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Article

Combined Mitral Valve Surgery in Hypertrophic Obstructive Cardiomyopathy Patients Undergoing the Modified Morrow Procedure: Impact on Kansas City Cardiomyopathy Questionnaire Scores and Management

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Abstract

Background: This study aimed to investigate the impact of the modified Morrow procedure, with or without concomitant mitral valve surgery, on Kansas City Cardiomyopathy Questionnaire (KCCQ) scores and quality of life (QoL) in patients with hypertrophic obstructive cardiomyopathy (HOCM), and to provide an evidence base for the development of perioperative management strategies. **Methods**: A retrospective analysis was conducted on 82 patients with HOCM who underwent the modified Morrow procedure. Patients were divided into two groups: those who received the modified Morrow procedure alone (n = 41) and those who underwent the combined procedure (n = 41). Baseline characteristics, postoperative follow-up parameters, and changes in KCCQ scores were compared between the two groups. **Results**: The two groups were comparable at baseline, except for a significant difference in preoperative mitral regurgitation ($p < 0.05$). No significant differences were observed between the groups in postoperative KCCQ scores or cardiac function parameters ($p > 0.05$). Repeated-measures analysis of variance revealed a significant main effect of time ($p < 0.001$), but no significant main effect of surgical group or time-by-group interaction ($p > 0.05$). **Conclusion**: The modified Morrow procedure significantly improves QoL in patients with HOCM. Concomitant mitral valve surgery does not impose an additional burden on KCCQ scores. Clinical efforts should focus on meticulous perioperative management throughout the care cycle and on personalized cardiac rehabilitation guidance to facilitate postoperative recovery. Ultimately, these measures support a closed-loop "assessment–intervention–monitoring–follow-up" management system that continuously safeguards the QoL and the long-term prognosis of patients undergoing the combined procedure.

Keywords: modified Morrow procedure; mitral valve surgery; hypertrophic obstructive cardiomyopathy (HOCM); KCCQ score; management strategies

1. Introduction

Hypertrophic obstructive cardiomyopathy (HOCM) is a common inherited cardiomyopathy characterized by abnormal ventricular wall thickening and left ventricular outflow tract (LVOT) obstruction. The clinical presentation is often severe, predisposing patients to malignant arrhythmias and sudden cardiac death, significantly threatening their life and quality of life (QoL) [1,2]. The modified Morrow procedure is the standard surgical treatment for drug-refractory, severely symptomatic HOCM patients, effectively relieving LVOT obstruction, improving clinical symptoms, and optimizing long-term prognosis [3,4]. HOCM patients often present with mitral regurgitation (MR), primarily due to systolic anterior motion (SAM) of the mitral valve leaflet, while in some cases, it stems from intrinsic mitral valve pathology [5]. Whether to intervene on the mitral valve during surgery has long been a subject of debate.

From a clinical management perspective, surgical success is only one crucial dimension of evaluating HOCM treatment outcomes; patients' postoperative QoL is equally a core concern in clinical practice [6]. The Kansas City cardiomyopathy questionnaire (KCCQ) is an internationally recognized, standardized self-administered instrument for assessing the health status of patients with heart failure. Its advantage lies in its sensitivity to capturing postoperative changes in symptom improvement, physical function recovery, social function adaptation, and overall QoL enhancement. However, studies utilizing the KCCQ to evaluate QoL in patients undergoing the modified Morrow procedure with concomitant mitral valve surgery are limited [7–9].

Based on this background, this study, from a clinical management perspective, aims to retrospectively analyze the clinical data of 82 HOCM patients who underwent surgical treatment at our hospital. It focuses on exploring whether concomitant mitral valve surgery during the modified Morrow procedure imposes an additional burden on postoperative QoL, as represented by KCCQ scores. The goal is to provide a scientific basis for optimizing the perioperative clinical management pathway assessment system, developing personalized health education plans, and implementing precise rehabilitation guidance for HOCM patients, thereby enhancing the quality of postoperative recovery and survival experience.

2. Materials and Methods

2.1 Study Population

This study screened hospitalized HOCM patients who underwent either the modified Morrow procedure alone or the combined procedure at Beijing Anzhen Hospital, Capital Medical University, between January 2022 and December 2024, using the Hospital Information System (HIS).

Inclusion criteria: (1) Diagnosed with HOCM (diagnostic criteria based on the "Chinese Guidelines for the Diagnosis and Treatment of Adult Hypertrophic Cardiomyopathy 2023") [10,11]; (2) Resting or provoked LVOT gradient $\geq$50 mmHg on transthoracic echocardiography; (3) Underwent the modified Morrow procedure with or without mitral valve surgery at our hospital; (4) Complete clinical data.

Exclusion criteria: (1) Echocardiography not meeting HOCM diagnostic criteria; (2) Incomplete echocardiographic data; (3) Missing other baseline data; (4) Comorbid severe hepatic or renal dysfunction, malignancy, mental illness, or incomplete clinical data.

Surgical indications and group allocation: All patients underwent the modified Morrow procedure for standard indications. Concomitant mitral valve surgery (repair) was performed based on predefined criteria: (1) moderate/severe MR (regurgitant jet area $\geq$4 cm^2) not solely due to SAM; (2) intrinsic mitral valve pathology; or (3) significant residual MR/SAM on intraoperative transesophageal echocardiography (TEE) after myectomy. Patients with MR primarily related to SAM, expected to resolve after septal reduction, constituted the isolated procedure group.

Ultimately, 82 HOCM patients were enrolled and divided into two groups based on the surgical approach: the modified Morrow procedure alone group (n = 41) and the combined procedure group (n = 41). The Ethics Committee of Beijing Anzhen Hospital, Capital Medical University approved this study. All patients gave their informed consent in compliance with the principles of the Declaration of Helsinki.

2.2 Data Collection

All enrolled patients underwent baseline assessment within 24 hours of admission, and the following data were collected; three experienced clinicians and nurses independently reviewed the data to ensure accuracy: (1) Demographic and clinical baseline data: age, gender, height, body mass index, past medical history, and comorbidities.

(2) Echocardiographic parameters: Left atrial diameter (LAD), interventricular septum thickness (IVST), left ventricular end-diastolic volume (LVVd), left ventricular ejection fraction (LVEF), left ventricular fractional shortening (LVFS), maximum velocity across the LVOT (Vmax), peak pressure gradient across the LVOT (PG), and MR severity.

(3) Perioperative data: Surgical approach, key operative parameters, length of hospital stay.

QoL assessment: The first visit at Beijing Anzhen Hospital in January 2022 was defined as the follow-up starting point. Follow-up was completed at 6 months postoperatively via outpatient review, telephone call, or rehospitalization. The short form of the Kansas City cardiomyopathy questionnaire (KCCQ-12) was used to assess QoL before surgery and at 6 months postoperatively, covering domains such as symptoms, physical limitations, social limitations, and quality of life. Scores range from 0 to 100, with higher scores indicating better QoL.

2.3 Statistical Analysis

SPSS version 26.0 (version number: 26.0.0.0, IBM Corp., Armonk, New York, USA) was used for statistical analysis. Normally distributed continuous data are presented as mean $\pm$ standard deviation (SD) and were compared between groups using independent samples *t*-tests. Categorical data are presented as numbers (percentages) and were compared using the Chi-square test. KCCQ scores before and after surgery constituted a repeated-measures design. Mauchly's test of sphericity was performed first; if the assumption of sphericity was violated, the Greenhouse-Geisser correction was applied. Subsequently, a two-way repeated measures analysis of variance (ANOVA) was conducted, with "Time" (preoperative/postoperative 6 months) as the within-subjects factor and "Surgical Type" (isolated modified Morrow/combined procedure) as the between-subjects factor. Partial eta-squared (η^2) was calculated to measure effect size. Simple effect analysis was used to interpret the time main effect when the interaction was not significant. A p-value $<$ 0.05 was considered statistically significant.

3. Results

3.1 Comparison of Baseline Characteristics Between the Two Groups

A total of 82 HOCM patients were enrolled and divided into the modified Morrow procedure alone group (n = 41) and the combined procedure group (n = 41), the combined procedure group consisted of patients undergoing isolated mitral annuloplasty, shown in Table 1. In the isolated procedure group, the mean age was 47.39 $\pm$ 12.27 years, with 26 males and 15 females, and a preoperative KCCQ

Table 1. Baseline characteristics of HOCM patients undergoing isolated vs. combined modified Morrow procedure.

Variable	Total (n = 82)	Isolated procedure group (n = 41)	Combined procedure group (n = 41)	p value
Ages (years)	50.00 ± 12.22	47.39 ± 12.27	52.67 ± 11.71	0.051
Male, n (%)	51 (62.20)	26 (63.41)	25 (60.98)	0.820
HTN, n (%)	24 (29.27)	14 (34.15)	10 (24.39)	0.332
T2D, n (%)	3 (3.66)	2 (4.88)	1 (2.44)	>0.999
AF, n (%)	5 (6.10)	1 (2.44)	4 (9.76)	0.356
CAD, n (%)	12 (14.63)	3 (7.32)	9 (21.95)	0.061
KCCQ	41.88 ± 15.88	42.61 ± 16.72	41.15 ± 15.16	0.679
LAD (mm)	44.22 ± 6.13	44.16 ± 6.40	44.27 ± 5.94	0.933
IVST (mm)	20.43 ± 5.21	20.84 ± 4.40	20.06 ± 5.89	0.522
LVPWT (mm)	12.68 ± 3.10	12.70 ± 3.25	12.65 ± 3.00	0.952
LVVd (mL)	81.18 ± 34.50	78.68 ± 33.82	83.67 ± 35.41	0.517
LVVs (mL)	24.33 ± 10.91	24.65 ± 10.53	24.02 ± 11.39	0.798
LVEF, (%)	67.82 ± 6.46	67.68 ± 5.63	67.95 ± 7.23	0.857
LVFS, (%)	37.97 ± 5.58	37.62 ± 4.47	38.31 ± 6.51	0.596
Vmax (cm/s)	363.61 ± 132.19	364.68 ± 138.85	362.62 ± 127.50	0.946
PG (mmHg)	64.56 ± 36.08	66.11 ± 36.93	63.08 ± 35.70	0.724
MR (cm^2)	8.19 ± 3.16	7.30 ± 2.92	8.94 ± 3.21	0.039

KCCQ, Kansas City cardiomyopathy questionnaire; LAD, left atrial diameter; IVST, interventricular septal thickness; LVPWT, left ventricular posterior wall thickness; LVVd, left ventricular end-diastolic volume; LVVS, left ventricular end-systolic volume; LVEF, left ventricular ejection fraction; LVFS, left ventricular fractional shortening; Vmax, maximum velocity across the left ventricular outflow tract; PG, peak pressure gradient across the left ventricular outflow tract; MR, mitral regurgitation (regurgitant jet area in cm^2); HOCM, hypertrophic obstructive cardiomyopathy; HTN, hypertension; T2D, type 2 diabetes; AF, atrial fibrillation; CAD, coronary artery disease.

score of 42.61 ± 16.72. In the combined procedure group, the mean age was 52.67 ± 11.71 years, with 25 males and 16 females, and a preoperative KCCQ score of 41.15 ± 15.16. There were no statistically significant differences between the two groups in age, gender, comorbidities, preoperative KCCQ score, or preoperative echocardiographic parameters ($p > 0.05$). The only significant difference in baseline characteristics was that patients in the combined procedure group had more severe preoperative mitral regurgitation (7.30 ± 2.92 vs. 8.94 ± 3.21, $p = 0.039$).

3.2 Perioperative and Postoperative Outcome Measures of the Two Patient Groups

As shown in Table 2, statistically significant differences were observed between the two groups in aortic cross-clamp time (Z = –3.080, $p = 0.002$) and cardiopulmonary bypass time (Z = –2.781, $p = 0.005$). The median aortic cross-clamp time was 150.0 min (127.0–182.0 min) in the combined procedure group and 113.8 min (100.5–144.3 min) in the isolated procedure group. The median cardiopulmonary bypass time was 122.0 min (102.0–178.0 min) and 80.0 min (80.0–122.0 min), respectively. However, no significant differences were found between the two groups in the duration of mechanical ventilation (Z = –1.346, $p = 0.178$), surgical time (Z = –1.218, $p = 0.223$), length of intensive care unit (ICU) stay (Z = –1.729, $p = 0.084$), or total hospital stay (Z = –0.796, $p = 0.426$). These results indicate that although the combined procedure required longer intraoperative times due to the additional handling of the mitral valve, it did not significantly prolong postoperative recovery time or hospitalization.

3.3 Comparison of Postoperative Follow-up Data at 6 Months Between the Two Groups

There were no significant differences between the two groups in postoperative KCCQ scores, LAD, IVST, LVVd, LVEF, LVFS, Vmax, PG, or MR at the 6-month follow-up ($p > 0.05$). This indicates that the two surgical approaches were equivalent in improving cardiac function and QoL. Furthermore, comparisons of postoperative LAD, IVST, LVEF, LVFS, Vmax, PG, and MR degree between the combined procedure group and the isolated procedure group showed no significant differences ($p > 0.05$), confirming that concomitant mitral valve intervention did not increase the risk of additional myocardial injury or obstruction. See Table 3 (Ref. [12]).

3.4 Comparison of Pre- and Postoperative KCCQ Scores in the Two Groups

No significant intergroup difference was observed in preoperative KCCQ scores ($p = 0.679$). A significant postoperative improvement in KCCQ scores was noted in both the isolated (42.61 ± 16.72 to 57.76 ± 8.81) and combined (41.15 ± 15.16 to 57.56 ± 6.73) procedure groups ($p < 0.001$ for both). The extent of improvement did not differ significantly between the two groups ($p = 0.842$, Table 4).

Table 2. Perioperative and postoperative outcome measures in HOCM patients undergoing isolated modified Morrow procedure versus Morrow procedure combined with mitral valve surgery.

Variables	Total (n = 82)	1 (n = 41)	2 (n = 41)	Statistic	p
Hospital stay, quant median, M (Q_1, Q_3)	16.000 (13.000, 23.000)	16.000 (13.000, 23.000)	16.000 (13.000, 16.000)	Z = –0.796	0.426
Cross-clamp times, quant median, M (Q_1, Q_3)	138.500 (107.125, 174.000)	113.750 (100.500, 144.250)	150.000 (127.000, 182.000)	Z = –3.080	0.002
Cardiopulmonary bypass times, quant median, M (Q_1, Q_3)	112.000 (96.500, 136.000)	80.000 (80.000, 122.000)	122.000 (102.000, 178.000)	Z = –2.781	0.005
Duration of mechanical ventilation, quant median, M (Q_1, Q_3)	25.000 (18.750, 49.500)	18.750 (15.000, 25.000)	25.000 (18.750, 49.500)	Z = –1.346	0.178
Surgical time, quant median, M (Q_1, Q_3)	6.000 (5.000, 7.000)	6.000 (5.000, 7.000)	6.000 (5.000, 7.000)	Z = –1.218	0.223
Length of ICU stay, quant median, M (Q_1, Q_3)	21.000 (18.000, 60.000)	19.000 (15.000, 21.000)	21.000 (19.000, 60.000)	Z = –1.729	0.084

ICU, intensive care unit; M (Q1, Q3), the median (first quartile, third quartile).

Table 3. Comparison of six-month outcomes after isolated vs. combined modified Morrow procedure for HOCM.

Variable	Total (n = 82)	Isolated procedure group (n = 41)	Combined procedure group (n = 41)	p-value
KCCQ after surgery	57.76 ± 8.81	57.95 ± 10.57	57.56 ± 6.73	0.842
LAD (mm)	39.05 ± 5.46	38.94 ± 5.70	39.14 ± 5.42	0.914
IVST (mm)	12.84 ± 3.15	12.59 ± 2.32	13.02 ± 3.64	0.671
LVVd (mL)	36.03 ± 45.22	36.61 ± 44.49	35.48 ± 46.47	0.914
LVVs (mL)	15.35 ± 19.18	13.42 ± 18.05	17.19 ± 20.26	0.389
LVEF (%)	60.36 ± 5.53	61.06 ± 4.81	59.82 ± 6.08	0.495
LVFS (%)	32.88 ± 4.12	33.33 ± 3.34	32.50 ± 4.78	0.617
Vmax (cm/s)	135.17 ± 33.44	143.00 ± 34.83	129.30 ± 31.98	0.236
PG (mmHg)	10.26 ± 7.10	12.31 ± 7.77	6.67 ± 4.50	0.222
MR* (n)				0.474
Without	80 (97.56)	39 (95.12)	41 (100.00)	
With	2 (2.44)	2 (4.88)	0 (0.00)	

KCCQ, Kansas City cardiomyopathy questionnaire; LAD, left atrial diameter; IVST, interventricular septal thickness; LVVd, left ventricular end-diastolic volume; LVVS, left ventricular end-systolic volume; LVEF, left ventricular ejection fraction; LVFS, left ventricular fractional shortening; Vmax, maximum velocity across the left ventricular outflow tract; PG, peak pressure gradient across the left ventricular outflow tract; MR, mitral regurgitation; MR*, moderate or severe mitral regurgitation. According to echocardiographic criteria, mitral regurgitation is considered moderate to severe when the regurgitant jet area is ≥4 cm^2 on transthoracic imaging [12].

3.5 Repeated Measures ANOVA of KCCQ Scores Before and After Surgery in the Two Groups

Further simple effect analysis showed that postoperative KCCQ scores increased significantly compared to preoperative scores in both groups ($p < 0.001$), and there was no significant difference in postoperative KCCQ scores between the isolated Morrow procedure group and the combined procedure group (p = 0.842). This indicates that the change in postoperative KCCQ scores in HOCM patients was related to the surgery itself but not to the type of surgery. The estimated marginal means plot (Fig. 1) visually demonstrates that preoperative KCCQ scores were similar between the groups, both increased significantly postoperatively, and the curves nearly overlap, verifying the comparable effectiveness of the two surgical approaches in improving KCCQ scores and the lack of difference in KCCQ score improvement between the two surgical strategies for HOCM patients.

3.6 Factors Associated With Postoperative KCCQ Score

Univariate and multivariate linear regression analyses were performed to explore factors associated with postoperative KCCQ score. Univariate analysis showed that preoperative interventricular septum thickness (IVST) was significantly associated with improvement in postoperative KCCQ score (p = 0.019). After adjusting for gender, age, preoperative KCCQ grade, and left ventricular structural and functional parameters in the multivariate analysis, IVST remained an independent predictor (p = 0.040) (Table 5). The results indicated that greater preoperative interventricular septum thickness was associated with higher postoperative KCCQ scores, and the difference was statistically significant.

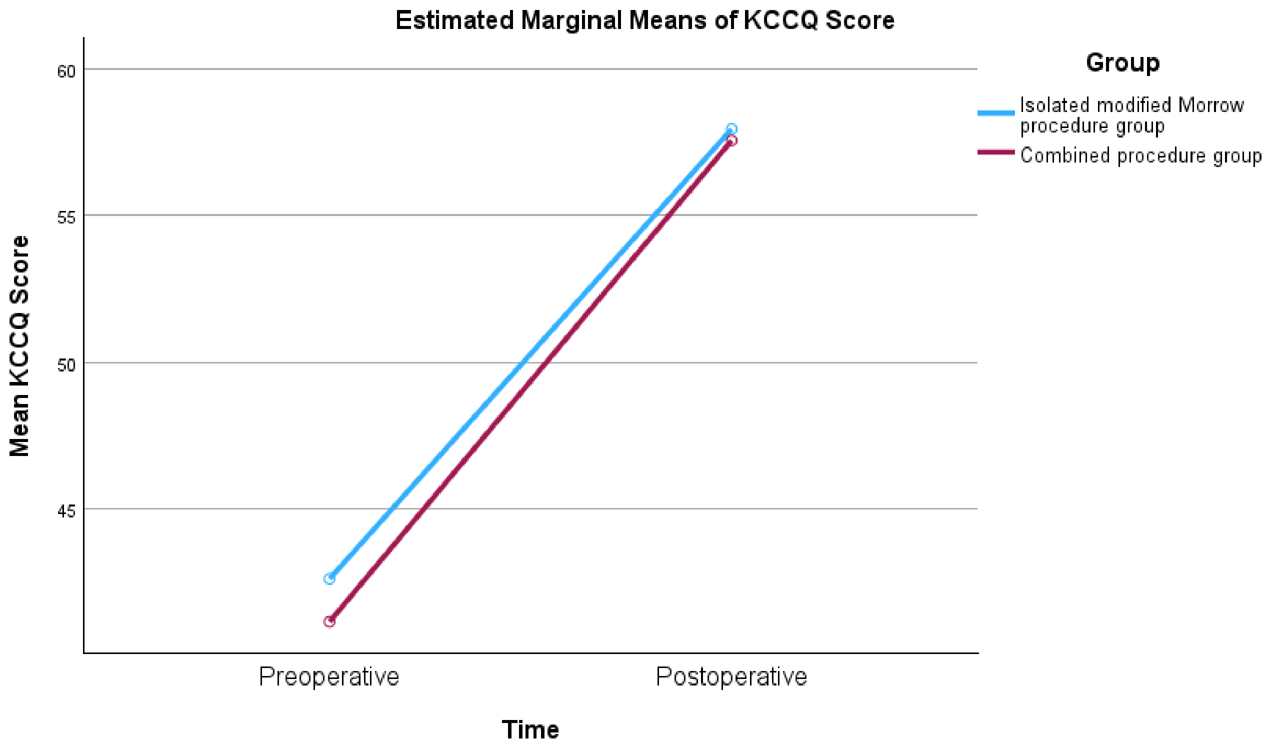

Fig. 1. Estimated marginal means of KCCQ scores from the pre- to postoperative period, by group. KCCQ, Kansas City cardiomyopathy questionnaire.

Table 4. Difference analysis of KCCQ scores before and after surgery in the two groups.

Variable	Time point	Isolated procedure group (n = 41)	Combined procedure group (n = 41)	*p* value (groups)
KCCQ score	preoperative	42.61 ± 16.72	41.15 ± 15.16	0.679
	postoperative	57.95 ± 10.57	57.56 ± 6.73	0.842
p value (times)		<0.001	<0.001	

KCCQ, Kansas City cardiomyopathy questionnaire.

4. Discussion

4.1 Impact of the Modified Morrow Procedure and Concomitant Mitral Valve Surgery on KCCQ Scores in HOCM Patients

The results of this study show that KCCQ scores significantly improved at the 6-month follow-up in HOCM patients, regardless of whether they underwent the isolated modified Morrow procedure or the combined procedure ($p < 0.001$). The average increase exceeded 15 points, surpassing the minimal clinically important difference threshold for this scale, suggesting improvements in subjective symptoms, physical function, and QoL in both groups, which is also confirmed by domestic research [7]. Univariate and multivariate logistic regression analyses exploring factors associated with postoperative KCCQ scores indicated that greater preoperative interventricular septum thickness predicted higher postoperative KCCQ scores. The significant increase in postoperative KCCQ scores in both groups of this study is consistent with previous findings, confirming that the modified Morrow procedure is an effective means of improving QoL in HOCM patients [13]. The improvement in MR after isolated myectomy is primarily attributable to the relief of SAM following septal reduction, which restores normal mitral valve function [2]. Whether or not combined with Mitral valve surgery, the procedure only increased the Operative times and did not translate into longer Hospital stay, Duration of mechanical ventilation, or ICU stay for the patients. Interestingly, greater preoperative IVST predicted better postoperative KCCQ scores. This may reflect that more severe septal hypertrophy allows for greater hemodynamic and symptomatic improvement after successful myectomy. Statistical collinearity with other severity markers should also be considered. This finding suggests that significant hypertrophy does not diminish the potential for substantial quality-of-life gain following surgery.

From a clinical management perspective, although early postoperative KCCQ scores did not differ between the combined surgery group and the isolated surgery group, the particularity of the former lies in the need for long-term

Table 5. Factors associated with postoperative KCCQ scores: Univariate and multivariable linear regression analyses.

Variables	Univariate linear analysis		Multivariate linear regression	
	β (95% CI)	p	β (95% CI)	p
Ages (years)	–0.157 (–0.313 to 0.000)	0.053		
KCCQ before surgery	0.263 (0.156 to 0.370)	<0.001	0.198 (0.079–0.317)	0.002
LAD (mm)	–0.006 (–0.330 to 0.317)	0.969		
IVST (mm)	0.484 (0.087 to 0.880)	0.019	0.421 (0.028–0.814)	0.040
LVPWT (mm)	0.167 (–0.470 to 0.804)	0.610		
LVVd (mL)	–0.020 (–0.076 to 0.035)	0.474		
LVVs (mL)	–0.101 (–0.279 to 0.077)	0.270		
LVEF (%)	0.232 (–0.071 to 0.534)	0.137		
LVFS (%)	0.303 (–0.054 to 0.660)	0.100		
Vmax (cm/s)	0.017 (0.002 to 0.032)	0.026		
PG (mmHg)	0.062 (0.006 to 0.118)	0.034	0.060 (0.008–0.111)	0.027
MR (cm^2)	–0.043 (–0.636 to 0.550)	0.887		
Gender (%)				
Male	0.000 (Reference)			
Female	–1.527 (–5.470 to 2.416)	0.450		
Procedure group				
Isolated procedure group	0.000 (Reference)			
Combined procedure group	–0.390 (–4.227 to 3.446)	0.842		

KCCQ, Kansas City cardiomyopathy questionnaire; LAD, left atrial diameter; IVST, interventricular septal thickness; LVPWT, left ventricular posterior wall thickness; LVVd, left ventricular end-diastolic volume; LVVS, left ventricular end-systolic volume; LVEF, left ventricular ejection fraction; LVFS, left ventricular fractional shortening; Vmax, maximum velocity across the left ventricular outflow tract; PG, peak pressure gradient across the left ventricular outflow tract; MR, mitral regurgitation.

anticoagulation (especially lifelong for those with mechanical valve replacements), stricter long-term monitoring of mitral valve function, and more stringent heart rate control. While these factors did not manifest as differences in KCCQ scores at 6 months, they are crucial for influencing long-term QoL and clinical outcomes. It is essential to construct a comprehensive management process tailored to their characteristics of "high long-term anticoagulation needs, stringent heart rate monitoring requirements, and need for long-term mitral valve function follow-up".

Furthermore, the KCCQ, as a heart failure-specific tool, has been proven sensitive to perioperative interventions. Research by Sherrod *et al*. [9] showed that every 10-point increase in the KCCQ overall summary score is associated with an 18% reduction in the risk of heart failure hospitalization or death within one year. For combined surgery patients, irregular anticoagulation or significant heart rate fluctuations might offset the KCCQ improvement gained from surgery and even increase the risk of thrombosis/bleeding. Therefore, clinical management should not stop at the conclusion of "no difference in early postoperative KCCQ". Instead, it must address the long-term management challenges specific to combined surgery patients. In clinical practice, using a "disease journey map" as a framework, precisely recording MR baseline and coagulation function preoperatively, managing international normalized ratio (INR) postoperatively via a "Valve Anticoagulation e-Assistant", monitoring heart rate with wearable devices, and leveraging mini-programs and official accounts after discharge to achieve intelligent transitional care encompassing "anticoagulation self-management-KCCQ score tracking - re-examination reminders" are crucial. This ultimately forms a closed-loop "Assessment-Intervention-Monitoring-Follow-up" management system, building a management framework centered on "intelligent tools + full-process closed-loop" to continuously safeguard the QoL and long-term prognosis of patients undergoing combined mitral valve surgery.

4.2 Clinical Management Strategies

4.2.1 Preoperative Precise Assessment and Intervention

Using the disease journey map as a framework, identify core management nodes in the preoperative phase. In addition to routine cardiac function assessment, KCCQ scoring, and admission evaluation, enhance dynamic monitoring of MR grade for combined surgery patients, record regurgitation jet area, valve leaflet morphology, and left atrial pressure via transthoracic echocardiography [14], and incorporate this data into the "preoperative baseline" module of the journey map. Simultaneously, complete baseline coagulation function testing. If preoperative MR is accompanied by left atrial thrombus, anticoagulation may need to be initiated preoperatively to strive for thrombus resolution.

Preoperative anxiety is the most common negative emotion in HOCM patients and can directly affect the speed of postoperative recovery and QoL. Nurses can implement stratified education based on KCCQ scores and anxiety scale assessment results [15]. Utilize visual aids, precise education, combined with videos and sharing previous successful cases to explain the protective effect of combined surgery on long-term cardiac function; alleviate patient concerns about "slower recovery with combined surgery", help patients establish positive treatment expectations, and enhance treatment confidence. Simultaneously, through preoperative preparation videos combined with face-to-face education, instruct patients in breathing exercises and bed-bound defecation training; complete preoperative preparations, including surgical site skin preparation, and guide and assist patients with personal hygiene and oral care to reduce the risk of postoperative infection and promote recovery.

4.2.2 Focusing on Anticoagulation and Heart Rate Monitoring, Building a Safety Net With Intelligent Tools

For combined mitral valve surgery patients, initiate anticoagulation therapy immediately postoperatively. Utilize the "Valve Anticoagulation e-Assistant" for fully digitalized management. Healthcare providers guide patients and family members to record daily warfarin administration time and dosage via a mini-program. The mini-program syncs INR test results and suggests dosage adjustments based on INR values. Nurses can log into the backend to review data. Patients can present their anticoagulation data during and follow-up visits, allowing healthcare providers to guide medication based on the data, avoiding bleeding or thrombotic risks.

The most common postoperative complication of the modified Morrow procedure is arrhythmia [6], most frequently conduction abnormalities. Closely monitor vital signs to promptly detect and manage complications [16]. Introduce wearable monitoring devices worn on the patient's wrist to monitor heart rate and rhythm in real-time without restricting patient mobility. Simultaneously, keep a temporary pacemaker ready at the bedside, checking its threshold, battery level, and lead connection each shift to ensure immediate availability for emergency pacing. Adjust fluid infusion rates appropriately, guide early mobilization, implement enhanced recovery after surgery (ERAS) principles to improve patient compliance with early breathing exercises and ambulation, promoting cardiopulmonary recovery [17]. Employ multimodal analgesia to enhance patient comfort. Develop individualized rehabilitation plans based on patient condition, including exercise, diet, and lifestyle adjustments.

4.2.3 Discharge Guidance: Constructing an Intelligent "Hospital-Home" Transitional Care System

Use the teach-back method before discharge to assess understanding of the patient and family members. Emphasize the importance of long-term self-management, instruct patients to adhere to medication (especially beta-blockers, warfarin), schedule regular echocardiographic follow-ups, monitor weight changes, heart rate variations, and avoid strenuous exercise and dehydration. Re-train on the use of the "Valve Anticoagulation e-Assistant" to ensure patients can independently record medication intake and query INR information. Continue the use of wearable devices; the hospital can remotely monitor heart rate and rhythm for three months postoperatively, utilizing information platforms to provide transitional care, offering remote guidance to patients with abnormal heart rate changes. Guide patients to initiate self-monitoring at home later. Regularly follow up on KCCQ score changes via WeChat, phone calls, or mini-programs to promptly understand their QoL status and provide guidance, building an integrated "hospital-family" chronic disease management model [18].

4.3 Considerations Regarding Prolonged Operative Time and Perioperative Risk

The combined procedure was associated with longer aortic cross-clamp and cardiopulmonary bypass times. Although no significant increase in early postoperative complications was observed in this cohort, extended operative and perfusion time may elevate the risk of neurological, respiratory, and inflammatory complications. This underscores the importance of meticulous intraoperative management and postoperative monitoring in patients undergoing combined surgery. Future studies with larger samples and longer follow-up are needed to better evaluate the safety profile of the combined approach.

5. Study Limitations

(1) Single-center, retrospective design, susceptible to selection bias and confounding factors; (2) Relatively small sample size of only 82 patients, which may be underpowered to detect small differences; (3) Follow-up endpoint was 6 months postoperatively, preventing assessment of the long-term stability of KCCQ scores; (4) The 6-month follow-up period was too short to allow for a meaningful comparison of major clinical events (e.g., mortality, heart failure rehospitalization) between the two surgical groups.

6. Conclusion

The modified Morrow procedure significantly improves KCCQ scores and QoL in HOCM patients. Concomitant mitral valve surgery does not add burden to patient KCCQ scores. Greater preoperative interventricular septum thickness is associated with higher postoperative KCCQ scores. This underscores the positive value of the surgery in improving patient QoL. In summary, when HOCM patients have coexisting mitral valve pathology requiring surgical intervention, surgeons can opt for the modified Morrow procedure combined with mitral valve surgery based on clear surgical indications, and patients need not excessively worry about potential negative impacts of this combined surgical approach on postoperative QoL.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Author Contributions

MH, XTL, and HC conceived the study; YQC, XTL, XRZ, and KZ curated the data; KZ, XWZ and HC performed the formal analysis; YQL acquired the funding; MH, XL, and YQL conducted the investigation; XRZ, CWR and YQL developed the methodology; MH, QYL, and XTL administered the project; XRZ, YQL, HC, and CWR provided the resources; HC developed the software; YQL, CWR and HC supervised the study; HC validated the results; XL and XRZ wrote the original draft; MH, CWR, XTL, KZ, YQC, XWZ, HC, and YQL reviewed and edited the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study follows the Declaration of Helsinki. The Ethics Committee of Beijing Anzhen Hospital, Capital Medical University, approved this study (approval ID: 2025266X). This study is a retrospective analysis of existing medical records data. According to the approval from our Institutional Review Board (IRB) and Ethics Committee, informed consent was waived.

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Conflict of Interest

The authors declare no conflict of interest.

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