

Sudden Death After Transcatheter Aortic Valve Implantation. Are Bradyarrhythmias Always The Cause?

Lida P.Papavasileiou^{1,2}, Antonios Halapas³, Michael Chrisocheris³, Kyriakos Bellos^{4,2}, Nikolaos Bouboulis⁵, Stratis Pattakos⁵, Georgios Zervopoulos¹, Luca Santini², Konstantinos Spargias³, Francesco Romeo², Giovanni Forleo², Theodoros Apostolopoulos¹.

¹Electrophysiology, Pacemaker and ICD Unit, Hygeia Hospital, Athens, Greece. ²University Hospital of Rome "Tor Vergata" Cardiology Department, Rome, Italy. ³Department of Transcatheter Heart Valves, Hygeia Hospital, Athens, Greece. ⁴1st Cardiac Surgery Department, Hygeia Hospital, Athens, Greece. ⁵2nd Cardiac Surgery Department, Hygeia Hospital, Athens, Greece.

Abstract

Transcatheter Aortic-Valve Implantation (TAVI) is considered to be highly effective in the treatment of high-risk patients with severe aortic stenosis. After TAVI, the rate of pacemaker implantation is 6.5%-40%. Some reports of sudden death after TAVI are mostly attributed to bradyarrhythmias.

We report the case of three patients who experienced sudden cardiac death or aborted sudden cardiac death after TAVI. All patients were affected from ischemic heart disease with an ejection fraction of approximately 40% and underwent pacemaker implantation (PM) after the procedure due to 1st degree atrioventricular block (AV) and left bundle branch block (LBBB). One of the patients died suddenly 30 days after the procedure. The PM interrogation revealed many episodes of non sustain ventricular tachycardias (NSVT) and one episode of ventricular fibrillation (VF) that led to death. The other two patients had syncope and during PM interrogation episodes of ventricular tachycardia >12 sec were recorded. Patients affected by ischemic heart disease undergoing TAVI, especially with borderline coronary lesions should receive particular attention in order to avoid potentially lethal ventricular arrhythmias. In addition, the physiopathologic mechanism of sudden arrhythmic death in these patients needs to be clarified.

Introduction

Transcatheter Aortic-Valve Implantation (TAVI) is considered to be highly effective in the treatment of patients with severe aortic stenosis who are inoperable. After TAVI, the rate of pacemaker implantation is 6.5%-40%.¹⁻³ Some reports of sudden death after TAVI are mostly attributed to bradyarrhythmias. Nevertheless, ventricular arrhythmias should always be taken in to consideration in patients with borderline ejection fraction.

Case Presentation

Patients with severe aortic stenosis at increased risk for surgical aortic valve replacement who underwent TAVI to our institution from October 2010 to May 2013 were retrospectively analyzed. Pa-

tients qualified for TAVI in the presence of an indication for aortic valve replacement according to current guidelines⁴ but unsuitable for surgical procedure due to high risk of morbidity and mortality as calculated with STScore and logistic Euroscore⁵⁻⁷

TAVI was performed either with the Medtronic Core Valve or the Edwards-SAPIENXT bioprosthesis with standard retrograde technique.¹ Vascular access was obtained either percutaneous trans-femoral or surgical transaortic. As required, a temporary pacemaker was inserted before the procedure in all patients and kept in site for a minimum of 48 hr. Prior to the procedure all patients performed screening by coronary angiogram and/or (in rare cases) stress test if considered necessary and ECG-gated multidetector computed tomography.

Data Analysis

From each patient, different parameters were collected with respect to patients' characteristics, demographic and echocardiographic parameters as well as clinical and procedural data.

A 12-lead electrocardiogram (ECG) was recorded before the procedure, immediately after, every day until discharge and during every follow-up (FU) visit. Electrocardiographic characteristics of pre and postprocedural ECGs were analyzed by 2 independent investigators

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Disclosures:

None.

Corresponding Author:

Lida Pieretta Papavasileiou, M.D., Ph.D.
Electrophysiology, Pacemaker and ICD Unit, Hygeia Hospital
9, Erythrou Stavrou Str., GR15123, Marousi, Athens, Greece.

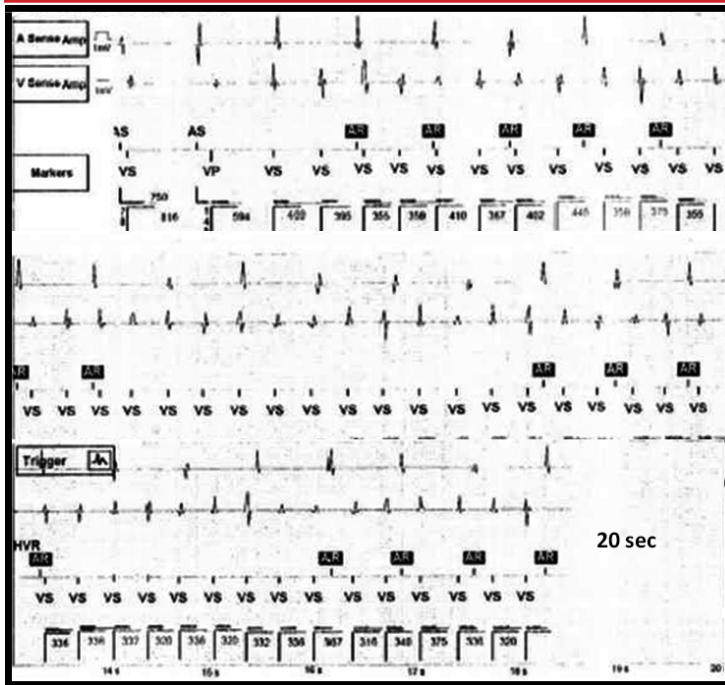


Figure 1: IEGM recorded in patient with syncope, 20 sec of ventricular tachycardia.

(MC, AC) in order to assess ECG changes. Follow-up visits were scheduled at 1, 3, 6 and 12 months after discharge.

In patients with prior pacemaker implantation complete device interrogation was performed before the procedure and all arrhythmic events were recorded.

All data were collected in a database that was updated after every FU visit; causes and timing of syncope or sudden death were also recorded.

For the purpose of this study we retrospectively analyzed the recorded data in order to access the incidence, time occurrence, predictive factors and causes of sudden cardiac death in patients after TAVI.

Results

Overall

A total of 146 consecutive patients were enrolled, (mean age 79±9y.o., 59% male, mean EUROSCORE 26,12±11,9, mean ST-Score 6,54±3,1). Seventeen patients (12%) had a previous pacemaker implantation. Ninety-one (62,3%) patients had coronary artery disease; in seventy (77%) of them revascularization was performed before or during the procedure. Baseline demographic and clinical, characteristics of the study population are reported in Table 1. Baseline ECG characteristics are reported in table 2.

Electrocardiographic Characteristics And Permanent Pacemaker Implantation (PPM)

Immediately after the procedure new onset left bundle branch block (LBBB) was observed in 39 (27%) patients. Complete atrio-ventricular block (AVB) was present in 14 patients (9,6%). Detailed electrocardiographic characteristics are reported in Table 2. Twenty five patients underwent permanent pacemaker implantation (17,1%) before discharge (11% in the Edward Sapien group and 21% in the Corvalve group); due to 3rd degree AV block (56%), right bundle branch block (RBBB) and LBBB alternans (8%), 2nd degree AV block with 2: 1 conduction (4%) and 1st degree AV block and LBBB (32%). No syncope was recorded during hospitalization. In all patients with

Table 1: Baseline demographic and clinical, characteristics of the study population.

Mean age	79±9	Ejection fraction (%)	51,9±12,14
Gender (male)	59%	Euroscore	26,12±11,9
Atrial fibrillation	45%	STScore mortality	6,54±3,1
Hypertension	66,4%	NYHA	3,12±0,56
Diabetes	47%	Corvalve	82,9%
Coronary artery disease	62,3%	In hospital stay (days)	5,4±2,2
PPM before	12%	PPM post	25/146 (17,1%)

complete AV block immediately after TAVI or during hospitalization a pacemaker was implanted. Regarding 1st degree AV block associated with new onset LBBB, only patients who presented progression of the conduction disturbance (progressive prolongation of the PR interval and increase of the duration of the QRS), recorder during hospital stay by ECG, received a pacemaker.

Syncope, Mortality And Ventricular Arrhythmias

In hospital mortality related to procedural complications, heart failure or multi organ failure was 4%, 30 day mortality was 2%. One sudden death occurred and 3 patients experienced syncope (excluding in hospital mortality).

Syncope was present in three patients, in one (with new onset LBBB after the procedure) due 3rd degree AV block so a PPM was implanted while in two other patients, with previous PPM, syncope was related to ventricular tachyarrhythmia's. [fig 1,2] Sudden death (during sleep) due to ventricular fibrillation occurred in one patient implanted with PPM after TAVI due to 1st degree AV block and LBBB. Intracavitary eletrogram (IEGM) and coronary angiogram of the patient is available in figure 3 A, B. All patients were affected by coronary artery disease and all procedures were performed by transfemoral approach. As reported in table 3 patients were assessed prior to the TAVI procedure and treated if necessary after adequate evaluation with coronary angiogram and/or stress test. Demographic and clinical characteristics of patients are reported in table 3.

All events were recorded in less than 30 days after the procedure. Sudden cardiac death was at day 21, 3rd degree AV block at day 19, and NSVT with syncope at 25 and day 29 respectively.

Discussion

Transcatheter aortic valve implantation (TAVI) for severe aortic stenosis (AS) has become a valid alternative for the treatment of older patients with severe co-morbidities.^{2,3,8-11} Despite the obvious benefits of the procedure, the experience acquired overtime revealed several intra and post procedural complications that can neutralize the potential benefits of valve replacement.² Other than possible vascular, kidney, coronary complications, stroke and paravalvular regurgitation¹² major interest is the occurrence of post-operative conduc-

Table 2: Baseline ECG characteristics before and after TAVI.

	Before TAVI	After TAVI
Sinus Rhythm	112/146 (77%)	99/146 (68%)
Atrial fibrillation	17/146 (12%)	16/146 (11%)
1st degree AV block	21/146 (14%)	30/146 (20,5%)
RBBB	11/146 (7,5%)	9/146 (6%)
LBBB	8/146 (5,5%)	39/146 (27%)
LAH	32/146 (22%)	19/146 (13%)
Total AV block	0	14/146 (9,6%)
Previous PPM	17/146 (12%)	

Table 3: Demographic and clinical characteristics of patients with syncope and sudden death.

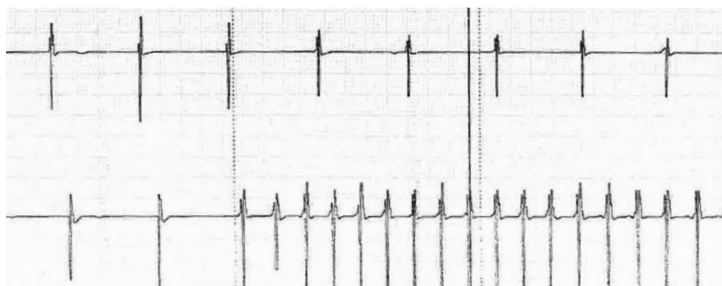
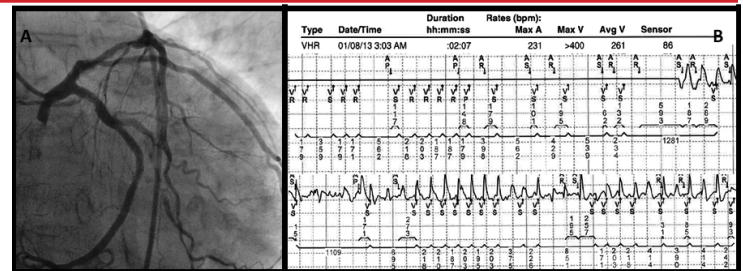
patient	Symptom	Age	Gender	CAD	Treated CAD	EF %	ECG
1	syncope	65	Male	+	-	50	3rd degree AVB
2	syncope	75	male	+	+	50%	VT
3	SCD	78	Female	+	-	35-40%	VF
4	syncope	80	male	+	+	35%	VT

tion disorders that require permanent pacemaker implantation and the occurrence of new left bundle branch block. Several studies have reported rates of new PPM up to 40% of cases^{2,3,13-14} with the occurrence being 6-7 times higher in case of the Medtronic CoreValve system (MCV; Medtronic) implantation.¹⁵ The variations of rate implantation most probably depends on different practice and threshold among physicians.¹²

The new onset LBBB is a common complication after both surgical aortic valve replacement (SAVR) and TAVI procedure. Regarding LBBB after SAVR this is known to be associated with higher rates of complete AV block, syncope and cardiac arrest at long term and it is mostly related to surgical trauma of the conduction system during debridement of the calcified annulus.¹⁶⁻¹⁹ Less is known about the potential effects of new LBBB in the TAVI population. The course of post TAVI-LBBB is not well known, and several cases of spontaneous resolution have been described.²⁰⁻²³ Recent reports correlate new LBBB with increased mortality²⁴ mostly related to progression to high-degree atrioventricular conduction disorders, progression of heart failure due to left ventricular remodeling induced by abnormal activation contraction pattern.²⁴⁻²⁵ In such causes some benefit may be provided by cardiac resynchronization therapy (CRT-D).²⁰

A gray zone of the TAVI population regards sudden cardiac death (SCD). The rate of SCD varies between 4% and 17%.²⁶⁻²⁸ but in most cases is related to bradyarrhythmias. Potential proarrhythmic effect of the procedure may be correlated more than complete heart block. In fact, as reported ventricular arrhythmias occurred in patients without elevated risk of sudden death according to current knowledge. The potential mechanism is not clear, QT dispersion or altered ventricular activation sequence as reported in patients with CRT-D³⁰⁻³¹ and PPM³² cannot be implicated in such patients. Potential increase of adrenergic tone due to improvement of functional class or myocardial ischemia due to increased demand or potential coronary ostia obstruction by the frame may be implicated.

In our cohort three patients experienced ventricular tachycardia/ventricular fibrillation after transcatheter aortic valve implantation. All patients were affected by ischemic heart disease with borderline ejection fraction. A probable proarrhythmic effect of new onset LBBB or aggressive left ventricular remodelling after TAVI can be

**Figure 2: IEGM recorded in patient with syncope, 12 sec of ventricular tachycardia.****Figure 3: A. Coronary angiogram demonstrating 50% stenosis of left anterior descending artery, total occlusion of right coronary artery and dominant circumflex with 80% stenosis of optuse marginal. B. Pacemaker IEGM documenting 2.07 minutes of ventricular fibrillation.**

assumed to be the trigger of ventricular arrhythmias in these patients with borderline left ventricular function. In addition, the time of occurrence of events in less than 30 days after the procedure collocates these events as procedural mortality, thus directly related to the procedure. In such scenario the reports of sudden death, reported to be up to 17%,²⁶⁻²⁸ should be reconsidered. The exact mechanism of such event cannot be clearly identified as, by definition is sudden and abrupt and in most cases there is no clear documentation of the event, only the result is assessed, but is clearly related to the new hemodynamics created in the left ventricle after the procedure. Regarding late occurrence of complete AV block this event is also less predictable as the TAVI population is older and most likely to receive a pacemaker for degenerative conduction disturbance irrelevant with the TAVI and the occurrence of such event shortly after the procedure might be circumstantial.

In any case, the occurrence of SCD in the TAVI population is a devastating event especially after the high expectations regarding lower rate of morbidity and mortality related to the procedure. Appropriate selection of patients, adequate medical treatment and more studies are necessary in order to completely understand such mechanism and potentially reduce its occurrence.

Conclusions

The TAVI is a valid alternative to SAVR in high risk or inoperable patients. Nevertheless, potential post procedural complications, especially arrhythmic, may reduce its potential benefit. Permanent pacemaker implantation is a frequently reported complication and even if many risk factors are reported none of them is currently considered to be a gold standard. Less is known about sudden cardiac death related to ventricular arrhythmias after TAVI. More research is necessary in order to improve outcomes of the TAVI population.

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