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Early outcomes of percutaneous pulmonary valve implantation using the Edwards SAPIEN XT transcatheter heart valve system

Nikolaus A. Haas [a,b,*], Ronald Giacomo Carere [c], Oliver Kretschmar [d], Eric Horlick [e], Josep Rodés-Cabau [f], Daniël de Wolf [g], Marc Gewillig [h], Michael Mullen [i], Anja Lehner [a], Cornelia Deutsch [j], Peter Bramlage [j], Peter Ewert [k]

[a] Department of Pediatric Cardiology, Pediatric Intensive Care, LMU, München, Germany
[b] Centre for Congenital Heart Defects, Heart and Diabetes Centre Bad Oeynhausen, Ruhr University Bochum, Bad Oeynhausen, Germany
[c] St. Paul's Hospital, Vancouver, Canada
[d] University Children's Hospital Zurich, University Hospital Zurich, Switzerland
[e] Toronto General Hospital, Toronto, Canada
[f] Quebec Heart and Lung Institute, Laval University, Quebec City, Quebec, Canada
[g] Gent University Hospital, Belgium
[h] ZU Gasthuisberg, Belgium
[i] The Heart Hospital, London, UK
[j] Institute for Pharmacology and Preventive Medicine, Cloppenburg, Germany
[k] Department of Pediatric Cardiology and Congenital Heart Disease, German Heart Centre Munich, Technical University Munich, Germany

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ABSTRACT

Background: Patients with congenital or acquired heart defects affecting the pulmonary valve and right ventricular outflow tract (RVOT) commonly require multiple surgical interventions, resulting in significant morbidity. A less invasive alternative is percutaneous pulmonary valve implantation (PPVI). Though studies have previously reported the safety and efficacy of the early generation transcatheter heart valves (THVs), data on more recent devices are severely lacking.

Methods and results: We performed a multinational, multicentre, retrospective, observational registry analysis of patients who underwent PPVI using the Edwards SAPIEN XT THV. Of the 46 patients that were enrolled, the majority had tetralogy of Fallot as the underlying diagnosis (58.7%), and stentless xenograft as the most common RVOT anatomy (34.8%). Procedural success rate was high (93.5%), with a low frequency of periprocedural complications and adverse events (6.5% and 10.9%, respectively). At 30 days post-procedure, NYHA class had improved significantly (90.6% were at NYHA I or II). The rate of moderate/severe pulmonary regurgitation had decreased from 76.1% at baseline to 5.0% at 30 days, and the calculated peak systolic gradient had decreased from 45.2 (SD ± 21.3) mm Hg to 16.4 (SD ± 8.0) mm Hg, with these values remaining low up to 2 years.

Conclusions: The data suggest the efficacy and safety of the SAPIEN XT THV in PPVI in common anatomies in patients with conduits, as well as those with native pulmonary valves or transannular patches. Continued data collection is necessary to verify long-term findings.

Clinicaltrials.gov identifier: NCT02302131.

1. Introduction

Malfunctioning pulmonary valves and alterations of the right ventricular outflow tract (RVOT) are frequent in many congenital heart defects. Typical examples include Tetralogy of Fallot (ToF), double outlet right ventricle (DORV), pulmonary stenosis (PS), pulmonary atresia (PA), truncus arteriosus (TA), transposition of the great arteries (TGA) with PS (Rastelli's Operation), absent pulmonary valve syndrome (Miller-Lev-Paul), and the Ross Procedure for aortic valve disease.

* Corresponding author at: Department of Pediatric Cardiology and Pediatric Intensive Care, Medical Hospital of the University of Munich, Marchioninistrasse 15, 81377 München, Germany.
E-mail addresses: nikolaus.haas@med.uni-muenchen.de (N.A. Haas), rcarere@providencehealth.bc.ca (R.G. Carere), oliver.kretschmar@kispi.uzh.ch (O. Kretschmar), eric.horlick@uhn.ca (E. Horlick), josep.rodes@criucpq.ulaval.ca (J. Rodés-Cabau), daniel.dewolf@uzgent.be (D. de Wolf), marc.gewillig@uzleuven.be (M. Gewillig), michael.mullen@ucln.nhs.uk (M. Mullen), anja.lehner@med.uni-muenchen.de (A. Lehner), cornelia.deutsch@ippmed.de (C. Deutsch), peter.bramlage@ippmed.de (P. Bramlage), ewert@dhm.mhn.de (P. Ewert).

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Surgical correction involves the repair or replacement of the native RVOT using biological valves such as homografts, bioprostheses, or xenografts. These valve corrections frequently become dysfunctional within 3 to 20 years after the primary intervention, depending on patient's age and size. This results in the requirement for a further pulmonary valve replacement procedure. An emerging, less invasive treatment option that aims to reduce the considerable morbidity associated with repeat operations is percutaneous pulmonary valve implantation (PPVI) [1,2].

Until recently, the Medtronic Melody and Edwards SAPIEN transcatheter heart valves (THVs) were the only registered devices for this purpose, with the Melody valve available in diameters of 18, 20, and 22 mm, and the Edwards SAPIEN valve being available in diameters of 23 and 26 mm [3–6]. On-going developments in THV design have led to the next generation SAPIEN XT being available in sizes of 20, 23, 26, and 29 mm (for further details see Supplementary Table 1); however, there is a clear need for data on the new valve technology. For this reason, we began to retrospectively collect the available data on SAPIEN XT implants in the pulmonic position, and to follow the identified patients within the structured environment of a multicentre registry. We aimed to describe patient experiences, and to document the feasibility and safety of using the SAPIEN XT THV for PPVI.

2. Methods

Pulmonic XT is an investigator-initiated, multicentre, observational registry collecting data on patients undergoing PPVI using the SAPIEN XT technology (Supplementary Fig. 1). The project was registered with clinicaltrials.gov in November 2014 and assigned the registration number NCT02302131. Enrolment was carried out either retrospectively or at the time of the procedure, with a retrospective and/or prospective follow-up, depending on the time of recruitment relative to implantation. All patients provided written informed consent and the respective ethics committees at each centre granted approval prior to patient documentation. The study was performed in accordance with the Declaration of Helsinki and its amendments.

2.1. Centres

Based on information provided by the core group of participating centres and Edwards Lifesciences, we estimated that approximately 23 centres globally (excluding the United States) had performed at least one PPVI using SAPIEN XT technology, with an approximate total of 92 patients receiving the valve (estimated range 77 to 120). We approached all 23 centres in November 2014 to initiate data collection. These included centres in Europe (Belgium, Switzerland, Germany, Netherlands, UK, Sweden, Italy, France), the Middle East (Israel, Saudi Arabia), North America (Canada), and Australia.

2.2. Patients

Patients with a clinical indication for PPVI who had undergone or were undergoing the procedure using the SAPIEN XT THV were eligible, provided that they supplied signed data release and informed consent. So as to cover the broadest possible spectrum of patients undergoing PPVI, no exclusion criteria were stipulated.

2.3. Endpoints

The endpoints of this registry were selected in order to evaluate the feasibility and safety of implanting a SAPIEN XT THV in the pulmonic position. The procedural and clinical outcome data collected were based on the standards of care for PPVI at each individual participating site. Examinations may include (but are not limited to) physical assessments, ECG, exercise testing, laboratory results, X-rays, angiograms, CT/MRI scans, and transthoracic and/or transoesophageal echocardiography.

Short-term outcomes included right ventricular (RV) and pulmonary artery (PA) pressures, maximum flow velocity RVOT, degree of pulmonary regurgitation, peak gradients, procedural success, and length of hospitalisation (from admission to discharge). Long-term outcomes included changes in New York Heart Association (NYHA) class; peak oxygen consumption (VO_2); anaerobic threshold (AT); device function; and evidence of structural valve deterioration, including stent fracture. Safety outcomes were device malfunction; arrhythmia; coronary compression; neurologic impairment; conduit/RVOT rupture; stent dislocation/THV dislocation; bleeding complications; need for surgical correction; endocarditis of the implanted valve; and any cardiovascular events, including death, myocardial infarction, coronary compression, pulmonary embolism, and stroke/transient ischemic attack (TIA).

2.4. Data collection

Authors collectively designed a case report form to accommodate the broadest possible spectrum of clinical situations in which PPVI may be indicated. Data collection was paper-based, with investigators transferring the obtained data (via letter, fax, or email) to the coordinating centre at the Institute for Pharmacology and Preventive Medicine (IPPMed, Cloppenburg, Germany). Double data entry was carried out by data managers to transfer the information to the *Pulmonic XT* database.

Follow-up time points were defined as follows: 30 days (post intervention up to and including 30 days), 6 months (>30 days and up to and including 6 months), 1 year (>6 months and up to and including 1 year), and 2 years (>1 years and up to and including 2 years).

2.5. Statistics

For categorical variables (e.g. gender) frequency distributions are given. For numerical variables (e.g. patient age) means with standard deviations (SD) and medians with ranges are given. Statistical analysis was performed using SPSS Statistics 23.0 (SPSS, Inc., Chicago, IL).

3. Results

A total of eight centres participated in the registry. Five of the 23 approached centres were unresponsive to the invitation to participate, five declined participation, and five did not deliver data. Up until May 31st 2017, the 8 participating centres provided data on a total of 46 patients (range 1 to 21 patients per centre). This corresponds to 50.5% of the 91 patients estimated to have received an implant up to this time point. Follow-up was 89.1% at day 30 (n = 41), 65.2% at 6 months (n = 30), 41.3% at 1 year (n = 19), and 41.3% at 2 years (n = 19). Three patients died during the extended follow-up (>30 days).

3.1. Patient characteristics

At baseline, the mean age was 29.0 (SD ± 14.1) years (range 9–64 years, median 27.5 years) and 28.3% were female (13/46) (Table 1). The majority of patients (27/46; 58.7%) had ToF as the underlying primary diagnosis, followed by 5 patients with truncus arteriosus (10.9%) and 4 patients who had undergone a Ross Procedure (8.7%). Of the two patients with simple PS as a primary diagnosis, one also had

Table 1
Patient characteristics.

	n/N (%)/mean ± SD/median (range)
Age [years]	29.0 ± 14.1
	27.5 (9–64) (N = 46)
Female gender	13/46 (28.3)
Weight [kg]	71.3 ± 20.5
	68.7 (22−110) (N = 46)
Height [cm]	167.8 ± 13.8
	172.5 (130–189) (N = 46)
Prior endocarditis	4/43 (9.3)
Underlying diagnosis	
ToF	27/46 (58.7)
Pulmonary atresia with VSD	3/46 (6.5)
Pulmonary atresia without VSD	3/46 (6.5)
Truncus arteriosus	5/46 (10.9)
Hx of Ross Procedure	4/46 (8.7)
TGA	2/46 (4.3)
Pulmonary stenosis	2/46 (4.3)
RVOT anatomy prior to valve implantation	
Native RVOT/PS	5/46 (10.9)
Transannular patch	6/46 (13.0)
Homograft	8/46 (17.4)
Stentless xenograft	16/46 (34.8)
Others (Carpentier-Edwards, Hancock etc.)	11/46 (23.9)

Legend: n, number of patients with variable; N, number of patients with data available; ToF, Tetralogy of Fallot; TGA, Transposition of the great arteries; DORV, double-outlet right ventricle; RVOT, right ventricular outflow tract; PS, pulmonary stenosis; SD, standard deviation.

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