Electrocardiographic and electrophysiological predictors of atrioventricular block after transcatheter aortic valve replacement

Lena Rivard, MD, MSc, Gernot Schram, MD, PhD, Anita Asgar, MD, Paul Khairy, MD, PhD, Jason G. Andrade, MD, Raoul Bonan, MD, Marc Dubuc, MD, FHRS, Peter G. Guerra, MD, Reda Ibrahim, MD, Laurent Macle, MD, Denis Roy, MD, FHRS, Mario Talajic, MD, FHRS, Katia Dyrda, MD, Azadeh Shohoudi, PhD, Jean-Benoit le polain de Waroux, MD, PhD, Bernard Thibault, MD, FHRS

From the Department of Cardiology at the Montreal Heart Institute and the Université de Montréal, Montreal, Canada.

BACKGROUND Electrophysiological predictors of atrioventricular (AV) block after transcatheter aortic valve replacement (TAVR) are unknown.

OBJECTIVE We sought to assess the value of electrophysiology study before and after TAVR.

METHODS Seventy-five consecutive pacemaker-free patients undergoing TAVR at the Montreal Heart Institute were prospectively studied.

RESULTS Eleven patients (14.7%) developed AV block during the index hospitalization and 3 (4.0%) after hospital discharge over a median follow-up of 1.4 years (interquartile range 0.6–2.1 years). AV block developed in 5 of 6 patients with preprocedural right bundle branch block (83.3%), 8 of 30 patients with new-onset left bundle branch block (LBBB; 26.7%), and 1 of 7 patients with preexisting LBBB (14.3%). In multivariate analysis that considered all patients, the delta-HV interval (HV interval after TAVR minus HV interval before TAVR) was the only factor independently associated with AV block. In the subgroup of patients with new-onset LBBB, the postprocedural HV interval was strongly associated with AV block. By receiver operating characteristic analysis, a delta-HV interval of $\geq$13 ms predicted AV block with 100.0% sensitivity and 84.4% specificity and an HV interval of $\geq$65 ms predicted AV block with 83.3% sensitivity and 81.6% specificity. In multivariate analysis, the HV interval after TAVR (hazard ratio 1.073 per ms; 95% confidence interval 1.029–1.119; $P = .001$) was also independently associated with all-cause mortality.

CONCLUSION A prolonged delta-HV interval ($\geq$13 ms) is strongly associated with AV block after TAVR. In patients with new-onset LBBB after TAVR, a postprocedural HV interval of $\geq$65 ms is likewise predictive of AV block.

KEYWORDS Aortic valve implantation; Aortic valve; Electrophysiology study; Atrioventricular block; Pacemakers

ABBREVIATIONS **AV** = atrioventricular; **CI** = confidence interval; **ECG** = electrocardiographic; **EP** = electrophysiological; **HR** = hazard ratio; **IQR** = interquartile range; **LBBB** = left bundle branch block; **LVOT** = left ventricular outflow tract; **PPM** = permanent pacemaker; **RBBB** = right bundle branch block; **TAVR** = transcatheter aortic valve replacement

(Heart Rhythm 2015;12:321–329)

Introduction

Over the last decade, transcatheter aortic valve replacement (TAVR) has emerged as an alternative treatment of severe aortic valve stenosis in patients at high operative risk of traditional surgical aortic valve replacement.[1,2] As with conventional surgery, new or worsened high-degree atrioventricular (AV) block necessitating permanent pacemaker (PPM) implantation has been reported after TAVR. It is thought that TAVR results in an increased likelihood of native conduction system damage owing to a combination of significantly greater patient comorbidity and the mechanism of TAVR deployment. While AV block has been reported with all percutaneous valves, the rates of PPM implantation appear higher with the CoreValve (Medtronic Inc, Minneapolis, MN) as compared with the SAPIEN percutaneous valve (Edwards Lifesciences Corporation, Irvine, CA) (ie, 19.2%–42.5% with CoreValve vs 7%–22% with SAPIEN).[2–4] We sought to determine the prevalence and predictors of complete AV block after TAVR and explore the value of electrophysiological (EP) study before and after TAVR.

Dr Asgar and Dr Bonan are proctors for Medtronic. Dr Bonan is a consultant for Medtronic. Dr Guerra has received lecture fees from St Jude Medical. Dr Talajic has received a grant from and is on the consulting board of Medtronic. Dr Thibault has received consulting fees from Medtronic.

Address reprint requests and correspondence: Dr Lena Rivard, Department of Electrophysiology, Montreal Heart Institute, 5000 Belanger St East, Montreal, Quebec, Canada H1T1C8. E-mail address: lena.rivard@umontreal.ca.

1547-5271/$-see front matter http://dx.doi.org/10.1016/j.hrthm.2014.10.023

Methods

Study population

Between January 2009 and July 2012, 75 consecutive patients with no prior PPM underwent TAVR at the Montreal Heart Institute. All patients were considered to have a prohibitively high risk of open heart surgery on the basis of a combination of Logistic EuroSCORE (ie, expected mortality >20%) and clinical judgment, and following consensus of a multidisciplinary committee including a cardiac surgeon, an interventional cardiologist, and a clinical cardiologist. The study was approved by the hospital ethics committee, and informed consent was obtained in all cases.

Data collection

EP studies were performed before and after TAVR under conscious sedation. Through femoral venous access, two 5-F quadripolar catheters were advanced into the heart under fluoroscopic guidance. Baseline measurements (AH, HV, QRS, QT, and RR intervals) were made, and anterograde and retrograde properties of the AV node and His-Purkinje system were assessed by means of atrial and ventricular decremental pacing and extrastimuli. The proximal His bundle recording was selected in all patients, and the average of 10 HV measurements was retained for analysis. At the end of the preprocedural EP study, a temporary pacemaker lead with an active fixation mechanism was implanted via the right internal jugular vein into the right ventricle in all patients. Continuous telemetry was performed throughout the entire hospitalization. In addition, electrocardiographic (ECG) tracings were obtained at baseline (within 24 hours before TAVR), immediately after TAVR, and every 24 hours until hospital discharge. *Transient left bundle branch block (LBBB)* was defined as the occurrence of new LBBB that resolved before hospital discharge. *Persistent LBBB* was defined as any new-onset LBBB that persisted after hospital discharge. Echocardiographic measurements of the left ventricular outflow tract (LVOT) were averaged from transthoracic and transesophageal studies. LVOT dimensions were measured at the level of leaflet hinges.[5] The implantation height of the final prosthesis placement was measured in a fluoroscopic aortogram with the deployed catheter valve in a right anterior oblique projection that displayed the aortic valve in optimal alignment with all 3 leaflets visible en face. The *depth of delivery* was defined as the distance from the native aortic annular margin on the side of the non–coronary cusp and on the side of the left coronary cusp to the most proximal edge (deepest in the left ventricle) of the deployed prosthesis stent frame.[6]

Outcomes and follow-up

Primary outcome was complete AV block. For patients with a PPM implanted prophylactically before reaching this outcome, AV block was defined as electrocardiographically documented AV block or the absence of an intrinsic ventricular rhythm over 30 beats/min during PPM interrogation, with >90% paced ventricular beats. Intrinsic AV conduction was reassessed at each PPM interrogation by gradually decreasing the pacing rate to 30 beats/min. The secondary outcome was all-cause mortality.

After TAVR, PPMs were implanted in patients who developed complete AV block, had a 25% increase in the HV interval, or had an HV interval >60 ms on the postprocedural EP study. After hospital discharge, clinical visits were scheduled at 30 days, 6 months, 1 year, and yearly thereafter.

Statistical analysis

Continuous variables are expressed as mean ± SD or as median and interquartile range (IQR; 25th, 75th percentile), depending on whether they were normally distributed. Continuous variables were compared using analysis of variance or nonparametric Kruskal-Wallis test, where appropriate. Categorical variables are expressed as frequency and percentage and were compared using either the Cochran-Mantel-Haenszel or the Fisher exact test. Event-free survival was plotted using the Kaplan-Meier technique, with comparisons done by using log-rank tests. Factors associated with events (ie, AV block and all-cause mortality) were assessed in univariate and multivariate Cox proportional hazards models. Variables associated with P values <.05 in univariate analyses were considered in the multivariate model. A second multivariate analysis was performed using all the variables described previously, except for EP measurements before the procedure. Receiver operating characteristic analysis was performed to determine the best cutoff values for delta-HV interval, delta-QRS duration, and HV interval after TAVR. Values with the greatest discriminatory potential were selected on the basis of Youden's index.[7] Two-tailed P values <.05 were considered statistically significant. Analyses were performed using SAS software version 9.3 (SAS Institute Inc, Cary, NC).

Results

Patients

Seventy-five patients (mean age 81.9 ± 7.4 years; 64.0% men) underwent TAVR with either the self-expanding CoreValve (n = 66 [88.0%]) or the balloon-expandable Edwards SAPIEN transcatheter valve (n = 11 [14.7%]) between January 2009 and July 2012. Baseline and procedural characteristics are summarized in Table 1. Outcomes are listed in Table 2. The median length of hospitalization after TAVR was 10.0 days (IQR 8.5–11.5 days), and the median follow-up period was 1.4 years (IQR 0.6–2.1 years).

AV block after TAVR

A flowchart of outcomes is shown in Figure 1. Of the 75 patients, 11 patients (14.7%) developed AV block during hospitalization and 3 patients (4.0%) after hospital discharge. The median time to AV block was 2.0 days (IQR 0-5 days; range 0–30 days). None of the 11 patients with an Edwards SAPIEN device developed AV block or had PPM implantation.