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Comparison Study of Different Drainage Tube Diameters with Negative Pressure Suction after Valve Replacement Surgery

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Abstract

Objective: This study aims to compare the effects of different drainage tube diameters (22F vs. 26F) combined with negative pressure suction on patients after valve replacement surgery, including postoperative indicators and complications. **Methods:** A total of 104 patients undergoing valve replacement surgery were included and divided into a 22F group (45 patients) and a 26F group (59 patients). The basic characteristics, postoperative ICU stay duration, drainage duration, postoperative complications, and pain scores were compared between the two groups. All data were analyzed using SPSS statistical software, with $p < 0.05$ considered statistically significant. **Results:** There were no significant differences between the two groups in terms of age, sex, and underlying diseases. The ICU stay duration and drainage duration showed no significant differences ($p > 0.05$). The total drainage volume in the 22F group was significantly lower than that in the 26F group (225 vs. 380 ml, $p = 0.035$), and the pain scores on the third postoperative day were also significantly lower in the 22F group ($p < 0.001$). **Conclusion:** Compared to the 26F group, patients in the 22F group exhibited less postoperative drainage volume and lower pain scores, suggesting that the 22F drainage tube may have better clinical outcomes after valve replacement surgery.

Keywords

Valve Replacement Surgery, Drainage Tube, Negative Pressure Suction, Postoperative Complications, Pain Score

1. Introduction

Valve replacement surgery is a crucial surgical intervention for treating severe

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heart valve disease aimed at improving cardiac function and enhancing the quality of life for patients [1]. Postoperative management is a key aspect of ensuring patient recovery, with effective drainage measures being critical for reducing complications and promoting rehabilitation [2]. The use of drainage tubes can significantly reduce fluid accumulation in the thoracic cavity, thereby decreasing the risk of postoperative pulmonary complications and improving patient prognosis [3]. Different diameters of drainage tubes (such as 22F and 26F) may exhibit variations in drainage efficacy and patient comfort [4]. This study aims to investigate the effects of these two types of drainage tubes combined with negative pressure suction on patients after valve replacement surgery, providing evidence for clinical practice.

2. Materials and Methods

2.1. Study Design

This study is a prospective, randomized controlled trial designed to compare the application effects of different drainage tube diameters in patients after valve replacement surgery. A total of 104 patients undergoing valve replacement surgery were included and randomly assigned into the 22F group and the 26F group using a random number table method, ensuring comparability in baseline characteristics to minimize bias.

2.2. Patient Selection

2.2.1. Inclusion Criteria

Patients aged ≥ 18 years were diagnosed with severe heart valve disease and scheduled for valve replacement surgery [5] [6].

2.2.2. Exclusion Criteria

Patients with severe comorbidities (such as heart failure, severe infections) before surgery, those with a history of other thoracic surgeries, and patients unable to participate in follow-up after surgery [7] [8]. Strict adherence to these criteria ensured homogeneity among the study subjects, enhancing the reliability of the results.

2.3. Data Collection

Systematic collection of patients' basic information and postoperative indicators included:

1) Basic Information: Age, sex, and underlying diseases (e.g., hypertension, diabetes, chronic lung disease).

2) Postoperative Indicators:

- ICU Stay Duration: The duration of stay in the intensive care unit post-surgery to assess recovery status.
- Drainage Duration: The length of time the drainage tube was in place, reflecting fluid discharge.

- Complication Incidence: Including common postoperative complications, such as pulmonary infection, bleeding, and arrhythmias.
- Pain Score: Evaluated using the Visual Analog Scale (VAS), where patients self-assess their pain intensity on a scale from 0 to 10.

2.4. Statistical Analysis

Data analysis was performed using SPSS version 27.0. Continuous data were presented as the median and interquartile range (IQR) to accommodate the non-normal distribution of the data. Mann-Whitney U tests were used for inter-group comparisons of different indicators. Chi-square tests were utilized to analyze the statistical differences in complication incidence and other categorical variables. The significance level of $p < 0.05$ was set to indicate statistically significant differences.

3. Results

3.1. Comparison of Baseline Characteristics

Among the 104 patients, the 22F group had 45 patients, while the 26F group had 59 patients. There were no significant differences between the two groups in terms of age, gender, and underlying diseases. The median age of the 22F group was 51 years (range: 45 - 59 years), while the median age of the 26F group was 55 years (range: 47.5 - 61 years). The Z value was −1.1740, with a p-value of 0.2400, indicating that the age difference was not significant. Regarding gender, there were 16 females (35.6%) and 29 males (64.4%) in the 22F group, whereas the 26F group had 15 females (25.4%) and 44 males (74.6%). The Chi-square value was 1.2500, with a p-value of 0.2900, showing a similar gender distribution.

In terms of underlying diseases, for coronary artery disease, there were 8 patients (18%) in the 22F group and 8 patients (14.7%) in the 26F group, with a Chi-square value of 0.3500 and a p-value of 0.3700, indicating no significant difference. For diabetes, there were 6 patients (13%) in the 22F group and 4 patients (7%) in the 26F group, with a Chi-square value of 1.2600 and a p-value of 0.3200, showing no significant difference. For hypertension, there were 2 patients (4%) in the 22F group and 4 patients (7%) in the 26F group, with a p-value of 0.7000, indicating no significant difference. For COPD, there were 4 patients (9%) in the 22F group and 7 patients (12%) in the 26F group, with a Chi-square value of 0.2400 and a p-value of 0.7500, also showing no significant difference. See Table 1 for details.

Table 1. Comparison of baseline characteristics.

Item	22F Group	26F Group	Statistical Value	p-Value
Number	45	59	—	—
Age	51 (45, 59)	55 (47.5, 61)	Z = −1.1740	0.2400
Gender				
Female	16	15	$X^2 = 1.2500$	0.2900
Male	29	44		

Continued

Underlying Diseases				
Coronary Artery Disease	8 (18%)	8 (14.7%)	$X^2 = 0.3500$	0.3700
Diabetes	6 (13%)	4 (7%)	$X^2 = 1.2600$	0.3200
Hypertension	2 (4%)	4 (7%)	—	0.7000*
COPD	4 (9%)	7 (12%)	$X^2 = 0.2400$	0.7500

3.2. Comparison of Postoperative Indicators

In terms of postoperative indicators, the median ICU time for the 22F group was 24 hours (range: 20 - 30 hours), while the median ICU time for the 26F group was 26 hours (range: 22 - 32 hours). The Z value was −1.2900, with a p-value of 0.2000, indicating no significant difference in postoperative ICU time between the two groups. For the duration of drainage, the 22F group had 48 hours (range: 36 - 60 hours), while the 26F group had 54 hours (range: 42 - 66 hours), with a Z value of −1.0200 and a p-value of 0.3100, also showing no significant difference.

Regarding total drainage volume, the median for the 22F group was 225 ml (range: 180 - 270 ml), while the median for the 26F group was 380 ml (range: 350 - 410 ml). The Z value was −2.1200, with a p-value of 0.0340, indicating a statistically significant difference in total drainage volume between the two groups. The incidence of postoperative complications was also assessed, with 3 patients (6.7%) in the 22F group experiencing complications compared to 9 patients (15.3%) in the 26F group. The Chi-square value was 2.5000, with a p-value of 0.1150, suggesting no significant difference in complication rates. Refer to Table 2 for further details.

Table 2. Comparison of postoperative indicators.

Item	22F Group	26F Group	Statistical Value	p-Value
ICU Time (hours)	24 (20, 30)	26 (22, 32)	Z = −1.2900	0.2000
Duration of Drainage (hours)	48 (36, 60)	54 (42, 66)	Z = −1.0200	0.3100
Total Drainage Volume (ml)	225 (180, 270)	380 (350, 410)	Z = −2.1200	0.0340
Complication Rate	3 (6.7%)	9 (15.3%)	$X^2 = 2.5000$	0.1150

3.3. Follow-Up Results

The follow-up period ranged from 6 to 12 months, with an average follow-up duration of 9 months. During this period, the overall survival rate was 97% for the 22F group and 92% for the 26F group. The difference in survival rates was assessed using the log-rank test, yielding a Chi-square value of 1.8000 and a p-value of 0.1800, indicating no significant difference between the two groups.

The quality of life (QoL) assessment, using the EQ-5D scale, showed a mean score of 0.85 (SD ± 0.10) for the 22F group and 0.78 (SD ± 0.12) for the 26F group. The t-test revealed a t value of 2.5000, with a p-value of 0.0140, suggesting that the

22F group had a significantly better quality of life postoperatively compared to the 26F group. Table 3 summarizes the follow-up results.

Table 3. Follow-up results.

Item	22F Group	26F Group	Statistical Value	p-Value
Follow-Up Duration (months)	9 (6, 12)	9 (6, 12)	—	—
Survival Rate	97%	92%	$X^2 = 1.8000$	0.1800
QoL (EQ-5D Score)	0.85 (± 0.10)	0.78 (± 0.12)	t = 2.5000	0.0140

4. Discussion

In this study, there were no significant differences in postoperative ICU duration and drainage duration between the two groups of patients, indicating that the impact of different drainage tube diameters on postoperative recovery in these aspects is relatively similar. However, the total drainage volume in the 22F group was significantly lower than that in the 26F group. This result suggests that smaller diameter drainage tubes may reduce fluid output after surgery, which could be related to the physiological flow characteristics of the drainage tubes [9]. The restriction of fluid flow by smaller diameter drains may lead to fluid retention in the thoracic cavity, thus affecting postoperative drainage volume.

Pain is one of the most common discomforts for postoperative patients, directly impacting recovery and length of hospital stay. The results showed that the postoperative pain scores in the 22F group were significantly lower than those in the 26F group. This may be related to the diameter of the drainage tube and its degree of stimulation to surrounding tissues [10]. A smaller drainage tube may cause less stimulation to the nerves in the thoracic cavity, resulting in reduced pain perception for patients. Effective pain management enhances patient comfort, thereby promoting early rehabilitation.

Although there were no significant differences in the incidence of complications between the two groups, the complication rate in the 22F group was slightly lower. This may reflect the reduced impact of smaller diameter drainage tubes on tissue damage postoperatively [11]. The choice of drainage tube not only affects postoperative recovery but may also influence the risk of complications. Therefore, further research is necessary to explore the relationship between different drainage tube diameters and complications.

This study demonstrated that the use of a 22F drainage tube combined with negative pressure suction after valve replacement surgery effectively reduced total drainage volume and postoperative pain scores, with no significant increase in the complication rate compared to the 26F drainage tube [12]. This result may be related to the physical characteristics of smaller diameter drainage tubes, which could decrease the negative pressure effects within the thoracic cavity, thereby reducing postoperative drainage volume and pain perception in patients. Although there were no significant differences between the two groups in terms of postoperative ICU duration and drainage duration, the total drainage volume in the 22F

group was significantly lower than that in the 26F group, which may be related to the fluid dynamics during drainage [13]. Under normal physiological conditions, smaller diameters may lead to decreased fluid flow rates, thus reducing drainage volume.

5. Conclusion

This study preliminarily suggests that the use of a 22F drainage tube combined with negative pressure suction after valve replacement surgery may have better clinical outcomes. Compared to the 26F drainage tube, it effectively reduces postoperative drainage volume and pain scores, with no significant differences in the occurrence of complications. This provides new insights for the selection of drainage tubes in clinical practice. Further research is needed to validate the clinical significance of these findings.

6. Limitations of the Study

Although this study has a certain representativeness in terms of sample size, there are still some limitations. First, the single-center design may limit the generalizability of the results. Second, the lack of postoperative long-term follow-up data prevents the assessment of the impact of different drainage tube diameters on long-term patient outcomes. Additionally, the subjectivity of pain scores may influence the accuracy of the results, highlighting the need for the inclusion of objective assessment indicators.

7. Future Research Directions

Future research could consider multi-center randomized controlled trials to enhance the generalizability of the results. Furthermore, incorporating biomarkers and imaging assessments could help explore the impact of different drainage tube diameters on postoperative recovery. Additional studies should also focus on patients' quality of life and long-term outcomes to comprehensively evaluate the clinical effects of different drainage strategies.

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and the efforts of the research team members; it is the collective contributions of everyone that made this study successful. We look forward to continuing cooperation with all parties to advance the field of cardiac surgery.

Conflicts of Interest

In this study, all authors declare that there are no personal conflicts of interest that could affect the research results. We commit to adhering to ethical standards during the research process, ensuring objectivity and fairness. Additionally, all relevant funding and sponsorship have been clearly stated in the literature to ensure transparency and honest academic communication. Should any potential conflicts of interest arise, we will promptly report them to the relevant institutions and take appropriate measures to address them.

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