Article

Impact of Individualized Positioning Care on Cardiac Function Recovery and Comfort in Patients After Heart Valve Surgery

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AIM: Postoperative recovery after heart valve surgery is an important topic in the realm of nursing care. This study aimed to evaluate the effect of individualized positioning care on cardiac function recovery and comfort in patients after heart valve surgery.
METHODS: A single-center, retrospective cohort study was conducted, continuously enrolling patients who underwent heart valve surgery at Affiliated Hospital of Xuzhou Medical University from June 2022 to June 2025. A total of 150 patients were included. The patients were divided into a control group (conventional positioning care, $n = 76$) and an experimental group (individualized positioning care, $n = 74$) according to the nursing method received. The primary outcome measures were changes in cardiac function indicators, such as left ventricular ejection fraction (LVEF) and N-terminal pro-brain natriuretic peptide (NT-proBNP) before and after nursing, as well as postoperative comfort scores measured using the Visual Analog Scale for Comfort (VAS-Comfort). Secondary outcomes included postoperative pain scores (Numeric Rating Scale [NRS]), sleep quality (Richards–Campbell Sleep Questionnaire [RCSQ]), pulmonary complications, pressure ulcer incidence, intensive care unit (ICU) length of stay, and postoperative hospital days. Group comparisons were performed using t-test, Mann–Whitney U test, Chi-square test, or Fisher's exact test. Postoperative NT-proBNP was analyzed using analysis of covariance (ANCOVA), adjusting for baseline levels.
RESULTS: Baseline characteristics were balanced and comparable between the two groups (all $p > 0.05$). Compared to the control group receiving conventional care, the experimental group receiving individualized positioning care showed more significant improvement in cardiac function: the change in LVEF (ΔLVEF) was significantly higher in the experimental group (0.85 ± 3.98% vs. –3.15 ± 4.20%, $p < 0.001$); NT-proBNP levels on postoperative day 7 were significantly lower in the experimental group (median: 685.00 pg/mL vs. 1003.50 pg/mL, $p < 0.001$), and the difference remained statistically significant after adjusting for preoperative values ($F = 12.13$, $p < 0.001$). The VAS-Comfort score at 72 h postoperatively was significantly higher in the experimental group ($p < 0.001$). For secondary outcomes, the experimental group had significantly lower NRS pain scores at 72 h postoperatively ($p < 0.001$), significantly higher RCSQ sleep scores (69.26 ± 9.87 vs. 59.86 ± 12.02, $p < 0.001$), a lower incidence of pulmonary complications (9.46% vs. 23.68%, $p = 0.019$), and significantly shorter ICU stay and postoperative hospital days (both $p < 0.001$). There were no statistically significant differences between the two groups in the incidence of pressure ulcers or adverse events ($p > 0.05$).
CONCLUSIONS: Individualized positioning care can significantly promote cardiac function recovery, enhance comfort, and improve clinical outcomes in patients after heart valve surgery without increasing safety risks.

Keywords: heart valve surgery; positioning care; individualized nursing

Introduction

Valvular heart disease (VHD) is a common cardiovascular condition, and its prevalence is continuously increasing with the aging population. The Global Burden of Disease studies show that from 1990 to 2017, cases of calcific aortic valve disease rose by 124%, while degenerative mitral valve disease increased by 106% [1]. Surgical valve replacement or repair remains the gold-standard treatment for severe VHD, with over 300,000 patients undergoing heart valve surgery globally each year [2]. Despite advances in surgical techniques and perioperative management, postoperative patients face numerous challenges, including slow recovery of cardiac function, pain, sleep disturbances, and complications like pulmonary infections, which significantly impede the rehabilitation process and diminish quality of life [3,4].

Postoperative cardiac function recovery is a core indicator of surgical success and nursing quality. Left ventricular ejection fraction (LVEF) and N-terminal pro-brain natriuretic peptide (NT-proBNP) are crucial indicators for assessing cardiac function; the former reflects myocardial contractility, while the latter reflects ventricular load status [5]. A study has shown that postoperative LVEF improvement is closely related to long-term survival, and the rate

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of NT-proBNP decline can predict the risk of early complications [6]. Therefore, promoting rapid recovery of cardiac function post-surgery is a vital goal of perioperative nursing.

Positioning care is a fundamental component of postoperative care following cardiac surgery. Appropriate positioning can optimize cardiopulmonary function, reduce tension on the incision, promote chest drainage, and prevent pressure injuries [7]. However, traditional positioning care often employs fixed protocols, such as timed turning and uniform head-of-bed elevation, without taking into account inter-individual differences in hemodynamic status, pain tolerance, and pressure ulcer risk [8]. Recent years have seen a gradual clinical adoption of the individualized nursing concept, with emphasis on dynamic adjustments based on real-time patient assessment [9]. Currently, high-quality evidence on the application of positioning care in postoperative cardiac rehabilitation remains relatively limited. Existing research has confirmed that postoperative positioning management plays a positive role in preventing pulmonary complications, such as atelectasis and ventilator-associated pneumonia, in patients undergoing cardiac surgery [10]. A Cochrane systematic review by Abraham *et al*. [11] suggests that early exercise-based rehabilitation interventions after valve surgery might improve functional status, but specific studies on positioning care are lacking. The quality of existing literature is variable, and most studies primarily focus on standardized positioning protocols, with less attention given to individualized positioning strategies based on patient-specific characteristics (e.g., hemodynamic tolerance, incision pain level, comorbidities) [12]. A narrative review by Santarpino *et al*. [13] summarized the application of prone positioning in postoperative cardiac surgery patients, but mainly focused on critically ill patients. Regarding individualized nursing, a study by Cao *et al*. [4] showed that a nurse-led individualized management model significantly reduced pneumonia incidence and shortened intensive care unit (ICU) stay in elderly patients after cardiac surgery. A study protocol by Zhou *et al*. [14] proposed that a nurse-led rehabilitation program based on positive emotion theory might improve the physical and mental state of patients after valve surgery. However, systematic research specifically targeting the impact of individualized positioning care on cardiac function recovery and comfort in patients after heart valve surgery is still relatively scarce. Based on this background, this study employs a retrospective cohort design to compare the effects of individualized positioning care versus conventional positioning care on cardiac function recovery (LVEF, NT-proBNP), comfort, pain, sleep quality, complications, and length of stay in patients after heart valve surgery, aiming to provide evidence-based guidance for optimizing postoperative nursing protocols.

Methods

Study Population

This study was a single-center, retrospective cohort study. Subjects were identified from the hospital's electronic medical record system, nursing information system, laboratory system, and echocardiography system. The study period spanned from June 2022 to June 2025. The study protocol was approved by the Ethics Committee of Affiliated Hospital of Xuzhou Medical University (Approval No.: XYFY2026-KL050-01). The study was conducted in accordance with the principles of the Declaration of Helsinki. Due to its retrospective nature, the requirement for individual informed consent was waived by the ethics committee. Patient information was de-identified during the research process and used solely for scientific analysis.

Inclusion criteria of the present study included: (1) age $\geq$18 years; (2) underwent heart valve surgery (valve replacement and/or valvuloplasty) during the study period; and (3) availability of complete nursing records.

Exclusion criteria were as follows: (1) death within 24 h post-surgery or requirement for emergency reoperation; (2) presence of severe central nervous system complications, impaired consciousness, or other conditions preventing assessment related to comfort; (3) presence of severe spinal/pelvic/bone/joint diseases or other reasons significantly limiting position adjustment; and (4) incomplete clinical data.

A flow diagram illustrating the patient inclusion and exclusion process is presented in Fig. 1.

Grouping and Nursing Care

The control group received conventional positioning care per departmental protocol, including supine/semi-recumbent positioning based on condition, routine turning and position changes (every 2–4 h), routine tube fixation and skin care, and routine health education. The specific execution was based on the departmental regulations and medical orders at the time.

The experimental group received individualized positioning care in addition to conventional care. The protocol was implemented by trained ward nurses who completed a standardized training session on the positioning protocol prior to study initiation. The core principle involved a closed-loop management of "assessment—implementation—reassessment", with assessments performed every 2–4 h, as well as before each position change or whenever the patient's clinical status changed. (1) Assessment: The assessment entailed the measurement of hemodynamic status (blood pressure, heart rate, urine output), respiratory status (SpO_2, respiratory rate, sputum expectoration), pain level (Numeric Rating Scale [NRS]), pressure ulcer risk (Braden Scale), tube status (mediastinal/chest drainage tubes, central venous catheter, urinary catheter), and patient subjective tolerance. (2) Positioning strategy: Based on the assessment results, the head-

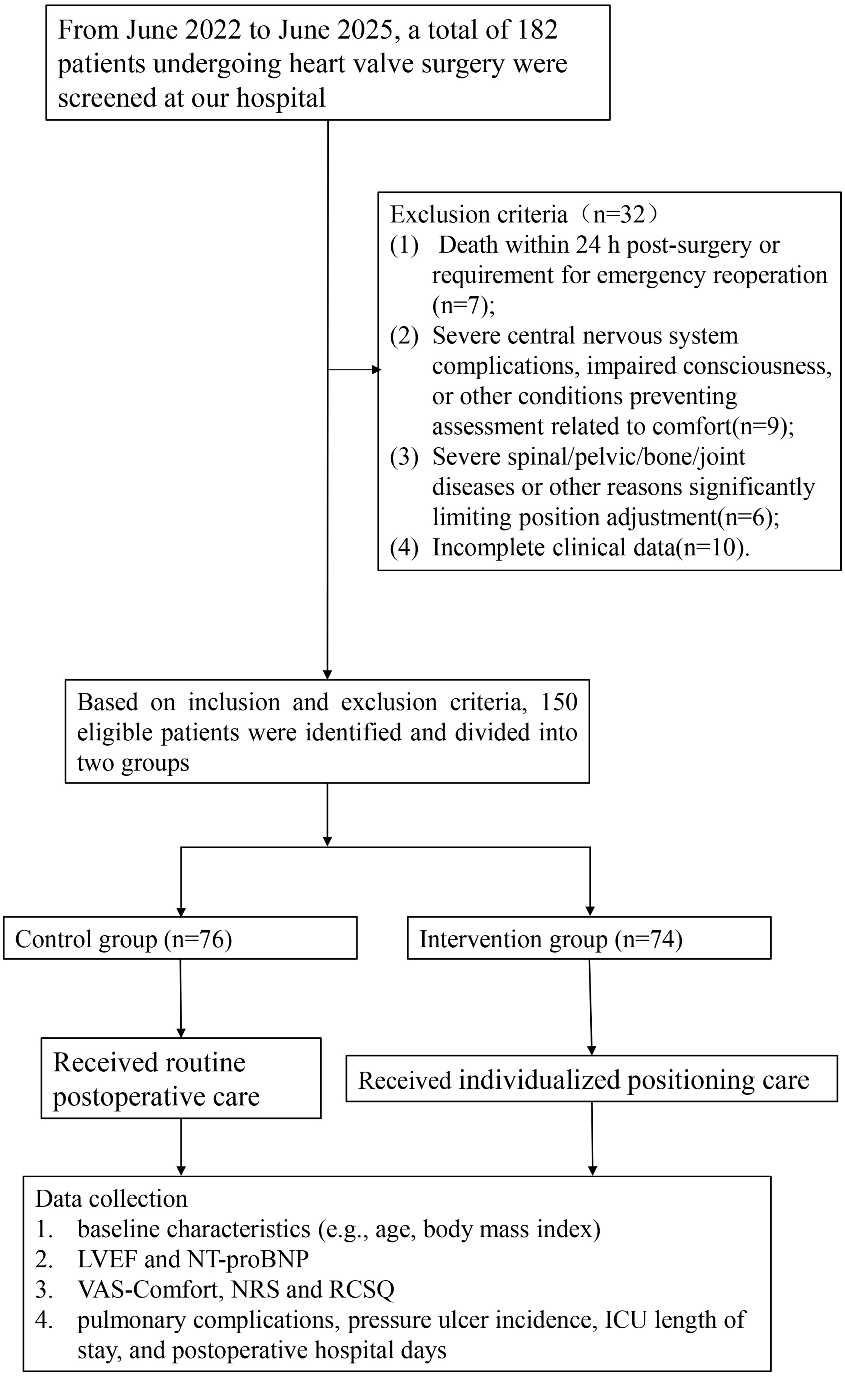

Fig. 1. Flow diagram of the patient inclusion and exclusion process. Abbreviations: ICU, intensive care unit; LVEF, left ventricular ejection fraction; NRS, Numeric Rating Scale; NT-proBNP, N-terminal pro-brain natriuretic peptide; RCSQ, Richards–Campbell Sleep Questionnaire; VAS-comfort, Visual Analog Scale for Comfort.

of-bed elevation was adjusted to an individualized angle (generally 15°–45°), with patients alternated between left and right lateral or slight lateral positions. The duration of each position was also tailored (approximately 20–60 min) according to patient tolerance. Position changes were performed at least every 2 h, with more frequent adjustments for patients with higher pressure ulcer risk or poor tolerance. Cushions/pressure-relief pads were used for support and pressure reduction. (3) Safety points: During position changes, tube protection should be reinforced and fixation should be checked. Vital signs and subjective discomfort were monitored immediately before and 5–10 min after each position adjustment; if significant intolerance occurred (defined as systolic blood pressure drop $>$20% from baseline, heart rate $<$50 or $>$130 bpm, or pain score increase $\geq$3 points on NRS), the adjustment was terminated promptly and the reason was recorded.

Table 1. Comparison of baseline characteristics between the control and experimental groups.

Variables	Total (n = 150)	Control group (n = 76)	Experimental group (n = 74)	Statistic	p
Age (years), mean ± SD	56.99 ± 11.59	57.63 ± 11.16	56.32 ± 12.04	t = 0.690	0.491
BMI (kg/m^2), mean ± SD	24.73 ± 3.11	24.25 ± 3.10	25.22 ± 3.07	t = –1.915	0.057
Preoperative LVEF, (%); mean ± SD	52.47 ± 7.97	53.35 ± 8.55	51.56 ± 7.28	t = 1.377	0.171
Cardiopulmonary bypass time (min), mean ± SD	97.23 ± 31.11	96.12 ± 31.88	98.38 ± 30.46	t = –0.444	0.658
Aortic cross-clamp time (min), mean ± SD	66.54 ± 21.39	64.47 ± 19.81	68.66 ± 22.83	t = –1.201	0.232
Mechanical ventilation time (h), M (Q_1, Q_3)	14.75 (10.10, 22.67)	16.30 (10.10, 24.98)	13.85 (9.95, 20.73)	Z = –0.994	0.320
Sex, n (%)				χ^2 = 0.787	0.375
Female	56 (37.33)	31 (40.79)	25 (33.78)		
Male	94 (62.67)	45 (59.21)	49 (66.22)		
Hypertension, n (%)				χ^2 = 0.648	0.421
No	82 (54.67)	44 (57.89)	38 (51.35)		
Yes	68 (45.33)	32 (42.11)	36 (48.65)		
Diabetes, n (%)				χ^2 = 3.177	0.075
No	112 (74.67)	52 (68.42)	60 (81.08)		
Yes	38 (25.33)	24 (31.58)	14 (18.92)		
COPD, n (%)				χ^2 = 0.292	0.589
No	121 (80.67)	60 (78.95)	61 (82.43)		
Yes	29 (19.33)	16 (21.05)	13 (17.57)		
Atrial fibrillation, n (%)				χ^2 = 0.011	0.916
No	106 (70.67)	54 (71.05)	52 (70.27)		
Yes	44 (29.33)	22 (28.95)	22 (29.73)		
NYHA class III–IV, n (%)				χ^2 = 0.400	0.527
No	55 (36.67)	26 (34.21)	29 (39.19)		
Yes	95 (63.33)	50 (65.79)	45 (60.81)		
Valve replacement, n (%)				χ^2 = 0.140	0.708
No	24 (16.00)	13 (17.11)	11 (14.86)		
Yes	126 (84.00)	63 (82.89)	63 (85.14)		
Multiple valves, n (%)				χ^2 = 0.293	0.588
No	92 (61.33)	45 (59.21)	47 (63.51)		
Yes	58 (38.67)	31 (40.79)	27 (36.49)		
PCIA, n (%)				χ^2 = 0.217	0.642
No	42 (28.00)	20 (26.32)	22 (29.73)		
Yes	108 (72.00)	56 (73.68)	52 (70.27)		

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; PCIA, patient-controlled intravenous analgesia; SD, standard deviation.

Outcome Measures

Demographic and clinical information were collected, including age, sex, body mass index (BMI), major comorbidities (hypertension, diabetes, chronic obstructive pulmonary disease, atrial fibrillation, etc.), preoperative New York Heart Association (NYHA) functional class, preoperative LVEF, surgical characteristics (valve replacement and multiple-valve surgery), cardiopulmonary bypass time, aortic cross-clamp time, mechanical ventilation time, and analgesia method (patient-controlled intravenous analgesia [PCIA]).

Cardiac function recovery indicators, such as LVEF and NT-proBNP, were measured. The measurement of LVEF entailed recording preoperative LVEF from the most recent echocardiogram and the last LVEF within 7 ± 3 days post-surgery, and subsequent computation of ΔLVEF, which was defined as: ΔLVEF = Postoperative LVEF – Preoperative LVEF. To measure NT-proBNP, results from preoperative assessment and postoperative day 7 were recorded; if multiple tests existed within the same time window, the value closest to the specified time point was used.

Other outcome measures were defined as follows: (i) Comfort was assessed using the Visual Analog Scale for Comfort (VAS-Comfort) [15], scored from 0 to 10 (0 = extremely uncomfortable, 10 = very comfortable), and recorded by the responsible nurse at 72 h post-surgery based on the patient's subjective report. (ii) Pain was evaluated using the Numeric Rating Scale (NRS; scored 0–10; 0 = no pain, 10 = worst imaginable pain), and recorded at 72 h post-surgery [16]. (iii) Sleep quality was measured using the Richards–Campbell Sleep Questionnaire (RCSQ; scored 0–

100, higher scores indicate better sleep quality), with nighttime sleep assessed each morning and the average score calculated at 72 h post-surgery [17]. (iv) Complications included pulmonary complications (e.g., atelectasis and pulmonary infection), which were determined based on imaging findings, clinical manifestations, and physician diagnosis. Pressure ulcers were recorded according to staging criteria and adverse event reports. Adverse events included position-related intolerance and tube dislodgement or displacement. (v) Length of stay included ICU length of stay (days from ICU admission to ICU discharge) and total hospital length of stay (days from hospital admission to hospital discharge).

Statistical Analysis

SPSS version 26.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean ± standard deviation and compared between groups using the independent samples *t*-test. Non-normally distributed data were expressed as median (interquartile range) and compared using the Mann–Whitney *U* test. Categorical variables were expressed as numbers (percentages) and compared using the Chi-square test or Fisher's exact test. Postoperative NT-proBNP levels, which were non-normally distributed, were natural log-transformed prior to analysis. Analysis of covariance (ANCOVA) was performed to compare differences between groups, with preoperative ln (NT-proBNP) included as a covariate to adjust for the influence of baseline levels. A *p*-value < 0.05 was considered statistically significant.

Results

Baseline Characteristics

A total of 182 patients undergoing heart valve surgery were screened during the study period, and 150 patients meeting the pre-defined criteria were finally included, with 76 in the control group and 74 in the experimental group.

Baseline characteristics of the two groups are presented in Table 1. There were no statistically significant differences between the two groups in age, sex, BMI, comorbidities, preoperative cardiac function, and surgery-related indicators (all $p > 0.05$), indicating good comparability between the two groups.

Cardiac Function Recovery Indicators

Comparisons of cardiac function indicators between the experimental and control groups are shown in Table 2. There were no significant differences in preoperative LVEF or NT-proBNP levels between the two groups ($p > 0.05$). After nursing, the experimental group showed a significantly more favorable change in LVEF than the control group (ΔLVEF: 0.85 ± 3.98 vs. -3.15 ± 4.20, $p < 0.001$). NT-proBNP levels on postoperative day 7 in the experimental group were significantly lower than those in the control group ($p < 0.001$).

VAS-Comfort, RCSQ and NRS Scores

Comparisons of comfort, pain, and sleep quality between the experimental and control groups after implementing positioning care are shown in Table 3. The VAS-Comfort scores at all postoperative time points were significantly higher in the experimental group than in the control group (all $p < 0.001$). NRS scores (pain) at all postoperative time points were significantly lower in the experimental group (all $p < 0.001$). The RCSQ score (sleep) was significantly higher in the experimental group ($p < 0.001$).

Complications, Hospital Stay, and Safety Events

Comparisons of complications, length of hospital stay, and incidence of adverse events between the experimental and control groups are shown in Table 4. The incidence of pulmonary complications was significantly lower in the experimental group compared to the control group ($p = 0.019$). The length of ICU stay and postoperative length of hospital stay were significantly shorter in the experimental group (both $p < 0.001$). There were no statistically significant differences between the two groups in the incidence of pressure ulcers and adverse events ($p > 0.05$).

Discussion

This retrospective cohort study evaluated the impact of individualized positioning care on patients after heart valve surgery. The results show that compared to conventional positioning care, individualized positioning care significantly improves patients' cardiac function (increased ΔLVEF, decreased NT-proBNP), enhances comfort and sleep quality, reduces pain, lowers the incidence of pulmonary complications, and shortens hospital stays, without increasing safety risks. The following discussion delves into these findings in the context of relevant literature.

In this study, the postoperative LVEF in the experimental group increased by an average of 0.85% compared to preoperative values, while it decreased by an average of 3.15% in the control group, with a significant difference in ΔLVEF between groups ($p < 0.001$). This result suggests that individualized positioning care has a protective effect on postoperative myocardial contractile function. Possible mechanisms include the following: (1) Optimization of cardiac preload and afterload via dynamic adjustment of the head-of-bed elevation angle (15°–45°); appropriate semi-recumbent positioning can reduce venous return, decrease ventricular wall tension, and simultaneously improve the ventilation/perfusion ratio in the lungs via gravity, thereby reducing pulmonary artery pressure and thus right ventricular afterload [18]; (2) Improved drainage from the mediastinal and pleural cavities by gravity, achieved through alternation of the left and right lateral positions, helps reduce the accumulation of pericardial and pleural ef-

Table 2. Comparison of cardiac function indicators between the two groups.

Variables	Total (n = 150)	Control group (n = 76)	Experimental group (n = 74)	Statistic	p
Preoperative LVEF (%), mean ± SD	52.47 ± 7.97	53.35 ± 8.55	51.56 ± 7.28	t = 1.377	0.171
Postoperative LVEF (%), mean ± SD	51.29 ± 9.01	50.19 ± 9.55	52.41 ± 8.34	t = –1.511	0.133
ΔLVEF (%), Mean ± SD	–1.18 ± 4.55	–3.15 ± 4.20	0.85 ± 3.98	t = –5.986	<0.001
Preoperative NT-proBNP (pg/mL), M (Q_1, Q_3)	1918.00 (1344.00, 2911.00)	2026.00 (1401.00, 3024.75)	1809.00 (1332.00, 2594.00)	Z = –1.002	0.316
Postoperative NT-proBNP (pg/mL), M (Q_1, Q_3)	803.50 (552.00, 1312.75)	1003.50 (694.00, 1478.50)	685.00 (505.75, 1071.50)	Z = –3.496	<0.001
ANCOVA^a				F = 12.13	<0.001

Note: ^{a} Dependent variable: postoperative NT-proBNP (log-transformed); Independent variable: group; Covariate: preoperative NT-proBNP (log-transformed).

Abbreviations: ANCOVA, analysis of covariance; NT-proBNP, N-terminal pro-brain natriuretic peptide.

Table 3. Comparisons of comfort, pain, and sleep scores between the two groups.

Variables	Total (n = 150)	Control group (n = 76)	Experimental group (n = 74)	Statistic	p
NRS score, M (Q_1, Q_3)	4.00 (3.00, 5.00)	4.00 (3.00, 6.00)	3.00 (2.00, 4.00)	Z = –4.993	<0.001
RCSQ score, Mean ± SD	64.49 ± 11.94	59.86 ± 12.02	69.26 ± 9.87	t = –5.228	<0.001
VAS-Comfort score, M (Q_1, Q_3)	7.00 (6.00, 8.00)	6.00 (5.00, 7.00)	7.00 (7.00, 8.00)	Z = –5.582	<0.001

Abbreviations: NRS, Numeric Rating Scale; RCSQ, Richards–Campbell Sleep Questionnaire.

fusions, thereby lessening mechanical compression on the heart, which could positively influence postoperative cardiac function recovery [19]; (3) Optimized positioning can avoid excessive traction on the sternal incision, reduce pain-induced sympathetic excitation, maintain stable coronary perfusion pressure, and create favorable conditions for myocardial repair [20]. Notably, although the absolute postoperative LVEF did not differ significantly between groups (p = 0.133), the significant improvement in ΔLVEF in the experimental group indicates that individualized positioning care may exert a protective effect on the trajectory of cardiac function recovery rather than directly altering myocardial contractility. The absence of a significant difference in absolute postoperative LVEF is likely attributable to the relatively small magnitude of change and the fact that both groups had preoperative LVEF within the normal range, leaving limited room for a substantial increase. The change from baseline (ΔLVEF) may therefore be a more sensitive indicator for detecting the effects of nursing interventions on early postoperative cardiac function.

The significant postoperative decrease in NT-proBNP levels further confirms the reduction in ventricular load. After adjusting for preoperative levels via ANCOVA, NT-proBNP on postoperative day 7 remained significantly lower in the experimental group (F = 12.13, $p < 0.001$). NT-proBNP is primarily secreted by ventricular myocytes in response to increased pressure and volume load, and its levels are positively correlated with ventricular wall tension [21]. The rapid decline in NT-proBNP in the experimental group suggests that individualized positioning care effectively reduces postoperative ventricular load by optimizing hemodynamic status, thereby accelerating the recovery of cardiac function.

Patients after heart valve surgery often experience significant physical discomfort and sleep deprivation due to multiple factors like incisional pain, drainage tube traction, and forced positioning [22,23]. In this study, the experimental group showed significantly higher VAS-Comfort scores at 72 h post-surgery ($p < 0.001$), significantly lower NRS pain scores ($p < 0.001$), and significantly higher RCSQ sleep scores ($p < 0.001$) compared to the control group, indicating that individualized positioning care is highly effective in improving subjective experiences.

The mechanisms can be explained from the following perspectives: (1) Incision tension management: By assessing the positions causing the most pain, the lateral angle and support points were individually adjusted to avoid direct pressure or excessive traction on the incision, thereby reducing pain without relying on additional analgesics [24]. (2) Pressure redistribution: Using aids like cushions and pressure-relief pads for targeted pressure relief on bony prominences (e.g., sacrum, scapulae, heels) reduces discomfort and micro-arousals caused by sustained local tissue compression. This method is compliant with the international pressure injury prevention guidelines [25]. (3) Psychological comforting effect: The process of dynamically assessing subjective tolerance and promptly adjusting positions instills a sense of "being cared for" in patients, which can help reduce postoperative anxiety and enhance psychological comfort [26]. Research also indicates that

Table 4. Comparison of complications, length of ICU and hospital stay, and safety events between the two groups.

Variables	Total (n = 150)	Control group (n = 76)	Experimental group (n = 74)	Statistic	p
Length of ICU stay (days), M (Q_1, Q_3)	3.00 (2.00, 4.00)	3.00 (2.75, 4.25)	2.00 (2.00, 3.00)	Z = –4.055	<0.001
Postoperative length of hospital stay (days), M (Q_1, Q_3)	10.00 (8.00, 13.00)	11.00 (10.00, 14.00)	9.00 (7.25, 10.00)	Z = –5.156	<0.001
Pulmonary complication, n (%)				χ^2 = 5.462	0.019
No	125 (83.33)	58 (76.32)	67 (90.54)		
Yes	25 (16.67)	18 (23.68)	7 (9.46)		
Pressure ulcer, n (%)				χ^2 = 1.146	0.284
No	136 (90.67)	67 (88.16)	69 (93.24)		
Yes	14 (9.33)	9 (11.84)	5 (6.76)		
Adverse event, n (%)				χ^2 = 2.311	0.128
No	139 (92.67)	68 (89.47)	71 (95.95)		
Yes	11 (7.33)	8 (10.53)	3 (4.05)		

Abbreviation: ICU, intensive care unit.

individualized nursing interventions can significantly improve sleep quality and daytime function in post-cardiac surgery patients [27].

Pulmonary infections and atelectasis are common complications after cardiac surgery, with reported incidences ranging from 15% to 30%, significantly impacting patient recovery [28]. In this study, the incidence of pulmonary complications in the experimental group (9.46%) was significantly lower than that in the control group (23.68%), representing a relative risk reduction of approximately 60% (p = 0.019). This finding aligns with existing research that positioning management measures, like prone positioning, can improve gas exchange in post-cardiac surgery patients and play a positive role in preventing pulmonary complications [13].

Individualized positioning care may exert lung-protective effects through the following pathways: (1) Improving ventilation distribution: Individualizing the head-of-bed elevation angle based on respiratory status can optimize diaphragm position, increase functional residual capacity, and improve ventilation in gravity-dependent lung regions [29]. (2) Promoting sputum drainage: Dynamic alternation of left and right lateral positions, combined with effective coughing exercises, can help mobilize and clear secretions from small airways, mitigating bacterial colonization and infection risk [30,31]. (3) Reducing aspiration risk: Appropriate semi-recumbent positioning can decrease gastroesophageal reflux and aspiration, especially in patients with delayed recovery of gastrointestinal function in the early postoperative period [32,33].

In this study, the experimental group had significantly shorter lengths of ICU and postoperative hospital stay (both $p < 0.001$), with median reductions of 1 day and 2 days, respectively. This finding has significant health economic implications: shorter hospital stays mean improved efficiency of medical resource utilization, reduced patient medical costs, and decreased risk of nosocomial infections. Large-sample studies have confirmed that postoperative complications significantly prolong hospital stays; for instance, infectious complications like deep surgical site infections can extend stays by 18.9 days, while respiratory complications like reintubation or prolonged ventilation can extend stays by over 10 days, highlighting the importance of complication prevention in shortening hospital stays [34].

Individualized positioning care requires more frequent, complex position changes. In this study, however, there were no statistically significant differences between the control and experimental groups in the incidence of pressure ulcers (11.84% vs. 6.76%, p = 0.284) or adverse events (10.53% vs. 4.05%, p = 0.128), indicating that this nursing model did not introduce additional safety risks. This finding is noteworthy in light of previous reports indicating that the incidence of in-hospital pressure ulcers following cardiac surgery may reach 21.3% and emphasizing the importance of positioning management in pressure ulcer prevention [35]. The controlled safety risks observed in the present study may be attributed to systematic monitoring of vital signs and verification of tube integrity before and after each position change. Furthermore, immediate discontinuation of positional adjustments in patients with poor tolerance, together with documentation of the underlying reasons, reflects a patient-safety–centered closed-loop management approach. This highlights the importance of integrating robust safety monitoring mechanisms into individualized care protocols.

This study has several limitations. First, the single-center retrospective design cannot completely rule out selection bias and confounding by temporal trends. Second, although baseline characteristics were comparable between groups, the allocation of patients to the individualized positioning care group was not based on predefined clinical criteria but on evolving nursing practices during the study period. This may introduce indication bias, as patients with more stable postoperative conditions might have been more likely to receive the intervention. Future prospective studies should adopt predefined allocation protocols to mitigate this bias. Third, the study spanned three years, during which advancements in medical technology (e.g., surgical techniques, anesthesia management) might have had confounding effects on the outcomes. Fourth, long-term follow-up was not conducted; therefore, the impact of individualized positioning care on long-term outcomes such as quality of life or readmission rates 6 months to 1 year post-surgery remains unclear. Fifth, causal relationships cannot be established due to the observational design, and mechanistic explanations derived from our findings require cautious interpretation.

Based on the results of this study, the following future research directions are suggested: (1) Multicenter prospective randomized controlled trials should be conducted to further validate the efficacy and safety of individualized positioning care. (2) The synergistic effects of combining individualized positioning care with other Enhanced Recovery After Surgery (ERAS) measures (e.g., early mobilization, multimodal analgesia) should be investigated. (3) Wearable device–based real-time position monitoring and feedback systems should be developed to enable intelligent and precise positioning care. (4) Health economic evaluations should be performed to quantify the cost-effectiveness of individualized positioning care. (5) Extended follow-up periods should be implemented to assess the impact of this nursing model on patients' long-term quality of life.

Conclusions

This single-center retrospective study indicates that individualized positioning care may significantly promote cardiac function recovery, enhance comfort, improve sleep quality, reduce pain, lower the incidence of pulmonary complications, and shorten ICU and postoperative length of hospital stay in patients following heart valve surgery, without increasing the risk of pressure ulcers or adverse events. By employing dynamic assessment, precise adjustment, and closed-loop management, this nursing model optimizes the postoperative recovery trajectory while ensuring patient safety. It is recommended that individualized positioning care be incorporated into routine postoperative nursing protocols for cardiac surgery, and that prospective multicenter studies be conducted to further validate its long-term efficacy and safety.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

YPZ and YN designed the research study. YPZ and YW performed the research. YN and YBH analyzed the data. YN drafted the article. All authors contributed to the critical revision of the manuscript for important intellectual content. 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

The study protocol was approved by the Ethics Committee of Affiliated Hospital of Xuzhou Medical University (Approval No.: XYFY2026-KL050-01). The study was conducted in accordance with the principles of the Declaration of Helsinki. Due to its retrospective nature, the requirement for individual informed consent was waived by the ethics committee. Patient information was de-identified during the research process and used solely for scientific analysis.

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Conflict of Interest

The authors declare no conflict of interest.

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