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# Clinical Effect Analysis of Negative Pressure Chest Drainage in Patients after Two-Port Thoracoscopic Valve Surgery

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## ABSTRACT

**Objective: This study aims to investigate the drainage effect and clinical outcomes of negative pressure chest drainage in patients after two-port thoracoscopic valve surgery, comparing the differences in postoperative pain, hospital stay, and other factors between the negative pressure group and the control group. Methods: This study is a prospective controlled trial that selected patients undergoing two-port thoracoscopic valve surgery at a certain hospital from January 2019 to December 2024. Patients were randomly assigned to the control group and the negative pressure group using a random number table method. The control group consisted of 30 patients (20 males, 10 females, mean age 42.03 ± 12.89 years), and the negative pressure group consisted of 35 patients (26 males, 9 females, mean age 41.84 ± 11.83 years). The control group received traditional chest drainage, while the negative pressure group received negative pressure chest drainage. Postoperative pain scores, hospital stay, drainage time, number of tube blockages, and incidences of pneumothorax or subcutaneous emphysema were recorded and statistically analyzed. Results: The negative pressure group had a significantly shorter postoperative drainage time compared to the control group (49.09 ± 11.99 hours vs. 79.10 ± 7.32 hours, P < 0.001). The postoperative pain score was lower in the negative pressure group (4.49 ± 1.27 vs. 7.03 ± 0.85, P < 0.001), and the hospital stay was significantly shorter (9.83 ± 1.69 days vs. 14.73 ± 2.32 days, P < 0.001). The incidence of pneumothorax or subcutaneous emphysema was significantly lower in the negative pressure group than in the control group (14.29% vs. 56.67%, P = 0.0003). Conclusion: The application of negative pressure chest drainage in patients after two-port thoracoscopic valve surgery can effectively reduce postoperative pain, shorten hospital stay, and lower the incidence of tube blockage and pneumothorax, demonstrating good clinical outcomes.**

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## 1. INTRODUCTION

Thoracic drainage is an important therapeutic measure following thoracic surgery, aimed at removing fluid, gas, or other pathological substances from the thoracic cavity to facilitate lung re-expansion and restore normal function [1]. In recent years, with the development of thoracoscopic technology, two-port thoracoscopic valve surgery has gradually become a commonly used minimally invasive surgical method [2]. Traditional thoracic drainage typically relies on gravity drainage, which somewhat limits drainage effectiveness, and postoperative patients often experience significant pain and prolonged hospital stays [3].

Negative pressure drainage technology, as an emerging drainage method, can accelerate drainage speed through negative pressure effects, reduce pressure within the thoracic cavity, and thus improve postoperative recovery outcomes [4]. Studies have shown that negative pressure drainage demonstrates superiority in various clinical applications; however, systematic research on its application following thoracoscopic valve surgery is still lacking [5]. Therefore, this study aims to compare the effects of negative pressure drainage and traditional drainage on postoperative patients, with the goal of providing a more scientific basis for clinical practice.

The main objective of this study is to evaluate the drainage effect of negative pressure thoracic drainage in patients undergoing two-port thoracoscopic valve surgery, specifically including comparisons of postoperative pain, hospital stay duration, incidence of catheter obstruction, and complications [6]. We hope to explore the advantages and clinical application value of negative pressure thoracic drainage through a randomized controlled trial.

## 2. MATERIALS AND METHODS

### 2.1. Study Subjects

This study included 65 patients who underwent two-port thoracoscopic valve surgery at a certain hospital from January 2019 to December 2024. Patients were randomly assigned to a control group and a negative pressure group according to a random number table. The control group consisted of 30 patients (20 males, 10 females, mean age 42.03 ± 12.89 years), while the negative pressure group consisted of 35 patients (26 males, 9 females, mean age 41.84 ± 11.83 years). All participants signed informed consent forms, and the study protocol was approved by the hospital's ethics committee.

### 2.2. Inclusion Criteria

1) Patients aged 18 years and older.

2) Diagnosed with valvular heart disease and underwent two-port thoracoscopic valve surgery.

3) Complete medical records were available, including surgical records, postoperative drainage conditions, and various examination indicators.

### 2.3. Exclusion Criteria

1) Preoperative severe pulmonary diseases, such as acute exacerbations of chronic obstructive pulmonary disease or severe pulmonary infections.

2) Serious intraoperative complications, such as massive hemorrhage or cardiac arrest, affecting postoperative recovery.

3) Postoperative abnormalities in thoracic drainage or prolonged hospital stays due to non-surgical related reasons (e.g., trauma, other severe systemic diseases).

4) Patients with mental disorders or cognitive impairments who were unable to cooperate with postoperative follow-up and data collection.

### 2.4. Methodology

Patients were randomly assigned into control and negative pressure groups using a random number

table. The control group received traditional thoracic drainage, while the negative pressure group underwent negative pressure thoracic drainage. Basic information of patients, including gender, age, drainage time, preoperative medical history, and comorbidities, was recorded. On postoperative days 1, 3, and 7, patients were evaluated, focusing on the following indicators:

1) Pain score: assessed using the Visual Analog Scale (VAS), with a maximum score of 10, where higher scores indicate greater pain [7].

2) Length of hospital stay: recorded as the number of days from surgery completion to discharge [8].

3) Drainage time: recorded as the time to catheter removal, measured in hours [9].

4) Incidence of complications: including pneumothorax and subcutaneous emphysema [10, 11].

### 2.5. Statistical Analysis

Data were analyzed using SPSS 26.0 statistical software. Measurement data were expressed as mean ± standard deviation ($x \pm s$), and inter-group comparisons were conducted using independent samples t-tests. Count data were expressed as percentages, with inter-group comparisons performed using $\chi^2$ tests. A P-value of <0.05 was considered statistically significant.

## 3. RESULTS

### 3.1. Comparison of Baseline Data

In this study, a total of 30 patients were included in the control group, comprising 20 males (66.67%) and 10 females (33.33%), with an average age of (42.03 ± 12.89) years. The negative pressure group included 35 patients, consisting of 26 males (74.29%) and 9 females (25.71%), with an average age of (41.84 ± 11.83) years. Statistical analysis showed no significant difference in gender distribution between the two groups ($\chi^2 = 0.4533$, $P = 0.5008$, $P > 0.05$). Additionally, there was no significant difference in average age ($t = 0.0619$, $P = 0.4754$, $P > 0.05$). Detailed results are presented in Table 1.

**Table 1. Comparison of gender and age between two groups.**

| Indicator | Control Group (n = 30) | Negative Pressure Group (n = 35) | Statistic Value | P Value |
|---|---|---|---|---|
| Male Patients | 20 (66.67%) | 26 (74.29%) | $\chi^2 = 0.4533$ | 0.5008 |
| Female Patients | 10 (33.33%) | 9 (25.71%) | | |
| Average Age (years) | 42.03 ± 12.89 | 41.84 ± 11.83 | t = 0.0619 | 0.4754 |

### 3.2. Comparison of Postoperative Drainage and Hospitalization Indicators

In terms of postoperative indicators, the control group (30 patients) had an average drainage time of (79.10 ± 7.32) hours, a postoperative pain score of (7.03 ± 0.85), and an average hospital stay of (14.73 ± 2.32) days, with an incidence of pneumothorax or subcutaneous emphysema in 17 cases (56.67%). In contrast, the negative pressure group (35 patients) had an average drainage time of (49.09 ± 11.99) hours, a postoperative pain score of (4.49 ± 1.27), and an average hospital stay of (9.83 ± 1.69) days, with an incidence of pneumothorax or subcutaneous emphysema in 5 cases (14.29%).

The negative pressure group showed significant improvements over the control group in terms of drainage time, postoperative pain scores, length of hospital stay, and incidence of pneumothorax or subcutaneous emphysema. Specifically, the comparison of average drainage time yielded ($t = 12.3617$, $P = 0.0000$), indicating a highly statistically significant difference ($P < 0.05$). The postoperative pain score comparison showed ($t = 9.5889$, $P = 0.0000$), also indicating a highly statistically significant difference ($P < 0.05$). Similarly, the length of hospital stay comparison resulted in ($t = 9.8237$, $P = 0.0000$), indicating a highly

statistically significant difference ($P < 0.05$). The incidence of pneumothorax or subcutaneous emphysema was compared with ($\chi^2 = 12.9584$, $P = 0.0003$), which also indicated a highly statistically significant difference ($P < 0.05$). Detailed results are presented in Table 2.

**Table 2. Comparison of postoperative drainage and hospitalization indicators between two groups.**

| Indicator | Control Group (n = 30) | Negative Pressure Group (n = 35) | Statistic Value | P Value |
|---|---|---|---|---|
| Average Drainage Time (hours) | 79.10 ± 7.32 | 49.09 ± 11.99 | t = 12.3617 | 0.0000 |
| Postoperative Pain Score | 7.03 ± 0.85 | 4.49 ± 1.27 | t = 9.5889 | 0.0000 |
| Length of Hospital Stay (days) | 14.73 ± 2.32 | 9.83 ± 1.69 | t = 9.8237 | 0.0000 |
| Incidence of Pneumothorax or Subcutaneous Emphysema | 17 cases (56.67%) | 5 cases (14.29%) | $\chi^2 = 12.9584$ | 0.0003 |

## 4. DISCUSSION

This study aimed to evaluate the efficacy of negative pressure thoracic drainage in patients undergoing two-port thoracoscopic valvular surgery and to compare it with traditional thoracic drainage. Through the analysis of 65 patients, we found that negative pressure drainage significantly outperformed the control group in terms of postoperative drainage time, pain management, length of hospital stay, and incidence of complications, providing evidence for the application of negative pressure drainage in cardiac surgeries.

In terms of baseline characteristics, there were no significant differences in sex ratio and age between the control group and the negative pressure group ($P > 0.05$), indicating that the two groups were comparable in preoperative characteristics. This comparability ensures the validity of subsequent comparisons, allowing the study results to more accurately reflect the clinical effects of the two drainage methods.

The results showed that the average drainage time in the negative pressure group was 49.09 hours, significantly shorter than the 79.10 hours in the control group ($P < 0.001$) [12]. This finding indicates that negative pressure drainage can effectively promote the expulsion of fluid from the thoracic cavity, thereby reducing postoperative drainage time. This may be related to the negative pressure effect of the drainage system, which enhances the drainage capacity of the tube and alleviates the resistance of fluid against the thoracic drainage tube, thereby accelerating fluid outflow.

Postoperative pain management is a critical factor affecting patient recovery. In this study, the postoperative pain score in the negative pressure group was significantly lower than that in the control group (4.49 vs. 7.03, $P < 0.001$) [13]. This result can be attributed to the advantages of negative pressure drainage in stimulating thoracic pressure equilibrium and reducing postoperative fluid accumulation. Reduced pain not only improves patient comfort but may also accelerate early recovery and decrease the need for analgesics, thereby reducing the risk of drug-related side effects [14].

A shortened length of hospital stay is an important indicator for assessing surgical outcomes and recovery quality. In this study, the length of stay for the negative pressure group was 9.83 days, compared to 14.73 days for the control group ($P < 0.001$) [15, 16]. This finding aligns with the positive impact of negative pressure drainage on postoperative recovery; earlier discharge not only alleviates the economic burden on patients but also enhances their quality of life.

Regarding the incidence of pneumothorax or subcutaneous emphysema, the negative pressure group exhibited a lower occurrence rate ($P < 0.001$) [17]. Pneumothorax and subcutaneous emphysema are serious complications that may arise after thoracic drainage, often associated with postoperative thoracic pressure

imbalance and ineffective drainage. The application of negative pressure drainage helps reduce the incidence of these complications, thereby improving patient safety.

In summary, the application of negative pressure thoracic drainage in patients after two-port thoracoscopic valvular surgery demonstrates significant advantages. This method not only effectively shortens drainage time and alleviates postoperative pain but also accelerates patient recovery and reduces the incidence of complications. These results suggest that negative pressure drainage has important clinical significance in postoperative care following cardiac surgery. We recommend the widespread adoption of negative pressure drainage technology in relevant surgeries to enhance overall treatment outcomes and quality of life for patients.

Future research should further explore the applicability and efficacy of negative pressure drainage in different types of thoracic surgeries and other surgical procedures, particularly in comparison with other novel drainage technologies. Additionally, studies should focus on the long-term prognosis and quality of life impacts of negative pressure drainage on patients, to comprehensively evaluate its clinical application value. Through ongoing research and clinical practice, negative pressure drainage may play a greater role in cardiac surgery and other related fields.

## 5. CONCLUSION

This study evaluated the efficacy of negative pressure chest drainage in patients undergoing two-port thoracoscopic valve surgery. The results showed that it outperformed traditional drainage methods in several aspects. The negative pressure group experienced a significantly shorter postoperative drainage time, lower pain scores, reduced hospital stay, and a notably lower incidence of tube blockage and complications. These findings indicate that negative pressure drainage can effectively promote postoperative recovery, enhance patient comfort, and reduce the consumption of medical resources, highlighting its important clinical significance. Therefore, negative pressure chest drainage, as an effective postoperative management approach, deserves to be promoted in cardiac surgery. Future research should continue to explore its applicability in different surgical procedures to further validate its clinical value and improve the overall quality of patient care.

## 6. LIMITATIONS OF THE STUDY

This study has certain limitations. First, the selection of research samples may affect the generalizability of the results, particularly regarding applicability in different regions and cultural backgrounds. Second, there may be information bias during the data collection process, impacting the accuracy of the conclusions. Additionally, limitations in the research methodology could lead to the neglect of certain variables, thus affecting a comprehensive understanding of the phenomena. Finally, time constraints may prevent capturing dynamic changes over time. Therefore, future research should enhance sample diversity, data comprehensiveness, and methodological rigor to better serve national development strategies and social progress.

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## CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest in this study. All research processes and data analyses were conducted with objectivity and impartiality, aiming to offer valuable references for the advancement of knowledge and clinical practice in the medical field.

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