

EDITORIAL

Need for a Permanent Pacemaker after Transcatheter Aortic Valve Implantation (TAVI)*

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TAVR; permanent pacemaker; aortic
prostheses*

ABBREVIATIONS

AV = atrioventricular;
AVR = aortic valve replacement;
LBBB = left bundle branch block;
RBBB = right bundle branch block;
TAVI/R = transcatheter aortic valve
implantation/replacement

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ABSTRACT

A permanent pacemaker is commonly required in patients undergoing transcatheter aortic valve implantation (TAVI) at ranges up to 30-50%. In general, the incidence is higher with the self- vs balloon-expandable valves. Several risk factors have been identified. Importantly, pacemaker implantation does not seem to improve prognosis and this needs to be further explored. Finally, new generation valves appear to increase the complication of AV block and need for permanent pacing. These issues are herein briefly reviewed.

INTRODUCTION

High-degree or complete atrioventricular (AV) block requiring permanent pacing is a well-known complication of surgical aortic valve replacement (AVR) due to injury of the AV conduction system incurred during surgery. Over the recent years, we have also become poignantly aware that there is a similar risk for a need for a permanent pacemaker in patients undergoing transcatheter aortic valve implantation (TAVI).¹ Although there is no tissue excision involved during TAVI as in AVR to explain the injury of the AV conduction system, it appears that such injury still occurs with compression of adjacent tissue by both the balloon and the stent of the new valve during TAVI. Furthermore, it appears that the need for pacing is higher after TAVI than after AVR.² In addition, among the TAVI patients, those receiving the self-expandable valve appear to have a higher risk compared to those receiving the balloon expandable valve.³

According to a recent review, the rate of permanent pacemaker implantation averages approximately 17% with a wide variation (from 2-51%). In general, the incidence is higher with the self-expanding valve (~28%) compared with the balloon-expandable valve (~6%).⁴

RISK FACTORS (TABLE 1)

As stated above, the self-expandable type of prosthesis has been associated with higher risk of pacemaker implantation.^{3,5} Balloon pre-dilatation has also been shown

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to confer a high pacemaker risk.⁵ Furthermore, in several studies, pre-existing right bundle branch block (RBBB) is an independent predictor of complete AV block after TAVI.^{3,5,6} Another risk factor relates to the depth of valve implantation, which may lead to AV block when greater than 6 mm for the self-expandable valve.^{3,7} Similarly, for the balloon-expandable valves, low implantation depth (mean 7 mm vs 3.5 mm of the inflow to annulus distance) is associated with clinically significant new conduction disturbances and permanent pacemaker implantation.⁸ Some have suggested to measure the AV membranous septum (MS) length by computed tomography (CT) as an anatomic surrogate of the distance between the aortic annulus and the bundle of His in an attempt to identify patient-specific anatomic risk of high-degree AV block.⁹ In patients with valve-in-valve procedures there appears to be a higher risk for a pacemaker.¹⁰

According to the large PARTNER trial registry of the balloon expandable valves, a new pacemaker was required in 173 of 1,973 patients (8.8%).¹¹ In addition to pre-existing RBBB, the prosthesis to left ventricular outflow tract diameter ratio and the left ventricular end-diastolic diameter were identified as predictors of pacemaker implantation. Furthermore, a new pacemaker was associated with a longer duration of hospitalization and more repeat hospitalizations and higher mortality at 1 year.

According to data obtained from a meta-analysis of 41 studies that included 11,210 TAVI patients, of whom 17% required a pacemaker, male gender, baseline conduction disturbances, and intraprocedural AV block emerged as predictors of pacemaker implantation after TAVI.¹²

New-onset LBBB may develop in about 30% of patients undergoing TAVI. In one study, patients with persistent LBBB and no pacemaker implantation at hospital discharge had a higher incidence of syncope (16% vs 0.7%; $p=0.001$) and complete AV block requiring a pacemaker (20% vs 0.7%; $p < 0.001$), but not of global mortality or cardiac mortality during the follow-up period (all, $p > 0.20$).¹³ New-onset LBBB

was the only factor associated with pacemaker implantation following TAVI.¹³ Some have suggested that measurement of the HV interval in this group of patients with development of new-onset LBBB can guide pacemaker implantation when the postprocedural HV interval is >65 ms.¹⁴ Other studies have indicated an adverse prognosis with increased mortality in patients with new-onset LBBB.¹⁵ However, in another study, new-onset LBBB, although it persisted in most patients, it was not a predictor of overall or cardiovascular mortality or permanent pacemaker implantation.¹⁶ Finally, there are no definite recommendations regarding the management of new-onset LBBB after TAVI by international societies, which leaves room for an individualized approach and strategy for such patients. The question remains whether these patients should receive a pacemaker, and whether a biventricular pacemaker would be a better choice. Future studies will need to explore these options.

CLINICAL OUTCOME

Some data indicate that prognosis is not favorably affected in patients receiving a pacemaker after TAVI.¹⁷ A likely explanation for this discrepancy may relate to the deleterious consequences of right ventricular pacing which may negate any beneficial effect of pacing.¹⁸ There are no studies comparing the effect of the RV pacing site in this population or the effects of right ventricular vs biventricular pacing. Contrariwise, other studies have indicated, as already mentioned above, that a new pacemaker is associated with a longer duration of hospitalization and more repeat hospitalizations and higher mortality at 1 year.¹¹ Others have reported an unfavorable hemodynamic impact of a pacemaker (reduced ejection fraction and impaired left ventricular unloading), however without affecting 2-year clinical outcome.¹⁹ It appears that although ejection fraction improves after TAVI in patients with severe aortic stenosis in patients in the absence of new conduction defects, in patients with a new conduction defect after TAVI, there appears that no such improvement in ejection fraction is observed at follow-up.²⁰

In patients with preexisting or new-onset LBBB, there is a higher risk of developing high-degree AV block, some investigators recommend intensified monitoring, especially in patients treated with the self-expandable valve.²¹ A recent meta-analysis confirms that new-onset LBBB post-TAVI is a marker of increased risk of cardiac death and need for pacemaker at 1-year follow-up.²²

NEW VALVES

Although the advent of new valves has facilitated the procedure and has reduced paravalvular leaks, the rate of pacemaker implantation has rather been adversely affected, especially

TABLE 1. Risk Factors for AV Block During TAVI

• Preexisting RBBB
• Self-expandable prosthesis
• Depth of valve implantation
• LVOT oversizing
• Prosthesis overexpansion
• Valve-in-valve procedure
• New-onset LBBB
➢ post-procedural HV interval of >65 ms
• New generation valves

AV = atrioventricular; LBBB = left bundle branch block; LVOT = left ventricular outflow tract; RBBB = right bundle branch block.

when associated with a lower implantation height.²³ Thus, the most recent experience has indicated that newer generation devices together with valve oversizing relative to the left ventricular outflow tract, and deeper valve implants are associated with a higher need for pacemaker implantation after TAVI.²⁴

CONCLUSION

The rate of permanent pacemaker implantation averages approximately 17% with a wide variation (from 2-51%). In general, the incidence is higher with the self-expanding valve (~28%) compared with the balloon-expandable valve (~6%). Among others, important high-risk factors include preexisting RBBB, low implantation depth of the valve, new-onset LBBB and intraprocedural AV block. Counterintuitively, permanent pacemaker implantation does not seem to improve prognosis and this needs to be further considered in terms of the type of pacing performed, such as right ventricular vs biventricular pacing, in light of evidence of deleterious effects of right ventricular apical pacing. Finally, new generation valves appear to increase the complication of AV block and need for permanent pacing.

REFERENCES

- Sinhal A, Altwegg L, Pasupati S, et al. Atrioventricular block after transcatheter balloon expandable aortic valve implantation. *JACC Cardiovasc Interv* 2008;1:305-309.
- Bagur R, Rodes-Cabau J, Gurvitch R, et al. Need for permanent pacemaker as a complication of TAVI and surgical AVR in elderly patients with severe aortic stenosis and similar baseline ECG findings. *JACC Cardiovasc Interv* 2012;5:540-51.
- Guetta V, Goldenberg G, Segev A, et al. Predictors and course of high-degree AV block after TAVI using the CoreValve Revalving System. *Am J Cardiol* 2011;108:1600-1605.
- Urena M, Rodes-Cabau J. Managing heart block after transcatheter aortic valve implantation: from monitoring to device selection and pacemaker indications. *EuroIntervention* 2015;11 Suppl W:W101-105.
- Gensas CS, Caixeta A, Siqueira D, et al. Predictors of permanent pacemaker requirement after transcatheter aortic valve implantation: insights from a Brazilian registry. *Int J Cardiol* 2014;175:248-252.
- Roten L, Wenaweser P, Delacretaz E, et al. Incidence and predictors of atrioventricular conduction impairment after transcatheter aortic valve implantation. *Am J Cardiol* 2010;106:1473-1480.
- Kammler J, Blessberger H, Fellner F, et al. Implantation depth measured by 64-slice CT is associated with permanent pacemaker requirement following TAVI with the Core Valve(R) system. *J Cardiol*. 2016;67:513-518.
- Binder RK, Webb JG, Toggweiler S, et al. Impact of post-implant SAPIEN XT geometry and position on conduction disturbances, hemodynamic performance, and paravalvular regurgitation. *JACC Cardiovasc Interv* 2013;6:462-468.
- Hamdan A, Guetta V, Klempfner R, et al. Inverse relationship between membranous septal length and the risk of AV block in patients undergoing TAVI. *JACC Cardiovasc Interv* 2015;8:1218-1228.
- Hoyt MJ, Hathaway J, Palmer R, et al. Predictors of permanent pacemaker implantation after TAVR. *J Cardiothorac Vasc Anesth* 2015;29:1162-1166.
- Nazif TM, Dizon JM, Hahn RT, et al. Predictors and clinical outcomes of permanent pacemaker implantation after transcatheter aortic valve replacement: the PARTNER trial and registry. *JACC Cardiovasc Interv* 2015;8:60-69.
- Siontis GC, Juni P, Pilgrim T, et al. Predictors of permanent pacemaker implantation in patients with severe aortic stenosis undergoing TAVR: a meta-analysis. *J Am Coll Cardiol* 2014;64:129-140.
- Urena M, Mok M, Serra V, et al. Predictive factors and long-term clinical consequences of persistent left bundle branch block following transcatheter aortic valve implantation with a balloon-expandable valve. *J Am Coll Cardiol* 2012;60:1743-1752.
- Rivard L, Schram G, Asgar A, et al. Electrocardiographic and electrophysiological predictors of AV block after transcatheter aortic valve replacement. *Heart Rhythm* 2015;12:321-329.
- Houthuizen P, Van Garsse LA, Poels TT, et al. Left bundle-branch block induced by transcatheter aortic valve implantation increases risk of death. *Circulation* 2012;126:720-728.
- Franzoni I, Latib A, Maisano F, et al. Comparison of incidence and predictors of left bundle branch block after transcatheter aortic valve implantation using the CoreValve versus the Edwards valve. *Am J Cardiol* 2013;112:554-559.
- Buellesfeld L, Stortecky S, Heg D, et al. Impact of permanent pacemaker implantation on clinical outcome among patients undergoing TAVI. *J Am Coll Cardiol* 2012;60:493-501.
- Manolis AS. The deleterious consequences of right ventricular apical pacing: time to seek alternate site pacing. *Pacing Clin Electrophysiol* 2006;29:298-315.
- Biner S, Michowitz Y, Leshem-Rubinow E, et al. Hemodynamic impact and outcome of permanent pacemaker implantation following transcatheter aortic valve implantation. *Am J Cardiol* 2014;113:132-137.
- Hoffmann R, Herpertz R, Lotfipour S, et al. Impact of a new conduction defect after transcatheter aortic valve implantation on left ventricular function. *JACC Cardiovasc Interv* 2012;5:1257-1263.
- Egger F, Nurnberg M, Rohla M, et al. High-degree atrioventricular block in patients with preexisting bundle branch block or bundle branch block occurring during transcatheter aortic valve implantation. *Heart Rhythm* 2014;11:2176-2182.
- Regueiro A, Abdul-Jawad Altisent O, Del Trigo M, et al. Impact of new-onset LBBB and periprocedural permanent pacemaker implantation on clinical outcomes in patients undergoing TAVR: A systematic review and meta-analysis. *Circ Cardiovasc Interv* 2016;9:e003635.
- De Torres-Alba F, Kaleschke G, Diller GP, et al. Changes in the pacemaker rate after transition from Edwards SAPIEN XT to SAPIEN 3 TAVI: The critical role of valve implantation height. *JACC Cardiovasc Interv* 2016;9:805-813.
- Rodriguez-Olivares R, van Gils L, El Faquir N, et al. Importance of the left ventricular outflow tract in the need for pacemaker implantation after transcatheter aortic valve replacement. *Int J Cardiol* 2016;216:9-15.