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Changes in Exercise Capacity and Psychosocial Factors in Hospitalized Cardiac Surgery Patients

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Abstract

Background: After cardiac valve surgery, postoperative exercise capacity and psychosocial parameters of patients change significantly, both of which can affect prognosis. This study aimed to analyze and clarify the relationship between changes in perioperative exercise capacity and psychosocial factors in the early phase after valvular surgery.
Methods: We enrolled 48 consecutive patients who underwent valvular surgery and studied their exercise capacity, health-related quality of life (HRQOL), anxiety disorders, depression symptoms, blood samples, and echocardiograms preoperatively and 14 days postoperatively.
Results: At the preoperative evaluation, the peak maximal oxygen consumption was 17.7 $\pm$ 5.9 mL/kg/min that decreased to 14.3 $\pm$ 4.4 mL/kg/min after the surgery ($P < 0.0001$). With regard to the HRQOL, the physical component summary (PCS) score and the role component summary scores (RCS) decreased significantly after the surgery ($P < 0.05$ for each). However, the mental component summary (MCS) score increased significantly after the surgery (51.9 $\pm$ 11.6 to 55.2 $\pm$ 10.4; $P = 0.04$). The ratios of above the cut-off value for postoperative anxiety and depression scores were 29.1% and 43.7%, respectively. Postoperative changes in exercise capacity were associated with variations in right ventricular function, chronotropic response during exercise, and the PCS score ($P < 0.05$ for each).
Conclusions: Exercise capacity reduced by approximately 20% during the postoperative period in patients who underwent valvular surgery, and changes in exercise capacity were related to changes in psychosocial factors, not only cardiac functions. Therefore, it is important to evaluate not only perioperative exercise capacity but also psychosocial indicators during postoperative cardiac rehabilitation programs.

Keywords: Exercise Tolerance, Thoracic Surgery, Cardiac Rehabilitation, Quality of Life, Exercise Test

1. Background

The efficacy of multidisciplinary cardiac rehabilitation (CR) programs has already been proven (1, 2). CR programs not only include exercise training but also are customized for a specific individual, aiming to improve quality of life by reducing risk factors and providing psychological support, nutritional care, and guidance on how to resume daily life activities, such as returning to work (1, 2). The benefits of CR include a reduction in mortality rates, symptom relief, improved exercise capacity, risk factor modification, and improved overall psychosocial well-being (3).

However, cardiac valve replacement results in a decline in postoperative exercise capacity despite the postoperative improvements in hemodynamic parameters (4, 5). Tourneau et al. (6) reported no improvement in exercise capacity even 1 year after the surgery. Importantly, postoperative physical activity levels are positively associated with higher survival rates (7). Therefore, it is very important to begin multidisciplinary CR as early as possible after surgery. It has been reported that early CR succeeded in improving exercise performance in post-cardiac surgery patients (8), and for every 1-day delay in starting CR, patients were 1% less likely to improve across all fitness-related measures (9).

Along with changes in exercise capacity, psychosocial parameters also were reported to change significantly before and after cardiac surgery (10, 11). Importantly, there is an association between a low health-related quality of life (HRQOL) score and re-hospitalization and mortality in heart failure patients (12). Khoueiry et al. reported that the HRQOL score returned to the baseline value at 9 months after surgery or improved as compared to the preoperative value (11). However, these previous studies focused on long-term changes and therefore, there is a specific need to investigate changes in exercise capacity and psychosocial indicators in the early phase after cardiac surgery to implement early multidisciplinary CR, including exercise training, life coaching, and counseling.

Based on the previous studies mentioned above, we hypothesized that both exercise capacity and psychosocial factors are impaired during the early postoperative period. This study aimed to reveal the changes in exercise capacity and psychosocial factors in the early phase after valvular surgery and to clarify the relationship between the changes in perioperative exercise capacity and psychosocial factors.

2. Methods

2.1. Study Population

Between December 2013 and January 2016, 223 consecutive patients who underwent valvular surgery were included in this study. Patients were excluded from the study if they required emergency surgery (N = 19), had severe clinical instability that would prevent them from performing the exercise test (N = 130), and refused to participate (N = 4). All patients received postoperative rehabilitation from the day after the surgery, according to the Japanese Circulation Society guidelines for rehabilitation in patients with cardiovascular disease (3). Fourteen days after the surgery, we obtained repeat measurements for the cardiopulmonary exercise test and resting echocardiography. Twenty-two patients were not included in the final analysis because 10 of them developed surgical complications and 12 could not reach the maximal exercise level due to orthopedic reasons. The remaining patients who had completed the preoperative and postoperative exercise tests were included in the final analysis. This study complied with the principles of the Declaration of Helsinki regarding investigations in humans as approved by the local institutional board at Kobe University. Written informed consent was obtained from each patient.

2.2. Data Collection

Patient characteristics were evaluated from electronic medical records. The baseline characteristics included age, sex, body mass index (BMI), comorbidities, brain natriuretic peptide levels, New York heart association functional classification (NYHA), and European system for cardiac operative risk evaluation (Euro SCORE) II (13). Laboratory data collection and two-dimensional and Doppler echocardiography were performed within 1 week before the surgery and 14 days after the surgery. The laboratory data collected included estimated glomerular filtration rate (eGFR), serum hemoglobin, C-reactive protein (CRP), and serum albumin levels. Echocardiography was performed using a commercially available echocardiography system with a 3.5-MHz transducer (Vivid 7; GE Vingmed Ultrasound, Horten, Norway). The left ventricular ejection fraction (LVEF) was determined using the modified biplane Simpson's method (14). Tricuspid annular plane systolic excursion (TAPSE) was determined from an apical four-chamber view with an M-mode cursor through the lateral tricuspid annulus to determine conventional right ventricular systolic function. Knee extensor muscle strength (KEMS) was measured using a handheld dynamometer (MicroFET2; Hoggan Health Industries, Salt Lake City, UT, USA). Measurements were obtained for both legs at maximum isometric contraction (15), and we calculated the average of the highest values (N) of the sum of the KEMS of the right and left knees as N/2/BW [body weight] = % BW (16).

2.3. Cardiopulmonary Exercise Test

Patients performed the exercise test on a cycle ergometer (Strength Ergo 8; Mitsubishi Electric Engineering, Tokyo, Japan), in accordance with the protocol described in American thoracic society guideline (17). Preoperative assessments were performed within 10 days of the surgery, and postoperative assessments were performed 14 days after the surgery. The exercise test was a continuous protocol test with a progressive increase of 10 W/min. The exercise finished at the point when the patient could not continue because of dyspnea or leg fatigue. Blood pressure (BP) was measured with an electronic sphygmomanometer every minute during the exercise test. Heart rate (HR) was registered using a 12-lead electrocardiogram continuously, and HR recovery at 1 minute was registered. The predicted value of maximal oxygen consumption (VO_2) was estimated using the Wasserman equation, normalizing VO_2 for weight, age, height, and gender (18). Ventilatory efficiency during exercise was expressed as the slope of minute ventilation (VE) versus carbon dioxide production (VCO_2) over the linear component of the plot of VE versus VCO_2 (VE/VCO_2 slope). Chronotropic response was measured as HR reserve [HR reserve = (peak HR - rest HR)/(age predicted maximal HR - rest HR)] (19). Age-predicted maximal HR was calculated using the formula: (220 - age) (19). The rate of increase in VO_2 relative to workload (WR) ($\Delta VO_2/\Delta WR$) has been interpreted as an indicator of cardiovascular efficiency and aerobically generated adenosine triphosphate. The $\Delta VO_2/\Delta WR$ slope was automatically calculated using a method described elsewhere (20).

2.4. Psychosocial Assessment

Anxiety and depression were assessed using the hospital anxiety and depression scale (HADS) (21). The HADS is a self-report questionnaire, which has been validated as a screening instrument to assess the presence or severity of anxiety disorders and depression symptoms (22). The HADS questionnaire consists of 14 items, 7 for each of the 2 subscales anxiety and depression. Each subscale is rated from 0 to 3, resulting in a maximum total score of 21 for each subscale. Generally, a cut-off value of > 8 indicates anxiety or depression (22). HRQOL was investigated with the Japanese version of the medical outcomes study 36-item short-form general health survey version 2.0 (SF-36; v2) (23). The validity and reliability of this questionnaire have already been proven in a previous study (23). SF-36 was measured on a scale from 0 to 100, with higher scores representing a higher HRQOL. To evaluate in detail, the SF-36 subscales were combined into the 3-component model: the role component summary (RCS) score, the physical component summary (PCS) score, and the mental component summary (MCS) score (24). Each component score is converted to an average of 50 and a standard deviation of 10, according to the population standard in Japan (25). A score of < 50 indicates that the specific health concept is below the normal value for the Japanese population.

2.5. Statistical Analysis

Results are expressed as mean ± standard deviation for continuous data and as ratio for categorical data. We conducted statistical analyses after confirming that the data were normally distributed using the Shapiro-Wilk test. The paired t-test was used to compare values before and after surgery. To compare the preoperative and postoperative values, percentage changes were obtained for continuous variables, and univariate linear regression analysis was applied to calculate the correlations between various parameters by determining Pearson correlation coefficients. The overall statistical significance level was set at 0.05. All statistical analyses were performed using JMP11.0 J software (SAS Institute Japan, Tokyo, Japan).

3. Results

3.1. Baseline Characteristics

Of the 223 patients, 175 were excluded from the study based on the exclusion criteria. Thus, 48 patients with a mean age of 65.1 ± 13.3 years were included in this study. The baseline demographic characteristics are shown in Table 1. patients were NYHA class I, 32 were NYHA class II, and 14 were NYHA class III.

Table 1. Patients Characteristics[a]

	Total (n = 48)
Age, y	65.1 ± 13.3
Male	22 (45.8)
BMI, kg/m²	22.3 ± 2.2
Hemoglobin, mg/dL	13.2 ± 1.3
eGFR	72.1 ± 18.5
LVEF, %	61.3 ± 7.9
Euroscore II	5.5 ± 1.6
Operation time, min	347.2 ± 82.8
CPB time, min	190.8 ± 47.3
ACC time, min	131.7 ± 48.1
NYHA class (I, II, III)	2, 32, 14
AF	6 (12.5)
Comorbidities	
Hypertension	14 (29.2)
Dyslipidemia	10 (20.8)
Diabetes	3 (6.3)
Smoking	5 (10.4)
Type of surgery	
Mitral valve surgery	27 (56.3)
Aortic valve surgery	14 (29.2)
Concomitant mitral and Aortic valve surgery	7 (14.6)

Abbreviations: ACC, aortic cross-clamp; AF, atrial fibrillation; BMI, body mass index; CPB cardiopulmonary bypass; eGFR, estimated glomerular filtration rate; NYHA, New York heart association.
[a]Values are expressed as No. (%) or mean ± SD.

3.2. Preoperative and Postoperative Characteristics

The preoperative and postoperative echocardiography findings, laboratory data, and medication data are shown in Table 2. Preoperative LVEF was 61.3 ± 7.9% that decreased to 54.8 ± 10.8% (P = 0.0024). TAPSE decreased significantly postoperatively (P < 0.0001). The Hb and serum albumin levels decreased significantly postoperatively; however, CRP levels and eGFR increased significantly (P < 0.05 for each). At the baseline, 39.5% of the patients were treated with β-blockers, and the ratio remained unchanged after the surgery (P = 0.37). In contrast, the ratio of patients treated with angiotensin-converting enzyme (ACE) inhibitors or angiotensin-II receptor blockers (ARBs) decreased significantly postoperatively (p = 0.0020). With regard to muscle strength, KEMS decreased significantly from 4.4 ± 1.0 to 4.3 ± 0.9 after the surgery (P = 0.04).

Table 2. Comparison of Physiological Data Between Pre- and Post-Surgery[a]

	Pre Op	Post Op	t or $\chi 2$ Value	P Value
LVEF, %	61.3 ± 9.0	54.8 ± 10.8	-3.3	0.0024
TAPSE	20.6 ± 5.2	12.1 ± 4.1	-8.2	< 0.0001
Hemoglobin, mg/dL	13.5 ± 1.6	10.3 ± 1.1	-12.1	< 0.0001
Albumin, mg/dL	4.3 ± 0.5	3.2 ± 0.3	-15.9	< 0.0001
CRP, mg/dL	0.11 ± 0.19	2.6 ± 2.4	6.2	< 0.0001
eGFR	72.1 ± 18.5	77.1 ± 18.3	2.6	0.0141
Medication				
Beta-blocker	19 (39.5)	21 (43.8)	0.8	0.37
ACE inhibitor/ ARB	21 (43.8)	9 (18.8)	9.2	0.0020
Diuretics	21 (43.8)	16 (33.3)	13.1	0.0002

Abbreviations: ACE, Angiotensin converting enzyme; ARB: angiotensin II receptor blocker; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction; TAPSE tricuspid annual plane systolic excursion.
[a]Values are expressed as No. (%) or mean ± SD.

3.3. Cardiopulmonary Exercise Test

At the preoperative evaluation, the peak VO_2 was 17.7 ± 5.9 mL/kg/min, which corresponded to the standard value for 69.5% of the population (Table 3). At the postoperative evaluation, the peak VO_2 decreased to 14.3 ± 4.4 mL/kg/min, which corresponded to the standard value for 57.2% of the population ($P < 0.0001$). Similarly, the peak WR, ΔVO2/ΔWR slope, HR reserve, HR recovery at 1 minute, and peak systolic BP decreased significantly after the surgery ($P < 0.05$ for each). The VE/VCO_2 slope significantly increased from 27.5 ± 6.5 to 32.9 ± 9.4 after the surgery. Whereas, there was no statistically significant difference in the respiratory exchange ratio (RER) before and after the surgery (1.3 ± 0.2 vs. 1.3 ± 0.2; P = 0.20).

3.4. Psychosocial Factors

During the follow-up, the PCS and RCS scores decreased significantly ($P < 0.05$ for each) (Table 4). The mean scores for both PCS and RCS were lower than the national standard values even before the surgery (45.0 ± 9.1 and 40.6 ± 16.6, respectively, for each). However, the postoperative MCS score increased significantly as compared to the value before the surgery (51.9 ± 11.6 to 55.2 ± 10.4; P = 0.04). The preoperative anxiety score was 6.1 ± 3.6 that decreased significantly to 5.2 ± 3.5 after the surgery (P = 0.03). The depression score was 5.7 ± 2.9 at the baseline that increased to 6.9 ± 3.5 after the surgery (P = 0.0037). The ratios of above the cut-off value for the postoperative anxiety and depression scores were 29.1% and 43.7%, respectively.

3.5. Relationship between changes in physiological outcomes and psychosocial outcomes

The matrix of correlation coefficients between changes in physiological outcomes and psychosocial outcomes is presented in Table 5. The changes in the peak VO_2 were associated with variations in TAPSE, HR reserve, KEMS, and PCS ($P < 0.05$ for each), and the changes in the PCS score were correlated with the changes in TAPSE and KEMS in addition to the peak VO_2. There was a statistically significant association between changes in the MCS score and changes in the anxiety score (r = 0.47; P = 0.0054). The change in the RCS score was correlated with age and changes in the depression score ($P < 0.05$ for each). There are no statistically significant differences in the change of exercise capacity and QOL by surgical procedures.

4. Discussion

To the best of our knowledge, this study is the first to examine postoperative changes in exercise capacity and HRQOL assessment over a short period. Our results suggest that exercise capacity reduced by approximately 20% after valvular surgery. With regard to HRQOL, the PCS and RCS scores reduced significantly, whereas the MCS score improved significantly after the surgery.

The peak VO_2 decreased from 17.7± 5.9 to 14.3 ± 4.4 mL/kg/min. It has been reported that exercise capacity < 15.0 mL/kg/min indicates a poor prognosis and higher mortality (26). The average of postoperative peak VO_2 was falling below this cut-off value, and it is likely that there is a severe limitation in exercise capacity after the surgery. We postulate that there are at least three factors relating

Table 3. Comparison of CPX Parameter Between Pre- and Post-Surgery[a]

	Pre Op	Post Op	t Value	P Value
VO_2, mL/kg/min	17.7 ± 5.9	14.3 ± 4.4	-6.7	< 0.0001
VO_2 % predict, %	69.5 ± 17.8	57.2 ± 14.0	-6.7	< 0.0001
VE/VCO_2 slope	27.5 ± 6.5	32.9 ± 9.4	3.4	0.0015
$\triangle VO_2/\triangle WR$	7.6 ± 2.7	6.6 ± 2.4	-3.3	0.0017
Peak WR, watt	85.7 ± 33.7	72.0 ± 29.4	-5.6	< 0.0001
HR reserve	0.60 ± 0.22	0.38 ± 0.20	-7.4	< 0.0001
HR recovery, beats	21.6 ± 12.2	10.3 ± 10.3	-5.2	< 0.0001
RER	1.3 ± 0.2	1.3 ± 0.2	1.3	0.2
Peak systolic blood Pressure, mm Hg	171.4 ± 40.4	149.0 ± 30.9	-3.9	0.0003

Abbreviations: CPX, cardiopulmonary exercise test; HR, heart rate; RER, respiratory exchange ratio; VE, minute ventilation; VO2, oxygen consumption; VCO2, carbon dioxide production; WR, workload.
[a]Values are expressed as mean ± SD.

Table 4. Comparison of Psychosocial and Physical Function Between Pre- and Post-Surgery[a]

	Pre Op	Post Op	t Value	P Value
HRQOL				
PCS	45.0 ± 9.1	40.3 ± 9.4	-3.2	0.0033
MCS	51.9 ± 11.6	55.2 ± 10.4	1.9	0.04
RCS	40.6 ± 16.6	27.6 ± 21.9	-3.9	0.0005
HADS				
Anxiety	6.1 ± 3.6	5.2 ± 3.5	-2.1	0.03
Anxiety (8 >)	16 (33.3)	14 (29.1)	-0.7	0.48
Depression	5.7 ± 2.9	6.9 ± 3.5	3.1	0.0037
Depression (8 >)	7 (14.6)	21 (43.7)	5.9	0.014
KEMS, N/kg	4.4 ± 1.0	4.3 ± 0.9	-2.1	0.04
6MWD, m	462.6 ± 93.4	412.2 ± 101.1	-2.8	0.0141

Abbreviations: HADS, hospital anxiety and depression scale; HRQOL, health related quality of life; KEMS, knee extensor muscle strength; MCS, mental component summary; PCS, physical component summary; RCS, role component summary; 6MWD, six minutes walking distance.
[a]Values are expressed as No. (%) or mean ± SD.

to the decline in postoperative exercise capacity. First, it is thought that muscle weakness due to postoperative deconditioning can be related to the decline in postoperative exercise capacity. We found that KEMS and peak WR during the exercise test significantly reduced after the surgery. A previous study demonstrated that even in the absence of perioperative complications, major surgery is associated with a 20% to 40% reduction in physiological capacity after the surgery (27). This reduction may be due to the postoperative inflammation and catabolic phase. Kamiya et al. also reported that muscle strength was a predictor of exercise capacity (28). This study support these reported findings; furthermore, we revealed that the perioperative changes in KEMS were correlated with changes in the peak VO_2.

Second, the decrease of postoperative exercise capacity is related to the decrease in cardiac function, which appears after valvular surgery using cardiopulmonary bypass (CPB). It is known that the length of CPB and the duration of aortic cross-clamping during cardiac surgery can affect the decline of cardiac function (29). Our findings of deteriorated right and left ventricular function after surgery, as indicated by the changes in the LVEF and TAPSE, are thought to trigger such a mechanism. On the other hand, the VE/VCO_2 slope during the exercise test increased significantly after the surgery from 27.5 ± 6.5 to 32.9 ± 9.4.

Table 5. Pearson's Correlation Coefficient Assessing the Relationship Between Changes in Physiological and Psychosocial Outcomes[a]

	Peak VO_2	PCS	MCS	RCS
Age	0.002	0.12	-0.12	-0.53[b]
△Hemoglobin	0.09	-0.23	-0.05	0.31
△LVEF	0.21	-0.13	0.27	0.21
△TAPSE	0.24[b]	0.35[b]	-0.23	0.27
△HR reserve	0.26[b]	0.21	0.032	-0.08
△HR recovery	0.13	0.06	0.2	-0.22
△KEMS	0.35[b]	0.41[b]	0.16	-0.06
△PCS	0.36[b]	-	-	-
△MCS	0.07	-	-	-
△RCS	-0.07	-	-	-
△Anxiety	-0.21	-0.12	0.47[b]	0.20
△Depression	-0.29	0.16	-0.11	0.55[b]

Abbreviations: HR, heart rate; △ %change, LVEF left ventricular ejection fraction; KEMS, knee extensor muscle strength; MCS, mental component summary; PCS, physical component summary; RCS, role component summary; TAPSE, tricuspid annual plane systolic excursion.
[a]Values are expressed as No. (%) or mean ± SD.
[b]$P < 0.05$.

VE/VCO_2 slope is a single predictor of mortality in heart failure, and VE/VCO_2 slope of 34 was a threshold for risk stratification (30). In this study, the threshold did not exceed even after the surgery; however, it is highly decreased compared to the healthy controls. Furthermore, we observed that the $\Delta VO_2/\Delta WR$ significantly deteriorated during the postoperative exercise test. A reduced contractile reserve and transient ischemia after surgery limits the stroke volume increase as shown by decreased peak systolic blood pressure; and a complete β-receptor blockade reduces the HR reserve, both leading to a diminished cardiac output (CO) response (31). Our results showed that the deteriorated resting right and left ventricular function after surgery and the insufficient increase in CO during the exercise test both had a strong role to play in exercise intolerance after surgery.

Third, the reduction in cardiovascular autonomic nervous system function could be associated with the decline in exercise capacity. We found that the HR reserve and HR recovery deteriorated significantly after the surgery. The attenuated HR recovery after exercise is a marker of reduced parasympathetic activity (32), and chronotropic incompetence implies a decreased sensitivity of the sinus node to sympathetic stimulation. Nishime EO et al. demonstrated that HR recovery under 12 beats was independent predictor of mortality in patients as the same as exercise capacity (33). In this study, the average of HR recovery was 10.3 ± 10.3 beats, as represented in reduced parasympathetic activity. Studies investigating perioperative exercise capacity after valvular surgery are sparse; nevertheless, it has already been reported that nervous-humoral factors such as the renin-angiotensin-aldosterone (RAS) system and sympathetic activity are enhanced after cardiac surgery (34). Furthermore, it has also been reported that impaired autonomic nervous function is a predictor of exercise intolerance and mortality (33, 35). As is evident from the findings mentioned above, postoperative exercise intolerance is probably associated with over activity of the sympathetic nervous system or attenuation of the parasympathetic nervous system or both. There was no statistical difference in the ratio of patients treated with β-blockers before and after the surgery, but there were significant differences in the ratio of patients treated with RAS system inhibitors such as ACE inhibitors or ARBs. It is possible that the reduction in the RAS system inhibitor contributed to the postoperative increase of sympathetic nervous system activity. Further studies are needed to confirm and generalize these findings.

With regard to psychosocial factors, we found that the PCS and RCS scores reduced after the surgery. In addition, perioperative changes in the PCS score were correlated with the changes in the peak VO_2 and KEMS. Perrotti et al. demonstrated that the PCS score did not return to the baseline value at 1 month after cardiac surgery (36); however, they did not investigate physical function along with HRQOL. In this study, the decline in the PCS score was related to the postoperative muscle weakness and decreased exercise capacity. In addition, it has been reported that postoperative complaints such as wound pain and sleep disorders affect the PCS score (37). We did not investigate such complaints, but it could be a possible explanation for the decreased PCS score, as observed in our study.

Our study is the first to demonstrate changes in the RCS score after surgery. It was reported that RCS represents not only roles in daily lives, but also patients' social functioning (24). Thus, it is inevitable that age is significantly correlated with changes in the RCS score because RCS decreased gradually with age in the general population. Before undergoing surgery, the study participants were living independently in a community setting and their mental state or social functioning was not severely impaired. Even in those patients, the RCS score further decreased after cardiac surgery. In a previous study, 13.8% of patients could not return to work even 12 months after surgery, and negative perception of health was an independent risk factor that inhibited early return to work after surgery (38). These results from a previous study were compatible with our results that the RCS score was correlated with changes in depression symptoms. Another randomized study showed that the performance of the exercise test after acute coronary syndrome shortened the time to return to work and resulted in community and patient cost savings (39). Thus, our results emphasize the importance of counseling patients, planning for rehabilitation, evaluating exercise capacity, and providing support to return to work as early as possible after cardiac surgery.

Surprisingly, the MCS and anxiety scores improved significantly after valvular surgery. This was in contrast to the findings of changes in PCS, RCS, and exercise capacity. Our study showed that 30% of the patients had anxiety scores above the cut-off value before the surgery, and the ratio remained unchanged after the surgery. Previous research showed that strong anxiety levels and low MCS scores before cardiac surgery were both independent risk factors for postoperative complications and mortality (40, 41). A possible explanation for the postoperative improvement in the MCS and anxiety scores observed in this study is that anxiety levels reduced because the patients experienced an alleviation of preoperative problems and a feeling of optimism about their health status. It has been reported that lack of information or communication from medical staff during the postoperative recovery period triggers anxiety in patients and caregivers (42). Thus, it is crucial to provide appropriate information, counseling, and psychological interventions for both patients and caregivers in the early phase after the surgery.

Depression symptoms increased significantly after the surgery. This result is in accordance with a previous study finding that reported the ratio of patients with depressive symptoms increased significantly after the surgery as compared to that before the surgery (43). Low levels of physical activity before surgery were correlated with not only preoperative depressive symptoms but also postoperative depression symptoms (44, 45). Our results emphasize the importance of initiating exercise training in the early phase after surgery, evaluating the intensity of physical activity and providing adequate counseling.

This study had several limitations. First, we used a pre-post design. We could not establish causation because we did not include a control group. Second, we did not analyze sex- or age-related differences or study the impact of social background because the sample size was small. Furthermore, we did not determine whether these short-term changes would have an impact on the long-term period. Thus, a long-term longitudinal study with a large sample size is needed to confirm the changes in physiological and psychosocial factors in the early phase after cardiac valve surgery.

4.1. Conclusions

Our study revealed that exercise capacity reduced by approximately 20% during the postoperative period in patients who underwent cardiac valve surgery, and changes in exercise capacity were related to postoperative muscle weakness, autonomic nervous function impairments, right ventricular function, and PCS score. Among the psychosocial factors, the MCS and anxiety scores improved significantly, while the PCS and RCS scores reduced in the postoperative period. Depression symptoms increased significantly after the surgery. Therefore, it is important to evaluate not only the perioperative exercise capacity but also psychosocial indicators during multidisciplinary CR after the surgery.

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Footnotes

Conflict of Interest: The authors declare that there are no conflicts of interest.

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