ORIGINAL ARTICLE

Usefulness of membranous septum length in the prediction of major conduction disturbances in patients undergoing transcatheter aortic valve replacement with different devices

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KEY WORDS
conduction disturbance, left bundle-branch block, membranous septum, permanent pacemaker implantation, transcatheter aortic valve replacement

ABSTRACT

BACKGROUND Conduction disturbances (CD) are one of the most common adverse events after transcatheter aortic valve replacement (TAVR), and seem to be dependent on the device used as well as anatomical factors.

AIMS The aim of this study was to evaluate whether the length of the membranous septum (MS) could provide useful information about the risk of CD and to examine the impact of the MS on CD after TAVR using different devices.

METHODS This study included 140 patients undergoing TAVR with a balloon-expandable valve or self-expanding valve. The length of the MS was assessed by preoperative computed tomography. ΔMSID was calculated as the length of the MS minus implantation depth.

RESULTS A total of 24 patients (17%) received a permanent pacemaker (PPM), 53 (38%) developed new-onset left bundle-branch block (LBBB) following TAVR. The MS length was shown to be the strongest independent predictor of new-onset LBBB (odds ratio [OR], 3.05; 95% CI, 1.96–4.77; *P* <0.001) and PPM implantation (OR, 3.76; 95% CI, 2.01–7.06; *P* <0.001). ΔMSID was also inversely associated with the development of LBBB and the need for PPM. In a head-to-head comparison, ΔMSID values were found to be statistically lower in the self-expanding valve group (–0.8 mm vs 0.7 mm; *P* <0.001).

CONCLUSIONS A short MS and ΔMSID with a negative value increase the risk of CD. Assessment of the MS length prior to TAVR might serve as an additional tool to guide clinical decision-making and appropriate device selection to reduce the the risk of CD.

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INTRODUCTION Cardiac conduction disturbances (CD), which include left bundle-branch block (LBBB) and complete heart block requiring the implantation of a permanent pacemaker (PPM), are the most frequent complications following transcatheter aortic valve replacement (TAVR).[1-3] The membranous septum (MS) is located at the base of the interleaflet triangle separating the noncoronary and right coronary leaflets of the aortic valve, which is closely related to the conduction pathways.[4,5] Thus, CD is thought to partly be due to the mechanical stress of deployment to the MS, resulting in possible injury to the nearby atrioventricular node and left bundle branch.

Recent studies reported that assessment of the MS and left ventricular outflow tract (LVOT) anatomy with multidetector computed tomography (MDCT) prior to TAVR improves the ability to predict CD and our understanding of its underlying mechanism.[6-9] A previous report showed that a short MS predicted PPM implantation after TAVR with a self-expandable valve (SEV).[6] The results of another study also indicated that a short MS is a prominent risk factor for PPM implantation with a balloon-expandable valve

WHAT'S NEW?

The assessment of the length of the membranous septum on multidetector computed tomography prior to transcatheter aortic valve replacement can be a useful tool to guide appropriate device selection and subsequently reduce conduction disturbances. The risk of major conduction disturbances such as new-onset left bundle branch block and atrioventricular block requiring a permanent pacemaker implantation can be reduced by using a slightly higher prosthesis position, not exceeding the length of the membranous septum (ΔMSID [the length of the membranous septum minus implantation depth] >0 mm), especially in self-expandable valves.

(BEV).[7] Conversely, 2 studies have shown conflicting results regarding whether there is an association between MS and CD in patients with a BEV.[8,9] Although there is available information about the impact of MS on CD in patients receiving transcatheter heart valves (THV) of different designs, inconsistencies and lack of standardization lead to lack of guidance for cardiac teams approaching a patient with a short MS. To date, no studies have summarized head-to-head trials comparing BEV and SEV.

The purpose of this study is to further elucidate TAVR-related new-onset LBBB and PPM implantation rates in patients with short MS and determine the respective PPM rates for different THV designs in patients with short MS to help guide patient-tailored THV selection.

METHODS

Study population We retrospectively examined 156 patients who underwent transfemoral TAVR between January 2017 and February 2020. Exclusion criteria were as follows: insufficient quality of MDCT images (n = 6), previously implanted PPM (n = 6), a second valve implantation required in the same procedure due to valve migration (n = 2), perioperative death (within first 24 hours) after TAVR (n = 2). Therefore, the remaining 140 patients were enrolled to the final study group. The patients were divided into 2 groups according to presence or absence of CD. The protocol was approved by the local ethics committee (Clinical Trial Registration: 2019 – 76), and conducted according to the principles of the Declaration of Helsinki. Patients provided written informed consent to participate in the study.

Acquisition protocol of multidetector computed tomography data All patients were scanned using a second-generation 320-row MDCT scanner (Aquilion ONE Vision Edition, Toshiba Medical Systems, Otawara, Japan). The aortic root was scanned with volume mode using a retrospective electrocardiography-gated acquisition mode and the following parameters: width of 16 cm, 100 kV, gantry rotation time of 275 ms, auto-mA maxed at 300 ms, acquisition over 1 heartbeat. The scan was acquired within a single breath hold and after a single bolus injection of iohexol in a dose of 350 mg/ml (Ultravist 370, Bayer Schering Pharma, Berlin, Germany) using an automatic power injector at a rate of 3.5 ml/s, followed by 30 ml of saline chaser at a rate of 3 ml/s. Patients with a body mass index (BMI) lower than 23 kg/m^2 had a bolus of 40 to 50 ml, those with a BMI between 23 and 30 kg/m^2 had a bolus of 60 to 70 ml, and those with a BMI over 30 kg/m^2 had a bolus of 70 to 80 ml. The bolus-tracking technique was used which was triggered using a region of interest positioned in the descending thoracic aorta and a threshold of 180 Hounsfield units. The MDCT acquisitions were reconstructed with a soft kernel and a third-generation iterative reconstruction algorithm. The aortic root volume was reconstructed with 10% increments from 0% to 90%. No β-blockers were used. All MDCTs were assessed in a consensus interpretation by an experienced radiologist and an interventional cardiologist, both blinded to the clinical data.

Transcatheter aortic valve replacement Patients underwent TAVR after a careful evaluation and discussion of the Heart Team. All TAVR procedures were performed through the transfemoral approach and under conscious sedation in a fully equipped hybrid operating room. Predilatation of the native aortic valve was performed at the discretion of the operator. The optimal position of the valve was checked by fluoroscopically and a rapid pacing (160 to 200 bpm) was triggered during the implantation of a BEV as previously described.[10] The final control was performed by aortography. The choice of a THV was based on the operators' preference with regard to the patient's individual characteristics, and valve size was selected according to manufacturer's recommendation. Two main categories of transcatheter aortic valve prostheses were compared: balloon-expandable Edwards Sapien XT (Edwards Lifesciences, Irvine, California, United States) or self-expandable devices such as the Medtronic CoreValve Evolut R (Medtronic, Minneapolis, Minnesota, United States) and St. Jude Portico valves (St. Jude Medical, St. Paul, Minnesota, United States).

Definitions The length of the MS was measured as the distance from the aortic annular plane to the superior portion of the muscular interventricular septum in the modified coronal view (FIGURE 1A), as previously described.[6] Implantation depth (ID) was assessed by fluoroscopy in the implantation projection determined on MDCT prior to TAVR.[11] Implantation depth was defined as the length of the stent frame from the basal plane to the LVOT, measured at the septal side of the LVOT (on the side of the noncoronary cusp) (FIGURE 1B). The difference between MS and ID length was calculated using the following equation: ΔMSID = MS – ID. The eccentricity of the aortic annulus was calculated by

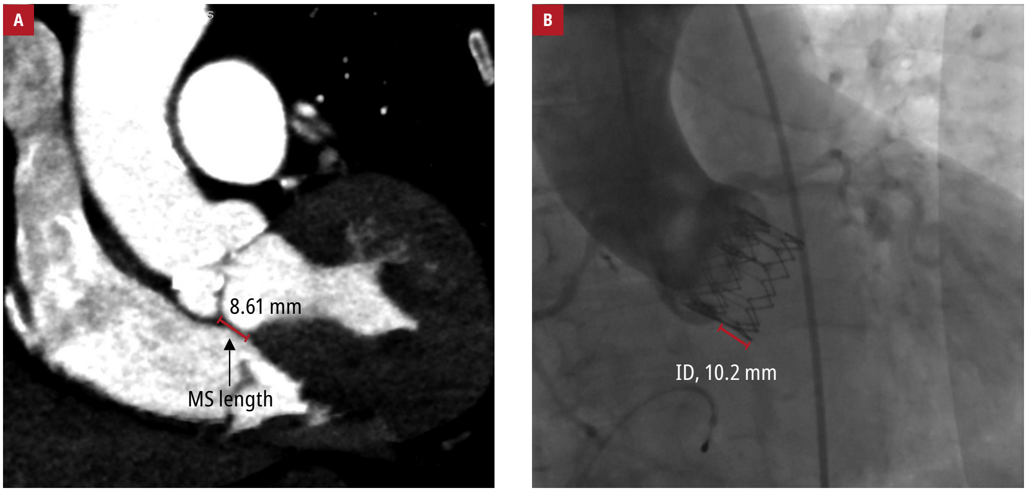

FIGURE 1 **A** – membranous septum length; **B** – implantation depth. Source: authors' own material.
Abbreviations: ID, implantation depth; MS, membranous septum

1 – (Dmin/Dmax).[12] Calcification of basal ventricular septum was determined by MDCT (0 = no calcification, 1 = presence of calcification), as previously described.[6] Baseline demographics, MDCT data, and procedural parameters were collected from medical records of each patient as well as information regarding the development of CD and the need for PPM after TAVR. Twelve-lead-electrocardiography was documented for all patients before and daily after the procedure until hospital discharge. The new-onset LBBB was defined as a complete LBBB (QRS >120 ms) that appeared after TAVR and was maintained at 1 week.

Statistical analysis The statistical analysis was done with the SPSS software, version 24.0 (SPSS Inc., Chicago, Illinois, United States). Normality of data distribution was verified with graphical (histograms, probability curves) and numerical methods (the Kolmogorov–Simirnov test and the Shapiro–Wilk test). Continuous variables were expressed as mean (SD) if normally distributed or as median (interquartile range) if not normally distributed. Categorical variables were presented as frequency and percentage. Patients were divided into groups according to whether they developed LBBB and required PPM. For comparison of continuous variables, the *t* test or the Mann–Whitney test was used, as appropriate. Categorical variables were analyzed with the χ^2 test or the Fisher exact test. The logistic regression analysis was performed to determine the predictors of PPM and LBBB. Univariate analysis included parameters with *P* value of less than 0.1 in binary comparisons. Multivariate analysis was performed to identify independent predictors and separated into 2 models: the ante factum prediction model (only preprocedural predictors) and the post factum prediction model (preprocedural and postprocedural predictors). In order to calculate cutoff values of independent predictors, the receiver operating characteristic (ROC) analysis was performed and the value with the highest sensitivity and specificity was considered as cutoff. In more than 2 groups, statistical analysis of numerical variables was done with the Kruskal–Wallis test and the Tamhane T2 test was used for the post hoc analysis. If a *P* value was less than 0.05, it was considered statistically significant.

RESULTS

Patient characteristics A comparison of baseline demographic, clinical, imaging, and procedural parameters between patients who had a PPM implanted or developed new-onset LBBB is shown in TABLE 1. The mean (SD) age was 78 (8) years, the majority of patients were women (63%), and the median Society of Thoracic Surgeons score was 7. Main baseline characteristics were not different between the 2 groups except for chronic renal failure. In total, 24 patients (17%) received a PPM and 53 patients (38%) developed a new-onset LBBB following TAVR. Indications for PPM implantation included complete heart block (n = 15), Mobitz type II second-degree AV block (n = 4), LBBB with a prolonged PR interval and atrial fibrillation with slow ventricular response resulting in hemodynamic instability (n = 5).

Multidetector computed tomography and procedural characteristics As seen in TABLE 1, the ratio of the valve perimeter, the mean dimensions, and the area of the native aortic valve annulus did not differ between the groups. The eccentricity of the aortic annulus was not different between the groups. According to the MDCT parameters, the mean (SD) MS length in the study was 7.6 (1.1) mm. The MS length was shorter in patients with new-onset LBBB when compared to those without LBBB (mean [SD], 6.9 [1.1] mm vs

TABLE 1 Baseline characteristics of the study population

Parameter	Total (n = 140)	LBBB (–) (n = 87)	LBBB (+) (n = 53)	*P* value	PPM (–) (n = 116)	PPM (+) (n = 24)	*P* value
Age, y, mean (SD)	78.8 (7.5)	78.2 (8.2)	79.7 (6)	0.26	78.5 (7.5)	79.9 (7.6)	0.4
Female sex	89 (63.6)	54 (62.1)	35 (66)	0.63	74 (63.7)	15 (62.5)	0.9
Hypertension	86 (61.4)	52 (59.8)	34 (64.2)	0.6	69 (59.5)	17 (70.8)	0.29
Diabetes	50 (35.7)	31 (35.6)	19 (35.8)	0.97	42 (36.2)	8 (33.3)	0.78
Coronary artery disease	90 (64.3)	56 (64.4)	34 (64.2)	0.97	72 (62.1)	18 (75)	0.22
Previous CABG	30 (21.4)	21 (24.1)	9 (17)	0.31	25 (21.6)	5 (20.8)	0.93
Chronic kidney disease	39 (27.9)	20 (23)	19 (35.8)	0.1	28 (24.1)	11 (45.8)	0.03
STS score, median (IQR)	7 (4.8–9.1)	6.8 (4.8–9)	7.4 (4.8–10)	0.32	7 (4.8–9.1)	7.5 (5–10)	0.48
Atrial fibrillation	29 (20.7)	16 (18.4)	13 (24.5)	0.38	23 (19.8)	6 (25)	0.58
BEV	66 (47.1)	45 (51.7)	21 (39.6)	0.16	57 (49.1)	9 (37.5)	0.29
MDCT parameters							
MS length, mm, mean (SD)	7.6 (1.1)	8.1 (0.9)	6.9 (1.1)	<0.001	7.9 (1)	6.54 (0.9)	<0.001
ID, mm, mean (SD)	7.7 (2.1)	6.8 (1.7)	9.2 (1.8)	<0.001	7.4 (2.1)	9.2 (1.7)	<0.001
ΔMSID, mm, median (IQR)	0.3 (–2.1 to 1.8)	1.2 (0.4–2.5)	–2.6 (–4 to –0.8)	<0.001	0.8 (–0.9–2.1)	–2.6 (–4.3 to –1.2)	<0.001
Annulus perimeter, mm, mean (SD)	78.1 (7)	78.5 (7.1)	77.4 (6.8)	0.35	78.2 (7)	77.5 (7.4)	0.67
Annulus diameter, mm, mean (SD)	24.3 (2.1)	24.5 (2.1)	24.1 (2.1)	0.26	24.4 (2.1)	23.9 (2.2)	0.31
Annulus area, mm^2, mean (SD)	472 (8)	477 (9)	464 (8)	0.38	474 (8)	464 (8)	0.62
LVOT area, mean (SD)	452 (8)	461 (9)	439 (8)	0.14	456 (8)	435 (8)	0.27
Eccentricity index, mean (SD)	0.21 (0.06)	0.2 (0.06)	0.21 (0.07)	0.59	0.2 (0.06)	0.23 (0.05)	0.07
Calcification in basal septum	26 (18.5)	11 (12.6)	15 (28.3)	0.01	17 (14.7)	9 (37.5)	0.01
Cover index$_A$[a], median (IQR)	21.1 (9–27.2)	17.3 (5.8–27)	22.8 (15.6–27.5)	0.03	21.5 (6.9–27.2)	19.3 (13.6–27.9)	0.59
Cover index$_{LVOT}$[b], median (IQR)	23.3 (15.6–28.7)	22.1 (10.2–26.9)	25.2 (22.2–30.6)	0.001	23 (14.1–28.5)	25.5 (21.7–29.1)	0.09

Data are presented as number (percentage) unless otherwise indicated.

a The cover index$_A$ was calculated as (THV nominal area / MDCT annulus area – 1) × 100.

b The cover index$_{LVOT}$ was calculated as (THV nominal area / MDCT LVOT area – 1) × 100.

Abbreviations: BEV, balloon-expandable valve; CABG, coronary artery bypass grafting; IQR, interquartile range; LBBB, left bundle-branch block; LVOT, left ventricular outflow tract; MDCT, multidetector computed tomography; ΔMSID, membranous septum length – implantation depth; PPM, permanent pacemaker; STS, Society of Thoracic Surgeons; others, see FIGURE 1

8.1 [0.9] mm; *P* <0.001). Also, the MS length was shorter in patients who required PPM implantation compared to those without PPM (mean [SD], 6.5 [0.9] mm 7.9 [1] mm; *P* <0.001). We found that calcifications in the basal septum were present in 18% of patients undergoing TAVR and is predictive of new CD.

The rate of postdilatation was comparable between patients with BEVs and SEVs. Greater ID into the LVOT was more likely to cause LBBB (mean [SD], 9.2 [1.8] mm vs 6.8 [1.7] mm; *P* <0.001) and PPM implantation (mean [SD], 9.2 [1.7] mm vs 7.4 [2.1] mm; *P* <0.001). Additionally, the median (interquartile range) ΔMSID was 0.3 (–2.1 to 1.8) mm. New-onset LBBB and PPM implantation were significantly higher in patients with lower ΔMSID than in those with higher ΔMSID.

Predictors of new-onset left bundle-branch block and permanent pacemaker implantation Univariate and multivariate analyses examining the occurrence of new-onset LBBB and subsequent CD requiring PPM implantation are summarized in TABLE 2. Multivariable logistic regression of the ante factum prediction model indicated that MS length was the strongest independent predictor of new-onset LBBB (odds ratio [OR], 3.05; 95% CI, 1.96–4.77; *P* <0.001). In the post factum prediction model, ΔMSID was the strongest independent predictor of

TABLE 2 Predictors of new-onset left bundle-branch block on univariate and multivariate analysis

Parameter	Univariate analysis			Multivariate analysis					
				Preprocedural			Pre- and postprocedural		
	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI	*P* value
Chronic kidney disease	1.87	0.88–3.97	0.1	–	–	–	–	–	–
Calcification in the basal septum	3.64	1.77–7.5	<0.001	3.33	1.4–7.93	0.006	3.65	1.25–10.7	0.01
SEV	1.79	0.89–3.57	0.1	–	–	–	–	–	–
Cover index$_A$	1.04	1.01–1.07	0.02	–	–	–	–	–	–
Cover index$_{LVOT}$	1.06	1.02–1.09	0.002	1.09	1.04–1.14	0.001	1.1	1.03–1.17	0.003
Membranous septum length	2.8	1.87–4.19	<0.001	3.05	1.96–4.77	<0.001	–	–	–
Implantation depth	2.11	1.61–2.77	<0.001	–	–	–	–	–	–
ΔMSID	2.22	1.71–2.89	<0.001	–	–	–	2.24	1.71–2.94	<0.001

Abbreviations: OR, odds ratio; SEV, self-expandable valve; others, see TABLE 1

TABLE 3 Predictors of permanent pacemaker implantation on univariate and multivariate analysis

Parameters	Univariate analysis			Multivariate analysis					
				Preprocedural			Pre- and postprocedural		
	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI	*P* value
Chronic kidney disease	2.66	1.07–6.60	0.03	–	–	–	–	–	–
Eccentricity	856	0.46–1 586 346	0.07	–	–	–	–	–	–
Calcification in basal septum	7.08	2.28–22	0.001	5.17	1.47–18.2	0.01	5.83	1.63–20.8	0.007
Cover index$_{LVOT}$	1.03	0.99–1.08	0.11	–	–	–	–	–	–
Membranous septum length	3.62	2.05–6.38	<0.001	3.76	2.01–7.06	<0.001	–	–	–
Implantation depth	1.48	1.18–1.85	0.001	–	–	–	–	–	–
ΔMSID	1.67	1.35–2.06	<0.001	–	–	–	1.68	1.32–2.15	<0.001

Abbreviations: see TABLES 1 and 2

new-onset LBBB (OR, 2.24; 95% CI, 1.71–2.94; *P* <0.001). Cover index$_{LVOT}$ and calcification in the basal septum were the other independent predictors. The univariate analysis showed that chronic kidney disease, eccentricity, calcification in the basal septum, cover index$_{LVOT}$, MS, ID, and ΔMSID were associated with PPM implantation (TABLE 3). According to the multivariate analysis, calcification in the basal septum significantly increased the odds of postprocedural PPM implantation (*P* = 0.007). MS length (OR, 3.76; 95% CI, 2.01–7.06; *P* <0.001) and ΔMSID (OR, 1.68; 95% CI, 1.32–2.15; *P* <0.001) were powerful pre- and postprocedural predictors of PPM, respectively. The distributions of MS length and ΔMSID in patients with and without new-onset LBBB or PPM are shown in the box plot format (Supplementary material, *Figure S1*).

As shown in FIGURE 2A and 2B, for predicting PPM implantation, an area under the curve (AUC) of 0.821 for MS length 6.95 mm and an AUC of 0.857 for ΔMSID of less than 0 mm indicated very good accuracy in differentiating PPM from non-PPM. In the ROC analysis, cutoff values of MS of less than 7.35 mm and ΔMSID of less than 0 mm were strongly associated with the occurrence of new-onset LBBB (AUC, 0.778; 95% CI, 0.694–0.862; and AUC, 0.902; 95% CI, 0.844–0.96, respectively; *P* <0.001 for both) (FIGURE 2C and 2D). Moreover, a smaller MS length and decreasing ΔMSID increase the probability of PPM implantation. According to the cutoff values, the OR of PPM was 10.7 for MS length (95% CI, 3.4–32.9) and 34.7 for the ΔMSID (95% CI, 4.4–271.3). Likewise, the OR of new-onset LBBB was 8.8 and 45.7 for these cutoff values, respectively (Supplementary material, *Figure S2*).

The comparison of the MS, ID, ΔMSID length, and PPM ratio in the BEV and SEV groups is summarized in FIGURE 3. In a head-to-head comparison, there was a higher incidence of PPM implantation (20.3% versus 13.6%) and new-onset LBBB (31.1% versus 21.2%) in the SEV group. However, these results were not significant. When the THV

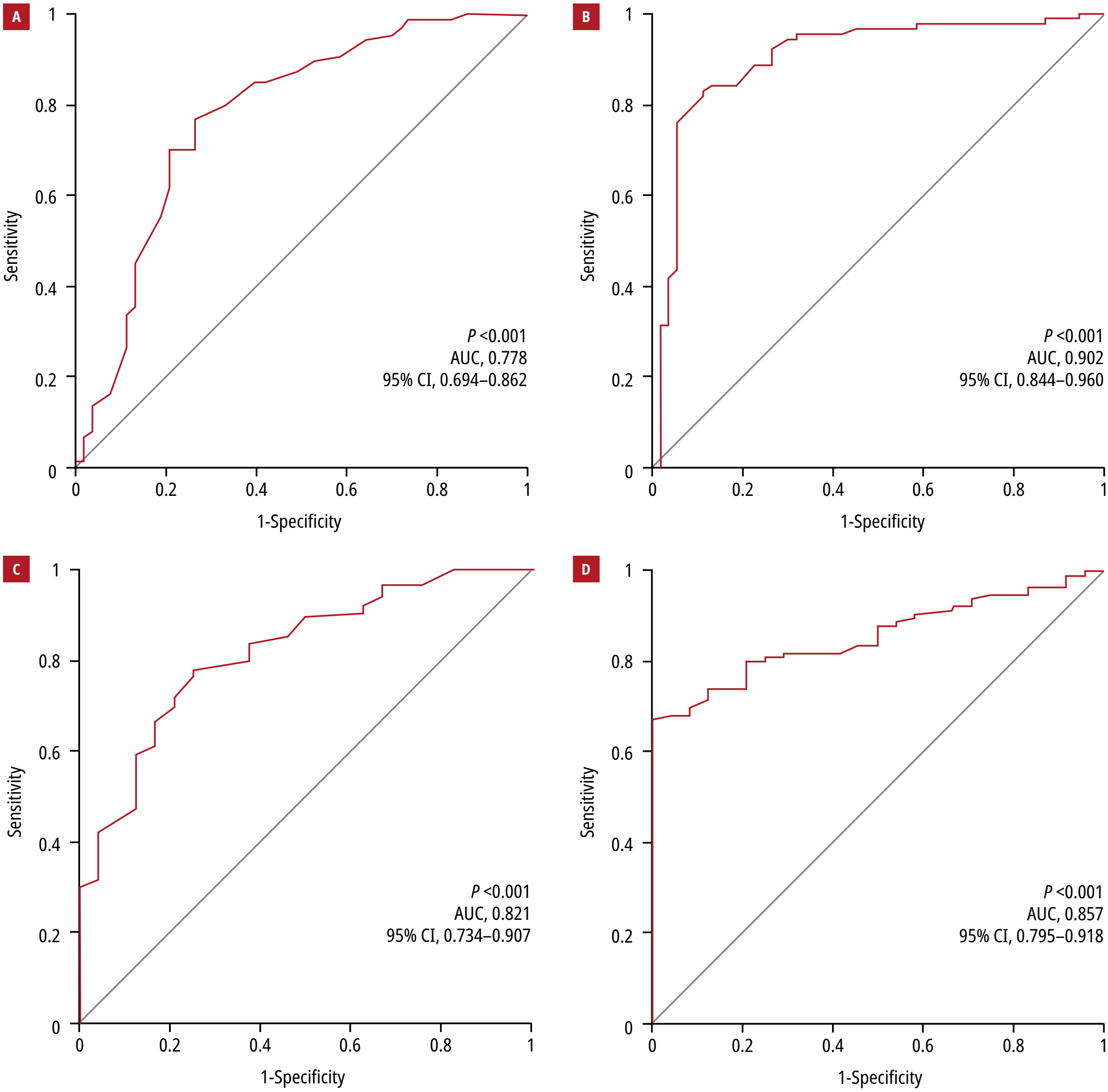

FIGURE 2 Receiver operating characteristic curves of membranous septum (MS) length (**A**) and ΔMSID (**B**) as predictors of new-onset LBBB; and of MS length (**C**) and ΔMSID (**D**) as predictors of permanent pacemaker implantation.
Abbreviations: AUC, area under the curve; others, see TABLES 1 and 2, FIGURE 1

designs (BEV vs SEV) were compared, the mean (SD) MS length did not differ between groups (BEV, 7.5 [1.2] mm vs SEV, 7.7 [1] mm; $P = 0.25$), while ΔMSID values were found to be lower in the SEV group (BEV, 0.7 [2.5] mm vs SEV, –0.8 [2.5] mm; $P < 0.001$). It was observed that this difference was due to the longer ID in the SEV group (BEV, 6.81 [1.9] mm vs SEV, 8.56 [1.9] mm; $P < 0.001$). Patients who had implanted Evolut R and Portico had similar ID and MS length.

DISCUSSION The main findings of our study were as follows: 1) a shorter MS length and the consequent high chance of a ΔMSID with negative value is associated with an increased risk of new-onset LBBB and PPM in patients with TAVR; 2) the length of the ΔMSID, which was inversely associated with CD, was significantly lower in the SEV group.

Although the need for PPM implantation has decreased after TAVR in recent years due to advances in valve technology,[13] CD still remains an issue in this patient population. A high incidence of CD occurs following TAVR mainly because of the close anatomical relationship between conduction pathways located under the MS and the aortic annulus.[4,5] The clinical significance of easy measurement and evaluation of MS with MDCT in patients undergoing TAVR

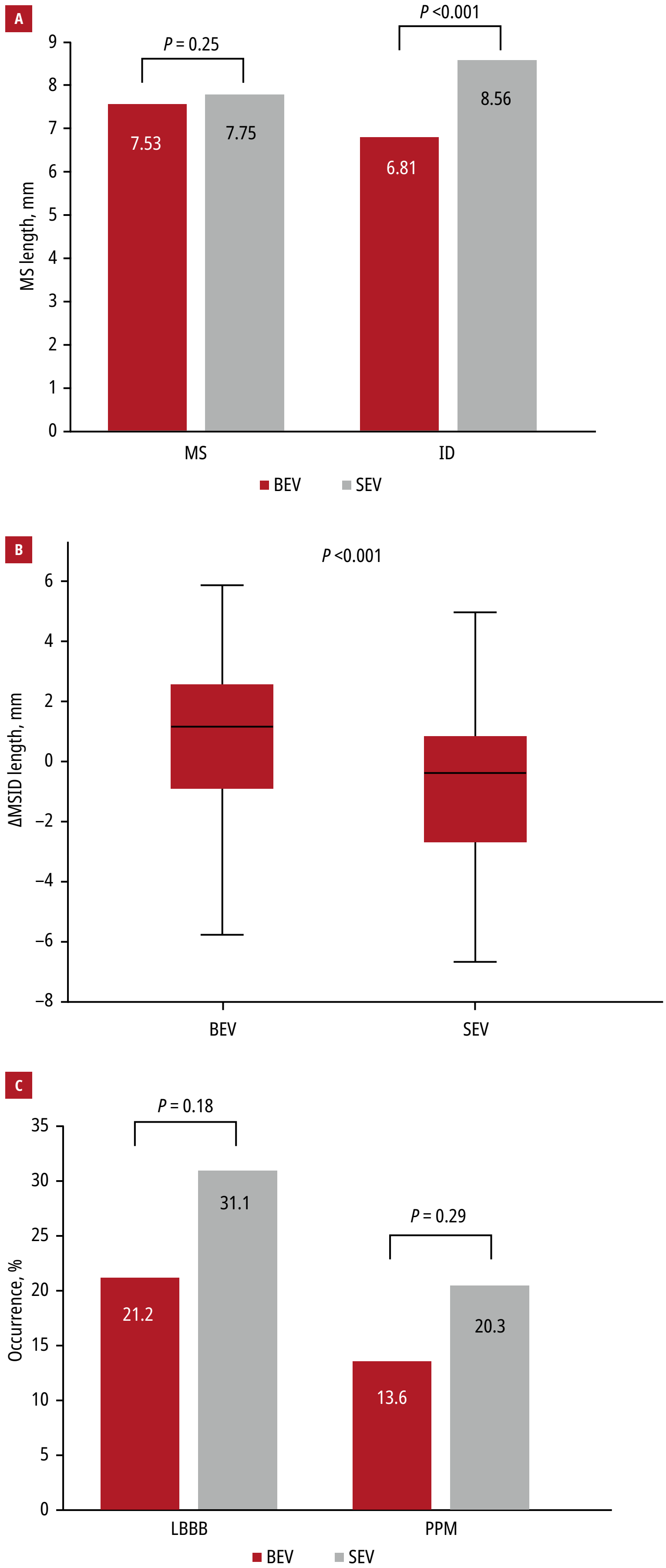

FIGURE 3 Membranous septum, implantation depth (**A**), ΔMSID (**B**), and percentage of permanent pacemaker implantations (**C**) according to the type of prosthesis
Abbreviations: see TABLES 1 and 2

has been shown in previous studies.[6,7] However, the relationship between MS length and the incidence of PPM implantation following TAVR is still controversial.[8,9]

In a prior study, Hamdan et al[6] found that shorter MS and ΔMSID lengths were associated with an increased risk of AV block and the need for PPM implantation with self-expanding prostheses and were inversely related to CD. They also revealed that patients with an MS length of less than 6.8 mm and ΔMSID of less than –1 mm had the highest risk of high-degree AV block. The OR was 4.7 for MS length (95% CI, 1.3–16.4), and 11.3 (95% CI, 2.9–43.8) for ΔMSID. Our results also reinforced the importance of short MS length as a risk factor for CD. According to ΔMSID, our study exhibited a higher risk of CD when compared to the results by Hamdan et al.[6] This might be explained by the fact that ID was longer in our study (mean [SD], 7.7 [2.1] mm compared to Hamdan et al[6], 6.4 [4.4] mm).

Miki et al[7] recently reported that patients who required new PPM had a significantly shorter MS and ΔMSID length as compared with patients who did not require PPM (mean [SD] MS length, 5.3 [1.3] mm vs 6.6 [1.4] mm, respectively; and mean [SD] ΔMSID, –1.7 [1.5] mm vs 0.8 [1.9] mm, respectively; *P* <0.001 for both). When considering the pre- and postprocedural parameters, both MS and ΔMSID length were independent predictors of CD.[7] Likewise, Maeno et al[8] recently showed that shorter MS length was an important predictor of PPM implantation following TAVR with the SAPIEN 3 valve (OR, 0.63; 95% CI, 0.48–0.82; *P* = 0.001). In our study, we used the Sapien XT prosthesis, unlike the previous 2 studies, which used the Sapien 3 prosthesis. The frame heights of the Sapien XT and Sapien 3 valves are similar, and the same prosthesis material is used for the scaffold. Furthermore, there are studies in which the PPM rates of the 2 prostheses have been found to be similar.[14]

On the contrary, Oestreich et al[9] found no significant differences among patients who had new-onset LBBB or required PPM versus those who did not in terms of MS length (mean [SD], 7.9 [2] mm vs 7.2 [2] mm; *P* = 0.2). The reasons for the relatively lower rate of CD in their cohort, which differed from previously published reports and our study, are based on anatomical and procedural characteristics. First, the median ID in their study was more aortic than in the previous studies (4.9 mm of the stent frame in the LVOT). Thus, the higher implant frame may have decreased the interaction between the valve and the conduction system and reduced the effects of short MS length on the risk of PPM implantation. Second, the bundle of His and its branch, which are the continuation of the AV node, continues under the MS. The variations in this relationship determine how susceptible these structures are to injury during TAVR. The left-sided

AV bundle variant may expose patients to a higher risk of TAVI-induced CD, especially in patients with a short MS.[4] According to this information, we surmised that patients in that study might have more right-sided AV bundles.

Technical aspects of TAVR procedures, especially the valve design and the potential of deeper implantation into the LVOT, may expose patients to a higher risk of TAVI-induced CD, especially those with a short MS. It is well known that self-expanding prostheses are a predictor of PPM because of their higher frame height, as the frame protrudes into the LVOT.[6,15-18] Additionally, implantation of a BEV with increased ID is associated with high rates of PPM implantation.[19] Therefore, we aimed to determine which type of valve we should choose in the presence of a short MS. In our head-to-head comparison, self-expandable prostheses appeared to be associated with higher rates of PPM implantation and LBBB. However, these results did not reach statistical significance. We would expect to reach statistical significance and demonstrate a true association between valve types and CD with a higher number of patients. In this study, self-expandable prostheses were associated with a shorter ΔMSID (P <0.001). This difference was due to longer ID in the SEV group. Accumulating data suggested that the CoreValve prosthesis ID is a predictor for PPM and LBBB. Another study revealed that the PPM rate was reduced to 13.3% at 1-month follow-up when Evolut R was implanted according to the recommended practice (ID <6 mm).[20]

To the best our knowledge, this is the first study to compare CD between a self-expanding Portico/Evolut R prosthesis and the balloon-expanded Sapien XT prosthesis according to variability in the length of the MS. We recommend selecting one of these 2 strategies in the presence of a short MS length: 1) Given that balloon-expandable devices have less TAVR-related CD due to a smaller ID and shorter frame height, operators may prefer this THV for patients with a shorter MS and avoid mechanically expanded valves; 2) If an SEV is planned, the risk of PPM implantation could be reduced by using a higher or more aortic implant height (ΔMSID >0 mm).

The present study has some limitations that have to be acknowledged. Although the frame height is similar in Sapien XT and Sapien 3 valves and the same prosthesis material is used for the scaffold, it may be inappropriate to compare our results. The decision to implant a PPM was made at the discretion of the attending physician, but it was most often for a high-degree AV block and thus conforms to current international guidelines.

In conclusion, a short MS length and decreasing ΔMSID increases the risk of new-onset LBBB and PPM implantation in patients undergoing TAVR. Assessment of the MS anatomy prior to TAVR can help guide appropriate device selection and subsequently reduce CD. The risk of new-onset LBBB and PPM implantation can be reduced by using a higher or more aortic implant height, not exceeding the length of the MS (ΔMSID >0 mm), especially with self-expandable prostheses.

SUPPLEMENTARY MATERIAL

Supplementary material is available at www.mp.pl/kardiologiapolska.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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