Clinical and hemodynamic effects of transcatheter aortic valve implantation
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Chapter 2.1

Percutaneous implantation of the CoreValve aortic valve prosthesis in patients at high risk or rejected for surgical valve replacement

Clinical evaluation and feasibility of the procedure in the first 30 patients in the AMC-UvA

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Berto J. Bouma
Stefan G. de Hert
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ABSTRACT

Objective To report the feasibility, safety and efficacy of percutaneous aortic valve implantation (PAVI) with the CoreValve self-expanding aortic valve bioprosthesis in elderly patients with aortic valve stenosis who are rejected for surgery or have a high surgical risk.

Methods PAVI using the CoreValve ReValving System was performed under general anesthesia in thirty (surgical) high risk patients with a symptomatic severe aortic valve stenosis.

Results The patients had a mean age of 80.5±7.7 years, a mean aortic valve area of 0.71±0.19 cm$^2$, a peak transvalvular aortic gradient of 79±25 mmHg, as measured with echo Doppler, a logistic EuroSCORE of 15±10% and a Society of Thoracic Surgeons (STS) score of 5.2±2.9%. Device success was achieved in all patients and acute procedural success in 27 patients (90%). In the surviving patients there was a reduction of the peak aortic pressure gradient from 76±24 mmHg to 22±7 mmHg (n=24, P<0.00001) 30 days after successful device implantation. At 30 days, major adverse cardiovascular and cerebral events had occurred in seven patients (23%). This included mortality in six patients (20%), of which one death was cardiovascular. The other five non-cardiovascular deaths involved two patients who died of an exacerbation of severe pre-existent pulmonary disease and three of infectious complications.

Conclusions Percutaneous aortic valve implantation was successfully performed in our centre in high-risk patients, with a 30-day mortality of 20%. When successful, marked haemodynamic improvement and relief of symptoms was achieved.
Introduction

Currently the standard therapy of symptomatic aortic valve stenosis (AS) is open chest aortic valve replacement. However, since symptomatic AS usually occurs in the elderly, a high prevalence of comorbidities is present in these patients. The common comorbidities in these patients, such as advanced age, previous cardiac surgery, reduced systolic left ventricular function, pulmonary disease and renal insufficiency are known to be associated with a high periprocedural and postprocedural risk of mortality and morbidity. Therefore almost one third of AS patients with these comorbidities are not referred or are rejected for surgery.\textsuperscript{3,2} Furthermore, the long revalidation period after open chest surgery may be a reason for high-risk patients to withhold from surgery. Therefore, the development of a less invasive, percutaneous approach of aortic valve replacement was required. Currently there are two Crédit Européen (CE) certified aortic bioprostheses available for percutaneous retrograde implantation: the CoreValve and the Cribier Edwards valve.\textsuperscript{3-6} Previous reports have shown that percutaneous retrograde implantation of aortic bioprosthetic valves is feasible but that mortality and morbidity remain high in these patients. This report is an evaluation of the feasibility, safety and efficacy of percutaneous aortic valve implantation (PAVI) with the CoreValve ReValvingTM System in the first 30 patients in our center.

Patients and methods

From October 2007 to June 2009 percutaneous aortic valve implantation was performed in thirty patients. A carefully designed clinical protocol was approved by the institutional research and ethical committee. This protocol included an independent data safety and monitoring board including an experienced interventional cardiologist.

After evaluation in a team of two interventional cardiologists, a cardiac surgeon, an echocardiographist and a cardioanaesthesiologist, 30 patients with severe symptomatic native aortic valve stenosis and a high surgical risk were selected to undergo PAVI. The patients were all considered poor surgical candidates with a high surgical risk: 21 patients were considered inoperable. All patients gave written informed consent.

Inclusion and exclusion criteria

Patients were considered as candidates for PAVI if the AS was severe i.e. aortic valve area $<1 \text{ cm}^2$ and symptomatic, the aortic annulus diameter of 20-27 mm, a sinotubular junction diameter $\leq 43 \text{ mm}$, and either patient age $\geq 80 \text{ years}$ or logistic
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EuroSCORE ≥15% or one or more of the following complicating factors: previous cardiac surgery, right ventricular insufficiency, pulmonary insufficiency, pulmonary hypertension, history of mediastinal radiotherapy, burning thoracic sequelae, severe connective tissue disease, liver cirrhosis, cachexia, morbid overweight, porcelain aorta and patients (n=9) who refused aortic valve surgery. Patients were considered not suitable for PAVI in case of known hypersensitivity or contraindication for aspirin, heparin, ticlopidine, clopidogrel or Nitinol, refusal of rescue aortic valve surgery by the patient if considered possible by the surgeon, sepsis (including active endocarditis), recent (<30 days) myocardial infarction, ventricular or atrial thrombus, previous surgical aortic valve replacement, evolutive or recent cerebrovascular accident, severe femoral, iliac or aortic stenosis, tortuosity or aneurysm (not applicable for PAVI via subclavian route), uncontrolled bleeding diathesis or coagulopathy, refusal of blood transfusion, and enrollment in another investigational study.

Figure 1: Implantation of the CoreValve prosthesis under fluoroscopic guidance (patient no. 7). A) Outer sheath is pulled back as a result of which the prosthesis can deploy. B) Maximally deployed prosthesis.

Transcatheter aortic valve procedure

The technique of PAVI with the CoreValve ReValving™ System has been described in previous studies.³ 4 6 Procedures were performed in the catheterization laboratory, with the patient under general anesthesia. Vascular access was obtained via the femoral artery (n=29) or left subclavian artery (n=1) and femoral vein. The procedure was initiated with a balloon valvuloplasty under rapid pacing using an Amplatz superstiff guidewire placed in the left ventricle (LV). Next, the CoreValve delivery system was advanced through the femoral artery or the subclavian artery (n=1) to the aortic annulus under fluoroscopic guidance. After reaching a correct
position of the delivery system the aortic valve prosthesis was deployed (figure 1A and B). After complete deployment of the prosthesis, valve position and function were assessed with angiography and transoesophageal echocardiography and if necessary a postdilatation of the valve was performed (n=2).

Follow-up and endpoints
Clinical follow-up, blood analysis and transthoracic echocardiography were obtained before discharge and at 1 month after discharge. Three feasibility endpoints were defined: (1) device success, (2) acute procedural success and (3) the occurrence of major adverse cardiovascular and cerebral events (MACCEs) within 30 days follow-up. (1) Device success was defined as stable device placement and adequate function as assessed by angiography and echocardiography. (2) Acute procedural success: device success with absence of periprocedural MACCEs in the first 48h after device implantation. The combined endpoint of MACCEs includes death from any cause, myocardial infarction, cardiac tamponade, stroke, urgent or emergent conversion to surgery or balloon valvuloplasty, emergent percutaneous coronary intervention, cardiogenic shock, endocarditis, aortic dissection or major bleeding. Other clinical endpoints were the presence of symptoms, New York Heart Association (NYHA) class and cardiac function and valve performance measured with echocardiography.

Statistical analysis
Statistical analysis was performed using SPSS 16.0.1. Descriptive summaries of the distributions of continuous baseline variables are presented in terms of frequencies and percentages. Categorical variables are presented as frequencies and compared by a binomial test or a Fisher’s exact probability test. Continuous variables are presented as mean ± standard deviation (SD). A paired Student t test for within group comparison of continuous variables is used. Values of P<0.05 is considered statistically significant.

Results
Patient population
Between October 2007 and April 2009, 30 patients (15 men, 15 women; mean age 80.5 years; range 55 to 89 years) underwent a PAVI. Baseline patient characteristics are shown in table 1. All patients had a severe symptomatic AS with an echocardiographic peak transvalvular aortic gradient of 79±25 mmHg, a mean gradient of 52±20 mmHg and a mean calculated aortic valve area of 0.71±0.19 cm². Twenty-three patients were in
NYHA functional class of III or IV. The predicted inhospital mortality rates were 15±10% according to the logistic EuroSCORE and 5.2±2.9% according to the Society of Thoracic Surgeons (STS) score in case of cardiac surgery. Table 2 shows the comorbidity and contraindications for heart surgery of the individual patients.

<table>
<thead>
<tr>
<th>TABLE 1. Baseline patient characteristics (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender, n (%)</td>
</tr>
<tr>
<td>Age, y, mean ± SD</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
</tr>
<tr>
<td>Chronic renal insufficiency,a n (%)</td>
</tr>
<tr>
<td>Peripheral vascular disease,b n (%)</td>
</tr>
<tr>
<td>Coronary artery disease, n (%)</td>
</tr>
<tr>
<td>Congestive heart failure, n (%)</td>
</tr>
<tr>
<td>Prior myocardial infarction, n (%)</td>
</tr>
<tr>
<td>Prior stroke, n (%)</td>
</tr>
<tr>
<td>Prior bypass graft surgery, n (%)</td>
</tr>
<tr>
<td>Prior percutaneous coronary intervention, n (%)</td>
</tr>
<tr>
<td>Chronic atrial fibrillation, n (%)</td>
</tr>
<tr>
<td>Chronic pulmonary disease,c n (%)</td>
</tr>
<tr>
<td>Pulmonary hypertension,d n (%)</td>
</tr>
<tr>
<td>Permanent pacemaker, n (%)</td>
</tr>
<tr>
<td>NYHA class, n (%)</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
<tr>
<td>IV</td>
</tr>
<tr>
<td>Left ventricular function, n (%)</td>
</tr>
<tr>
<td>Poor</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Logistic EuroSCORE, mean ± SD</td>
</tr>
<tr>
<td>STS Risk score, mean ± SD</td>
</tr>
<tr>
<td>Peak pressure gradient, mm Hg, mean ± SD</td>
</tr>
<tr>
<td>Mean pressure gradient, mm Hg, mean ± SD</td>
</tr>
<tr>
<td>Aortic valve area, cm², mean ± SD</td>
</tr>
</tbody>
</table>

a Renal insufficiency = estimated Glomerular filtration rate <60 using the 4-variable modified diet in renal disease (MDRD) equation: eGFR (ml/min/1.73 m²) = 32788 × serum creatinine⁻¹.₁₁⁵ × age⁻₀.₂₀₃ × 0.7₄₂ [if the patient is female] × 1.₂₁₀ [if the patient is black]. Where serum creatinine is in μg/dL, and age is in years.
b Peripheral vascular disease is defined by a history of symptomatic claudication, previous or planned intervention on abdominal aorta or limb arteries and/or evident peripheral arterial disease on angiogram.
c Chronic pulmonary disease = a history of respiratory problems associated with maintenance inhaled bronchodilator therapy.
d Pulmonary hypertension = Pulmonary artery systolic pressure >30 mmHg.
TABLE 2. Patient comorbidities and contraindications for surgery

<table>
<thead>
<tr>
<th>Patient</th>
<th>Gender</th>
<th>Age</th>
<th>Rejected for surgery</th>
<th>Comorbidity</th>
<th>Logistic EuroScore</th>
<th>STS Risk</th>
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<tr>
<td>1</td>
<td>M</td>
<td>76</td>
<td>Yes</td>
<td>Prior CABG; PVD</td>
<td>20.0</td>
<td>6.2</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>85</td>
<td>No</td>
<td>CAD</td>
<td>10.7</td>
<td>3.3</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>70</td>
<td>Yes</td>
<td>Pulmonary fibrosis (FEV₁: 47%), renal failure, obesity</td>
<td>5.0</td>
<td>4.6</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>76</td>
<td>Yes</td>
<td>Prior CABG; poor LV; 3VD; TMLR; PVD; renal failure</td>
<td>42.7</td>
<td>5.8</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>75</td>
<td>Yes</td>
<td>Severe COPD (FEV₁: 33%)</td>
<td>16.4</td>
<td>3.3</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>81</td>
<td>Yes</td>
<td>Prior stroke, obesity (BMI &gt; 30 kg/m²)</td>
<td>8.4</td>
<td>9.0</td>
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<tr>
<td>7</td>
<td>M</td>
<td>84</td>
<td>No</td>
<td>SSS with cRBBB</td>
<td>7.5</td>
<td>1.8</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>81</td>
<td>Yes</td>
<td>Pectus excavatum</td>
<td>6.2</td>
<td>1.9</td>
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<tr>
<td>9</td>
<td>F</td>
<td>77</td>
<td>Yes</td>
<td>Severe COPD (FEV₁: 37%)</td>
<td>10.4</td>
<td>8.4</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>88</td>
<td>Yes</td>
<td>DDD pacemaker (bradycardia)</td>
<td>12.8</td>
<td>5.5</td>
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<tr>
<td>11</td>
<td>F</td>
<td>74</td>
<td>Yes</td>
<td>Previous MVR (mechanical), moderate COPD (FEV₁: 64%)</td>
<td>35.7</td>
<td>5.4</td>
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<tr>
<td>12</td>
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<td>Yes</td>
<td>Severe COPD (FEV₁: 23%)</td>
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<td>3.7</td>
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<tr>
<td>13</td>
<td>M</td>
<td>78</td>
<td>Yes</td>
<td>Prior CABG, porcelain aorta</td>
<td>24.1</td>
<td>3.0</td>
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<tr>
<td>14</td>
<td>F</td>
<td>87</td>
<td>No</td>
<td>No important</td>
<td>17.3</td>
<td>4.8</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
<td>84</td>
<td>Yes</td>
<td>Obesity (BMI &gt; 30 kg/m²)</td>
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<td>3.6</td>
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<tr>
<td>16</td>
<td>F</td>
<td>87</td>
<td>Yes</td>
<td>Bifascicular block</td>
<td>12.1</td>
<td>4.9</td>
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<tr>
<td>17</td>
<td>M</td>
<td>86</td>
<td>Yes</td>
<td>Prior stroke, anemia</td>
<td>13.2</td>
<td>2.2</td>
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<tr>
<td>18</td>
<td>F</td>
<td>84</td>
<td>No</td>
<td>Renal failure</td>
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<td>4.1</td>
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<tr>
<td>19</td>
<td>M</td>
<td>88</td>
<td>Yes</td>
<td>Renal failure</td>
<td>16.9</td>
<td>7.6</td>
</tr>
<tr>
<td>20</td>
<td>M</td>
<td>85</td>
<td>No</td>
<td>Moderate LVF, PVD</td>
<td>11.6</td>
<td>8.8</td>
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<tr>
<td>21</td>
<td>F</td>
<td>89</td>
<td>Yes</td>
<td>Prior chest radiation</td>
<td>13.6</td>
<td>7.0</td>
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<tr>
<td>22</td>
<td>F</td>
<td>82</td>
<td>No</td>
<td>No important</td>
<td>9.0</td>
<td>3.8</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>72</td>
<td>Yes</td>
<td>Poor LV, PVD</td>
<td>9.8</td>
<td>3.9</td>
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<td>24</td>
<td>F</td>
<td>55</td>
<td>Yes</td>
<td>Obesity (BMI = 45 kg/m²)</td>
<td>2.1</td>
<td>1.5</td>
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<td>25</td>
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<td>67</td>
<td>Yes</td>
<td>Severe LVH, T-cell lymphoma</td>
<td>2.5</td>
<td>9.8</td>
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<tr>
<td>26</td>
<td>F</td>
<td>89</td>
<td>No</td>
<td>Mild COPD</td>
<td>13.6</td>
<td>4.7</td>
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<tr>
<td>27</td>
<td>F</td>
<td>87</td>
<td>No</td>
<td>No important</td>
<td>12.1</td>
<td>3.8</td>
</tr>
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<td>28</td>
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<td>Yes</td>
<td>Severe cachexia</td>
<td>8.0</td>
<td>3.5</td>
</tr>
<tr>
<td>29</td>
<td>F</td>
<td>77</td>
<td>No</td>
<td>Mild COPD</td>
<td>16.9</td>
<td>4.7</td>
</tr>
<tr>
<td>30</td>
<td>F</td>
<td>88</td>
<td>Yes</td>
<td>Moderate LVF, PVD</td>
<td>45.8</td>
<td>15.1</td>
</tr>
</tbody>
</table>

CABG, coronary artery bypass grafting; PVD, peripheral vascular disease; CAD, coronary artery disease; FEV₁, Forced expiratory volume in 1 second; LVF, left ventricular function; 3VD, trivascular coronary artery disease; TMLR, transmyocardial laser revascularization; COPD, chronic obstructive pulmonary disease; BMI, body mass index; SSS, sick sinus syndrome; cRBBB, complete right bundle branch block; MVR, mitral valve replacement; LVH, left ventricular hypertrophy.

Clinical outcomes

Procedural data (table 3) Device success was achieved in all 30 PAVI patients. Acute procedural success rate was 90% (27 patients), due to MACCEs in 3 patients within 48 hours after device implantation (described hereafter).

30 days mortality (table 3) At 30 days follow-up, the mortality rate was 20% (6 patients), which included 1 cardiovascular death and 5 non-cardiovascular
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deaths. The cardiovascular death involved a 76-year-old man (patient 4) with a prior CABG, a poor LV function, three vessel coronary artery disease with only one functioning jump-graft, severe peripheral arterial disease and renal insufficiency, who was therefore rejected for surgery. During the procedure the patient developed a retroperitoneal hematoma after injury of the right iliac artery, which was treated with a covered stent and blood transfusion. A few hours after PAVI he died however of hypovolemic and cardiogenic shock on the intensive care unit (ICU). Autopsy showed extensive myocardial fibrosis due to previous performed transmyocardial laser therapy and multiple myocardial infarctions. The cause of death was deemed to acute heart failure due to hypotension caused by bleeding in a patient with a preprocedural poor left ventricular function. The valve position was good with no obstruction of the coronary ostia or venous bypass graft ostium.

Of the five non-cardiovascular related deaths, two patients (patients 3 and 9) died of respiratory failure due to an exacerbation of their pre-existent chronic pulmonary disease (severe pulmonary fibrosis and severe COPD, respectively). The other non-cardiovascular deaths involved three patients (no. 16, 21 and 25) who died of infectious complications: 1 patient died one week after PAVI on the ICU as a direct consequence of sepsis, probably caused by an infection of the central venous line or external pacemaker wire. Two patients died eventually of an aspiration pneumonia, one week and three weeks after PAVI, respectively. Both patients were in a poor clinical condition, due to renal failure in one patient and severe left ventricular hypertrophy with obliteration and advanced stage T-cell lymphoma in the other patient. No autopsy was performed in the three patients who died of infectious causes.

**Other 30 days MACCE’s (table 3).** An 85-year-old lady (patient 2), developed a cardiac tamponade one day after PAVI caused by an incorrect removal of the right ventricular external pacemaker wire. This was initially treated with pericardial drainage but required surgical repair. She recovered uneventfully and resumed her former activities.

**Echocardiographic evaluation (table 4).** The peak transvalvular aortic pressure from the patients who were alive after 30 days, decreased from 76±24 mmHg preprocedurally to 22±7 mmHg (n=24, P<0.00001) a few days after the procedure (figure 2) and the aortic valve area increased from 0.69±0.18 cm² to 2.0±0.6 cm² (n=24, P<0.00001; figure 3).
### TABLE 3. Procedural data and 30 days MACCEs and outcome (n=30)

<table>
<thead>
<tr>
<th>Device success, n (%)</th>
<th>30 (100.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute procedural success, n (%)</td>
<td>27 (90.0)</td>
</tr>
<tr>
<td>Predilatation balloon diameter, mm, mean±SD</td>
<td>22.9±2.4</td>
</tr>
<tr>
<td>Median procedure time, min, mean±SD</td>
<td>90±29</td>
</tr>
<tr>
<td>Postdilatation, n (%)</td>
<td>2 (6.7)</td>
</tr>
</tbody>
</table>

**MACCEs within 30 days, n (%)**

- Death: 6 (20.0) <sup>a-f</sup>
- Major arrhythmia: 0 (0.0)
- Myocardial infarction: 0 (0.0)
- Cardiac tamponade: 2 (6.7) <sup>d, g</sup>
- Cardiogenic shock: 1 (3.3) <sup>b</sup>
- Respiratory failure: 3 (10.0) <sup>a, c, f</sup>
- Stroke: 0 (0.0)
- Conversion to surgery: 0 (0.0)
- Conversion to valvuloplasty: 0 (0.0)
- Emergent PCI: 0 (0.0)
- Endocarditis: 0 (0.0)
- Aortic dissection: 0 (0.0)
- Major bleeding: 1 (3.3) <sup>b</sup>

**Other events within 30 days, n (%)**

- Bradyarrhythmia: 9 (30.0)
- New permanent pacemaker: 7 (23.3)
- New left bundle branch block: 18 (60.0)

**Median duration of admission, days, mean±SD**

- Intensive Care Unit: 2±6
- Hospital: 10±6

*MACCEs*, Major adverse cardiovascular and cerebral events; *PCI*, percutaneous coronary intervention.

<sup>a</sup> Patient no. 3; <sup>b</sup> Patient no. 4; <sup>c</sup> Patient no. 9; <sup>d</sup> Patient no. 16; <sup>e</sup> Patient no. 21; <sup>f</sup> Patient no. 25; <sup>g</sup> Patient no. 2

### TABLE 4. Postprocedure Hemodynamic Valve Performance in Patients With Immediate Procedural Success (see also figures 2 and 3)

<table>
<thead>
<tr>
<th>Before implantation (n=30)</th>
<th>At discharge (n=24)</th>
<th>At 30 day follow-up (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak pressure gradient, mmHg, mean±SD</td>
<td>79±25</td>
<td>22±7</td>
</tr>
<tr>
<td>Mean pressure gradient, mmHg, mean±SD</td>
<td>52±20</td>
<td>13±5</td>
</tr>
<tr>
<td>Aortic valve area, cm², mean±SD</td>
<td>0.71±0.19</td>
<td>2.0±0.6</td>
</tr>
<tr>
<td>Aortic regurgitation (AR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Mild</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Moderate</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
**Figure 2:** Improvements in aortic valve mean pressure before and after PAVI (n=30).

**Figure 3:** Improvements in aortic valve area before and after PAVI (n=30).
Other clinical outcomes. Of the 24 patients who were alive after 30 days follow-up 23 were clinically improved, as partially expressed by the improvement of NYHA class (figure 4). One patient, who was treated with PAVI via a subclavian access route, did not improve clinically after the procedure, eventhough postprocedural echocardiography showed a good function of the prosthetic valve. None of the surviving 24 patients had any major adverse events within 30-day follow-up after PAVI. Repeat echocardiography 1 month after discharge showed a stable position of the device with sustained performance of the prosthetic valve compared with the immediate postprocedural echo. Figure 5 shows the stable position of the CoreValve prosthesis on a cardiac MRI, performed in one of the patients six months after PAVI.

Postmortem device assessment. Autopsy which was performed in three deceased patients showed good position of the prosthetic valve device and no device-related complication as cause of the deaths (figure 5). All coronary and bypass graft ostia were patent and no structural damages were observed.

![Figure 4: Improvements in New York Heart Association functional class before and one month after PAVI (n=24, P=0.002).](image)
Figure 5: Coronal MRI image of the heart with the CoreValve prosthesis in situ, 6 months after implantation (patient no. 7).

Figure 6: Postmortem with a caudal view of the aortic root and the CoreValve prosthesis in situ (patient no. 9).
Discussion

This study shows that percutaneous aortic valve implantation performed in patients with a high-risk for conventional treatment is feasible in our center. Direct device success was achieved in all patients. Proper and fixed device position without obstruction of coronary ostia was reached in all patients directly after implantation, demonstrated by means of angiography. This was confirmed in the post-mortem assessments of three patients. Maintenance of stable device position at 30 days after PAVI was shown in the other 24 patients by means of transthoracic echocardiography. Feasibility of PAVI has also been demonstrated by the instantaneous improvement of aortic valve performance with a marked reduction of the transvalvular pressure gradient, which sustained after 30 days follow-up. Hemodynamic improvement translated in the relief of symptoms after PAVI in at least 18 of the 24 patients at 30 days follow-up.

The postprocedural 30 days mortality rate of 20% (patients) is considerably higher than the predicted mortality rate according to the logistic EuroSCORE. However, there was only one cardiovascular death, which involved an extreme high risk patient (patient 4). The other five deaths, which were not cardiovascular, occurred between one week and one month after the procedure and were caused by an exacerbation of pre-existing pulmonary disease and infectious complications. It is of important notice that all six deceased patients were highly symptomatic, had a poor prognosis and were declined for conventional aortic valve replacement. Patient characteristics, device success and acute procedural success rates and occurrences of postprocedural MACCEs of our study are comparable with those reported by Grube et al. and Webb et al.\textsuperscript{4,5,7}

An important lesson that can be learned from this study is that the mortality risk of PAVI is substantial in patients with comorbidity who does not tolerate general anaesthesia nor temporary hypotension. A critical patient selection, in which appropriate risk stratification and proper outweighing of the expected benefits against the risks of PAVI are essential, may reduce the mortality rate.

The decision to perform PAVI as a “last resort treatment” on this high risk patient group should only be made after the risks of the procedure have been properly discussed with and accepted by the patient. Performing PAVI in the six patients who deceased in the 30 day follow-up period of this study had been a well-considered choice of both patient and relatives.

Another lesson from this study is that PAVI’s can be performed with good results in patients who are not rejected for surgery and/or have an intermediate risk for surgical treatment. Such an approach would expand the indication to perform PAVI in patients with lower risks for a surgical valve replacement, i.e. patients, specifically at older age who prefer a less invasive treatment.
The costs of these novel treatment techniques are mainly determined by the high cost of the new devices. However, the shorter ICU and hospital stay as well as the shorter rehabilitation may eventually result in a more cost-effective treatment.

Conclusion

We report the successful initiation of our percutaneous aortic valve implantation program. Before initiation we drew up a specific protocol, in which the feasibility and safety parameters were defined. Feasibility and safety of this procedure by means of the CoreValve self-expandable device is shown by the high rates of direct and acute device success and a direct and long-term hemodynamic improvement in the majority of the patients. However, the postprocedural mortality and morbidity rates remain high in patients who have severe comorbidities. When successful, PAVI can reduce symptoms and improve quality of life in patients with severe symptomatic aortic stenosis who are considered at high risk for conventional aortic valve surgery.

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