Heart Surgery Forum 2023; 26(3): E219–E224
doi: 10.1532/hsf.5411

Article

A Study for QOL and Surgical Incision Pain in Patients Undergoing Totally Thoracoscopic Combined Aortic and Mitral Valve Replacement Surgery

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Submitted: 25 December 2022 Revised: 23 January 2023 Accepted: 14 February 2023 Published: 28 May 2023

Abstract

Background: In recent years, based on traditional median sternotomy surgery, totally thoracoscopic for aortic and mitral valve replacement surgery is increasingly being performed despite little published evidence. This study investigated postoperative pain and short-term quality of life (QOL) of patients undergoing double valve replacement surgery. **Methods**: From November 2021 to December 2022, 141 patients with double valvular heart disease who underwent thoracoscopic group (N = 62) and median sternotomy group (N = 79) were included. Clinical data were recorded, and a visual analog scale (VAS) was used to measure postoperative pain intensity. The medical outcomes study (MOS) 36-item Short-Form Health Survey assessed short-term QOL after surgery. **Results**: Sixty-two patients underwent total thoracic double valve replacement, and 79 patients underwent median sternotomy double valve replacement. Both groups were similar in terms of demographics and general clinical data, as well as the incidence of postoperative adverse events. The VAS scores of the thoracoscopic group were lower than those in the median sternotomy group. The hospital stay time was significantly shorter in the thoracoscopic group than in the median sternotomy group (30.2 $\pm$ 12 days *vs.* 36 $\pm$ 19 days, $p = 0.03$). The scores of bodily pains and some of the subscales in SF-36 were significantly different between the two groups ($p < 0.05$). **Conclusions**: Thoracoscopic combined aortic and mitral valve replacement surgery can reduce postoperative pain and improve short-term postoperative QOL, which has specific clinical application value.

Keywords

totally thoracoscopic; double-valve surgery; quality of life; SF-36; VAS

Introduction

Totally thoracoscopic surgery is a minimally invasive cardiac surgery adopted by many surgeons, gaining popularity and proving to be a safe procedure. At present, total thoracoscopic surgery has been able to carry out part of congenital heart diseases, such as a simple mitral valve or aortic valve disease, and it has gradually expanded to mitral and aortic valve replacement [1,2]. Totally thoracoscopic heart surgery involves a shorter hospital stay, less pain, and quick functional recovery compared to traditional median sternotomy surgery in many fields. The pursuit of higher postoperative life quality also is one of the therapeutic goals. Whether thoracoscopic surgery of poly-valvular heart disease improves QOL and reduces the patients' pain remains to be seen; there is little published evidence [3,4]. Therefore, we conducted a retrospective cohort study with 141 patients who underwent total thoracoscopic surgery or median sternotomy surgery combined with aortic and mitral valve replacement surgery in our hospital. We compared the VAS and SF-36 scores between the two groups.

Materials and Methods

Study Design

A total of 141 consecutive patients who underwent combined aortic and mitral valve replacement surgery, either totally thoracoscopic surgery or median sternotomy surgery, in our hospital from November 2021 to December 2022 were enrolled.

Ethics Approval

This was an observational study. The study complied with the requirements of the Ethics Committee of Fujian Medical University [approval ID: No.2022KY215] and adhered to the Declaration of Helsinki.

Materials were collected by calling the patient or following up as the patient returned to the clinic for a follow-up visit. Written informed consent was obtained from the

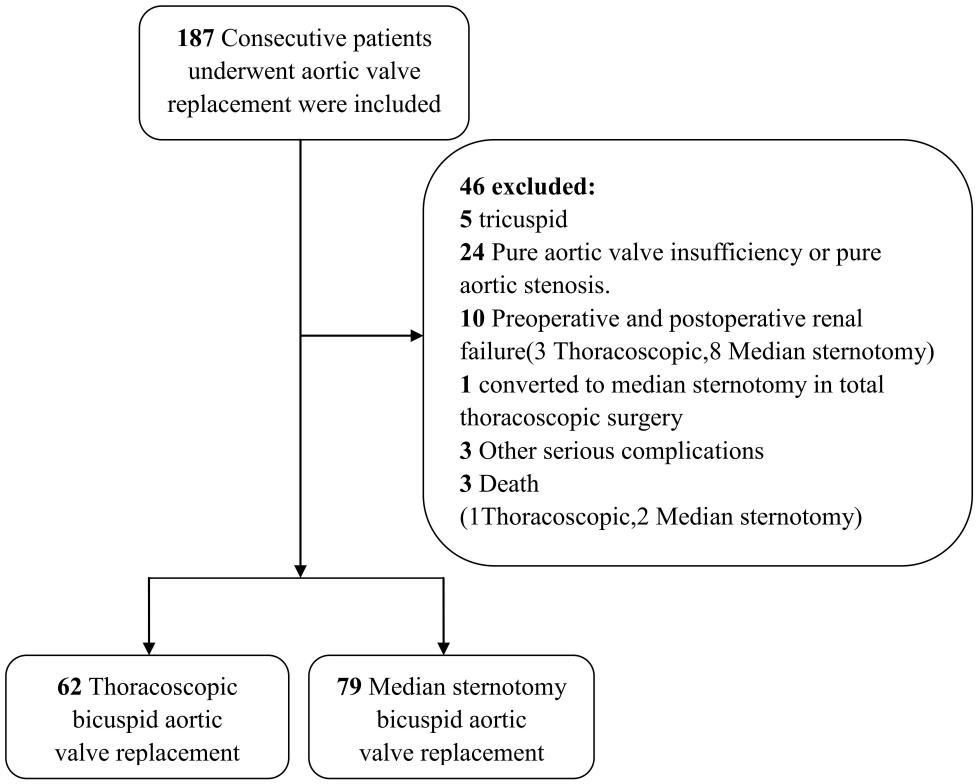

Fig. 1. Inclusion and exclusion criteria.

patient or a relative.

The inclusion and exclusion criteria were as follows: (Fig. 1).

Inclusion Criteria

Patients were diagnosed with moderate-severe aortic and mitral valve disease (insufficiency or stenosis) by cardiac color Doppler ultrasound; double valve replacement surgery was performed by totally thoracoscopic or median sternotomy; and the patient's ability to complete a questionnaire survey and follow-up work.

Excluded Criteria

Patients with preoperative and postoperative renal failure and other serious complications; patients converted to median sternotomy in total thoracoscopic surgery; patients with severe heart failure; and those who died within three months post-surgery.

Surgical Procedure

The patient was intubated after general anesthesia, and the left internal jugular vein catheterization and radial artery catheterization were routinely performed. The right chest was elevated 30 degrees, and a (16F) venous catheter was inserted into the right internal jugular vein for backup. Thoracoscopy was placed at the right mid-clavicular line at the 5th intercostal position. The aortic clamping clamp and central operating apparatus were placed in the suitable axillary third intercostal space. A straight incision was made in the right groin, the femoral artery and vein were exposed, and extracorporeal circulation was established through the femoral artery and vein cannulation. After the right lung collapsed, the pericardium was cut in front of the right phrenic nerve and suspended. A carbon dioxide blow tube was placed, and a perfusion tube was sutured at the root of the aorta. The left heart was drained through the right superior pulmonary vein. The ascending aorta was cut open and perfused with blood-containing HTK (histidine-tryptophan-ketoglutarate solution) directly through the left and right coronas. After cardiac arrest, incising the aortic root and exposing the aortic valve by lifting the valvular junction. Through the ascending aortic incision, the aortic valve was removed, and the artificial aortic valve was sutured intermittently with 9–10 pins of 2–0 nonabsorbable sutures with a gasket. The incision of the ascending aorta was sutured. The mitral valve was exposed through the right atrium, interatrial septal incision, or room sulcus incision and replaced with an artificial mitral valve, which was sutured intermittently with 10–12 stitches of 2/0 nonabsorbable suture with and sutured intermittently with 10–12 stitches of 2/0 nonabsorbable suture with spacer. The ascending aorta clamping clamp was opened, and the heart automatically was restarted. Breathing was given, and gradually weaned from cardiopulmonary bypass. A proper chest

Table 1. The Characteristics of patients.

Basic information	Thoracoscopic group (n = 62)	Median sternotomy group (n = 79)	*p* value
Sex (male/female)	39/23 (62.9%/37.1%)	49/30 (62%/38%)	0.91
Age, year	52.1 ± 14	53.8 ± 13	0.46
BMI	24.3 ± 2.4	24.7 ± 2.9	0.38
History of hypertension	42 (68%)	58 (73%)	0.51
History of diabetes	10 (16%)	15 (19%)	0.64
ICU stay, day	3.5 ± 13	5.5 ± 15	0.4
Hospital stay, day	30.2 ± 12	36 ± 19	0.03
Cardiopulmonary bypass time (min)	100 ± 22	110 ± 52	0.16
EF (Preoperative)	63.9 ± 3.6	64.1 ± 4.6	0.78
EF (Postoperative)	65.2 ± 5.3	65.9 ± 3.9	0.37

drainage tube was placed, the chest routinely was closed, and the groin incision was sutured. Conventional open mitral valve surgery was performed via median sternotomy [5,6] (Fig. 2).

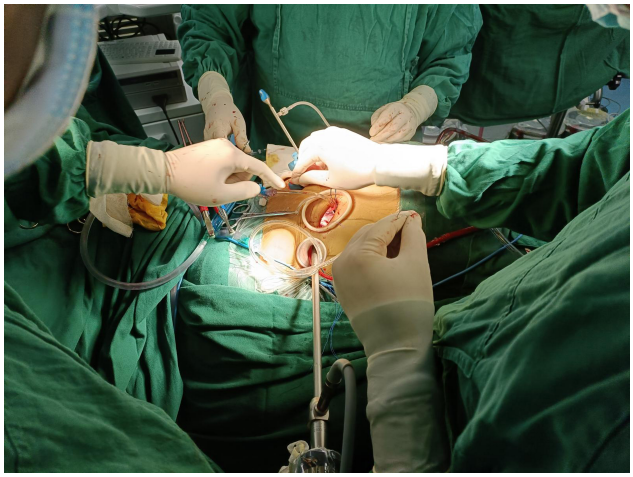

Fig. 2. Full thoracoscopic surgery.

Quality of life assessment and surgical incision pain assessment: QOL was assessed with the (SF-36) on month three after surgery [7,8]. No patient was considered unsuitable for QOL assessment. SF-36 scores are widely used in QOL analysis after cardiac surgery and chronic cardiovascular disease [9,10]. The SF-36 summary scores range from 0 to 100, with higher scores representing better self-reported health. The SF-36 consists of 36 items which include eight domains of health, including physical functioning, role physical, bodily pain, general health, vitality, social functioning, function emotional, and mental health [11,12].

Surgical incision pain also was assessed with VAS on day three and month three after surgery ranging from 0 to 100, with higher scores indicating more surgical incision pain [13,14]. In clinical use, the side with the scale will be back to the patients so that the patients can mark the position on the ruler that can represent their pain level. We evaluated the score according to the post marked by the patient, and the clinical evaluation is between 4 and 10 as moderate to severe pain and between 0 and 3 as no or mild pain [15].

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 20 (IBM Corp., Armonk, NY, USA), and p-values < 0.05 were defined as statistically significant. The mean $\pm$ standard deviation was calculated for quantitative data with a normal distribution. Pearson correlation coefficient was used for ranked data to assess the correlation between VAS and the SF-36 scores.

Results

Basic Information

Sixty-two patients underwent total thoracic double valve replacement, and 79 patients underwent median sternotomy double valve replacement. Both groups were similar in terms of demographics and general clinical data, as well as the incidence of postoperative adverse events. There was no significant difference in sex, age, year, body mass index (BMI), history of hypertension, history of diabetes, intensive care unit (ICU) stay, hospital stay, cardiopulmonary bypass time (min), EF (preoperative), and EF (postoperative) between preoperative and postoperative patients in the two groups. The hospital stay time was significantly shorter in the thoracoscopic group than in the median sternotomy group (30.2 $\pm$ 12 days *vs.* 36 $\pm$ 19 days, p = 0.03) (Table 1).

SF-36: The quality of life was measured on the 36-Item Short Form Health Survey (SF-36) three months after surgery. Table 2 shows no differences were observed between the two groups of patients in the role of physical, vitality, and role emotional (Table 2). But in the thoracoscopic group, role physical and role emotional scores were lower than in the median sternotomy group ($p > 0.05$). In the thoracoscopic group, scores of physical functioning, bodily pain, general health, social functioning, and mental health were higher than in the other group ($p < 0.05$).

Table 2. SF-36 scores between the two groups (Three months after surgery).

Item	Thoracoscopic group (n = 62)	Median sternotomy group (n = 79)	*p* value
Physical functioning	67.3065 ± 16.61284	45.1899 ± 17.49804	0.0001
Role physical	64.4677 ± 12.58117	66.2025 ± 15.27725	0.471
Bodily pain	54.3065 ± 17.56168	47.3291 ± 13.81723	0.013
General health	57.8065 ± 15.68108	51.481 ± 14.61634	0.015
Vitality	58.2258 ± 18.37891	53.1266 ± 17.09878	0.091
Social functioning	77.6613 ± 10.88230	70.7089 ± 15.08196	0.003
Role emotional	72.9194 ± 16.80193	75.6962 ± 12.98950	0.27
Mental health	76.371 ± 13.49588	69.8987 ± 13.55577	0.006

Table 3. VAS analyses between two groups.

Basic information	Thoracoscopic group (n = 62)	Median sternotomy group (n = 79)	*p* value
VAS (Postoperative day 3)	3.67 ± 1.5	4.27 ± 1.5	0.018
VAS (Postoperative month 3)	1.53 ± 0.9	1.67 ± 1.0	0.39

Table 4. The results of Pearson correlation coefficient between SF36 and VAS in two groups.

	Thoracoscopic group	Median sternotomy group
	VAS M3	VAS M3
VAS M3	1 (0.000)	1 (0.000)
Physical functioning	–0.03 (0.816)	–0.103 (0.364)
Mental health	–0.207 (0.107)	0.102 (0.370)
Role physical	0.208 (0.105)	0.104 (0.362)
Role emotional	0.044 (0.733)	–0.13 (0.253)
Social functioning	–0.1 (0.440)	0.136 (0.231)
Vitality	0.211 (0.099)	0.058 (0.610)
General health	–0.107 (0.410)	0.132 (0.248)
Bodily pain	0.073 (0.572)	–0.009 (0.940)

M3, month three.

VAS: The VAS scores of the thoracoscopic group were similar to the median sternotomy group in month three (p = 0.39) after surgery but lower than the median sternotomy group in day three (p = 0.018) (Table 3). This indicates that the pain scores of the two groups were similar after three months but significantly lower in the endoscopic group on the third postoperative day.

Pearson correlation coefficient: The results of the Pearson correlation coefficient between SF36 and VAS in the two groups were not significant ($p > 0.05$) (Table 4).

Discussion

The application of thoracoscopic technology in cardiovascular surgery is a new mode of cardiac surgery, which has aroused the great interest of more and more cardiac surgeons. Thoracoscopic technology is gradually being applied in the field of cardiovascular surgery, and it has been able to complete part of the operation. The reported techniques of thoracoscopic cardiovascular surgery can be divided into two categories: small incision cardiac surgery assisted by thoracoscopy and totally thoracoscopic cardiac surgery. The former belongs to the category of a small field of vision surgery, which is relatively mature and widely used. The latter belongs to the category of microsurgery, which is highly respected for its minor trauma, dull pain, and fast postoperative recovery. However, due to the complex equipment, long learning curve, and high medical cost, the popularization of thoracoscopic technology is limited by many restrictions. Thoracoscopic surgery is not only necessary to achieve the purpose of safe treatment of primary diseases through surgery but also to pursue higher postoperative QOL [16].

As there are many kinds of cardiovascular surgery conditions, different surgical incisions, surgical fields, and operation ranges are different, so the disease range of totally thoracoscopic technology applied in the field of cardiac surgery also is constantly explored and expanded. At present, most thoracoscopic cardiac surgery is performed in China for single valve repair or single valve replacement, while there are few reports for double valve replacement. In recent years, our center has carried out completely thoracoscopic mitral valve and aortic valve replacement (Fig. 3).

For total thoracoscopic mitral and aortic valve replacement, the patients should be evaluated before surgery, considering the safety and clinical effect of the procedure. Patients with an ample thoracic space and a lean body type will be selected as the object of operation. Patients with a history of right thoracic radiotherapy, right pleurisy, and right chest trauma leading to severe adhesion or reoperation of the right thoracic cavity, as well as patients with peripheral vascular lesions or malformations that cannot perform peripheral cardiopulmonary bypass, patients with obvious dilation of the ascending aorta, severe valve calcification, and poor cardiac function are considered as contraindications for totally thoracoscopic double valve replacement.

This study found that the time associated with surgery and the incidence of postoperative complications were sim-

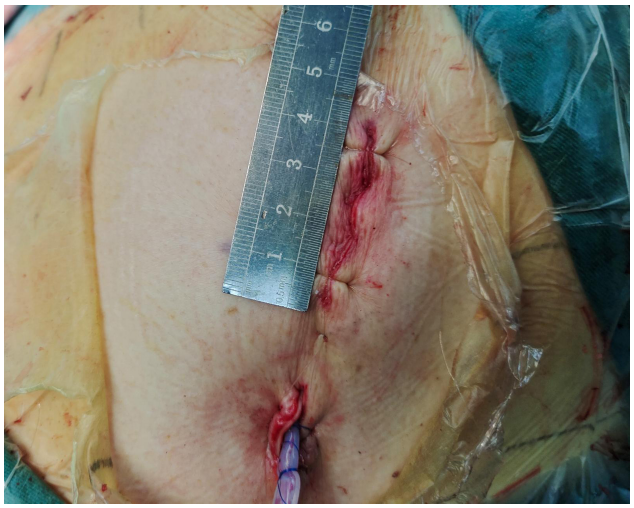

Fig. 3. Full thoracoscopic incision.

ilar between the thoracoscopic group and the median sternotomy group. For easy exposure and manipulation, the location of the ascending aorta can be determined by preoperative chest or cardiac CT. If the position of the ascending aorta is found to be too far from the incision during surgery, the left lung can be given a static expansion to promote the right displacement of the mediastinal septum and better exposure of the aortic valve. And the ascending aorta should not be too far from the left. (1) Severe thoracic adhesion was found during the operation. (2) Severe bleeding occurred during the operation. (3) A damaged coronary artery requires bypass surgery. (4) Perivalvular leakage of the aortic valve was found.

We believe that attention should be paid to the implementation of total thoracoscopic mitral and aortic double valve replacement: (1) The femoral artery and vein were cannulated. (2) The ascending aorta was directly dissected, and cardioplegia was perfused through the left and right coronary artery openings. (3) Due to the long operation time, it is necessary to actively protect the myocardium and infuse the cardioplegic solution at the appropriate time. (4) The main operation hole is made from the third rib of the right axillary line, which can make the mitral and aortic valves better exposed and more convenient to operate. (5) We should treat the aortic valve first and wait until the aortic valve is sutured before performing mitral valve surgery.

Postoperative pain is a common problem plaguing doctors and patients. Studies have shown that thoracoscopic surgery is less painful than median sternotomy [4, 15]. The results showed that the VAS score of the endoscopic group was significantly lower than that of the median sternotomy group 3 days after surgery, and the VAS score of the two groups was similar three months after surgery, suggesting that the endoscopic surgery can reduce the pain of patients in the early postoperative period. Postoperative pain can affect the cough, expectoration, and early activity of patients and hinder rapid recovery after surgery [17]. Intercostal nerve injury is one of the main causes of pain, so the probability of intercostal nerve injury is reduced due to only 1–2 intercostal incisions in endoscopic surgery. Thoracoscopic surgery can relieve the adverse physiological and psychological stress reaction caused by pain in patients so that they can establish rehabilitation confidence as soon as possible and shorten their postoperative hospital stay [18].

Compared with conventional median sternotomy, thoracoscopic surgery also improved the short-term QOL after cardiac surgery [19]. In the thoracoscopic group, scores of physical functioning, bodily pain, general health, social functioning, and mental health were higher than in the other group. In the results of SF36, the bodily pain scores of the thoracoscopy group were significantly higher than that of the median sternotomy group, indicating pain is an important component affecting the QOL, but there was no difference in VAS scores between the two groups after three months. The results of the Pearson correlation coefficient between SF36 and VAS in the two groups were not significant. Therefore, VAS scores can be used for early postoperative pain observation, and SF36 is more suitable for relatively long-term pain observation.

Limitations

There are some shortcomings to be pointed out in this paper. The sample size was not large, but it had statistical value. SF36 and VAS can be used to study the quality of life of patients from multiple aspects. If conditions allow, multiple scales can be used to analyze, and the results will be more credible. Our follow-up period was three months, and long-term follow-up results are better.

Conclusions

Totally thoracoscopic combined aortic and mitral valve replacement surgery can reduce postoperative pain and improve short-term postoperative QOL, which has certain clinical application value.

Availability of Data and Materials

The datasets generated and/or analyzed during the present study is available from the corresponding author on reasonable request.

Author Contributions

Conceptualization: ZX. Formal analysis: XD. Methodology: HW, WW. Project administration: HW. Supervision: XD. Visualization: XD. Writing – original draft:

ZX, WW. Writing – review & editing: ZX. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study complied with the requirements of the Ethics Committee of Fujian Medical University [approval ID: No.2022KY215], and adhered to the Declaration of Helsinki. No consent.

Acknowledgment

Thank you to all who have helped me.

Funding

Key Laboratory of Cardio-Thoracic Surgery (Fujian Medical University), Fujian Province University (No. 2019-67).

Conflict of Interest

The authors declare no conflict of interest.

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