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Retrospective Study

Application effect of thoracoscopic tricuspid valvuloplasty in geriatric patients with tricuspid valve disease

Jiang W *et al.* Thoracoscopic tricuspid valvuloplasty

Abstract

BACKGROUND

Thoracoscopic-assisted technology can ensure that doctors can implement minimally invasive treatment through the right intercostal incision or small incision of the lower sternum. This approach not only can achieve a cardiac correction effect equivalent to that of a thoracotomy but also has the benefit of a clear surgical field ensuring the safety of surgical treatment.

AIM

To investigate the effect of thoracoscopic tricuspid valvuloplasty in patients with tricuspid valve disease.

METHODS

A total of 41 patients with tricuspid valve disease underwent traditional thoracotomy treatment between January 2018 and June 2020. Forty-one patients with tricuspid valve disease who underwent thoracoscopic tricuspid valvuloplasty treatment between July 2020 and June 2021 in our hospital were selected as controls for our retrospective analysis. The study group underwent thoracoscopic tricuspid valvuloplasty, while traditional thoracotomy was performed in the control group. The operation conditions (the duration

of extracorporeal circulation, aorta blocking, endotracheal intubation, and surgery), inflammatory response-related indices (C-reactive protein and white blood cell count) before and after surgery, parameters related to myocardial injury (myocardial troponin T, creatine kinase isoenzyme, creatine kinase, and lactate dehydrogenase), and the incidence of adverse events in the two groups was counted.

RESULTS

The duration of extracorporeal circulation (109.35 ± 50.31 min), aortic occlusion (94.26 ± 59.61 min), endotracheal intubation (12.59 ± 3.54 h), and hospital stay (5.29 ± 2.34 d) in the study group were shorter than those in the control group (114.91 ± 46.98 min, 101.37 ± 61.44 min, 13.11 ± 4.01 h, 7.09 ± 3.11 d, respectively). The difference in hospital stay between the two groups was statistically significant ($P < 0.05$). Serum C-reactive protein level (4.69 ± 1.35 mg/L) and white blood cell count ($6.21 \pm 1.97 \times 10^9$ /L) in the study group were found to be not significantly different than those in the control group (5.01 ± 1.18 mg/L, $5.98 \pm 2.01 \times 10^9$ /L, respectively; $P > 0.05$). Myocardial troponin T (0.04 ± 0.02 ng/mL), creatine kinase isoenzyme (4.02 ± 1.11 mg/mL), creatine kinase (91.35 ± 10.44 U/L), and lactate dehydrogenase (179.81 ± 60.04 U/L) in the study group were also not statistically significant different than those in the control group (0.05 ± 0.03 ng/mL, 3.97 ± 1.05 mg/mL, 89.69 ± 13.05 U/L, 186.35 ± 56.96 U/L; $P > 0.05$). After the operation, serum C-reactive protein level (7.89 ± 1.73 mg/L) and white blood cell count ($10.76 \pm 2.35 \times 10^9$ /L) in the study group were significantly lower than those in the control group (9.96 ± 2.04 mg/L, $14.84 \pm 3.07 \times 10^9$ /L, respectively) ($P < 0.05$). In addition, myocardial troponin T (0.89 ± 0.32 ng/mL), creatine kinase isoenzyme (26.96 ± 4.95 mg/mL), creatine kinase (608.32 ± 202.33 U/L), and lactate dehydrogenase (282.56 ± 101.34 U/L) in the study group were lower than those in the control group (2.61 ± 0.69 ng/mL, 34.37 ± 6.87 mg/mL, 689.94 ± 214.64 U/L, 369.15 ± 114.46 U/L) ($P < 0.05$). The incidence of adverse events in the study group (4.88%) was lower than that in the control group (19.51%) ($P < 0.05$).

CONCLUSION

Thoracoscopic tricuspid valvuloplasty can achieve good results in treating patients with tricuspid valve disease, reduce the risk of adverse events, and promote the rapid recovery of patients.

Key Words: Senile tricuspid valve disease; Thoracoscopic tricuspid valvuloplasty; Inflammatory reaction; Myocardial injury

INTRODUCTION

The clinical definition of tricuspid valve disease includes multiple types of heart disease. One of these conditions, rheumatic heart disease, has a significant clinical burden. The disease mainly affects the aortic and mitral valves. In the past, clinical research focused on treating mitral valve and aortic valve disease, but the tricuspid valve was overlooked^[1,2]. Through clinical studies, researchers have found that there is a high incidence of tricuspid valve symptoms related to left heart valve disease. As a result, clinical intervention for tricuspid valve disease has received increasing attention^[3].

Patients with tricuspid valve disease can have decreased tolerance of exercise tolerance and fatigue due to reduced cardiac output. Heart failure and systemic edema can occur during disease progression. Therefore, timely interventions are important for patients^[4]. Traditional clinical treatments of tricuspid valve disease by thoracotomy can achieve specific results. However, trauma from these treatments is significant and the risk of complications is high, both of which negatively impact prognosis^[5]. Thoracoscopic-assisted technology can ensure that doctors can implement minimally invasive treatment through the right intercostal incision or small incision of the lower sternum. This approach not only can achieve a cardiac correction effect equivalent to that of a thoracotomy but also has the benefit of a clear surgical field ensuring the safety of surgical treatment^[6,7].

To further clarify the value and safety of thoracoscopic tricuspid valvuloplasty, clinical data from patients with tricuspid valve disease treated with thoracotomy and thoracoscopic tricuspid valvuloplasty in our hospital were retrospectively analyzed.

MATERIALS AND METHODS

Baseline data

A total of 41 patients with tricuspid valve disease underwent traditional thoracotomy treatment between January 2018 and June 2020. In our hospital, forty-one patients with tricuspid valve disease who underwent thoracoscopic tricuspid valvuloplasty treatment between July 2020 and June 2021 were selected for retrospective analysis.

The study group included 23 men and 18 women, with a mean age of 75.35 ± 11.71 (mean \pm SD) years, ranging from 61 to 89 years, and a mean body mass index (BMI) of 23.05 ± 3.94 kg/m², ranging between 16.4 and 29.7 kg/m². We used the New York Heart Association (NYHA) Functional Classification to characterize our patients, in which 11 cases were Class II, 25 cases were Class III, and five cases were Class IV.

There were 26 men and 15 women in the control group, with a mean age of 73.97 ± 12.02 years and a mean BMI of 22.64 ± 4.05 kg/m², ranging between 16.1 and 28.7 kg/m². Based on the NYHA classification, we identified 13 cases of Class II, 22 cases of Class III, and six cases of Class IV. Clinical data on sex, age, NYHA grade of heart function, and BMI were comparable between the two groups ($P > 0.05$).

Inclusion criteria

We included patients with diagnostic chest radiographs, electrocardiogram, cardiac color Doppler ultrasound, complete clinical data, an age < 60 years, and a NYHA classification of Class II-IV.

Exclusion criteria

Patients with hyperthyroidism, coronary heart disease, peripheral vascular disease, sick sinus syndrome, pericardial cavity and severe adhesion of the thoracic cavity, benign or

malignant tumors, previous tricuspid valve surgery, or a history of pulmonary embolism were excluded.

Surgical procedure

Patients in the study group underwent thoracoscopic tricuspid valvuloplasty and were intubated with a 35 F double-lumen endotracheal tube for one-lung ventilation. Patients were moved to the horizontal position with the right chest raising approximately 30°, and systemic heparinization was implemented. The right femoral artery and vein were intubated with a 16–24 F catheter using Seldinger technology to perform a cardiopulmonary bypass. We made a 3.5–4.0 cm incision between the front line axillary and the axillary midline of the fourth intercostal space. An inferior vena cava blocking band passed through this incision to place the soft tissue retractor (Anhui aofu Medical Company) allowing the placement surgical instruments. There was an additional 2.0–2.5 cm incision for the endoscope at the posterior axillary line of the fourth intercostal space. We placed the endoscope, left ventricular suction, perfusion tube, superior vena cava blocking band, aortic blocking forceps, and carbon dioxide trachea through this incision for the thoracoscopy (Karl STOs, Germany) and set aside the thoracic drainage tube after the operation. After successful placement of the instrument, a pericardiotomy was performed and 3–4 sutures were used to suspend the pericardium.

The right atrium was opened for the first time to examine the tricuspid valve. If the tricuspid valve was narrow, a valve replacement was performed. If regurgitation of the tricuspid valve was found, the surgeon determined whether valvuloplasty was necessary. The incision was extended outward for a circular suture, fixed to the suture ring, knotted outside the body, and pushed tightly through the knot pusher.

Patients in the control group underwent a traditional thoracotomy. The standard median thoracotomy procedure was adopted, and the right atrium was closed after the operation.

After surgery, patients in both groups were monitored in the cardiac surgery intensive care unit and transferred to the general ward after their hemodynamics was stabilized.

Observation indices

From the medical records, we collected information on operational conditions, including the duration of extracorporeal circulation, aorta blocking, endotracheal intubation, and surgery. We also extracted indices related to the inflammation response, C-reactive protein (CRP), and white blood cell count (WBC) before and after surgery. Parameters related to myocardial injuries, such as myocardial troponin T (cTnT), creatine kinase isoenzyme (CK-MB), creatine kinase (CK), and lactate dehydrogenase (LDH), before and after surgery were collected. Finally, the incidence of adverse events in the two groups was counted.

Statistical analysis

SPSS v22.0 (IBM, Armonk, New York, United States) was used for data analysis. Continuous measurement data were expressed as mean \pm SD and discrete data as n (%). The data were analyzed with t -tests and χ^2 test, as appropriate. Statistical significance was at $P < 0.05$.

RESULTS

Comparison of operation conditions between the two groups

The duration of extracorporeal circulation, aortic occlusion, endotracheal intubation, and hospital stay was shorter ⁷ in the study group than in the control group. There was a significant difference in the duration of hospital stay between the two groups (Table 1).

Comparison of inflammatory reaction-related indices ² between the two groups before and after the operation

Before the operation, serum CRP and WBC in the study group were not significantly ¹ different from those in the control group. After the operation, serum CRP and WBC in the study group were significantly lower than those in the control group (Table 2).

Comparison of myocardial injury-related indices between the two groups before and after the operation

Before the operation, cTnT, CK-MB, CK, and LDH were not significantly different between the two groups. After the operation, cTnT, CK-MB, and CK¹ in the study group were lower than in the control group (Table 3).

Comparison of the incidence of adverse events between the two groups

⁴The incidence of adverse events in the study group was significantly lower than that in the control group, as shown in Table 4.

DISCUSSION

The tricuspid valve^{is} the largest heart valve with a complex anatomical structure. Studies have shown that effective closure of the tricuspid valve during cardiac contraction requires coordination of the papillary muscle, tendon, valve leaf, valve ring, and right ventricular function. Any abnormality in these parts can lead to tricuspid valve disease^[8,9]. Tricuspid valve disease has a high incidence rate in the elderly population and poses a significant threat to the life and health of patients. Therefore, it is necessary to implement safe and effective treatment for elderly patients with tricuspid valve disease^[10].

Traditional thoracotomy is applied earlier in tricuspid valve diseases in the elderly, and the operation technology is relatively mature. However, traumatic injury is significantly severe and the risk of postoperative complications is high, both of which negatively impact postoperative rehabilitation of the diseases and improved quality of life^[11]. With continual development and improvement of medical and imaging technology as well as surgical instruments, which ensure that doctors can implement tricuspid valve treatment through the right intercostal incision or a small incision under the sternum with the help of external instruments, the sternum can be effectively retained and the occurrence of related complications can be minimized^[12,13]. At the same time, thoracoscopy can provide surgeons with a clear operative field during the operation of

the thoracoscopic tricuspid valve. The endoscope has an amplification function, which can ensure the accuracy of treatment and avoid accidental injury^[14].

We retrospectively analyzed the clinical data of geriatric patients with tricuspid valve disease treated with either traditional thoracotomy (control group) or thoracoscopic tricuspid valve surgery (study group). We found that hospital stay was shorter, and the incidence of adverse events was lower in the study group than in the control group ($P < 0.05$). Our findings suggest that, compared to traditional thoracotomy, thoracoscopic tricuspid valvuloplasty has a high application value in terms of reducing the duration of extracorporeal circulation and aortic occlusion, as well as the risk of adverse events, and promoting hospital recovery of the patients.

In cardiac surgery, ischemia-reperfusion, cardiopulmonary bypass time, and other factors can cause varying degrees of ischemia-reperfusion injury and systemic inflammatory response by promoting the coagulation pathway, complement factors, and activation of the cellular immune response^[15,16].

WBC and CRP are essential indicators for the clinical evaluation of the degree of inflammatory response *in vivo*, and their levels are closely related to the degree of tissue damage. Our study compared changes in WBC and CPR in patients with tricuspid valve disease before and after treatment. The results show that levels of WBC and CRP in the study group were significantly lower than those in the control group ($P < 0.05$), indicating that tricuspid valvuloplasty with the thoracoscope can reduce the impact of the operation on geriatric patients with tricuspid valve disease caused by the degree of inflammatory reaction. This is primarily because tricuspid valvuloplasty of the thoracoscope can reduce the inflammatory response, soft tissue damage, ischemia-reperfusion injury of the organ, invasive surgery, blood dilution, blood transfusion reaction, postoperative pain and stress response, immune system activation, as well as local infection of the incision^[17,18].

Furthermore, cardiac tissue injury is a significant predictor of postoperative complications; therefore, reducing myocardial injury is of positive importance to ensure the therapeutic effect. Cardiomyocytes are perfused by cardioplegia during cardiopulmonary bypass. During this period, the cells are in a state of ischemia and

hypoxia. After cardiopulmonary bypass, blood supply and systolic function of the cardiomyocytes are recovered. In the stage of myocardial ischemia, calcium accumulation in cells and membrane lipid degradation can occur. After the aortic blocking clip is removed, active nitrogen is passed during the reperfusion. The generation of reactive oxygen species leads to different degrees of oxidative stress on cardiomyocytes^[19,20]. cTnT, CK-MB, CK, and LDH all play an important role in evaluating the cardiac function, and there is a significant positive correlation between them. In this study, levels of cTnT, CK-MB, CK, and LDH were significantly lower in study group than in the control group postoperatively ($P < 0.05$). From the perspective of myocardial injury, our findings further confirm that thoracoscopic tricuspid valvuloplasty can achieve good results in the treatment of geriatric patients with tricuspid valve disease. This procedure can also effectively reduce the injury of myocardial tissue caused by surgical operation and plays an important role in ensuring the effectiveness and safety of the treatment and improving the prognosis of the disease.

CONCLUSION

Thoracoscopic tricuspid valvuloplasty can achieve good results in treating geriatric patients with tricuspid valve disease, which can cause a slight inflammatory reaction and myocardial injury, reduce the risk of adverse events, and promote the recovery of patients in the hospital. However, this study has some limitations. This is a single-center study with small sample size. Therefore, expanding the scope of the clinical study and increasing the sample size are necessitated to further explore and confirm whether the results of the study have a wide range of effectiveness.

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Table 1 The comparison of operation conditions between the two groups (mean \pm SD)

Groups	Cases	Extracorporeal circulation time (min)	Aortic occlusion time (min)	Endotracheal intubation time (h)	Hospital stay (d)
Study group	41	109.35 \pm 50.31	94.26 \pm 59.61	12.59 \pm 3.54	5.29 \pm 2.34
Control group	41	114.91 \pm 46.98	101.37 \pm 61.44	13.11 \pm 4.01	7.09 \pm 3.11
<i>t</i> value		0.517	0.532	0.622	2.961
<i>P</i> value		0.606	0.596	0.535	0.004

Table 2 Comparison of inflammatory reaction related indices between the two groups before and after the operation (mean \pm SD)

Groups	Cases	CRP (mg/L)	WBC ($\times 10^9/L$)
Before the operation			
Study group	41	4.69 \pm 1.35	6.21 \pm 1.97
Control group	41	5.01 \pm 1.18	5.98 \pm 2.01
<i>t</i> value		1.143	0.523
<i>P</i> value		0.257	0.602
After the operation			
Study group	41	7.89 \pm 1.73	10.76 \pm 2.35
Control group	41	9.96 \pm 2.04	14.84 \pm 3.07
<i>t</i> value		4.955	6.757
<i>P</i> value		0.000	0.000

CRP: C-reactive protein; WBC: White blood cell count.

Table 3 Comparison of myocardial injury related indices between the two groups before and after the operation (mean \pm SD)

Groups	Cases	cTnT (ng/mL)	CK-MB (mg/mL)	CK (U/L)	LDH (U/L)
Before the operation					
Study group	41	0.04 \pm 0.02	4.02 \pm 1.11	91.35 \pm 10.44	179.81 \pm 60.04
Control group	41	0.05 \pm 0.03	3.97 \pm 1.05	89.69 \pm 13.05	186.35 \pm 56.96
<i>t</i> value		1.776	0.210	0.637	0.506
<i>P</i> value		0.080	0.835	0.526	0.614
After the operation					
Study	41	0.89 \pm 0.32	26.96 \pm 4.95	608.32 \pm 202.33	282.56 \pm 101.34

group					
Control group	41	2.61 ± 0.69	34.37 ± 6.87	689.94 ± 214.64	369.15 ± 114.46
t value		14.480	5.603	1.772	3.627
P value		0.000	0.000	0.080	0.001

cTnT: Myocardial troponin T; CK-MB: Creatine kinase isoenzyme; CK: Creatine kinase; LDH: Lactate dehydrogenase.

Table 4 Comparison of the incidence of adverse events between the two groups, n (%)

Groups	Cases	Arrhythmia	Infection	Low cardiac output syndrome	Pleural effusion	Total incidence
Study group	41	1 (2.44)	0 (0.00)	1 (2.44)	0 (0.00)	2 (4.88)
Control group	41	2 (4.88)	1 (2.44)	2 (4.88)	3 (7.32)	8 (19.51)
χ ² value						4.100
P value						0.043

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