Incidence, Predictors, and Prognostic Impact of Immediate Improvement in Left Ventricular Systolic Function After Transcatheter Aortic Valve Implantation

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Immediate improvement in left ventricular ejection fraction (LVEF) following transcatheter aortic valve implantation (TAVI) is common; however, data on the pattern and prognostic value of this improvement are limited. To evaluate the incidence, predictors, and clinical impact of immediate improvement in LVEF, we studied 694 consecutive patient who had underwent successful TAVI for severe aortic stenosis (AS) between March 2010 and December 2019. We defined immediate improvement of LVEF as an absolute increase of ≥5% in LVEF at post-procedure echocardiogram. The primary outcome was major adverse cardiac or cerebrovascular event (MACCE), defined as a composite of death from cardiovascular cause, myocardial infarction, stroke, or rehospitalization from cardiovascular cause. Among them, 160 patients showed immediate improvement in LVEF. The independent predictors of immediate LVEF improvement were absence of hypertension and baseline significant aortic regurgitation, and greater baseline LV mass index. Immediate improvement in LVEF was significantly associated with a lower risk of MACCE (adjusted hazard ratio, 0.48; 95% confidence interval, 0.28−0.81; p = 0.01). In conclusion, approximately one-fourth of patients with severe AS who underwent TAVI showed immediate improvement in LVEF during index hospitalization. Immediate LVEF recovery was associated with a lower risk of MACCE during follow-up. **(Am J Cardiol 2021;152:99−105)**

Aortic valve stenosis (AS), a common valvular heart disease, is predominant among the elderly.[1] Severe AS is characterized by left ventricular (LV) pressure overloading, leading to LV hypertrophy, concentric remodeling, and impaired LV systolic function.[2] Approximately one-third of patients with severe symptomatic AS have systolic LV dysfunction.[3] Previous studies have shown that significant LV dysfunction was associated with poor prognosis in patients undergoing surgical aortic valve replacement (SAVR).[4] Early recovery of left ventricular ejection fraction (LVEF) after SAVR was observed in more than two-thirds of patients and was associated with improved clinical outcomes.[5] Although the response of LV function after TAVI has become increasingly important, there are limited data on the pattern of immediate LVEF recovery following TAVI and its relationship with long-term clinical outcomes. Therefore, we aimed to determine the incidence and predictors of immediate LVEF recovery following TAVI during index hospitalization and its prognostic effect on long-term cardiovascular outcomes.

Methods

The ASAN-TAVR registry is a prospective registry that includes "all-comers" consecutive patients with symptomatic severe AS who undergo TAVI at Asan Medical Center (Seoul, Republic of Korea).[6-8] The traditional surgical risk score was calculated according to the Society of Thoracic Surgeons (STS) score and the Logistic European System for Cardiac Operative Risk Evaluation (EuroSCORE).

TAVI was performed under general anesthesia or monitored anesthesia care using standard methods. The transfemoral route was preferred, but other approaches, such as apical, subclavian, or direct aortic routes, were considered if not feasible. The type (balloon expandable [Sapien XT and the Sapien 3; Edwards Lifesciences] or self-expandable devices [CoreValve, Evolut R and Evolut Pro; Medtronic or Lotus; Boston Scientific]) and size of devices were determined before the procedure based on assessment using 3-dimensional, multi-detector CT scans and transesophageal echocardiography. This study was approved by the

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Institutional Review Board of Asan Medical Center, and all patients provided written informed consent before participation.

Transthoracic echocardiography was routinely performed before TAVI (at index hospitalization), immediately after the procedure (1 day), after 30 days, 6 months, and 1 year after TAVI, and annually thereafter. If the post-procedure echocardiogram was not performed immediately due to some critical reason (e.g. conversion to open heart surgery, cardiogenic shock, or other fatal complications), a post-TAVI echocardiogram was performed before discharge. Echocardiography was performed using standard views, and the chamber and valvular quantitative parameters were reported using standardized definitions. The LVEF was measured using the biplane Simpson volumetric method combining apical 4- and 2-chamber views.

Based on prior reports,[9,10] immediate improvement in LVEF was defined as a $\geq$ 5% absolute increase in LVEF immediately post-TAVI compared with baseline LVEF measurement. The presence or absence of early LVEF recovery was assessed in all patients and in subgroups according to the status of LVEF at baseline using clinically relevant cut points: group 1 (normal LV function group): LVEF $\geq$ 55%, group 2 (mild-to-intermediate LV dysfunction group): 35% $<$ LVEF $<$ 55%, and group 3 (severe LV dysfunction group): LVEF $\leq$ 35%). The serial changes in LVEF from baseline to post-procedure, 30 days, 6 months, and 1 year were also assessed according to the presence or absence of immediate improvement in LVEF.

The primary outcome of this study was a major adverse cardiac or cerebrovascular event (MACCE), which was defined as a composite of death from cardiovascular cause, myocardial infarction (MI), stroke, or rehospitalization from cardiovascular causes. The secondary outcomes included components of the primary composite outcome, death (all-cause, cardiovascular or non-cardiovascular), systemic embolization, rehospitalization (any, cardiovascular or non-cardiovascular), new permanent pacemaker, infective endocarditis, and major bleeding. All study outcomes were defined according to the Valve Academic Research Consortium-2 (VARC-2) definitions.[11] All events were independently reviewed and were adjudicated by an independent group of clinicians blinded to the study purpose.

The baseline characteristics of the study population, including patient demographics, risk factors or comorbidities, clinical presentation, cardiac status, and anatomic/procedural features were compared according to the presence or absence of immediate improvement in LVEF. Continuous variables are reported as mean $\pm$ standard deviation and were compared using the Student's *t*-test or Wilcoxon rank sum tests. Categorical variables are expressed as counts and percentages and were compared using the chi-square or Fisher exact test as appropriate. The occurrence of immediate improvement in LVEF after TAVI was assessed in the overall population and in each subgroup according to the baseline LVEF. Independent predictors of immediate LVEF improvement were determined in a stepwise multivariate logistic regression model, and included age, sex, and clinical, anatomic, hemodynamic, and procedural variables with p-values $<$ 0.10 in univariate analysis. Cumulative event rates were estimated using the Kaplan −Meier method, and the log-rank test was used for between-group comparisons. The entire follow-up was used to analyze the time-to-event outcomes, and patients were censored at the time of clinical events or last available follow-up. To determine the independent association of immediate LVEF improvement with the occurrence of primary composite of MACCE, multivariate Cox proportional hazard regression model was performed using clinically relevant variables and statistically significant variables with p-values $<$ 0.10 in univariate analysis. The following covariates were included in the final model: age, sex, logistic EuroSCORE, diabetes, pulmonary hypertension, and baseline LVEF.

A two-sided p-value $<$ 0.05 was considered statistically significant for all tests. Data analyses were performed using R software version 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria; www.r-project.org).

Results

Between March 2010 to December 2019, 700 patients with severe symptomatic AS who underwent TAVI were enrolled in the ASAN-TAVR registry, of which 6 were excluded from the current analysis for the following reasons: Two patients died before post-TAVI echocardiography, 2 underwent conversion to SAVR, and 2 did not receive post-TAVI echo during the index hospitalization. Therefore, 694 patients were included in the final analysis.

Among the 694 eligible patients, 160 (23.1%) demonstrated immediate improvement in LVEF at post-TAVI echocardiography during the index hospitalization. According to the status of baseline LVEF, the incidences of immediate LVEF improvement were 15.5% (85/547) in group I with LVEF $\geq$ 55%, 47.6% (50/105) in group 2 with 35% $<$ LVEF $<$55%, and 59.5% in group 3 (25/42) with LVEF $\leq$ 35%.

The demographic, echocardiographic and procedural characteristics of patients according to the presence or absence of immediate LVEF improvement are shown in Table 1. The baseline characteristics were similar between the two groups, except that patients with immediate LVEF improvement had a higher mean logistic EuroSCORE, lower proportion of hypertension, and higher proportion of prior heart failure than those without immediate LVEF improvement. Patients with immediate LVEF improvement had lower baseline LVEF, smaller aortic valve area, and higher LV mass index. The procedural characteristics were similar between the two groups, except that pre-dilation before TAVI was more frequently performed in patients with immediate LVEF improvement.

Univariate and multivariate logistic regression analyses were performed to identify the key predictors of immediate LVEF improvement (Table 2 and Online Table 1). In univariate analysis, logistic EuroSCORE, the absence of hypertension, previous heart failure, pre-dilation before TAVI, annulus diameter, and higher LV mass index were associated with a higher incidence of immediate LVEF improvement. In multivariate analysis, the independent predictors of immediate LVEF improvement after TAVI were the absence of hypertension (odds ratio [OR], 0.56; 95%

Table 1
Patients with or without early improvement of left ventricular ejection fraction - baseline clinical characteristics, medication, echocardiographic and procedural characteristics

Variable	Immediate Improvement in LVEF		p-value
	Yes (n = 160)	No (n = 534)	
Age (years)			
Mean	79.9 ± 5.1	79.7 ± 5.5	0.76
Age > 80	158 (98.8%)	522 (96.7%)	0.26
Men	86 (53.8%)	267 (49.4%)	0.38
Body mass index (kg/m^2)	23.8 ± 3.3	24.0 ± 3.4	0.49
Logistic EuroSCORE	14.2 ± 11.1	12.2 ± 10.9	0.05
STS score	3.8 ± 2.4	4.0 ± 3.0	0.44
Hypertension	130 (81.2%)	480 (88.9%)	0.02
Diabetes mellitus	71 (44.4%)	275 (50.9%)	0.17
Dyslipidemia	115 (71.9%)	412 (76.3%)	0.30
Peripheral artery disease	5 (3.1%)	14 (2.6%)	0.93
ESRD on dialysis	6 (3.8%)	18 (3.3%)	0.99
Chronic lung disease	25 (15.6%)	72 (13.3%)	0.54
Chronic liver disease	7 (4.4%)	28 (5.2%)	0.84
Previous heart failure	37 (23.1%)	79 (14.6%)	0.02
Previous MI	6 (3.8%)	25 (4.6%)	0.80
Previous history of stroke	13 (8.1%)	71 (13.1%)	0.11
Previous history of PCI	43 (26.9%)	153 (28.3%)	0.79
Previous history of CABG	7 (4.4%)	26 (4.8%)	0.99
Previous history of surgical AVR	1 (0.6%)	16 (3.0%)	0.16
Bicuspid AS	13 (8.1%)	58 (10.9%)	0.39
Baseline EKG abnormalities			
LBBB	5 (3.1%)	10 (1.9%)	0.51
RBBB	19 (11.9%)	47 (8.7%)	0.29
Atrial fibrillation/flutter	20 (12.5%)	58 (10.7%)	0.63
Pacemaker implanted	5 (3.1%)	13 (2.4%)	0.83
Medication at discharge			
Vitamin K antagonist	6 (3.8%)	26 (4.8%)	0.73
NOAC	26 (16.2%)	76 (14.1%)	0.58
Aspirin	135 (84.4%)	434 (80.4%)	0.31
P2Y12 inhibitors	127 (79.4%)	413 (76.5%)	0.51
Statins	98 (61.2%)	368 (68.3%)	0.12
ACE inhibitor or ARB	75 (46.9%)	274 (50.8%)	0.43
Beta-blocker	52 (32.5%)	163 (30.2%)	0.66
Calcium channel blocker	56 (35.0%)	219 (40.6%)	0.24

Data are presented as mean ± SD or number (%%).

ACE = angiotensin-converting-enzyme; ARB = angiotensin receptor blocker; AS = aortic stenosis; AVR = aortic valve replacement; CABG = coronary artery bypass grafting surgery; LBBB = left bundle branch block; EKG:, ESRD = end-stage renal disease; LVEF = left ventricular ejection fraction; MI = myocardial infarction; NOAC = novel oral anti-coagulant; PCI = percutaneous coronary intervention; RBBB = right bundle branch block; STS = Society of thoracic surgery

confidence interval [CI], 0.34−0.94; p = 0.03), absence of significant (moderate to severe) baseline aortic regurgitation (OR, 0.48; 95% CI, 0.27−0.85; p = 0.01), and greater LV mass (per 100 g/m^2, OR, 1.07; 95% CI, 1.01−1.12; p = 0.02).

The median follow-up duration was 409 days (interquartile range: 220 to 1108 days). Serial LVEF changes on in-hospital and follow-up echocardiography among patients with or without immediate LVEF improvement are illustrated in Figure 1. In patients with immediate LVEF recovery, improved LVEF was maintained for up to 1 year. The change in LVEF was minimal in patients without immediate LVEF improvement. Serial changes in LVEF were more remarkable in patients with more severe LV dysfunction at baseline (Online Figure 1). Other echocardiographic parameters during follow-up are described in Online Table 2.

Crude and adjusted risks for primary and secondary outcomes according to the presence or absence of immediate LVEF improvement are shown in Table 3. Those for the patients with baseline LV dysfunction are described in Online Table 3. The 3-year rate of primary composite of MACCE was significantly lower in patients with immediate LVEF improvement than in those without immediate LVEF improvement (11.9% vs. 21.0%, log-rank, p = 0.01) (Figure 2). The Kaplan−Meier curves for primary outcome stratified by baseline LVEF strata are shown in Online Figure 2, in which the overall findings were similar in each group, even though statistical significance varied by the number of patients. After adjustment of clinically relevant and statistically significant covariates, the presence of immediate LVEF improvement was significantly associated with a lower risk of MACCE (hazard ratio [HR], 0.48; 95% CI, 0.28−0.81; p = 0.01). In multivariate analysis, immediate LVEF improvement was an independent predictor of primary composite of MACCE at 3 years in the overall population undergoing TAVI (Table 4).

Discussion

This study examined the incidence, predictors, and prognostic impact of immediate LVEF recovery in “real-world” patients with severe AS undergoing TAVI; the main findings were as follows: (1) Nearly one-fourth of patients undergoing TAVI had immediate LVEF improvement post-TAVI during the index hospitalization, and this pattern was more prominent in patients with severe LV dysfunction at baseline; (2) absence of hypertension and increased baseline LV mass index were independent predictors of immediate LVEF improvement; and (3) immediate LVEF improvement was significantly associated with a lower risk of primary composite of MACCE.

LV dysfunction is common in patients with severe AS, and concentric LV hypertrophy with myocardial fibrosis is the main mechanism of LV dysfunction.[12] The significant association of lower LVEF at baseline with a worse clinical outcome after TAVI has been well documented.[13] However, the pattern and prognostic impact of immediate LVEF improvement post-TAVI is poorly understood. In our study, the rapid improvement in LVEF following TAVI among patients with systolic LV dysfunction was consistent with the findings of previous studies.[14-16] A pattern of significant EF recovery within 48 hours after TAVI was observed in patients with LV dysfunction. These findings may indicate that successful TAVI procedures immediately relieve LV obstruction, which lowers the gradient across the aortic valve and rapidly improves hemodynamics.

We identified that the absence of hypertension, absence of significant baseline aortic regurgitation, and greater LV mass index were key determinants of immediate LVEF improvement. Previous studies have reported that

Table 2
Univariate and multivariate analysis for predicting immediate improvement in left ventricular ejection fraction

Variables	Univariate analysis			Multivariate analysis†		
	Odds ratio	95% CI	p-value	Odds ratio	95% CI	p-value
Age (years)	1.01	0.97−1.04	0.76	1.01	0.97−1.05	0.45
Men	1.19	0.83−1.69	0.34	1.03	0.65−1.66	0.89
BMI (kg/m^2)	0.98	0.93−1.03	0.49			
Logistic EuroSCORE	1.01	1.00−1.03	0.05	1.00	0.99−1.03	0.76
Baseline LBBB	1.71	0.58−5.08	0.33			
New onset LBBB after TAVI	1.38	0.82−2.33	0.22			
Baseline atrial fibrillation/flutter	1.19	0.69−2.04	0.53			
Permanent pacemaker implantation after TAVI	1.29	0.45−3.68	0.63			
Hypertension	0.54	0.34−0.87	0.01	0.56	0.34−0.94	0.03
Diabetes mellitus	0.77	0.54−1.10	0.15			
Hyperlipidemia	0.79	0.53−1.18	0.26			
Peripheral artery disease	1.21	0.43−3.42	0.72			
Chronic kidney disease	0.97	0.66−1.44	0.89			
ESRD on dialysis	1.13	0.44−2.90	0.80			
Previous heart failure	1.76	1.13−2.72	0.01	1.61	0.98−2.64	0.06
Previous MI	0.80	0.32−1.99	0.64			
Previous history of PCI	0.93	0.63−1.38	0.72			
Previous history of stroke	0.58	0.31−1.09	0.09	0.69	0.35−1.39	0.30
Previous history of CABG	0.90	0.39−2.12	0.82			
Previous history of surgical AVR	0.21	0.03−1.57	0.13			
Baseline significant AR‡	0.61	0.37−1.04	0.06	0.48	0.27−0.85	0.01
Baseline significant MR‡	1.56	0.95−2.56	0.08	1.38	0.80−2.40	0.25
Monitored anesthesia care	0.82	0.57 − 1.57	0.27			
Significant immediate paravalvular leakage	0.51	0.06−4.31	0.54			
Valve size (mm)	1.06	0.98−1.14	0.12			
Pre-dilatation before valve implantation	1.64	1.08−2.50	0.02	1.42	0.88−2.29	0.15
Patient-prosthesis mismatch*	0.81	0.38−1.72	0.58			
Average diameter of annulus	1.09	1.01−1.18	0.03	1.08	0.97−1.19	0.17
Baseline AV Vmax	1.06	0.86−1.31	0.60			
Peak pressure gradient (per 100 mmHg)	1.35	0.80−2.28	0.27			
Mean pressure gradient	1.76	0.79−3.93	0.17			
E/e'	1.00	0.98−1.02	0.89			
LV mass index (per 100 g/m^2)	1.08	1.03−1.13	< 0.001	1.07	1.01−1.13	0.02
Pulmonary hypertension	1.37	0.92−2.03	0.12			

BMI: Body Mass Index, LBBB: Left Bundle Branch Block, TAVI: Transcatheter Aortic Valve Replacement, ESRD: End-Stage Renal Disease, MI: Myocardial Infarction, PCI: Percutaneous Coronary Intervention, CABG: Coronary Artery Bypass Grafting, AVR: (Surgical) Aortic Valve Replacement, AR: Aortic Regurgitation, MR: Mitral Regurgitation, AV: Aortic Valve, LV: Left Ventricle

* Defined as an effective orifice area < 0.85 cm^2/m^2 by continuity equation and transaortic Vmax ≥ 3 m/sec [34].

† Independent predictors of immediate LVEF improvement were determined using a stepwise multivariate logistic regression model including age, sex, and clinical, anatomic, hemodynamic, and procedural variables with p-values < 0.10 in univariate analysis.

‡ significant refers to grade 3 (moderate) or grade 4 (severe) regurgitation

hypertension can progress or deteriorate AS.[17,18] Moreover, hypertension may interfere with the regression of LV hypertrophy even after proper aortic valve replacement.[19,20] Uncontrolled hypertension hinders the assessment of AS severity as it can increase supra-valvular afterload and lower the flow and pressure gradient through the aortic valve. Hypertension increases vascular resistance, and the shear stress of the left ventricle, even after TAVI, could interfere with immediate LVEF improvement.[18,21]

Importantly, greater LV mass index was an independent predictor of immediate LVEF improvement. Proper management of AS with TAVI or SAVR can regress LV hypertrophy, and recent studies have suggested that pre-procedural hypertrophy is not associated with adverse outcomes.[22,23] Moreover, several studies have shown that LV mass regression is more prominent in patients with greater LV mass at baseline, which was subsequently associated with improved clinical outcomes during follow-up.[20,24] In our study, patients with immediate LVEF improvement had a greater LV mass index at baseline than those without. Moreover, the regression of LV mass was remarkable during serial echocardiography follow-up in patients with immediate improvement in LVEF (Online Table 1).

Beyond a known association between baseline LV dysfunction and clinical outcomes after TAVI, the impact of TAVI on myocardial contractility recovery and related clinical outcomes has varied among previous studies.[16,25] We demonstrated that patients with immediate LVEF improvement showed better clinical outcomes than those without. LV dysfunction in patients with severe AS may be attributed to afterload mismatch resulting from valvular obstruction or irreversible myocardial damage. When LV dysfunction occurs due to increased afterload with normal myocardial contractility, systolic function is expected to

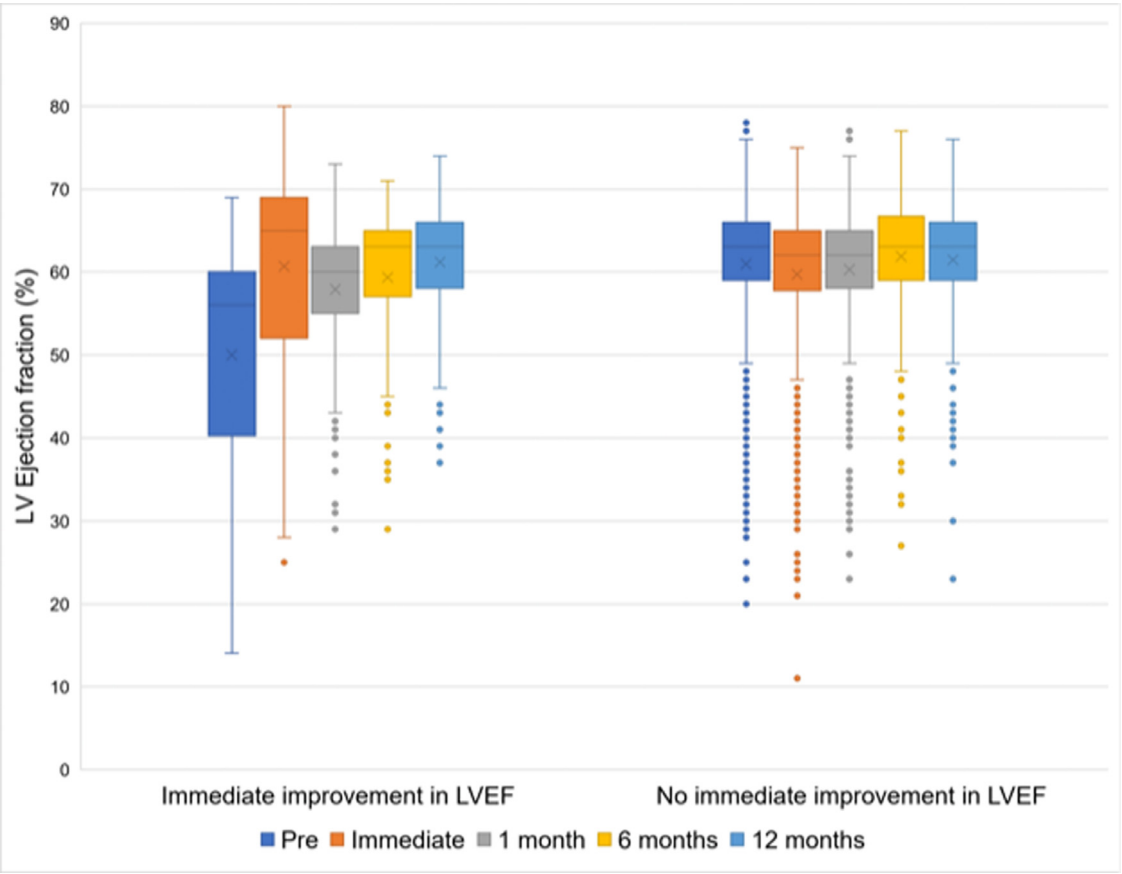

Figure 1. Serial follow-up of *left* ventricular ejection fraction among patients with or without immediate improvement in ejection fraction
CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; SYNTAX = synergy between percutaneous coronary intervention with taxus and cardiac surgery.

Table 3
Clinical outcomes at 3 years in patients with or without immediate improvement in left ventricular ejection fraction

Outcomes	Immediate Improvement in LVEF			Adjusted Cox Regression Analysis		
	Yes(n = 160)	No(n = 534)	p-value	Hazard Ratio	95% CI	p-value
Primary outcome						
MACCE*	19 (11.9%)	112 (21.0%)	0.01	0.48	0.28−0.81	0.01
Secondary outcomes						
Death	18 (11.2%)	61 (11.4%)	0.71	0.72	0.40−1.30	0.27
Cardiovascular cause	4 (2.5%)	18 (3.4%)	0.51	0.44	0.13−1.45	0.18
Non-cardiovascular cause	14 (8.8%)	43 (8.0%)	0.98	0.88	0.45−1.75	0.72
Myocardial Infarction	5 (3.1%)	22 (4.1%)	0.52	0.61	0.21−1.79	0.37
Stroke	7 (4.4%)	40 (7.4%)	0.15	0.47	0.20−1.14	0.10
Systemic embolization	1 (0.6%)	4 (0.7%)	0.87	0.72	0.06−7.87	0.78
Rehospitalization	41 (25.6%)	148 (27.7%)	0.45	1.04	0.71−1.52	0.85
Cardiovascular cause	10 (6.2%)	58 (10.9%)	0.06	0.57	0.28−1.19	0.13
Non-cardiovascular cause	31 (19.4%)	90 (16.8%)	0.59	1.35	0.86−2.14	0.20
Permanent pacemaker implantation after TAVI	15 (9.4%)	52 (9.6%)	0.83	1.25	0.66−2.36	0.49
Infective endocarditis	2 (1.2%)	11 (2.0%)	0.48	0.79	0.16−4.00	0.77
Major bleeding	44 (27.5%)	165 (30.9%)	0.48	0.82	0.60−1.12	0.21

* MACCE was defined as a composite of death from cardiovascular cause, MI, stroke, or rehospitalization from cardiovascular causes.
†Cumulative event rates (percentages) were derived from the Kaplan−Meier method and compared by the log-rank test.
‡Hazard ratios are adjusted for age (continuous), sex (male or female), logistic EuroSCORE (continuous), and following clinically relevant variables and statistically significant variables with p-values < 0.10 by univariate analysis: diabetes (diabetes or not), pulmonary hypertension (pulmonary hypertension or not), and baseline EF (continuous).
CI: Confidence interval, MACCE: Major adverse cardiac or cerebrovascular events; other abbreviations as outlined in Tables 1 and 2.

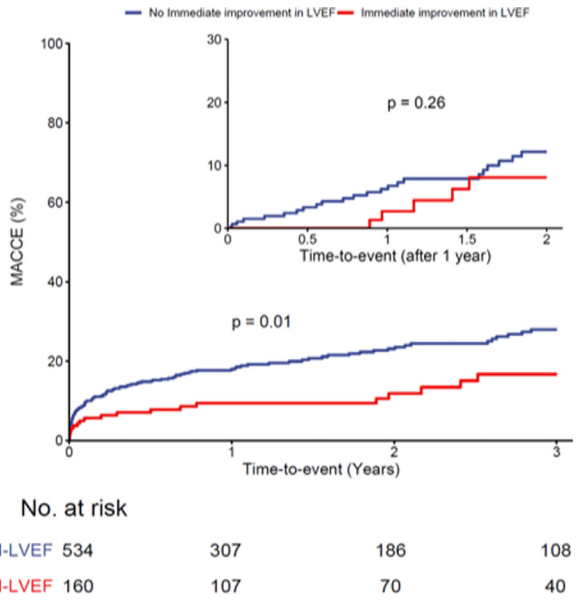

Figure 2. Time-to-event curves for the primary composite outcome according to the presence or absence of immediate improvement in *left* ventricular ejection fraction

Kaplan−Meier estimates of the rate of the primary composite of major adverse cardiac or cerebrovascular events (MACCE), which was defined as a composite of death from cardiovascular cause, myocardial infarction, stroke, or rehospitalization from cardiovascular causes. A landmark analysis for the primary composite outcome after 1 year from procedure was also performed.

II-LVEF = immediate improvement in left ventricular ejection fraction.

improve after relief of the outflow obstruction. Hence, subjects with early LVEF recovery reflect a subset distinct from those with intrinsic myocyte dysfunction. By contrast, subjects without immediate LVEF improvement are likely to suffer from the advanced stage of cardiac remodeling accompanying irreversible fibrosis, which is associated with worse clinical outcomes.[26] In addition, multiple factors are known to affect LV remodeling in patients with severe AS.[27] Of note, although reduced LVEF may correspond to a more advanced stage of AS, our findings suggest that even in patients with reduced LVEF, subjects with preserved contractile reserve are candidates for reversible modeling after TAVI, which is linked to improved clinical outcomes.[28,29]

Table 4
Independent predictors of primary composite outcome in patients undergoing TAVI

Variables	HR	95% CI	p-value
Immediate improvement in LVEF	0.47	0.28−0.80	0.01
Age (years)	0.99	0.96−1.03	0.72
Male sex	0.70	0.49−1.01	0.06
Hypertension	1.15	0.65−2.02	0.64
Diabetes	1.52	1.06−2.19	0.02
Chronic kidney disease	0.89	0.59−1.33	0.56
Atrial fibrillation	1.33	0.79−2.23	0.28
Pulmonary hypertension	1.46	0.99−2.16	0.06
Logistic EuroSCORE	1.00	1.00−1.00	0.71
Baseline LVEF (%)	0.98	0.97−1.00	0.06
Baseline significant AR	0.81	0.53−1.38	0.42

LVEF: Left Ventricular Ejection Fraction, AR: Aortic Regurgitation

Our study has several limitations. First, the study was observational, and therefore the overall findings should be considered hypothesis-generating only. Second, our study is limited by a relatively small sample size, which may limit statistical significance in the between-group comparison or in the prediction models. Third, we were unable to comment on the entire complex patient group with low-flow or low-gradient AS, which was associated with worse clinical outcomes after TAVI[9]; this warrant further large-scaled studies to analyze this subset distinctly. Fourth, because dobutamine stress echocardiography was selectively performed in patients with reduced LV function at the discretion of the treating physician, no detailed information on contractile reserve was available in the current analyses. Fifth, although serial echocardiographic measurements were performed in each qualified center with the reliable manners, the imaging data were not analyzed by an independent core laboratory. Finally, although we reported cardiovascular medication profiles at discharge, detailed medication profiles and compliance during follow-up were not systematically evaluated, which might influence long-term clinical outcomes.

In patients with severe symptomatic AS undergoing TAVI, immediate LVEF improvement post-TAVI occurred in one-fourth of patients and was more common in patients with lower LVEF at baseline. Immediate LVEF improvement was significantly associated with a low risk of MACCEs during clinical follow-up.

Author Contributions

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Seung-Jung Park: Conceptualization, Resources, Investigation, Methodology, Supervision, Funding aquisition

Dae-Hee Kim: Resources, Supervision

Duk-Woo Park: Conceptualization, Resources, Investigation, Methodology, Supervision, Writing − Original Draft, Review & Editing

Supplementary materials

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