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ScienceDirect
Journal of Electrocardiology 48 (2015) 637 – 642
JOURNAL OF Electrocardiology
www.jecgonline.com

Influence of QRS infarct score and QRS duration prior to transcatheter aortic valve replacement on follow-up left ventricular end systolic volume in patients with new persistent left bundle branch block

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Abstract

Background: New-onset left bundle branch block (LBBB) is a known complication during Transcatheter Aortic Valve Replacement (TAVR). This study evaluated the influence of pre-TAVR cardiac conditions on left ventricular functions in patients with new persistent LBBB post-TAVR.
Methods: Only 11 patients qualified for this study because of the strict inclusion criteria. Pre-TAVR electrocardiograms were evaluated for Selvester QRS infarct score and QRS duration, and left ventricular end-systolic volume (LVESV) was used as outcome variable.
Results: There was a trend towards a positive correlation between QRS score and LVESV of $r = 0.59$ ($p = 0.058$), while there was no relationship between QRS duration and LVESV ($r = -0.18$ [$p = 0.59$]).
Conclusion: This study showed that patients with new LBBB and higher pre-TAVR QRS infarct score may have worse post-TAVR left ventricular function, however, pre-TAVR QRS duration has no such predictive value. Because of the small sample size these results should be interpreted with caution and assessed in a larger study population.
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Keywords: Transcatheter aortic valve replacement; Left bundle branch block; Selvester QRS-score; QRS duration; TAVR; LBBB

Introduction

Symptomatic severe calcific aortic valve stenosis has a high mortality rate [1,2]. Transcatheter aortic valve replacement (TAVR) has recently emerged as a therapeutic option for patients who have high mortality risk with conventional surgical treatment [3]. Recent studies have shown, however, that TAVR can induce inter-ventricular conduction abnormalities such as left bundle branch block (LBBB) or atrio-ventricular (AV) block [4]. The reported incidence of new-onset LBBB after TAVR is between 16% and 40% [5], while complete AV-block occurs in 6%–13% of patients [6,7]. LBBB causes dyssynchronous left ventricular contraction that potentially compromises left ventricular function [8,9]. It was also shown that patients who developed new LBBB after TAVR are at higher risk for all-cause mortality [9], especially those in whom this LBBB persisted after hospital discharge [10].

Patients with new persistent LBBB have continuous dyssynchronous contractions that, unless compensated, can lead to dilation of the left ventricle (LV) and clinical development of heart failure [11]. However, it is unknown which pre-TAVR cardiac conditions are predictive of poor compensation for this dyssynchronous LV contraction caused by new-onset LBBB. These patients may have concomitant coronary artery disease, and the presence, location, and amount of myocardial scar pre-TAVR may have an influence on their compensation mechanisms. Also, a variable amount of left ventricular hypertrophy (LVH) has already occurred as compensation for the systolic overloading of aortic stenosis [1]. Calculated LV mass has a higher predicted value for detecting LVH than left ventricular wall thickness [12], and it would be interesting to know if patients with a higher

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http://dx.doi.org/10.1016/j.jelectrocard.2015.04.010
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pre-TAVR left ventricular mass (LVM) are more likely to compensate for new persisting LBBB.

We investigated the predictive values of pre-TAVR LV scar (estimated by QRS score) and LV mass (estimated by QRS duration). We tested the hypotheses that there are correlations between pre-TAVR higher Selvester QRS scores and/or longer QRS duration and an increase in left ventricular end-systolic volume (LVESV) at 6–12 months of follow-up.

Methods

Study population

This is a retrospective study, utilizing information from Duke University Medical Center clinical databases, between April 2011 and May 2014. The Duke Cardiovascular Disease Database, the Duke Echocardiology Lab and hospital administrative resources provided data for these assessments. The study was approved by the Duke University Institutional Review Board.

To be included in this study, patients were required to have a TAVR procedure with either Edwards SAPIEN™ valve or Corevalve™. They also received both pre-interventional screening and 6–12 months post-interventional follow-up ECGs and echocardiography studies. The QRS complexes on the post-TAVR ECGs had to meet the strict LBBB criteria, proposed by Strauss et al. [13] (n = 22). Exclusion criteria were LBBB on ECG before TAVR (n = 3), atrial fibrillation on ECG (n = 3), lack of a pair of echocardiograms of sufficient quality to determine outcome (n = 2) and atrial fibrillation on the echocardiogram post-TAVR (n = 3). Finally, 11 patients met the inclusion criteria for this study.

Electrocardiographic analysis

Standard resting 12-lead ECGs (0.5–150 Hz, 25 mm/s, 10 mm/mV) were evaluated for strict LBBB [13], Selvester QRS score [14], and QRS duration from three different time points: the ECGs pre-TAVR, immediately post-TAVR and at 6–12 months follow-up. We used the electronically determined QRS duration and confirmed it manually. ECGs were analyzed by two independent investigators (LH, GW) who were blinded to any echocardiographic data. Disagreements were resolved by consensus.

Strict LBBB

For the evaluation of LBBB we used the criteria for strict LBBB by Strauss et al. [13]. These criteria include: QS or rS in lead V1, QRS duration of ≥ 140 ms in men and ≥ 130 ms in women, and mid-QRS notch/slurring in ≥ 2 leads of V_1, V_2, V_5, V_6, I and/or aVL.

Selvester QRS score

The modified Selvester QRS score was used for estimating myocardial scar location and size, depending on the presence of confounding factors [14]. Of a maximum of 31 points that can be given, each point resembles 3% infarct of the left ventricular myocardium. Presence of left ventricular hypertrophy was also evaluated based on the Romhilt–Estes criteria, since these criteria evaluate multiple aspects (e.g. QRS duration) of the ECG [15].

Echocardiographic analysis

Complete standard resting 2-dimensional (2D) and Doppler echocardiograms were performed on all patients, as a part of standard clinical care. The echocardiograms retrieved were pre-TAVR, and after 6–12 months post-TAVR. A single experienced reader, blinded to ECG findings, measured all echocardiograms for analysis (FA). Baseline measurements included: septal wall thickness (SWT), left ventricle end-diastolic dimension (LVEDD), posterior wall thickness (PWT), left ventricle end-systolic dimension (LVESD) and the mean measurement (from apical 2-chamber and apical 4-chamber) for left ventricular end-systolic volume (LVESV), left ventricular end-diastolic volume (LVEDV) and aortic valve peak pressure gradient (AVP PPG). Also, all post-TAVR echocardiograms were evaluated for AVP PPG, new abnormalities in wall motion other than caused by LBBB and paravalvular/valvular aortic regurgitation. LVESV was used as the outcome variable for determining left ventricular function, as LVESV has been shown to correlate with impaired left ventricular function, based on an analysis by White et al. [16]. LVESV was calculated using the biplane method of discs (modified Simpson's rule) in the apical 2- and 4-chamber views at end systole, as recommended by the American Society of Echocardiography [12].

Statistical analysis

Baseline characteristics are presented in absolute numbers and as a percentage of the study population. Continuous variables are displayed as mean, median, interquartile range (IQR) and standard deviation (SD), where appropriate. In order to detect left ventricle change over time, we used the delta (Δ) LVESV from baseline and 6–12 months follow-up echocardiogram measurements. The Spearman's correlation coefficient was used to measure the association between QRS scoring/QRS duration and ΔLVESV separately. A linear regression model was generated to further assess the relationship between the variables and outcomes. All calculations were performed using SAS version 9.4 (Cary, NC, USA).

Results

Patient characteristics

Table 1 shows the baseline characteristics of the study population before TAVR. From the 11 patients who were included, 7 were male and 4 female, with a mean age of 81 ± 7.7 years. The mean QRS score pre-TAVR was 2.4 ± 2.6 points, QRS duration 104 ± 12.5 ms and LVESV 37 ± 25.3 mL. The time between pre-TAVR ECG and TAVR procedure varied from 3 months up to a couple of hours before the procedure while the pre-TAVR echo varied from 2 months till 2.5 weeks before the procedure. The follow-up ECGs and echocardiograms were performed 6 to 8 months after TAVR. Considering confounding factors that were

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