Our interest in the percutaneous treatment of aortic valve stenosis begun in December 2006, when we commenced a contemporary BAV program. We applied the TCV implantation criteria for patient selection in our BAV program. This acted as useful preparation for the later development of our TCV program, and formed the foundations of the necessary collaboration between different specialties and subspecialties. This program also assisted in the optimal coordination of the short rapid cardiac pacing during the balloon inflation. To date, 36 BAV procedures have been performed, with procedural, in hospital and 6-month (mean and median follow up) mortality 0%, 7% and 22%, respectively. Since the beginning of our transcatheter implantation program, patients fulfilling the described criteria for percutaneous treatment do not necessarily undergo BAV, but instead can be directly listed for TCV implantation.

The procedure

The procedures were performed in the catheterisation laboratory with operating room-like sterile precautions. The room is spacious, so as to accommodate the anaesthesia and echocardiography equipment, as well as the additional tables required for the preparation of the valve. In addition, for the TAV procedure extracorporeal circulation equipment was in the room.

General sterile cleaning of the room was carried out the night before the procedure and access to it was restricted only to those immediately involved in the procedure. The main room entrance was locked after the patient was transferred in. Entrance to the room without head cap and facial mask was forbidden.

The personnel in the room for the TFV implantations consisted of 2 interventional cardiologists, 1 cardiac surgeon, 1 cardiac anaesthesiologist, 1 echocardiographer, 2 nurses and one valve technician (carrying out valve preparation and crimping on the balloon). For the TAV implantations the personnel composition changed slightly with the participation of a second cardiac surgeon and an operating room nurse.

All possible patient body entry sites were subjected to meticulous surgical scrubbing. Premedication with aspirin and clopidogrel was given, and teicoplanin 400 mg and ceftazidime 1000 mg were administered IV just before the procedure. After anaesthesia induction, the transoesophageal echo probe was inserted and accurate measurement of the aortic valve annulus was obtained for valve sizing. Heparin 50 U/kg IV was administered.

For the TFV procedure access to the suitable common femoral artery for valve delivery and the contralateral femoral artery and vein was obtained. For the TAV procedure access to a common femoral artery and vein was obtained, and then access to the left ventricular apex was obtained via an incision between the left 4th to 5th or 5th to 6th ribs. A purse string was placed in the apical surface of the left ventricle before its puncture.

Ascending aortography was performed in a view that lined up all three sinuses of Valsalva, essential for optimal valve positioning. Cardiac pacing was with a transvenous pacing wire in the right ventricle for the TFV procedure and a wire directly stitched epicardially for the TAV procedure. Rapid pacing capacity (usually 180-220 /min) and its desired haemodynamic effect (constant aortic pressure <40 mmHg) were confirmed.

The valve was then crossed with a stiff extra long wire and BAV, via a 12-14 F sheath in the common femoral artery for the TFV and in the left ventricle for the TAV procedure, was performed during a short burst of rapid ventricular pacing. Following BAV, the larger sheath for valve delivery was inserted (TFV: 22 F and 24 F for the 23 mm and 26 mm diameter valves, respectively; TAV: 26 F sheath). The valve prosthesis with its introducing device (Retroflex catheter for the TFV, Ascendra introducer for TAV) was then inserted and advanced to the level of the aortic annulus. Its position was checked with aortography performed with the pigtail catheter positioned just above the aortic valve and with transoesophageal echocardiography. Deployment was performed with a volume-controlled inflation of the carrying balloon during a short period of rapid cardiac pacing (Figure 3). The valve positioning aim for the TFV implantation was with two thirds of it below the hinge points of the aortic leaflets and one third above. For the TAV implantation the aim was half below and half above.

The result was checked by assessing haemodynamic responses, transoesophageal echocardiography and ascending aortography (Figure 4).

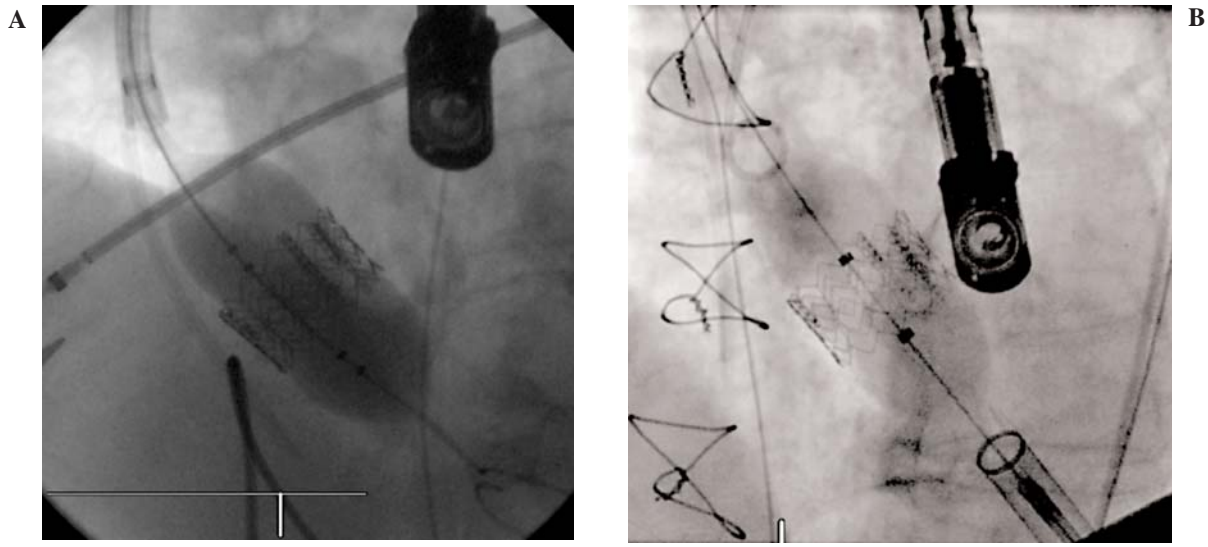

Figure 3. The inflation of the SAPIEN valve delivered transfemorally (A) and transapically (B).

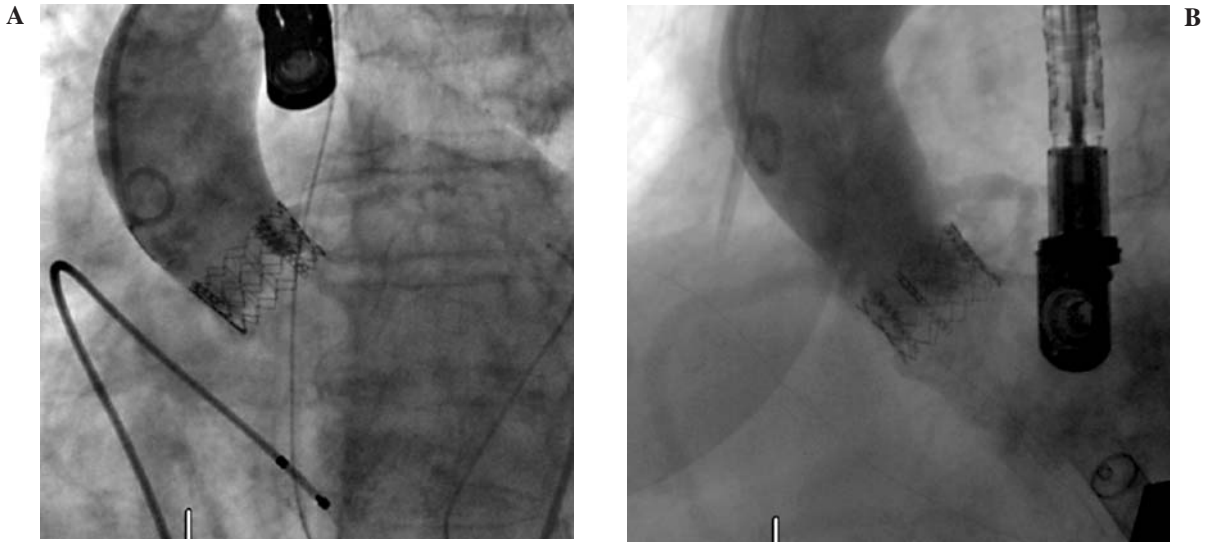

Figure 4. Ascending aortography following the SAPIEN valve implantation transfemorally (A) and transapically (B).

The procedure was completed by surgical closure of the prosthetic valve entry sites. The patients were then transferred to the coronary care unit (CCU: TFV implantation) or the intensive care unit (ICU: TAV implantation) where they were awakened and extubated.

The first 3 TFV procedures and all 4 TAV procedures were performed with Drs. J. Webb (for TFV) and T. Walther (for TAV) acting as proctors.

Results

Patients

Table 1 summarises clinical and echocardiographic data of the first series of 12 patients who underwent TCV implantation in our centre. The mean age was 81 ± 5 years, the mean NYHA functional status 2.8 ± 0.7 and the mean body mass index 25.3 ± 4.4 kg/m^2. All patients had a logistic EuroSCORE above 20%, except patient 12, who had a score of 11% but for whom the surgical option was rejected because of porcelain aorta. The mean logistic EuroSCORE was 34 ± 15% (median 31%, min 11%, max 61%).

Three (3) of these patients had undergone percutaneous coronary artery intervention and another 3 at least one BAV procedure before transcatheter valve implantation.

Outcomes

Table 2 summarises the procedural and clinical outcomes of the first series of 12 patients who underwent TCV implantation in our centre.

The mean procedure time was 178 ± 38 minutes (time on procedure table), and the mean fluoroscopy time was 13.2 ± 5.8 minutes. The procedure success rate was 100% (correct positioning of the TCV and extubation of the patient). The procedural, in-hospital and 2-month (mean follow up 50 days, median 27, min 17 days, max 122 days) mortality was 0%. The mean length of hospital stay was 8 ± 2 days (median 8 days, min 5, max 12 days) and the mean CCU/ICU stay was 2.9 ± 1.4 days. The NYHA functional status was significantly improved at follow-up (1.3 ± 0.5, $p<0.001$ compared to baseline).

The echocardiographically assessed aortic valve area increased from 0.64 ± 0.14 cm^2 to 1.83 ± 0.14 cm^2 ($p<0.001$, post-procedure assessment within 4 days). The mean pressure gradient decreased from 57 ± 23 mmHg to 10 ± 3 mmHg, and the maximum pressure gradient from 91 ± 33 mmHg to 22 ± 7 mmHg ($p<0.001$ for both). The angiographically assessed mean degree of aortic insufficiency was grade 1.3 ± 1.0 before the procedure and 1.1 ± 0.6 after valve implantation (immediate post-implantation assessment). The mean degree of mitral insufficiency was grade 1.1 ± 0.7 before the procedure and 1.0 ± 0.5 after valve implantation.

Patient 1 had a markedly elevated serum creatinine concentration before the procedure that gradually returned to normal a few days afterwards (from 4.1 mg/dL to 1.2 mg/dL).

Patient 2 developed severe and haemodynamically non-tolerated (marked reduction of the diastolic arterial pressure) paravalvular aortic valve insufficiency immediately after TFV implantation. The positioning of the valve was correct and this complication was treated successfully with repeat balloon dilatation of the prosthetic valve, increasing the inflating volume by 2 ml. Figure 5 illustrates the transoesophageal echocardiographic images of the insufficiency before and after the balloon dilatation and its reduction from severe to moderate. The patient was extubated in a timely manner and without any sequel.

Patient 10 also developed severe and haemodynamically non-tolerated central aortic valve insufficiency immediately after TAV implantation. He became markedly hypotensive (systolic arterial pressure in the region of 50 mmHg) and soon progressed to electrical storm. He was successfully resuscitated with electrical cardioversions and direct heart compressions. He was stabilised with immediate placement on femoral-femoral bypass and then a second valve-in-valve prosthesis was deployed, correcting the insufficiency from severe central to moderate paravalvular. His recovery was delayed and he required high-dose inotropic and intra-aortic balloon pump support. He was extubated after 2 days and inotropic and pump support were discontinued soon thereafter. He was discharged 10 days after the procedure in good condition.

Patient 7 had severe obstructive airway disease that made extubation difficult and required extensive respiratory support (2 days).

Patients 2 and 6 developed entry site complications that delayed their hospital discharge significantly. In patient 2 an obstructive common femoral artery dissection was noted by angiography after initial surgical closure. The surgical closure had to be re-explored and corrected with the use of a Dacron patch. The healing process was delayed as a result. Patient 6 developed back skin necrosis, partly related to mechanical skin removal by an adhesive bandage and partly related to possible

Table 1. Patients' clinical and echocardiographic data.

Patient	Age	Sex	BMI	NYHA	Mean PG	AVA	MR grade	AR grade	EuroSCORE	EuroSCORE components	Other comorbidities
1	77	female	28.1	3	88	0.45	1	1	32	COAD, CRF, PHT	PAF, anaemia, breast cancer
2	72	male	24.5	2	36	0.80	2	1.5	23	CABG, PAD, LVEF 40%,	PAF, anaemia
3	86	female	29.8	3	39	0.60	1.5	1	31	COAD, PHT	Anaemia
4	83	female	30.0	2	45	0.80	1	1	26	PHT, LVEF 45%	PAF
5	80	female	21.9	3	72	0.50	0	3.5	23	COAD, PHT	Anaemia
6	83	female	22.8	4	99	0.54	1	1	52	COAD, PAD, LVEF 45%, PHT	AF, previous CVA
7	85	female	29.3	4	71	0.70	0	2.5	45	COAD, PAD, PHT, CRF	PAF
8	86	male	30.2	3	60	0.59	2	0	61	CABG, LVEF 45%, PHT, PAD	–
9	84	female	21.1	3	45	0.68	1	0	26	COAD, PAD	Anaemia
10	76	male	16.2	4	20	0.65	2	1	49	COAD, CRF PAD, PHT, LVEF 35%,	AF, anaemia, partial gastrectomy
11	85	female	25.3	2	59	0.90	1	2	30	COAD, PHT	–
12	78	female	24.2	2	48	0.50	1	1	11	COAD	Porcelain aorta, severe arthritis
Mean (SD)	81.3 (4.6)		25.3 (4.4)	2.8 (0.7)	57 (23)	0.64 (0.14)	1.1 (0.7)	1.3 (1.0)	34 (15)		

AVA – aortic valve area (cm^2); BMI – body mass index (kg/m^2); COAD – chronic airway obstructive disease; CRF – chronic renal failure; CVA – cerebrovascular accident; LVEF – left ventricular ejection fraction; Mean PG – mean aortic valve pressure gradient (mmHg); MR/AR grade – grade of mitral/aortic valve insufficiency; PAD – peripheral arterial disease; (P)AF – (paroxysmal) atrial fibrillation;

Table 2. Patients' procedural and clinical outcomes.

Patient	Type	AV annulus	SAPIEN size	Fluoroscopy time	Procedure time	AVA	Mean PG	MR grade	AR grade	LOS	ICU stay	BUT	NYHA	FU
1	TF	19.5	23	18.6	180	1.94	11	1	1	8	2	4	1	122
2	TF	22	26	20.6	165	2.0	6	2	1	12	4	2	1	121
3	TF	19	23	20.5	270	1.6	7	1	2	6	2	4	1	120
4	TF	20	23	19.5	145	1.8	6	1	1	6	4	0	1	59
5	TF	19.5	23	14.7	195	1.7	13	0	1.5	9	2	1	2	34
6	TF	19	23	11.7	140	1.8	10	1	1	10	2	0	2	34
7	TA	19.5	23	6.6	170	1.65	14	0	1.5	10	4	2	2	20
8	TA	23	26	5.1	120	2.0	9	1	0	8	1	0	1	20
9	TA	19.5	23	4.1	165	1.75	11	1	0	9	2	0	1	19
10	TA	25	26	13.1	210	1.8	8	1.5	2	10	6	15	2	19
11	TF	20	23	12.5	190	1.96	12	1	1.5	5	4	0	1	17
12	TF	19	23	11.8	185	1.97	15	1	1	5	2	0	1	17
Mean (SD)		20.4 (1.9)		13.2 (5.8)	178 (38)	1.83 (0.14)	10 (3)	1.0 (0.5)	1.1 (0.6)	8 (2)	2.9 (1.4)	3.1 (4.7)	1.3 (0.5)	50 (44)

AV annulus – aortic valve annulus diameter (mm); AVA – aortic valve area (cm^2); BUT – blood units transfused; FU – follow up (days); ICU – intensive care unit (days); LOS – length of hospital stay (days); Mean PG – mean aortic valve pressure gradient (mmHg); MR/AR grade – grade of mitral/aortic valve insufficiency; PHT – pulmonary hypertension; TA – transapical; TF – transfemoral.

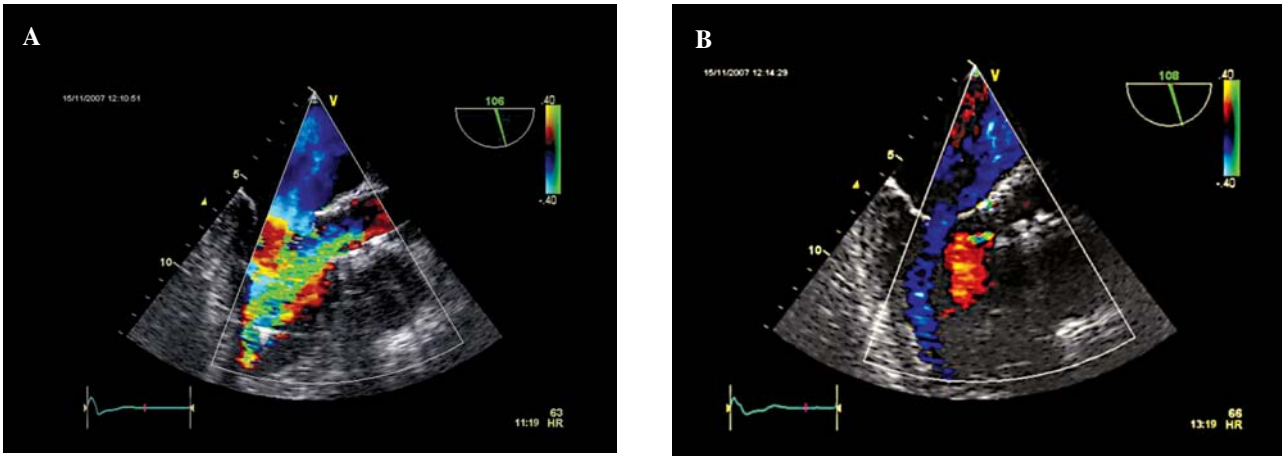

Figure 5. Transoesophageal echocardiographic images of patient 2 before (A) and after (B) redilatation of the SAPIEN valve, illustrating a substantial reduction in the aortic insufficiency.

burns due to defective diathermy. The healing process was delayed as a result.

Discussion

Our initial experience with the novel procedure of transcatheter aortic valve implantation (SAPIEN, Edwards) reproduces the outstanding results reported by other centres. We have proved that these procedures can be performed safely and with excellent outcomes, with proper patient selection, in a well prepared and organized cardiac catheterisation laboratory setting, by a trained and coordinated team.

The 100% procedure success and zero mortality (mean follow-up 50 days) observed in this first series of 12 patients with a predicted 30-day surgical mortality of 34% is rewarding. These results were obtained during the initial phase of our learning curve. The mounting reflection of worldwide experience, though small, together with our previous BAV experience, multidisciplinary dedication applying defined selection criteria, formal training and the initiation of our program under supervision by proctors, all played an important role in setting the beginning of our learning curve at high levels. However, as experience mounts and acceptance of less ideal patients is more likely, no further improvements or even less optimal outcomes in the future cannot be excluded, a scenario seen in other centres.

The number of patients in our first series is relatively small and even one fatality would have resulted in a mortality of 8%. In fact, this mortality (8%) was observed in the larger series of the Edwards TFV implantations when the EuroSCORE predicted mortality was 30%.[15] In this selected high-risk population, and with currently available technology, a realistic expectation is that TCV implantation can reduce the predicted surgical risk by at least two thirds. Admittedly, the accuracy of EuroSCORE and other available objective predictors of surgical mortality is controversial, sometimes underestimating but perhaps more commonly overestimating risk.[20-22] However, until randomised trials of TCV implantation and surgery report, this is the only available way to make comparisons.

Hospital stay in this high-risk group of largely elderly patients was relatively short at a mean and median of 8 days and as little as 5 days. However, since in some instances we kept the patients for longer observation without any particular reason this is expected to reduce as our program advances. In comparison, the median hospital stay in the larger Edwards TFV series was 5 days.[15] Although morbidity is difficult to quantify further, none of our patients suffered a procedural stroke or other clinically detectable neurological damage. Our patients experienced a significant early symptomatic improvement and further improvement is very likely with the full mobilisation of our TAV implanted patients. As important as mortality risk may be, procedural morbidity may weigh as heavily in the decisions made by elderly patients and their physicians. Indeed, in a recent series of surgical aortic valve replacements in octogenarians the mean hospital stay was 20 days, 8 of which were in the ICU.[23]

The prognosis of patients with symptomatic aortic stenosis is poor, and surgical aortic valve replacement improves survival regardless of age.[23-24] Surgical mortality rates escalate with age and in the presence of comor-

bidities.[2,23] It is estimated that for each two patients with severe symptomatic aortic stenosis undergoing surgical valve replacement, there is at least one patient who will never undergo surgery because of the perceived extremely high risk.[4-6] Before the advance of TCV implantation, these patients presented a real management challenge with no reasonable therapeutic option, since medical therapy is ineffective and BAV has a short-lasting palliative effect without altering survival. It is rather unorthodox for a new therapeutic procedure to be tested first in such a high-risk population, but in the case of TCV implantation there was no other choice, since its long-term results remain unknown and conventional surgery performs excellently in lower risk patients.

The most important clinical trial of the SAPIEN, Edwards valve is the ongoing PARTNER trial program. This consists of two parallel, randomised studies. The first compares conventional surgery to TCV implantation in patients at medium surgical risk (EuroSCORE >15%) and is designed as a non-inferiority study. The second compares TCV implantation to medical treatment in patients at extremely high surgical risk (EuroSCORE >20%) and is designed as a superiority study. They are not expected to report results before 2010.

It is estimated that approximately 2000 aortic valve replacements are performed yearly in Greece, and according to the EuroSurvey statistics[4] there should be another 1000 patients yearly with severe symptomatic aortic stenosis who are never referred for surgery or are turned down because of perceived excessively high risk. According to current indications, most of these patients would be candidates for TCV implantation.

The relative composition of the TCV procedures regarding the route of implantation (TFV or TAV) is currently almost equally divided in the SAPIEN valve clinical program. However, since this is largely dependent on the size of the arterial sheath required for TFV delivery, the relative composition will change in favour of the TFV procedure with the expected reduction of sheath sizes by 3 F within 2009. Finally, the availability of new valve sizes next year will expand TCV implantations to patients with aortic valve annulus sizes from 16 mm to 28 mm (from the current 18 mm to 25 mm).

Conclusions

Conventional open-heart surgery remains first-line therapy for symptomatic aortic stenosis. However, it is now evident that transcatheter valve replacement is a viable alternative to conventional open-heart surgery in selected high-risk patients with severe symptomatic aortic stenosis. It appears that TCV implantations are not only safe, but can also be performed with a small fraction of the perceived surgical risk. The first Greek series of such procedures performed at our hospital demonstrates that these results can be reproduced successfully in our country.

References

1. Task Force. ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease. Circulation. 2006; 114; 84-231.
2. The Task Force on the management of valvular heart disease of the European Society of Cardiology. Guidelines on the management of valvular heart disease. Eur Heart J. 2007; 28: 230-268.
3. Hara H, Pedersen WR, Ladich E, et al. Percutaneous balloon aortic valvuloplasty revisited: time for a renaissance? Circulation. 2007;115;334-338.
4. Iung B, Baron G, Butchart EG, et al. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. Eur Heart J. 2003; 24: 1231-1243.
5. Charlson E, Legedza AT, Hamel MB. Decision-making and outcomes in severe symptomatic aortic stenosis. J Heart Valve Dis. 2006; 15: 312-321.
6. Pellikka PA, Sarano ME, Nishimura RA, Malouf JF, Bailey KR, Scott CG. Outcome of 622 adults with asymptomatic, hemodynamically significant aortic stenosis during prolonged follow-up. Circulation. 2005; 111: 3290-3295.
7. Otto CM, Mickel MC, Kennedy JW, et al. Three-year outcome after balloon aortic valvuloplasty: insights into prognosis of valvular aortic stenosis. Circulation. 1994; 89: 642-650.
8. Lieberman EB, Bashore TM, Hermiller JB, et al. Balloon aortic valvuloplasty in adults: failure of procedure to improve long-term survival. J Am Coll Cardiol. 1995; 26: 1522-1528.
9. Andersen HR, Knudsen LL, Hasenkam JM. Transluminal implantation of artificial heart valves: description of a new expandable aortic valve and initial results with implantation by catheter technique in closed chest pigs. Eur Heart J. 1992; 13: 704-708.
10. Cribier A, Eltchaninoff H, Bash A, et al. Trans-catheter implantation of balloon-expandable prosthetic heart valves: early results in an animal model. Circulation. 2001; 104 (suppl II): I-552.
11. Sochman J, Peregrin JH, Pavcnik D, Timmermans H, Rosch J. Percutaneous transcatheter aortic disc valve prosthesis implantation: a feasibility study. Cardiovasc Intervent Radiol. 2000; 23: 384-388.
12. Lutter G, Kuklinski D, Berg G, et al. Percutaneous aortic valve replacement: an experimental study. J Thorac Cardiovasc Surg. 2002; 123: 768-776.
13. Bonhoeffer P, Boudjemline Y, Qureshi SA, et al. Percutaneous insertion of the pulmonary valve. J Am Coll Cardiol. 2002; 39: 1664-1669.
14. Webb JG, Chandavimol M, Thompson CR, et al. Percutaneous aortic valve implantation retrograde from the femoral artery. Circulation. 2006; 113: 842-850.

15. Webb JG, Pasupati S, Humphries K, et al. Percutaneous transarterial aortic valve replacement in selected high-risk patients with aortic stenosis. Circulation. 2007; 116: 755-763.
16. Lichtenstein SV, Cheung A, Ye J, et al. Transapical transcatheter aortic valve implantation in humans: initial clinical experience. Circulation. 2006; 114: 591-596.
17. Grube E, Schuler G, Buellesfeld L, et al. Percutaneous aortic valve replacement for severe aortic stenosis in high-risk patients using the second- and current third-generation self-expanding CoreValve prosthesis: device success and 30-day clinical outcome. J Am Coll Cardiol. 2007; 50: 69-76.
18. Nashef SA, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon P. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg. 1999; 16: 9-13.
19. Shroyer AL, Coombs LP, Peterson ED, et al. The Society of Thoracic Surgeons: 30-day operative mortality and morbidity risk models. Ann Thorac Surg. 2003; 75: 1856-1864.
20. Nashef SA, Roques F, Hammill BG, et al. Validation of European System for Cardiac Operative Risk Evaluation (EuroSCORE) in North American cardiac surgery. Eur J Cardiothorac Surg. 2002; 22: 101-105.
21. Fuster V, Goldbarg SH, Hansalia RJ, Stevens GR, Tiyyagura SR. The inoperable valvular heart disease patient: the pluses and minuses of percutaneous valvular replacement. Eurointervention. 2006; 2: 154-160.
22. Roques F, Nashef SA, Michel P; for the EuroSCORE Study Group. Risk factors for early mortality after valve surgery in Europe in the 1990's: lessons from the EuroSCORE pilot program. J Heart Valve Dis. 2001; 10: 572-578.
23. Kolh P, Kerzmann A, Lahaye L, Gerard P, Limet R. Cardiac surgery in octogenarians. Peri-operative outcome and long-term results. Eur Heart J. 2001; 22: 1235-1243.
24. Varadarajan P, Kapoor N, Bansal RC, Pai RG. Survival in elderly patients with severe aortic stenosis is dramatically improved by aortic valve replacement: Results from a cohort of 277 patients aged 80 years. Eur J Cardiothorac Surg. 2006; 30: 722-727.