

# Minimally Invasive Myxoma Resection: A Single-center 5 Years' Experience

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## Research article

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# Abstract

## Background

Increasing demand for minimally invasive myxoma resection. This study aimed to investigate the safety and feasibility of minimally invasive myxoma resection.

## Methods

This is a retrospective study, we collected information on 95 patients who underwent myxoma resection from January 2016 to December 2020. According to the operative approach, they were divided into a minimally invasive myxoma resection(Mini-MR) group (n=30) and a sternotomy myxoma resection(SMR) group (n=65), we compared the intraoperative and postoperative data between the two groups.

## Results

Postoperative ventilator assisted time, CSICU time and postoperative hospital stay of Mini-AVR were shorter than SAVR [(13.05 ± 4.98) VS (17.07 ± 9.52)h ;(1.73 ± 0.29) VS (2.27 ± 1.53)d; (6.20 ± 1.50) VS (9.48 ± 3.37)d], the difference was statistically significant (P <0.05). Mini-AVR has lower postoperative drainage and blood transfusion rate of the first 24 h compared with SAVR [(38.93 ± 69.62) VS (178.25 ± 153.06)ml; 26.6% VS 63.1%], the differences were statistically significant (P <0.05).

## Conclusion

Mini-MR has the advantages of less CSICU stay time, less ventilator time, less postoperative drainage the first 24h, less blood transfusion, fewer postoperative hospital stays, and faster recovery. Mini-MR is a safe and feasible surgical procedure for the resection of myxoma.

## Background

Primary cardiac tumor is a rare disease and 75% of cardiac tumors are benign[1, 2]. Myxoma are the most common primary cardiac tumors, accounting for 50% of all benign cardiac tumors[3].Myxoma can cause embolic symptoms, obstructive symptoms, and even sudden cardiac death depending on the location and size of the mass[4–7]. Surgery should be done as soon as the diagnosis is established[1]. In most hospitals, myxoma resections are performed through a median sternotomy, which splits the sternum in the middle and longitudinally, destroys the stability of the thorax, and slows down the patient's postoperative recovery.

With the development of cardiac surgery technology and treatment concepts, a variety of minimally invasive cardiac surgery techniques for the treatment of heart diseases have been successfully carried out in the world, especially minimally invasive valve surgery[8]. However, there are still doubts about the safety and effectiveness of minimally invasive myxoma surgery due to the particularity of the tumor disease, and large-sample, multicenter, randomized controlled clinical trials are lacking. We

retrospectively analyzed 95 myxoma patients who received minimally invasive myxoma resection (Mini-MR) or sternotomy myxoma resection (SMR) from January 2016 to December 2020 in our hospital. Compare the clinical effects and complications of the two different surgical techniques to explore the safety and feasibility of minimally invasive myxoma resection.

The study was done after agreement from the local ethics committee and with the patients' informed consent. The study was conducted according to the ethical principles of the Declaration of Helsinki.

## Methods

### General information

Patients who underwent myxoma resection in our hospital between January 2016 and December 2020 were selected as the research objects. The postoperative pathological diagnoses of all the patients included were myxoma. According to the different surgical procedures, they were divided into two groups, Mini-MR and SMR. The Mini-MR group included 11 males and 19 females, with an age range of 27–85 years and a mean age of  $55.87 \pm 12.45$  years. The SMR group included 26 males and 39 females, with an age range of 17–82 years and a mean age of  $56.94 \pm 12.88$  years. There was no significant difference in general clinical data between the two groups ( $P > 0.05$ ). (Table 1)

Table 1  
Preoperative characteristics

Items	Mini-MR (n = 30)	SMR (n = 65)	P value
Gender (male/female)	11/19	26/39	0.757
Age (years)	55.87 ± 12.45	56.94 ± 12.88	0.704
BMI (kg/m <sup>2</sup> )	21.57 ± 2.49	22.58 ± 3.46	0.154
LVEF (%)	63.30 ± 6.33	62.75 ± 6.96	0.716
LAD (mm)	37.60 ± 6.71	38.62 ± 7.64	0.534
LVEDD (mm)	46.77 ± 4.63	46.85 ± 5.55	0.946
LVESD (mm)	30.43 ± 3.93	30.83 ± 5.55	0.725
NYHA class /	13/17	23/42	0.458
AF (n, %)	1 (3.3%)	2 (3.1%)	1.000
Stroke (n, %)	4 (13.3%)	13 (20.0%)	0.617
Diabetes (n, %)	5 (16.7%)	5 (7.7%)	0.185
Hypertension (n, %)	8 (26.7%)	18 (27.7%)	0.917
BMI: body mass index; LVEF: left ventricular ejection fraction; LAD: left atrial diameter;LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter AF: atrial fibrillation Mini-MR: Minimally invasive Myxoma Resection; MR: Steronotomy Myxoma Resection			
Values expressed as means ± SD, n(%), or n1/n2			

### Surgical procedures

Mini-MR Group. The patient underwent general anesthesia and double-lumen endotracheal intubation. Choose the supine position, suspend the patient's right hand on the head frame, and raise the right chest by 30°. Cut the skin-level subcutaneous tissue in the right groin area to fully expose the femoral artery and femoral vein. Cut the skin and subcutaneous tissue in the right groin area to fully expose the femoral artery and femoral vein. Heparinized. Use 5-0 prolene as a purse-string in the femoral artery and femoral vein, and intubate the femoral artery and femoral vein. Establish peripheral cardiopulmonary bypass(CPB). The fourth intercostal incision on the right thorax and axillary side was selected as the surgical route. Gradually incise the skin, subcutaneous tissue, muscle layer, and parietal pleura. Place left ventricular drainage tube and CO2 inflation tube through the fourth intercostal space of the mid-axillary line. Start peripheral cardiopulmonary bypass and lower body temperature. Place a thoracoscope above the incision (Third intercostal space). Cut the pericardium longitudinally at 2cm in front of the phrenic nerve. Suspend the pericardium and expose the heart. Make a purse-string at the aortic root and insert a perfusion tube used for heart protection solution. Use the GLAUBER blocking forceps through the 4th intercostal hole in the mid-axillary line to block the ascending aorta. After blocking-up the ascending

aorta, myocardial perfusion was performed by perfusion of 4:1 oxygenated blood cardioplegia. Open the interatrial groove. The myxoma in the atrium was exposed, the tumor was removed together with the pedicle, the pedicle was burnt with an electric knife, the pedicle was reinforced and sutured, and washed thoroughly. The atrial incision was sutured with 4-0 prolene. Rewarm, ventilate the lungs, and open the GLAUBER blocking forceps. Wait for the heart to recover automatically or use an electric defibrillator to recover. Stop the CPB after the circulation stabilize. The femoral vein cannula was removed, protamine neutralized heparin, and the femoral artery cannula was removed. Suture the groin incision. Check carefully the pericardial cavity for no obvious bleeding, and suture part of the pericardium. Check the thoracic cavity for no active bleeding, place the thoracic drainage tube, check the surgical instruments and gauze, and close the chest layer by layer.

SMR Group. Sternotomy myxoma resection was performed as a standardized procedure.

## Data collection

We observed intraoperative variables, focusing on CPB time, aortic cross-clamp time and operation time, the size of myxoma, and also determined the occurrence of sternotomy conversion. Postoperative variables include ventilator assistance time, Cardiac Surgery Intensive Care Unit (CSICU) stay, the postoperative drainage the first 24h, and the rate of blood transfusion during the first 24h, reoperation for hemostasis, and the probability of complications (such as stroke, pneumonia, pleural effusion, new-onset atrial fibrillation, renal insufficiency, poor incision healing, death).

## Statistical method

Statistical analysis was performed on the data using SPSS 22.0 software. Independent-sample t-test analysis was used to compare the operation time, CPB time, cross-clamp time, myxoma size, CSICU stays, assisted ventilation time, postoperative drainage during the first 24 h, and postoperative hospital stay. Chi-square test analysis was performed to compare the rates of blood transfusion, postoperative related complications, and mortality.  $P < 0.05$  indicates that the difference is statistically significant.

## Results

The operation was successfully completed in all patients. There was no transition to thoracotomy in the Mini-MR group, and no patients died after surgery. All patients eventually recovered and were discharged. In the Mini-MR group, the operation time was  $212.10 \pm 44.18$  min; the CPB time was  $77.07 \pm 28.05$  min; the aortic cross-clamp time was  $46.34 \pm 24.11$  min. In the SMR group, the operation time was  $229.92 \pm 39.27$  min; the CPB time was  $69.46 \pm 24.81$  min; the aortic cross-clamp time was  $42.51 \pm 17.93$  min. The myxoma excised by the Mini group was  $45.37 \pm 19.48$ mm long and  $29.37 \pm 9.62$ mm wide; the myxoma excised by SMR was  $50.02 \pm 16.18$ mm long and  $30.35 \pm 9.96$ mm wide. There were no significant differences in the operation time, CPB time, and aortic cross-clamp time for either group ( $P > 0.05$ ). (Table 2).

Table 2  
Operative characteristics

Items	Mini-MR (n = 30)	SMR (n = 65)	P value
Operation time (min)	212.10 ± 44.18	229.92 ± 39.27	0.051
CPB time (min)	77.07 ± 27.56	69.46 ± 24.81	0.183
Aortic cross-clamp time (min)	46.33 ± 23.69	42.51 ± 17.93	0.386
Myxoma size			
Length (mm)	45.37 ± 19.48	50.02 ± 16.18	0.226
Width (mm)	29.37 ± 9.62	30.35 ± 9.96	0.651
CPB: cardiopulmonary bypass			
Mini-AMR: Minimally invasive Myxoma Resection; SAMR: Steronotomy Myxoma Resection			
Values expressed as the means ± SD			

Mini-MR group compared with SMR group, the CSICU stays time was  $1.73 \pm 0.29d$  VS  $2.27 \pm 1.53d$  ( $P = 0.008$ ), the postoperative ventilator assistance time of the two groups was  $13.05 \pm 4.98h$  VS  $17.07 \pm 9.52h$  ( $P = 0.032$ ), the postoperative hospital stays were  $6.20 \pm 1.50d$  VS  $9.48 \pm 3.37d$  ( $P < 0.001$ ), and the postoperative drainage the first 24h was  $38.93 \pm 69.62ml$  VS  $178.25 \pm 153.06ml$  ( $P < 0.001$ ), and the rate of blood transfusion during the first 24 h was 26.6% VS 63.1% ( $P = 0.001$ ), the differences were statistically significant ( $P < 0.05$ ). In Mini-MR, 2 cases had pneumonia, 1 had a pleural effusion, and 1 had renal insufficiency. In the SMR group, 1 case had a stroke, 3 had pneumonia, 1 had pleural effusion, 9 had atrial fibrillation, 1 had renal insufficiency, and 3 had poor wound healing. The results showed that compared with the SMR group, the CSICU stays time, the postoperative ventilator assistance time, postoperative drainage the first 24h, the rate of blood transfusion during the first 24 h, and postoperative hospital stay in the Mini-MR group were reduced, and the difference was significant ( $P < 0.05$ ). Compared with the rate of stroke, the rate of pneumonia, the rate of pleural effusion, the rate of new-onset atrial fibrillation, the rate of renal insufficiency, the rate of poor incision healing, the rate of reoperation for hemostasis, and postoperative mortality between the two groups, the difference were no significant ( $P > 0.05$ ). (Table 3).

Table 3  
Postoperative characteristics

Items	Mini-MR (n = 30)	SMR (n = 65)	P value
CSICU stays time (d)	1.73 ± 0.29	2.27 ± 1.53	0.008*
Ventilator assisted time (h)	13.05 ± 4.98	17.07 ± 9.52	0.032*
Drainage of first 24h (ml)	38.93 ± 69.62	178.25 ± 153.06	0.001*
Blood transfusion rate of first 24h (n, %)	8(26.6%)	41(63.1%)	0.001*
Days of postoperative hospital stay (d)	6.20 ± 1.50	9.48 ± 3.37	0.001*
Incidence of stroke (n, %)	0 (0.0%)	1 (1.5%)	1.000
Incidence of pneumonia (n, %)	2 (6.7%)	3 (4.6%)	1.000
Incidence of pleural effusion (n, %)	1 (3.3%)	1 (1.5%)	1.000
Incidence of atrial fibrillation (n, %)	0 (0.0%)	9 (13.8%)	0.053
Incidence of renal insufficiency (n, %)	1 (3.3%)	1 (1.5%)	1.000
Incidence of poor incision healing (n, %)	0 (0.0%)	3 (4.6%)	0.549
Reoperation for hemostasis (n, %)	0 (0.0%)	0 (0.0%)	-
Mortality rate (n, %)	0 (0.0%)	0 (0.0%)	-
CSICU: Cardiac surgery intensive care unit;			
Mini-MR: Minimally invasive Myxoma Resection; SMR: Steronotomy Myxoma Resection			
Values expressed as means ± SD, n(%)			
*: P 0.05			

## Discussion

The routine resection of myxoma is SMR, with a long history, and many studies have proved that it is safe and feasible[5, 6, 9, 10]. However, SMR needs to split the sternum in the middle, which will destroy the normal bone structure of the sternum and increase the pain of the patient after the operation. With the use of wire and bone wax, the risk of foreign body rejection is higher in SMR, obese patients or patients with diabetes are more prone to incision fat liquefaction or infection, resulting in a prolonged unhealed incision, and large scars are left. Mini-MR adopts a small right chest incision operation method, the position of the surgical incision is hidden and the appearance is better. On the one hand, Mini-MR does not need to saw the sternum, thus maintaining the stability of the sternum, which is beneficial to reduce postoperative thoracic deformities and adverse reactions caused by wire fixation and other related complications. On the other hand, the respiratory function of patients who choose right chest small incision surgery is well protected because the normal structure of the sternum is maintained, and the

postoperative pain of the patient is reduced, which is conducive to faster postoperative recovery and earlier discharge.

In this study, compared with the SMR group, the Mini-MR group had shorter operation time, longer aortic cross-clamp time, and longer CPB time, but the difference was no significant ( $P > 0.05$ ). Minimally invasive surgery shortens the time of opening and closing the chest, but due to the small space and high difficulty, the time of heart operation is prolonged. The study by Dong et al.[11] showed that Mini-MR compared with SMR has a longer operation time, aortic cross-clamp time, and CPB time, but the difference is also no significant. Mini-MR relies on special minimally invasive surgical instruments and requires the assistance of thoracoscopy. The surgeon has a learning curve. At the same time, because the assistance of thoracoscopy is needed, the cooperation of assistants is also very important. With the improvement of surgical proficiency, the time of minimally invasive aortic cross-clamp and CPB time will gradually shorten to the same as that of median thoracotomy. Minimally invasive surgery will greatly shorten the overall operation time because it does not require complicated chest closure to stop bleeding.

Patients after cardiac surgery will be immediately transferred to the CSICU for monitoring and follow-up treatment, routinely given ventilator-assisted breathing and then transferred to the general ward for recovery after the condition is stable. Increased duration of ventilator-assisted has been shown to be related to pulmonary complications, length of stay in the hospital, and increased length of stay in CSICU[12, 13]. This study found that the ventilator assistance time of the Mini-MR group was significantly shorter than that of the SMR group, and the CSICU stay time and postoperative hospital stay were also greatly reduced. Early removal of the tracheal intubation can reduce pulmonary complications, and the short stay in the CSICU can enable the patient to be transferred to the general ward as soon as possible, which is conducive to postoperative recovery and shortens the hospital stay, thereby saving the patient's cost.

Massive postoperative drainage and blood transfusion will bring many complications. Massive postoperative drainage will lead to reoperation for hemostasis. Studies have shown that the amount of input red blood cells greater than 4 units is an independent risk factor for a lung infection[14]. Another study showed that blood transfusion plays an important role in the process of acute kidney injury after cardiac surgery[15]. This may be related to the decreased ability of red blood cells to deform during storage, impaired energy metabolism, and decreased oxygen-carrying capacity. The hemoglobin released by the red blood cells destroyed during the storage of red blood cells blocks the renal tubules, which may also be the cause of acute kidney injury after a large number of blood transfusions. Compared with SMR, Mini-MR can reduce postoperative drainage and postoperative blood transfusion rate.

The complications after cardiac surgery will increase the risk of death of the patient. In this study, there was no difference in the rate of stroke, the rate of pneumonia, the rate of pleural effusion, the rate of new-onset atrial fibrillation, the rate of renal insufficiency, the rate of poor incision healing, the rate of reoperation for hemostasis, and postoperative mortality between Mini-MR and SMR. This can also indicate that Mini-MR does not increase the risk of these postoperative complications compared with

SMR. In addition, Mini-MR requires the establishment of peripheral cardiopulmonary bypass, so it needs to free the femoral artery, femoral vein. Free the femoral artery and vein may cause femoral artery dissection, thrombus, hemangioma, stenosis, etc[16]. This did not happen during our surgery. The maturity of surgical techniques can avoid such related complications.

## **Conclusion**

Compared with SMR, the CSICU stays time, the postoperative Ventilator assisted time, the postoperative hospital stays, the postoperative drainage the first 24h, and the rate of blood transfusion during the first 24h were significantly reduced in Mini-MR. Mini-MR is a safe and feasible surgical procedure for the resection of myxoma.

## **Abbreviations**

Mini-MR: Minimally invasive myxoma resection; SMR: Steronotomy myxoma resection; CPB: Cardiopulmonary bypass; CSICU: Cardiac Surgery Intensive Care Unit.

## **Declarations**

### **Ethics approval and consent to participate**

Ethical approval was obtained from the institutional review board, The Second Affiliated Hospital of Nanchang University. After the explanation of the possible consequences of the study, written informed consent was obtained from all study participants. The study was conducted according to the ethical principles of the Declaration of Helsinki.

### **Consent for publication**

Not applicable.

### **Availability of data and materials**

The datasets used during the current study are available from the corresponding author on reasonable request.

### **Competing interests**

There are no conflicts of interest to disclose.

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## Authors' contributions

FL and XY contributed equally to this work. XL and FL designed the study, FL conducted the study with the assistance of XL and XY, FL and XY interpreted the results and drafted the paper, SWC, HPZ, RZN and ZLL participated in the interpretation of the results, JJX revised the paper. JJX and YBW performed all the operations with the assistance of XL and SQZ. All authors read and approved the final manuscript and have given final approval for its publication.

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## References

1. Hoffmeier A, Sindermann JR, Scheld HH, Martens S: **Cardiac tumors—diagnosis and surgical treatment.** *DTSCH ARZTEBL INT* 2014, **111**(12):205-211.
2. Lam KY, Dickens P, Chan AC: **Tumors of the heart. A 20-year experience with a review of 12,485 consecutive autopsies.** *ARCH PATHOL LAB MED* 1993, **117**(10):1027-1031.
3. Poterucha TJ, Kochav J, O'Connor DS, Rosner GF: **Cardiac Tumors: Clinical Presentation, Diagnosis, and Management.** *Curr Treat Options Oncol* 2019, **20**(8):66.
4. ElBardissi AW, Dearani JA, Daly RC, Mullany CJ, Orszulak TA, Puga FJ, Schaff HV: **Analysis of benign ventricular tumors: long-term outcome after resection.** *J Thorac Cardiovasc Surg* 2008, **135**(5):1061-1068.
5. Shah IK, Dearani JA, Daly RC, Suri RM, Park SJ, Joyce LD, Li Z, Schaff HV: **Cardiac Myxomas: A 50-Year Experience With Resection and Analysis of Risk Factors for Recurrence.** *ANN THORAC SURG* 2015, **100**(2):495-500.
6. Garatti A, Nano G, Canziani A, Gagliardotto P, Mossuto E, Frigiola A, Menicanti L: **Surgical excision of cardiac myxomas: twenty years experience at a single institution.** *ANN THORAC SURG* 2012, **93**(3):825-831.
7. Elbardissi AW, Dearani JA, Daly RC, Mullany CJ, Orszulak TA, Puga FJ, Schaff HV: **Survival after resection of primary cardiac tumors: a 48-year experience.** *CIRCULATION* 2008, **118**(14 Suppl):S7-S15.
8. Doenst T, Diab M, Sponholz C, Bauer M, Farber G: **The Opportunities and Limitations of Minimally Invasive Cardiac Surgery.** *DTSCH ARZTEBL INT* 2017, **114**(46):777-784.
9. Tasoglu I, Tutun U, Lafci G, Hijaazi A, Yener U, Yalcinkaya A, Ulus T, Aksoyek A, Saritas A, Birincioglu L *et al*: **Primary cardiac myxomas: clinical experience and surgical results in 67 patients.** *J Card Surg* 2009, **24**(3):256-259.
10. Lee KS, Kim GS, Jung Y, Jeong IS, Na KJ, Oh BS, Ahn BH, Oh SG: **Surgical resection of cardiac myxoma—a 30-year single institutional experience.** *J CARDIOTHORAC SURG* 2017, **12**(1):18.

11. Dong NG, Zhang KL, Wu L, Hong H: **Right Anterolateral Minithoracotomy versus Median Sternotomy Approach for Resection of Left Atrial Myxoma.** *Thorac Cardiovasc Surg* 2018, **66**(2):193-197.
12. Wang C, Zhang GX, Lu FL, Li BL, Zou LJ, Han L, Xu ZY: **A local risk prediction model for prolonged ventilation after adult heart valve surgery in a Chinese single center.** *HEART LUNG* 2013, **42**(1):13-18.
13. Reddy SL, Grayson AD, Griffiths EM, Pullan DM, Rashid A: **Logistic risk model for prolonged ventilation after adult cardiac surgery.** *ANN THORAC SURG* 2007, **84**(2):528-536.
14. El SA, Bhora M, Pineda L, Dhillon R: **Nosocomial pneumonia in elderly patients following cardiac surgery.** *Respir Med* 2006, **100**(4):729-736.
15. Karkouti K, Wijeyesundera DN, Yau TM, Callum JL, Cheng DC, Crowther M, Dupuis JY, Fremes SE, Kent B, Laflamme C *et al*: **Acute kidney injury after cardiac surgery: focus on modifiable risk factors.** *CIRCULATION* 2009, **119**(4):495-502.
16. Cheng DC, Martin J, Lal A, Diegeler A, Folliguet TA, Nifong LW, Perier P, Raanani E, Smith JM, Seeburger J *et al*: **Minimally invasive versus conventional open mitral valve surgery: a meta-analysis and systematic review.** *Innovations (Phila)* 2011, **6**(2):84-103.