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ORIGINAL ARTICLE

Physical performance as a predictor of midterm outcome after mitral valve surgery

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Abstract

The usefulness of performing physical function assessments for evaluating clinical outcomes after all cardiac surgeries has been reported. However, no studies have evaluated the relationship between physical function and prognosis in patients undergoing cardiac open surgery with mitral valve regurgitation (MR). This study investigated whether physical assessment, such as the short physical performance battery (SPPB), could predict unplanned readmission events in patients undergoing mitral valve surgery due to MR. SPPB could predict unplanned admission events in patients undergoing mitral valve surgery due to MR. This retrospective study included 168 patients who underwent mitral valve surgery. SPPB was performed 1.6 ± 1.1 days before surgery. The primary endpoint was unplanned readmission. The mean follow-up period was 762 ± 480 days, mean age was 73.8 ± 6.3 years, and 43% of the patients were women. Of the study patients, 46 required unplanned readmissions; 29 of these patients required readmissions within 1 year. Multivariate Cox regression analysis demonstrated that SPPB was independently associated with the primary endpoint. Receiver-operating characteristic analysis showed that SPPB had an area under the curve of 0.71, with an optimal cutoff of 11. The study patients were stratified into SPPB 12 or SPPB ≤ 11 groups. Kaplan–Meier analysis showed that the event-free rate was significantly lower in the SPPB ≤ 11 group (hazard ratio 3.8, 95% confidence interval 2.1–7.0; $p < 0.001$). SPPB was a useful tool for predicting unplanned readmission in patients undergoing mitral valve surgery due to MR.

Keywords Physical performance · Mitral valve regurgitation · Midterm outcome · Mitral valve surgery

Introduction

Recently, in this aging society, the number of older Japanese patients undergoing cardiac surgery has increased owing to medical technological breakthroughs and high incidence of valvular heart disease in aged persons. Preoperative risk evaluation has played a crucial role in this occurrence [1, 2]. Predicting postoperative risk based on preoperative evaluations is indispensable for appropriate operation adaptation and perioperative care. Preoperative frailty assessment, which mainly evaluates physical status in cardiac surgery patients, is useful for predicting short- and midterm cardiac events and mortality [3, 4]. Furthermore, physical assessment has been reported to predict unplanned readmission [5]. A short physical performance battery (SPPB), which encompasses slowness, weakness, and balance, initially emerged as an objective tool for measuring the lower extremity physical performance status and, currently, is regarded as one of the promising physical frailty markers [6]. Earlier published studies demonstrated associations between a low SPPB score and poor outcomes such as prolonged hospital stay, readmission, disability, and mortality in patients with decompensated heart failure [7–9]. In 2016, Pavasini et al. [10] reported that if an SPPB score ≤ 6 points had twofold increase risk of all-cause mortality, and even if it was ≤ 9 points, the risk of death was 1.5 times. These studies also indicated the usefulness of gait speed in the evaluation of slowness. To date, several studies have reported the usefulness of SPPB as a predictor of poor clinical outcomes in patients undergoing cardiac surgery [11, 12], but the

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usefulness of SPPB in mitral valve surgery has not been reported. The clinical features of physical function in mitral open heart surgery patients have not been fully elucidated. Therefore, this study aimed to investigate whether physical assessment, such as SPPB, could predict unplanned readmission in patients undergoing mitral valve surgery due to mitral regurgitation (MR).

Materials and methods

Study population

Between April 2013 and July 2016, 208 patients with severe MR (aged 65 years and older) underwent surgery at the Sakakibara Heart Institute. The exclusion criteria included patients with other concomitant valve replacement or aortic surgery ($n=12$), active endocarditis ($n=2$), and patients who were not physically evaluated using SPPB ($n=26$). After the application of the exclusion criteria, 168 patients were selected. The Society of Thoracic Surgeons (STS) risk score for predicting the risk of mortality was calculated for each patient. All patients were evaluated using SPPB before cardiac surgery. The discharge time was based on whether the general condition improved, regardless of preoperative SPPB value. This study was performed in accordance with the ethical principles set forth in the Declaration of Helsinki and was approved by the Human Investigation Committee of Sakakibara Heart Institute (Study Protocol No. 1604). All information was retrospectively obtained from patients' medical records and via telephone interview; that is, all patients were followed with accountability.

Parameters

All data were collected using a predefined form, including demographic data and past medical history, cardiovascular risk, preoperative hemodynamic status, surgical characteristics, perioperative data, combined surgery, and postoperative complication. Among them, the definitions are same as the STS score calculation [1].

Physical assessment

SPPB was derived from a composite of 4-m walking velocity, time to rise from a seated position five times, and standing balance [9]. Walking velocity was measured via a 4-m walk performed at the patient's "usual" pace; the patients were allowed to use canes or walkers [13]. Regarding the time to rise from a seated position, the patients sat in a straight-back chair with arms folded across their chests and stood up five times consecutively as quickly as possible. The time to complete five chair rises was measured. For standing balance, the patients were asked to hold three increasingly difficult standing positions for 10 s each: the side-by-side stand, semi-tandem stand (standing with the feet parallel and the heel of one foot touching the base of the first toe of the opposite foot), and full-tandem stand (standing with one foot directly in front of the other). The patients who received 0 points for each task were unable to complete the test, whereas those who obtained 1–4 points were assigned the subsequent tasks, according to the established methods. The points were summed to obtain SPPB, which ranged from 0 to 12, with higher points reflecting better physical function.

Endpoint

The endpoint was unplanned readmission, which was defined as a subsequent or unscheduled readmission to the hospital. Readmission was defined as admission to a hospital ward or an intensive care unit following discharge after the index hospitalization for mitral surgery. The primary diagnosis on the discharge report was used to determine the main cause of readmission. Planned readmission was defined as either readmission for a few specific conditions or elective procedure categories or readmission for which the principal diagnosis was not an acute condition or a complication of care. Readmission not meeting either criterion was categorized as unplanned. Causes of readmission were grouped as being of cardiac or non-cardiac origin. Cardiac causes included heart failure, arrhythmia, endocarditis, and abdominal aortic aneurysm rupture. Non-cardiac causes included infection (respiratory, urinary tract, gastrointestinal, and others), trauma, ischemic stroke, ileus, acute renal failure, and other condition (hyperventilation) [5, 14].

Statistical analysis

Continuous variables are expressed as mean ± standard deviation and categorical variables as number and percentage. Normality of distribution for continuous variables was evaluated using the Shapiro–Wilk test. A two-sided p value of <0.05 was considered statistically significant. Variables with $p<0.20$ in the univariate analysis were included into the multivariate Cox regression modeling to investigate their influence on the primary endpoint. Receiver-operating characteristic (ROC) analysis was performed using unplanned readmission at 1 year, and the area under the curve (AUC) was compared using the Delong method. Survival variables were compared using the log-rank test, and Kaplan–Meier survival curves were constructed. All analyses were performed using JMP pro version 13 (SAS Institute, Cary, NC, USA) and R version 2.13 (R Foundation for Statistical Computing).

Results

Overall outcomes after mitral valve surgery

The mean follow-up period was 762 ± 348 days. SPPB evaluation as physical assessment was performed 1.6 ± 1.1 days before operation. The average SPPB was 11.3 ± 1.5 points. Figure 1 shows the SPPB point distribution divided by sex. Only 12 people obtained < 10 points with SPPB, four of them were unable to perform chair stand test, and they had 0 points for that test. Of the study patients, 46 required unplanned readmissions; 29 of these patients required these readmissions within 1 year. Five patients were in rehabilitation or a skilled nursing facility, four of whom had unplanned readmissions. Nine patients had cardiovascular-related death, and two patients had non-cardiovascular-related death. Patients' demographic and clinical characteristics at baseline are shown in Table 1. The mean patient age was 73.8 ± 6.3 years and 43% were women. Patients with unplanned readmission (event group) were older and had a higher New York Heart Association (NYHA) classification, higher STS score, lower SPPB points, and lower hemoglobin and albumin levels than those without the primary endpoint (no-event group). No differences in body mass index were observed between the two groups. The causes of unplanned readmission are shown in Table 2; 21 patients had a cardiac cause, 10 had infection, seven had fracture, and eight had other triggers. Non-cardiac causes occurred more frequently after 1 month. The procedure outcome is shown in Table 3. The mortality at 30 days after mitral valve surgery was 0%. The mean hospital stay after mitral valve surgery was 12.9 ± 10.9 days. The patients in the event group demonstrated a lower atrial fibrillation correction and higher percentage of mitral valve replacement and readmission rate within 30 days. As a reason for the high ratio of mitral valve replacement, this study targeted elderly people aged 65 years and older.

Univariate and multivariate analyses

The results of the univariate analysis for baseline variables (Table 4) indicated that the primary endpoint was significantly associated with age, NYHA classification, diabetes mellitus, hypertension, dyslipidemia, hemoglobin level, albumin level, estimated glomerular filtration rate, ejection fraction, left atrium diameter, mitral valve stenosis, urgent surgery, prior cardiac surgery, mitral valve replacement, STS score and SPPB. These parameters were analyzed in the multivariate Cox regression model (Table 4), resulting in independent associations between the primary endpoint and each of the dyslipidemia, hemoglobin level, and SPPB.

Kaplan–Meier analysis

The ROC analysis for the primary endpoint at 1 year after discharge showed that SPPB had an AUC of 0.71, with an optimal cutoff of 11. The study patients were stratified into two groups according to a cutoff of 11 for SPPB based on the highest AUC. The Kaplan–Meier analysis indicated that the 3-year event-free rate was 0.75 ± 0.06 in patients with SPPB 12 points and 0.43 ± 0.08 in patients with

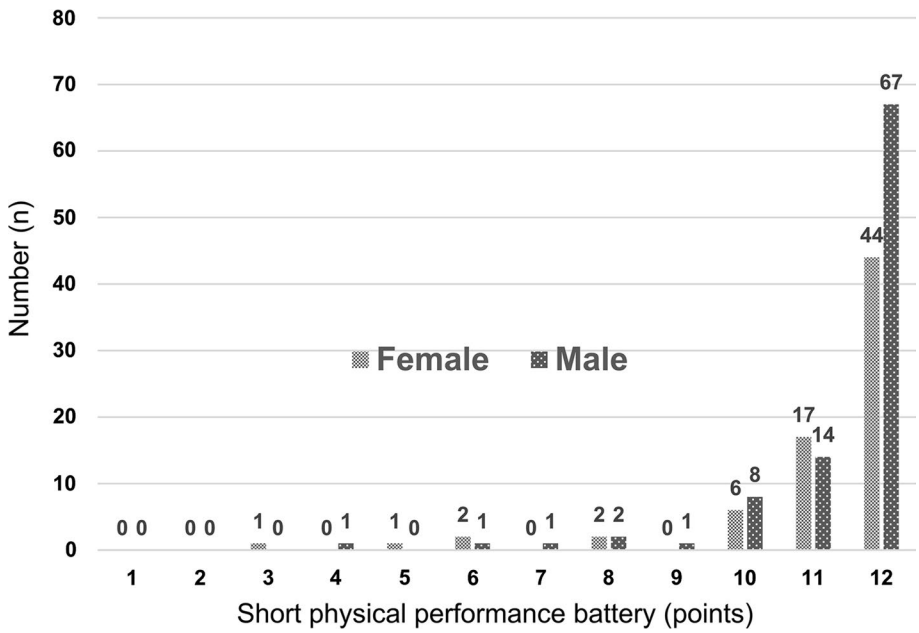

Fig. 1 Distribution of short physical performance battery score stratified by sex. The short physical performance battery score distribution according to the sex of patients undergoing mitral valve surgery

Table 1 Baseline characteristics

Characteristic	Overall ($n=168$)	Unplanned readmission ($n=46$)	Event free ($n=122$)	p value
Age, years	73.8 ± 6.3	75.5 ± 5.8	72.9 ± 5.9	0.01
Men, %	95 (56.5)	27 (58.7)	68 (55.7)	0.70
Body mass index, kg/m^2	21.3 ± 2.6	21.0 ± 3.1	21.5 ± 2.4	0.33
Hypertension, %	95 (56.5)	31 (67.4)	64 (52.5)	0.20
Dyslipidemia, %	41 (24.4)	9 (19.6)	32 (26.2)	0.15
Diabetes mellitus, %	9 (5.4)	4 (8.7)	5 (4.1)	0.24
Peripheral artery disease, %	7 (4.2)	1 (2.2)	6 (4.9)	0.43
COPD, %	9 (5.4)	3 (6.3)	2 (3.6)	0.68
Coronary artery disease, %	33 (19.6)	10 (21.7)	23 (18.9)	0.77
Liver disease, %	9 (5.4)	2 (4.3)	7 (5.7)	0.73
Cancer, %	18 (10.7)	6 (13.0)	12 (9.8)	0.93
Connective tissue disease, %	5 (3.0)	0 (0.0)	5 (4.1)	0.15
Previous myocardial infarction, %	5 (3.0)	2 (4.3)	3 (2.5)	0.52
Previous stroke/TIA, %	17 (10.1)	7 (15.2)	10 (8.2)	0.44
NYHA classification, %				0.02
I	44 (26.2)	6 (13.0)	38 (31.1)	
II	105 (62.5)	32 (65.6)	73 (59.8)	
III	19 (11.3)	8 (17.4)	11 (9.0)	
Euro SCORE II, %	3.9 ± 4.4	5.2 ± 6.4	3.2 ± 3.2	0.01
STS score (mortality), %	3.3 ± 3.2	4.5 ± 3.8	2.8 ± 2.8	< 0.01
Short physical performance battery	11.3 ± 1.5	10.4 ± 2.2	11.6 ± 0.9	< 0.01
Previous cardiac surgery, %	16 (9.5)	9 (19.6)	7 (5.7)	0.01
Urgent surgery, %	15 (8.9)	7 (15.2)	8 (6.6)	0.14
Atrial fibrillation, %	94 (56.0)	26 (56.5)	68 (55.7)	0.46
Hemoglobin, g/dL	12.3 ± 1.4	11.6 ± 1.4	12.6 ± 1.4	< 0.01
Albumin, g/dL	4.1 ± 0.4	4.0 ± 0.3	4.1 ± 0.3	0.04
eGFR, mL/min/1.73 m^2	67.5 ± 20.1	63.2 ± 19.9	69.3 ± 20.1	0.09
LV diastolic diameter, mm	53.0 ± 6.6	52.1 ± 7.5	54.5 ± 5.8	0.36
LV systolic diameter, mm	34.7 ± 6.4	34.5 ± 7.3	34.6 ± 5.8	0.96
LV ejection fraction, %	62.1 ± 7.6	61.6 ± 7.9	62.6 ± 7.0	0.43
Left atrial diameter, mm	50.9 ± 11.3	51.5 ± 11.0	50.7 ± 11.3	0.68
Pulmonary artery pressure, mmHg	42.1 ± 15.5	43.4 ± 17.4	41.5 ± 14.6	0.49
Moderate or severe MS, %	7 (3.6)	3 (6.3)	4 (3.3)	0.94

Values are mean ± SD [median] or n (%)

COPD chronic obstructive pulmonary disease, *TIA* transient ischemic attack, *NYHA* New York Heart Association, *eGFR* estimate glomerular filtration rate, *LV* left ventricle, *MS* mitral valve stenosis

SPPB ≤ 11 points. The event-free rate was significantly lower in patients with SPPB ≤ 11 points ($p < 0.001$; Fig. 2).

ROC analysis

ROC analysis was performed for unplanned readmission. AUC of STS mortality score was 0.67. When SPPB was added to the STS mortality score, AUC showed a significantly increased discriminatory performance for predicting unplanned readmission (0.81; $p = 0.02$, Fig. 3, Table 5).

Discussion

This study investigated whether SPPB could predict adverse clinical events such as unplanned readmission in the midterm period following mitral valve surgery due to MR. We found that SPPB was independently associated with unplanned readmission in the multivariate analysis. In this study, physical function was relatively maintained in most patients and SPPB points were generally high. In contrast, unplanned readmission was independently higher

Table 2 Causes of unplanned readmission

Causes	First 30 days	More than 1 month	Overall
All-cause unplanned readmission	10	36	46
Cardiac causes	6	15	21
Heart failure	4/6 (67)	13/15 (87)	17/21 (81)
Arrhythmia	2/6 (33)	0	2/19 (10)
Tachycardia	1	0	1
Bradycardia	1	0	1
Endocarditis	0	1/15 (7)	1/21 (5)
Abdominal aortic aneurysm rupture	0	1/15 (7)	1/21 (5)
Non-cardiac causes	4	21	25
Infection	3/4 (75)	7/21 (33)	10/25 (40)
Gastrointestinal infection	0	5	5
Surgical site infection	2	0	2
Pneumonia	1	1	2
Upper respiratory infection	0	1	1
Traumatology	0	7/21 (33)	7/25 (28)
Fracture	0	7	7
Cerebrovascular event	0	4/21 (19)	4/25 (16)
Ileus	0	2/21 (10)	2/25 (8)
Renal failure	1/4 (25)	0	1/25 (4)
Other (hyperventilation)	0	1/21 (5)	1/25 (4)

Values are *n* (%)

Table 3 Procedure outcomes

Outcome	Overall ($n=168$)	Unplanned readmission ($n=46$)	Event free ($n=122$)	p value
Operative time, min	256.8 ± 93.6	263.5 ± 115.6	250.1 ± 79.7	0.40
Cardiopulmonary bypass time, min	157.2 ± 65.1	155.6 ± 81.7	155.6 ± 62.3	0.99
Cross-clamp time, minutes	114.6 ± 50.9	115.7 ± 63.8	113.3 ± 49.0	0.80
Concomitant procedure, %				
Tricuspid valve repair	86 (51.2)	23 (50.0)	63 (51.6)	0.45
Coronary artery bypass graft	29 (17.3)	9 (19.6)	20 (16.4)	0.87
Left atrial appendage closure	45 (26.8)	14 (30.4)	31 (25.4)	0.43
Atrial fibrillation correction	38 (22.6)	6 (13.0)	32 (26.2)	0.03
Valve repair, %	114 (67.9)	26 (56.5)	88 (72.1)	0.03
Valve replacement, %	54 (32.1)	20 (43.5)	34 (27.9)	
Mechanical valve	18 (9.9)	6 (13.0)	12 (9.8)	
Postoperative length stay, days	12.9 ± 10.9	14.1 ± 13.5	12.1 ± 9.3	0.27
Readmission within 30 days, %	16 (9.5)	10 (21.7)	6 (4.9)	0.01
Mortality at 30 days, %	0 (0.0)	0 (0.0)	0 (0.0)	
Perioperative complication, %	15 (8.9)	7 (14.6)	8 (6.6)	0.10
Reoperation, %	9 (5.4)	2 (4.2)	7 (5.7)	
Ventilation > 24 h, %	4 (2.4)	3 (6.3)	1 (0.8)	
Deep sternal wound infection, %	4 (2.4)	4 (8.7)	0 (0.0)	
Myocardial infarction, %	0 (0.0)	0 (0.0)	0 (0.0)	
Renal failure, %[a]	2 (1.2)	1 (2.1)	1 (0.8)	
Disabling stroke, %	1 (0.6)	0 (0.0)	1 (0.8)	

Values are mean ± SD [median] or *n* (%)

[a]Renal failure: (1) increase of serum creatinine to > 2.0 and 2 × most recent preoperative creatinine level. (2) a new requirement for dialysis postoperatively

Table 4 Predictors of unplanned readmission in univariate and multivariate cox regression analyses

Parameters	HR	95% CI	*p* value	Adjusted HR	95% CI	*p* value
Age (every 5-year increase)	1.36	1.05–1.77	0.021	0.98	0.69–1.39	0.916
Women	0.96	0.53–1.73	0.884			
BMI (every 3-kg/m^2 decrease)	1.12	0.78–1.61	0.537			
NYHA	1.82	1.13–2.88	0.014	1.09	0.53–2.25	0.812
Diabetes mellitus	2.14	0.64–5.35	0.191	0.21	0.27–5.39	0.800
Hypertension	1.58	0.89–2.93	0.122	0.68	0.80–3.54	0.173
Dyslipidemia	0.48	0.18–1.06	0.070	0.21	0.07–0.65	0.006
COPD	1.52	0.37–4.16	0.512			
Atrial fibrillation	0.91	0.50–1.64	0.746			
Previous myocardial infarction	2.26	0.37–7.44	0.319			
Previous cerebral infarction	1.35	0.51–2.96	0.506			
Hemoglobin level ($\leq$12 g/dL)	2.51	1.39–4.64	0.002	2.87	1.36–6.15	0.006
Albumin (every 0.5-g/dL decrease)	1.52	0.99–2.34	0.057	1.23	0.75–2.01	0.411
eGFR (every 15-mL/min/1.73 m^2 decrease)	1.24	0.97–1.59	0.085	1.24	0.92–1.68	0.163
LVEF (under 50%)	3.71	1.39–8.36	0.012	2.20	0.68–7.14	0.191
Left atrium diameter (every 5-mm increase)	1.13	0.95–1.35	0.170	0.96	0.76–1.21	0.706
PA pressure (every 15-mmHg increase)	1.09	0.89–1.30	0.401			
Moderate or severe MS	4.62	1.45–12.67	0.039	1.62	0.20–13.40	0.653
Urgent surgery	2.32	0.94–4.92	0.065	0.34	0.08–1.39	0.134
Prior cardiac surgery	2.17	0.94–4.44	0.068	0.74	0.23–2.35	0.604
Mitral valve replacement	2.21	1.21–4.00	0.011	1.11	0.46–2.67	0.808
Coronary artery bypass grafting	1.13	0.49–2.31	0.750			
STS score (every 5% increase)	1.66	1.15–2.26	0.010	1.42	0.82–2.45	0.215
SPPB (every 1-point decrease)	1.40	1.23–1.56	$<$0.001	1.34	1.09–1.65	0.006

CI confidence interval, *HR* hazard ratio, *BMI* body mass index, *NYHA* New York heart association, *COPD* chronic obstructive pulmonary disease, *eGFR* estimated glomerular filtration rate, *LVEF* left ventricular ejection fraction, *PA* pulmonary artery, *MS* mitral valve stenosis, *STS* society of thoracic surgeons, *SPPB* short physical performance battery

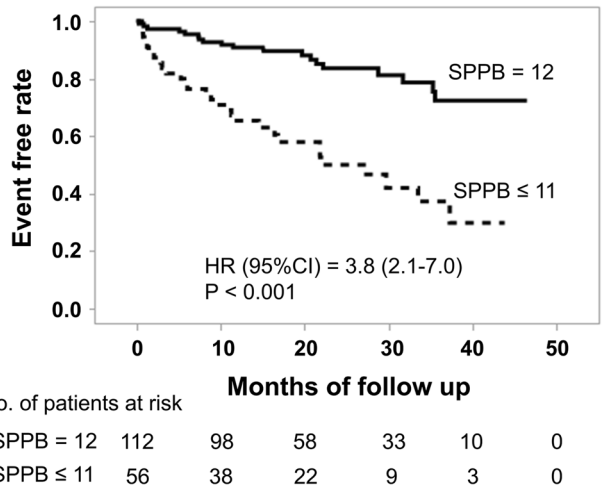

Fig. 2 Kaplan–Meier analysis estimating event-free rate. The Kaplan–Meier analysis, using a short physical performance battery (SPPB), shows the cumulative event-free rates in patients who underwent mitral valve surgery. The patients with a lower SPPB had a higher incidence of unplanned readmission ($p<0.001$). (*HR* hazard ratio, *CI* confidence interval)

in patients with SPPB $\leq$ 11 points, and we recognized the importance of the physical function assessment. In addition, SPPB was noted to have improved prognostic power with the addition of the STS score, which is the risk score of open heart surgery.

Usefulness of SPPB for the evaluation of physical function

We found that SPPB was independently associated with the unplanned readmission in the multivariate analysis. SPPB is often used as an indicator of physical function in frailty. Frailty is a concept considered to include physical problems, mental or psychological problems, and social problems; however, social problems are difficult to evaluate. Thus, most frailty indicators often use combinations of cognitive functions and evaluation of depression for physical assessment. Although SPPB, compared to other evaluation tools, focuses on physical frailty, its usefulness has been reported to be comparable to that of other methods

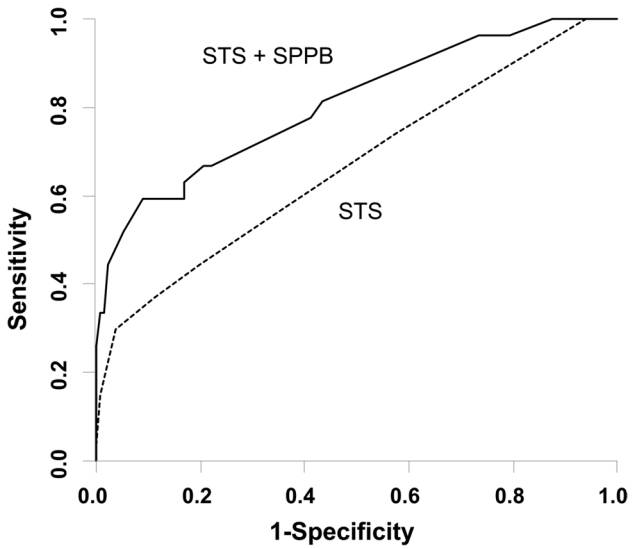

Fig. 3 Receiver-operating characteristic analysis. Receiver-operating characteristic (ROC) analysis for unplanned readmission. The short physical performance battery (SPPB) was added to the Society of Thoracic Surgeons (STS) mortality score model. The ROC curve demonstrates that the STS mortality score plus SPPB had a significantly increased discriminatory performance for predicting unplanned readmission

Table 5 Incremental AUC of SPPB for unplanned readmission

	AUC	95% CI	ΔAUC	*p* value
STS	0.67	0.55–0.79		
STS + SPPB	0.81	0.71–0.91	0.14	0.02

AUC area under the curve, *CI* confidence interval, *SPPB* short physical performance battery, *STS* society of thoracic surgeons

[11, 12]. In 2018, Saji et al. [5] reported the possibility that SPPB can be a good evaluation method compared with gait speed, etc., in the unplanned readmission prediction following transcatheter aortic valve implantation. It is suggested that the decline in physical function relates not only to the risk of unplanned readmission but also to further poor outcomes. One study has demonstrated that patients with poor physical performance tend to have a higher number of comorbidities [11]; poor physical function level is associated with marked endocrine dysfunction, inflammation, and oxidative stress [15–17]. Furthermore, low physical function level appears to be associated with a higher risk of several conditions that accelerate the transition to death, including malnutrition, dementia, and cardiovascular disease [17, 18]. Thus, poor physical performance might indirectly increase the risk of mortality through the development of such severe comorbidities.

Decrease of physical function and prognosis

In this study, physical function was relatively maintained in most patients and 92.9% of the patients had SPPB ≥ 10 points. Generally, the definition of frailty is SPPB < 5 points, while an SPPB of 6–9 points is defined as pre-frailty [6, 9, 10, 19]. Previous reports have suggested that both frailty and pre-frailty have a poor prognosis [6, 7, 11]. In this study, in the ROC analysis predicting the primary endpoint in the 1-year follow-up period, when SPPB ≤ 11 points was taken as the cutoff value, the highest AUC value was 0.71. In patients with SPPB ≤ 11 points, event occurrence increased significantly in the follow-up period compared to patients with 12 points. The results of this study suggest that even in a patient who is not diagnosed with frailty or pre-frailty, a slight decline in physical function may affect the patient's prognosis.

Although the STS score was not a significant prognostic factor in this multivariate analysis, the endpoint of this study was not death but unplanned readmission. Generally, the STS score is used for preoperative risk assessment. However, the STS score does not incorporate physical function assessment. Therefore, when the prediction of unplanned readmission was evaluated by combining the STS score with SPPB, the AUC had a significantly higher predictive ability than that of STS alone. This result reveals the importance of evaluating physical function in addition to the evaluation of STS score, which is a preoperative risk assessment tool.

Evaluation of preoperative function by SPPB and future task

This study is the first to show that physical functioning before mitral valve surgery due to MR affects postoperative outcomes. In the past, especially as part of the frailty evaluation, evaluating physical function before open heart surgery was considered important [3, 4, 11, 12]. Since catheter treatment was started for MR, preoperative assessment including physical functions becomes more important in determining treatment methods.

Patients with impaired physical function may benefit from preoperative, postoperative, or perioperative rehabilitation interventions. These interventions include early mobilization and planned admissions for professional physical rehabilitation, comprehensive geriatric assessment and management, and intensive monitoring [20–22]. We believe that it is most practical to enforce early rehabilitation after surgery and outpatient rehabilitation after discharge from the hospital. Regarding preoperative assessment, the usefulness of physical function assessment has been suggested; thus, it appears necessary to consider in the future not only prognostic prediction via preoperative evaluation but also

the contribution to prognosis in perioperative management including rehabilitation.

Limitations

Several limitation of this study should be acknowledged. First, this single-center study was limited by its retrospective nature and the relatively small number of patients; thus, the generalizability of our findings may be limited. However, the preliminary results of this study suggest that these findings might be adapted to a broader mitral valve surgery population. Second, in this study, the distribution of SPPB was narrow, so we could not evaluate the presence of dose–response relationship. Third, we had not been able to evaluate the physical function of the group of patients who could not perform SPPB, which may have the most decreased physical function. Finally, the changes in SPPB were not obtained; thus, further studies appear necessary in this regard.

Conclusions

Patients who undergo mitral valve surgery and who have decreased physical function were at a higher risk of adverse outcomes; therefore, physical evaluations, such as SPPB, should play a crucial role in selecting surgical or transcatheter mitral valve surgery. Further investigation is required to establish an appropriate assessment in such patients.

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Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

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