Hellenic Society of Cardiology (2018) 59, 100—107

Available online at www.sciencedirect.com

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ORIGINAL ARTICLE

Effect of diabetes mellitus on clinical outcomes and quality of life after transcatheter aortic valve implantation for severe aortic valve stenosis

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Received 9 May 2017; received in revised form 3 August 2017; accepted 7 August 2017
Available online 12 August 2017

KEYWORDS
Frailty;
Transcatheter aortic valve replacement;
Aortic valve disease;
High-risk patients;
Registry

Abstract *Background:* Diabetes mellitus (DM) is considered a marker of poor prognosis after cardiac surgery. We sought to investigate the effect of DM on clinical outcomes and quality of life (QoL) after transcatheter aortic valve implantation (TAVI).
Methods: A total of 148 consecutive patients with symptomatic, severe aortic stenosis who underwent TAVI were included. Baseline characteristics, procedural and long-term clinical outcomes, and the results of frailty and QoL assessment with EQ-5D-3L questionnaire were compared between patients with and without DM.
Results: DM was present in 48 of 148 (32.4%) patients. No differences in periprocedural risk (Logistic Euroscore and Society of Thoracic Surgeons (STS) scale) between groups were observed. There were no differences in 30-day and 12-month all-cause mortality between groups [DM(−) vs. DM(+): 7 (7.0%) vs. 5 (10.4%), $p = 0.53$ and 12 (12.0%) vs. 10 (20.8%), $p = 0.16$, respectively]. No influence of DM presence on the risk of death was confirmed after adjustment for age and gender (for 30-day mortality, age/gender-adjusted OR 1.55, 95%CI 0.47—5.17; for 12-month mortality, age/gender-adjusted OR 2.05, 95%CI 0.79—5.32). Similarly, at the longest available follow-up, mortality did not differ between groups [14 (29.2%) vs. 19 (19.0%), $p = 0.16$; age/gender-adjusted OR 1.81, 95%CI 0.80—4.08]. Similar rates of other complications after TAVI were noted. Frailty measured with the 5-meter walking test was more

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Peer review under responsibility of Hellenic Society of Cardiology.

http://dx.doi.org/10.1016/j.hjc.2017.08.002

frequently reported in patients with DM [11 (22.9%) vs. 10 (10.0%), $p = 0.035$]. No differences in QoL parameters at baseline and 12 months were noted.
Conclusions: Patients with DM undergoing TAVI demonstrated similar mortality, complication rates, and QoL outcomes compared to patients without DM.

1. Introduction

Transcatheter aortic valve implantation (TAVI) has been demonstrated as a feasible option for the treatment of severe aortic valve stenosis (AS) in patients at high risk of surgical aortic valve replacement (SAVR).[1–4] Improvement in clinical outcomes and quality of life (QoL) after TAVI in long-term follow-up was confirmed by several studies.[1–8] However, several clinical and procedural factors may influence the outcomes of TAVI. For instance, diabetes mellitus (DM) has been considered a marker of poor prognosis in the currently used Society of Thoracic Surgeons (STS) and the EuroSCORE II risk scores.[9–11] DM has a well-established role in worsening prognosis in various cardiovascular disorders. It exacerbates arterial stiffening and atherosclerosis, leading to worse outcome in coronary and peripheral artery disease, with potential impact on morbidity and mortality.[11–21] Furthermore, DM is a risk factor for the progression of calcification and stenosis of the aortic valve.[11] DM may alter the pathophysiological process of AS, thereby worsening postprocedural outcomes.[11] Some studies reported no influence of DM on survival rate after TAVI, while other suggested a detrimental effect on clinical outcomes. Despite rapidly evolving technology and an exponential increase in interest in TAVI, there are still limited and inconsistent data regarding the effect of DM on long-term prognosis.[11–21] Moreover, data on QoL and frailty for patients undergoing TAVI are lacking. Thus, we aimed to investigate the effect of DM status on clinical outcomes, complication rates, and QoL in patients after TAVI.

2. Methods

A total of 148 consecutive patients who underwent TAVI were included.[4] All patients were diagnosed with symptomatic severe AS and had high risk or contraindications for SAVR. Patients were clinically evaluated to assess operative risk, comorbidities, frailty, and procedural feasibility. Baseline characteristics and procedural data were prospectively collected. Frailty features before TAVI were assessed using the Katz index of independence in activities of daily living (KI), elderly mobility scale score (EMS), Canadian Study of Health and Aging (CSHA) scale, 5-meter walking test (5MWT), dominant hand grip strength, and Identification of Seniors at Risk (ISAR) scale that were previously described.[22] Patient screening and selection were performed by a multidisciplinary Heart Team supported by clinical and imaging resources. TAVI procedures were performed using Edwards Sapien, Edwards Sapien XT, Edwards Sapien 3 (Edwards Lifesciences), Medtronic CoreValve/Evolut R (Medtronic, Inc), and JenaValve (JenaValve Technology), as well as Lotus (Boston Scientific) and NVT (New Valve Technology). Procedures were performed under general anesthesia or local anesthesia with sedation. Clinical endpoints of the study included all-cause mortality at 30 days and every 6 months up to maximal available follow-up and complication rates up to 12 months. QoL was assessed using the validated Polish version of the EQ-5D-3L questionnaire at baseline and 12 months after TAVI. The visual analog scale (VAS) score, which is a part of the EQ-5D-3L, was also assessed. All endpoints were assessed according to the recommendations of the Valve Academic Research Consortium (VARC-2).[23] For this analysis, patients were divided into two groups according to DM status. Patients were considered as patients with DM according to diagnosis in past medical history, with fulfilled criteria of Polish Diabetes Association.[24] The study was approved by the institutional ethics board. All patients provided written informed consent to participate in the study. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and its later amendments.

3. Statistical analysis

Results are presented as the number of patients (percentage) or median (interquartile range [IQR]) where applicable. Differences between groups were tested using the Chi-square test and Fisher's exact test for dichotomous variables and the Mann-Whitney U test for continuous variables. Changes in the proportions of patients who reported either "no problems" or "some problems"/"extreme problems" on the EQ-5D-3L between baseline and follow-up visits were analyzed using McNemar's test. Differences in the VAS score between baseline and follow-up assessments were analyzed with a Wilcoxon signed-rank test. All paired comparisons between baseline and 12-month measurements were performed excluding unpaired results. The difference in mortality between patients with and without DM during follow-up was assessed by the Kaplan-Meier method. In addition, differences in outcomes were presented as age/gender-adjusted odds ratios (OR) with 95% confidence intervals (CI). In addition, multivariable Cox regression analysis was performed to determine significant predictors of 12-month mortality. All baseline characteristics and procedural data were tested. Forward selection with a probability value for covariates to enter the model

was set at the 0.05 level. Results were presented as hazard ratios (HR) with 95%CI. All tests were two-tailed, and a p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS 15.0 (SPSS, Inc, Chicago, IL, USA).

4. Results

DM was present in 48 of 148 (32.4%) patients who underwent TAVI. Half of them required insulin, the remaining 24 (16.2%) patients were treated with oral drugs or diet. Baseline clinical and demographic characteristics are presented in Table 1. Patients with DM had higher body mass index [DM (−) vs. DM (+): 26.5 (25.1−30.0) vs. 28.4 (26.7−32.0) [kg/m^2]; $p = 0.02$] and lower rate of chronic obstructive pulmonary disease [9 (9.0%) vs. 10 (20.8%); $p = 0.04$]. Similar rates of other comorbidities were observed in both groups. Notably, no differences in periprocedural risk measured with Logistic Euroscore and STS were reported. Procedural details are shown in Table 2. Similar length of hospital stay was observed for patients without and with DM [9.5 (8.0−12.0) vs. 11.0 (8.5−14.0) days; $p = 0.4$]. Frailty measured with 5MWT was more common in patients with DM [11 (22.9%) vs. 10 (10.0%); $p = 0.04$] (Table 3). No differences between groups in all components of EQ-5D-3L questionnaire were confirmed at 12 months (Figure 1). The median VAS at baseline [40.0 (30.0−50.0) vs. 40.0 (40.0−50.0); $p = 0.7$] and 12 months after TAVI [70.0 (60.0−80.0) vs. 70.0 (60.0−80.0); $p = 0.9$] was comparable between groups. Similarly, no difference in VAS change during follow-up between both groups was reported [25.0 (10.0−40.0) vs. 25.0 (15.0−40.0); $p = 0.8$]. Median follow-up of all patients was 13.3 (6.0−31.1) months. There were no differences in 30-day and 12-month all-cause mortality between groups [7 (7.0%) vs. 5 (10.4%); $p = 0.5$ and 12 (12.0%) vs. 10 (20.8%); $p = 0.2$, respectively]. Furthermore, no influence of DM status on the risk of death was confirmed after adjustment for age and gender (for 30-day mortality, age/gender-adjusted OR 1.55, 95%CI 0.47−5.17; for 12-month mortality, age/gender-adjusted OR 2.05, 95%CI 0.79−5.32). At 12-months, no survival benefit was observed as compared to patients with insulin-treated DM and those on oral drugs or diet (3 (12.5%) vs. 7 (29.2%); $p = 0.2$; age/gender-adjusted OR 3.08, 95%CI 0.63−15.09); $p = 0.20$). The longest available follow-up mortality did not differ between patients with

Table 1 Baseline clinical and echocardiographic characteristics

	All patients n = 148	DM (−) n = 100	DM (+) n = 48	*p* value
Age median, years	82.0 (77.0−85.0)	82.0 (77.0−85.0)	81.5 (77.5−83.5)	0.3
Age ≥80 years, number (%)	92 (62.2)	65 (65.0)	27 (56.3)	0.3
Men, number (%)	56 (37.8)	38 (38.0)	18 (37.5)	1.0
Body mass index, kg/m^2	27.2 (25.2−30.6)	26.5 (25.1−30.0)	28.4 (26.7−32.0)	0.02
eGFR, ml/min/1.73 m^2	56.5 (40.0−72.0)	59.0 (40.0−72.5)	50.0 (38.0−66.0)	0.3
NYHA class, number (%)				0.6
I	0 (0.0)	0 (0.0)	0 (0.0)	
II	41 (27.7)	29 (29.0)	12 (25.0)	
III	97 (65.5)	63 (63.0)	34 (70.8)	
IV	10 (6.8)	8 (8.0)	2 (4.2)	
Arterial hypertension, number (%)	139 (93.9)	93 (93.0)	46 (95.8)	0.7
Atrial fibrillation, number (%)	52 (35.1)	38 (38.0)	14 (29.2)	0.3
Previous MI, number (%)	48 (32.4)	30 (30.0)	18 (37.5)	0.4
Previous PCI, number (%)	43 (29.1)	28 (28.0)	15 (31.3)	0.7
Previous CABG, number (%)	28 (18.9)	22 (22.0)	6 (12.5)	0.2
CTO, number (%)	14 (9.5)	9 (9.0)	5 (10.4)	0.8
Incomplete revascularization, n (%)	22 (14.9)	13 (13.0)	9 (18.8)	0.5
COPD, number (%)	19 (12.8)	9 (9.0)	10 (20.8)	0.04
Stroke/TIA, number (%)	17 (11.5)	13 (13.0)	4 (8.3)	0.4
Pacemaker, number (%)	17 (11.5)	9 (9.0)	8 (16.7)	0.2
Logistic Euroscore I, %	14.5 (10.0−22.7)	14.5 (10.7−23.0)	14.4 (9.0−22.0)	0.7
STS, %	6.2 (4.0−17.3)	6.0 (4.0−18.5)	7.5 (5.0−15.0)	0.2
TG max, mmHg	86.0 (69.0−103.0)	87.0 (71.5−103.5)	82.0 (66.0−101.0)	0.5
TG mean, mmHg	50.0 (42.0−63.0)	50.0 (42.3−63.0)	48.0 (39.5−63.0)	0.5
AVA, cm^2	0.7 (0.6−0.8)	0.7 (0.6−0.8)	0.7 (0.6−0.8)	0.6
LVEF, %	60.0 (50.0−65.0)	60.0 (50.0−65.0)	60.0 (49.5−65.0)	0.9
TG max after TAVI, mmHg	13.0 (10.0−19.0)	13.0 (10.0−19.0)	15.0 (10.6−19.0)	0.3
TG mean after TAVI, mmHg	7.4 (5.1−10.0)	7.0 (5.0−10.0)	8.0 (6.0−12.0)	0.2
LVEF after, %	48.0 (41.0−55.0)	47.0 (40.0−55.0)	49.0 (42.5−57.5)	0.5

Abbreviations: AVA, aortic valve area; CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; CTO, chronic total occlusion; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; LVEF, left ventricle ejection fraction; MI, myocardial infarction; NYHA, New York Heart Association; PCI, percutaneous coronary intervention; STS, The Society of Thoracic Surgeons; TG, transaortic gradient; TIA, transient ischemic attack. Data are presented as median and interquartile range or number (percentage).

Table 2 Procedural and follow-up data

	All patients n = 148	DM (−) n = 100	DM (+) n = 48	*p* value
Transfemoral access, number (%)	117 (79.1)	77 (77.0)	40 (83.3)	0.3
Transapical access, number (%)	28 (18.9)	21 (21.0)	7 (14.6)	
Transaortic access, number (%)	2 (1.4)	2 (2.0)	0 (0.0)	
Subclavian access, number (%)	1 (0.7)	0 (0.0)	1 (2.1)	
Medtronic CoreValve, number (%)	21 (14.2)	15 (15.0)	6 (12.5)	1.0
Edwards Sapien, number (%)	95 (64.2)	64 (64.0)	31 (64.6)	
Jena, number (%)	10 (6.8)	7 (7.0)	3 (6.3)	
Lotus, number (%)	9 (6.1)	5 (5.0)	4 (8.3)	
NVT, number (%)	5 (3.4)	3 (3.0)	2 (4.2)	
Prosthesis size, number (%)				0.7
23 mm	30 (20.3)	19 (19.0)	11 (22.9)	
25 mm	8 (5.4)	5 (5.0)	3 (6.3)	
26 mm	56 (37.8)	42 (42.0)	14 (29.2)	
27 mm	8 (5.4)	5 (5.0)	3 (6.3)	
29 mm	38 (25.7)	23 (23.0)	15 (31.3)	
31 mm	8 (5.4)	6 (6.0)	2 (4.2)	
Prosthesis size, mm	26.0 (25.0—29.0)	26.0 (26.0—29.0)	26.0 (25.0—29.0)	0.9
AR before, number (%)				0.7
0	48 (32.4)	34 (34.0)	14 (29.2)	
1	75 (50.7)	47 (47.0)	28 (58.3)	
2	20 (13.5)	15 (15.0)	5 (10.4)	
3	5 (3.4)	4 (4.0)	1 (2.1)	
AR after, number (%)				0.3
0	84 (56.8)	61 (61.0)	23 (47.9)	
1	55 (37.2)	33 (33.0)	22 (45.8)	
2	7 (4.7)	4 (4.0)	3 (6.3)	
3	2 (1.4)	2 (2.0)	0 (.0)	
Radiation dose, mGy	721.0 (632.5—827.5)	721.0 (628.0—831.5)	712.5 (635.5—823.0)	0.9
Contrast media load, ml	75.0 (50.0—137.5)	75.0 (50.0—150.0)	75.0 (50.0—100.0)	0.8
Fluroscopy time, min	13.0 (12.0—15.0)	13.0 (12.0—14.5)	14.0 (11.5—15.0)	0.3

Abbreviations: AR, aortic regurgitation; DM, diabetes mellitus; LVEF, left ventricle ejection fraction; TAVI, transcatheter aortic valve implantation; TG, transaortic gradient. Data are presented as median and interquartile range or number (percentage).

Table 3 Frailty indices in patients with and without diabetes mellitus

	Categories	All patients n = 148	DM (−) n = 100	DM (+) n = 48	*p* value
5MWT, s	≥6, frail	21 (14.2)	10 (10.0)	11 (22.9)	0.04
EMS, points	<10, frail	8 (5.4)	4 (4.0)	4 (8.3)	0.6
	10-13	93 (62.8)	63 (63.0)	30 (62.5)	
	>13	47 (31.8)	33 (33.0)	14 (29.2)	
CSHA scale, points	1-3	87 (58.8)	61 (61.0)	26 (54.2)	0.2
	4	44 (29.7)	31 (31.0)	13 (27.1)	
	5, frail	3 (2.0)	1 (1.0)	2 (4.2)	
	6—7, frail	14 (9.5)	7 (7.0)	7 (14.6)	
Katz index, points	<6, frail	19 (12.8)	13 (13.0)	6 (12.5)	0.9
Grip strength, grade	1 = weak, frail	7 (4.7)	4 (4.0)	3 (6.3)	0.08
	2 = mild	14 (9.5)	6 (6.0)	8 (16.7)	
	3 = strong	127 (85.8)	90 (90.0)	37 (77.1)	
ISAR scale, points	≥2, functional decline, frail	53 (35.8)	35 (35.0)	18 (37.5)	0.8

Abbreviations: 5MWT, 5-meter walking test: ≥6 s — frail, <5 s not frail; EMS, elderly mobility scale <10 — high level of help with mobility and activities in daily living, 10—14 — borderline in terms of safe mobility and independence in activities of daily living (ADL), i.e., home with help, >14 — independent mobility, home, and no help needed; CSHA, Canadian Study of Health and Aging scale: 1 — very fit for one's age, 2 — well but less fit than people in category 1, 3 — well, with treated comorbid disease, 4 — apparently vulnerable, although not frankly dependent, 5 — mildly frail with limited dependence, 6 — moderately frail, help is needed, 7 — severely frail, completely dependent on others, 8 — terminally ill; Katz index: 6 — not frail, <6 — frail; ISAR, Identification of Seniors at Risk scale: ≥2 indicates person at high risk of functional decline, 0 or 1 indicates person at low risk. Data are presented as number (percentage).

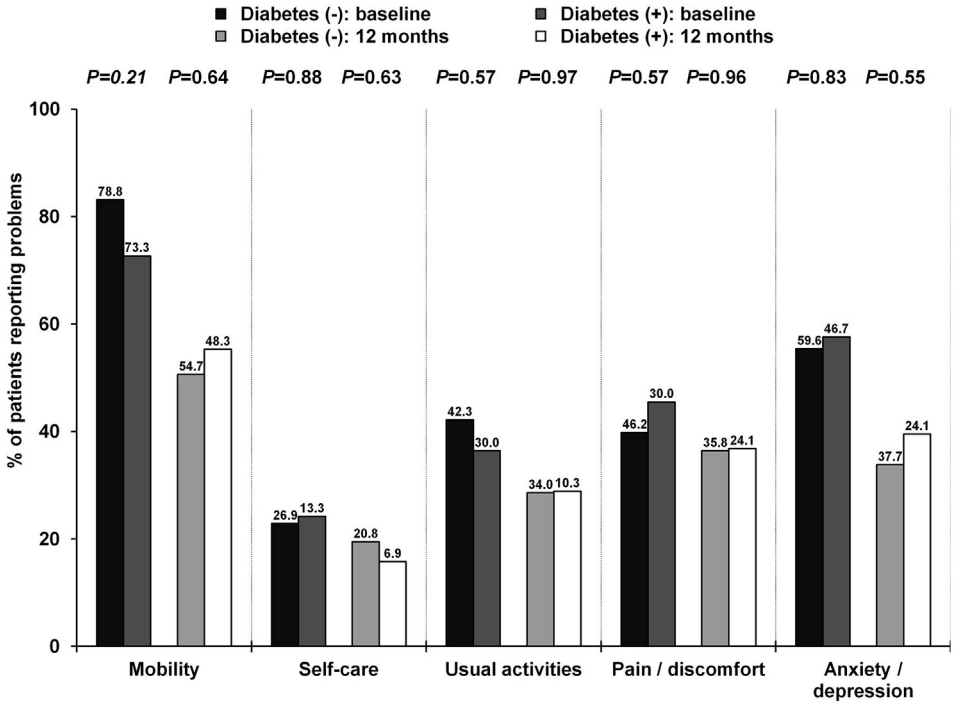

Figure 1 Proportions of patients that reported either "some problems" or "extreme problems" for each category of the EQ-5D-3L at baseline and at 12 months.

and without DM [14 (29.2%) vs. 19 (19.0%); $p = 0.2$; age/gender-adjusted OR 1.81, 95%CI 0.80—4.08]. Inversely, a higher rate of all-cause death at maximal available follow-up was noted among patients with DM and those requiring insulin as compared to the remaining diabetic patients [4 (16.7%) vs. 10 (41.7%); $p = 0.01$]. However this difference was not significant after adjustment for age and gender (OR 3.58, 95%CI 0.90—14.17; $p = 0.07$). Kaplan-Meier curves for survival after TAVI stratified by DM status and treatment type are presented in Figure 2. At the longest available follow-up, 12 of 33 deaths were related to cardiovascular (CV) causes. A trend toward higher CV mortality in patients with DM was observed [DM (−) vs. DM (+): 5 (5.0%) vs. 7 (14.6%); $p = 0.06$; age/gender-adjusted OR 3.35, 95%CI 0.99—11.29; $p = 0.05$). Among diabetic patients, no differences in CV mortality was reported regarding the type of treatment (non-insulin treated vs. insulin-treated: 4 (16.7%) vs. 3 (12.5%); p = 0.99; age/gender-adjusted OR 0.73, 0.14—3.84; $p = 0.7$). Rates of in-hospital grade 3 acute kidney injury [4 (4.0%) vs. 4 (8.3%); $p = 0.3$; age/gender-adjusted OR 2.33, 95%CI 0.55—9.97], bleeding complications [30 (30.0%) vs. 19 (39.6%); $p = 0.3$; age/gender-adjusted OR 1.57, 95%CI 0.76—3.24], and blood transfusions [29 (29.0%) vs. 15 (31.2%); $p = 0.8$; age/gender-adjusted OR 1.14, 95%CI 0.54—2.42] were comparable between groups. Similarly, no differences in stroke/transient ischemic attack (TIA) [6 (6.0%) vs. 4 (8.3%); $p = 0.6$; age/gender-adjusted OR 1.47, 95%CI 0.38—5.60], myocardial infarction [1 (1.0%) vs. 3 (6.2%); $p = 0.1$; age/gender-adjusted OR 10.29, 95%CI 0.79—134.46], need for permanent pacemaker stimulation [17 (17.0%) vs. 7 (14.6%); $p = 0.7$; age/gender-adjusted OR 0.84, 95%CI 0.32—2.19], and new-onset atrial fibrillation [5 (5.0%) vs. 5 (10.4%); $p = 0.3$; age/gender-adjusted OR 2.33, 95%CI 0.61—8.90] were reported during the 12-month follow-up. DM was not identified as an independent predictor of mortality in multivariable Cox regression analysis. The only independent predictors were incomplete coronary revascularization (HR 5.45, 95%CI 2.38—12.52; $p = 0.001$), estimated glomerular filtration rate (HR 0.96 per 1 ml/min/1.73 m^2 increase, 95%CI 0.94—0.98; $p = 0.001$), and previous stroke/TIA (HR 2.86, 95%CI 1.17—7.00; $p = 0.02$).

5. Discussion

Following TAVI procedure, patients with DM demonstrated similar short- and long-term mortality and complication rates as the non-diabetic group. These results were maintained even after adjustment for age and gender. Similarly, DM was not identified as an independent predictor of all-cause long-term mortality. A trend toward higher CV mortality in patients with DM was observed. No differences in the results of QoL assessment were observed between groups. Our findings stay in line with results from recent studies reporting no influence of DM on survival rate after TAVI.[12,13,15,16,20] However, some of the studies presented contradictory results suggesting an association between DM and adverse clinical outcomes after TAVI. Independent association between DM and increased 30-day mortality with no effect on longer term survival was previously demonstrated.[18,25] Furthermore, data from two large registries confirmed an independent association between DM and long-term mortality. However, DM was not associated with in-hospital mortality after aortic valve implantation.[19,26] In addition, some studies found that DM is independently

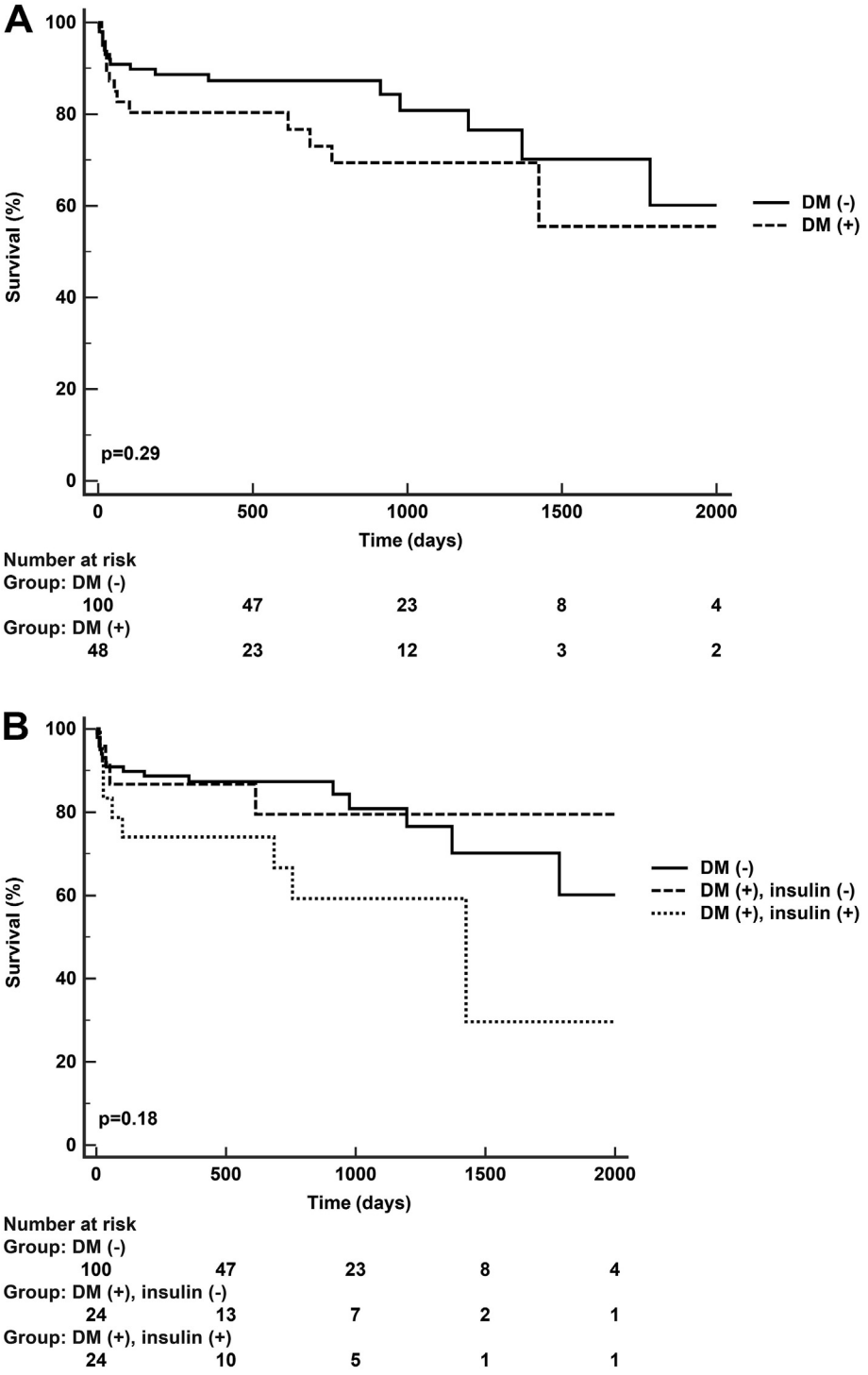

Figure 2 Kaplan-Meier curves for survival after transcatheter valve implantation stratified by diabetes status (A) as well as diabetes status and treatment type (B)

associated with increased mid-term all-cause mortality and myocardial infarction. However, increased overall mortality was demonstrated in the insulin-treated DM subgroup and not in orally treated patients with DM.[13,20] On the contrary, another study reported similar mortality regardless of the type of treatment of DM.[15] It remains unclear whether insulin affects the outcome directly or if it is only a marker of advanced stage of DM.[27] In our study, patients with insulin-treated DM had similar survival to diabetics on oral drugs or diet. However, a higher rate of all-cause death at maximal available follow-up was noted among patients with DM and those requiring insulin as compared to the rest of the DM subgroup. This difference was not significant after adjustment for age and gender. Furthermore, no differences in CV mortality were reported regarding the type of treatment for DM. Puls et al. demonstrated poor

outcome in diabetic patients following TAVI, but in contrast to our study, they used a transapical approach in most of the procedures.[14] Finally, a recent meta-analysis including a total of 13,253 patients has reported no significant difference between DM and non-DM groups with regard to the 30-day (RR 1.07,95% CI 0.90—1.27, $p = 0.5$) or 1-year (RR 1.04, 95% CI 0.94—1.15, $p = 0.4$) all-cause mortality.[27] The risks of 30-day complications, including myocardial infarction, stroke, major vascular complications, major bleeding, and acute kidney injury, were similar between patients with and without DM.[27] In our study, no difference in all-cause mortality at longest available follow-up was confirmed. However, mortality rates were numerically higher in patients with DM than those without DM. Moreover, we did not confirm differences in the risk of other complications up to 12 months. One of the possible explanations for these contradictory results may be increased vascular and bleeding complications in previous years when device profile and vascular access sheaths were larger. An association between major vascular and bleeding complications and insulin-treated DM was previously reported.[28] Furthermore, AS initiates a cascade of intra- and extracellular events resulting in ventricular hypertrophy, which is manifested as a diastolic dysfunction.[16] A recent study reported the aggravation of this process in patients with DM and concomitant AS.[16,29] Moreover, DM plays an important role in the process of myocardial fibrosis in hypertrophic remodeling by accumulating extracellular matrix within the hypertrophied myocardium.[8] It was also demonstrated that chronic hyperglycemia causes oxidative stress on cardiomyocytes, leading to mitochondrial damage and cell death.[8,29] These findings may propose the potential mechanisms of irreversible myocardial fibrosis and hypertrophy in patients with DM.[8,29] DM may reduce the ability of the myocardium to adapt to the hemodynamic changes after aortic valve implantation.[8,29] Finally, it has been shown that DM is associated with significantly worse outcomes after valve operations.[9—11,20] Therefore, it was included in the STS risk score as a predictor of poor outcomes after cardiac operations, and the revised EuroScore II added insulin-treated DM to the model that predicts short-term outcome after cardiac surgery.[9—11,20] However, pathophysiological changes related to DM in patients with AS do not necessarily result in elevated mortality in the "real world".[27] The independent influence of DM on mortality could be reduced by the overall effect of frailty and comorbidities, which are common in elderly patients.[22,27,30] Although mortality is being used to measure the effectiveness of treatments, QoL should be an additional target.[5—7] In particular, QoL improvement is commonly considered as a major expectation for elderly patient's profile after TAVI.[7] Amelioration of QoL after TAVI was presented in recently published studies.[5—7,31] The improvement in QoL after TAVI may be higher than that observed after SAVR, even with the use of minimally invasive surgical techniques (mini-thoracotomy, mini-sternotomy).[7] In our study, no differences in QoL were observed between groups. This suggests the presence of equal response to TAVI regardless of DM status. However, we used a questionnaire with low sensitivity. Only a non-disease-specific tool was used for patient assessment. Frailty has also been presented as a valuable factor to determine overall health status, which is combined with morbidity and mortality in various clinical settings.[22,30—32] Because of the nonspecificity of frailty as a risk factor, it should be considered during the medical treatment of older people with several diseases, including DM.[32] Predictive value of frailty for mortality and disability remain unclear.[32] However, in a recent study, survival analysis has shown a relationship between frailty quartiles and the risk of death in elderly patients with DM.[32] In the adjusted Cox models, only age and frailty indices were associated with the risk of death and incident disability after adjusting for measures of frailty.[32] Higher frailty prevalence in patients with DM was confirmed only for the assessment of 5MWT. Higher body mass index in the DM group could be a possible explanation for this difference. Frailty should be included as a part of the routine comprehensive evaluation of all older patients, especially those qualified for TAVI.

6. Limitations

The present study has several limitations. Most important is the single-center, prospective, non-randomized observational design of the study. Patients were allocated to TAVI after evaluation by a multidisciplinary local heart team, as suggested by current guidelines, although this policy might generate an unavoidable risk for bias regarding treatment selection. Therefore, these results can only be considered to be hypothesis generating rather than causative. Durations of DM before TAVI and glycemic control (e.g., hemoglobin A1c levels, fasting glucose level) were not systematically collected and were not available for this analysis. Therefore, it cannot be excluded that the level of diabetic control has more effect on the outcome than the type of treatment. A relatively small cohort of included patients and the size of the two main groups did not allow us for definitive confirmation/exclusion of the relationship between DM status and clinical outcomes of patients after TAVI. There is a lack of data and recommendations for frailty assessment in patients undergoing TAVI.

7. Conclusions

DM was not associated with an increased mortality risk or complication rates after TAVI. Both diabetic and non-diabetic patients seem to have similar QoL outcomes during long-term follow-up. Thus, TAVI can be considered an effective and safe treatment strategy in high-risk patients, regardless of their DM status.

Conflict of interest

There is no potential conflict of interest.

Author contributions

TT, AD, AW, and PK conceived the idea for the study and prepared the manuscript. DD, TT, AD, AW, and PK contributed to the design of the research. TT, AD, AW, and PK coordinated this research at all steps of the study. All authors were involved in data collection and follow-up of

the patients. AD made statistical analysis. All the authors have participated in the analysis and interpretation of data. All the authors revised the manuscript critically for important intellectual content. All authors edited and approved the final version of the manuscript.

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