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

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ABSTRACT

Background: There is an increasing demand for minimally invasive myxoma resection. This study aimed to investigate the safety and feasibility of minimally invasive myxoma resection.

Methods: In this retrospective study, we collected information from 95 patients who underwent myxoma resection between January 2016 and December 2020. Based on the operative approach, the patients were divided into the minimally invasive myxoma resection (Mini-MR) group (N = 30) and the sternotomy myxoma resection (SMR) group (N = 65). Intraoperative and postoperative data were compared between the two groups.

Results: The postoperative ventilator-assisted time, CSICU time, and postoperative hospital stay were shorter in the Mini-MR group than in the SMR (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, respectively), and the difference was statistically significant (P < 0.05). Mini-MR had lower postoperative drainage and blood transfusion rate in the first 24 h compared with SMR (38.93 ± 69.62 vs. 178.25 ± 153.06 ml; 26.6% vs. 63.1%), and 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 in the first 24h, less blood transfusion, fewer postoperative hospital stays, and faster recovery. Mini-MR is a safe and feasible surgical procedure for myxoma resection.

INTRODUCTION

Background: Primary cardiac tumors are rare, and 75% of cardiac tumors are benign [Hoffmeier 2014; Lam 1993]. Myxoma is the most common primary cardiac tumor, accounting for 50% of all benign cardiac tumors [Poterucha 2019]. It can cause embolic symptoms, obstructive symptoms, and even sudden cardiac death, depending on the location and size of the mass [Elbardissi 2008; Shah 2015; Garatti 2012; Elbardissi 2008]. Surgery should be performed as soon as the diagnosis is established [Hoffmeier 2014]. In most hospitals, myxoma resection is 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 worldwide, especially minimally invasive valve surgery [Doenst 2017]. However, there still are doubts about the safety and effectiveness of minimally invasive myxoma surgery, due to the particularity of the tumor disease. Additionally, large-sample, multicenter, randomized controlled clinical trials are lacking. We retrospectively analyzed 95 myxoma patients who underwent minimally invasive myxoma resection (Mini-MR) or sternotomy myxoma resection (SMR) between January 2016 and December 2020 in our hospital. The clinical effects and complications of the two different surgical techniques were compared to explore the safety and feasibility of minimally invasive myxoma resection.

Ethical approval was obtained from the institutional review board of the Second Affiliated Hospital of Nanchang University. After explaining the possible consequences of the study, written informed consent was obtained from all study participants. The study was conducted in accordance with 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 study subjects. The preoperative echocardiography of all included patients was left atrial myxoma, and emergency patients were excluded. The postoperative pathological diagnoses of all included patients were myxoma. According to the different surgical procedures, the patients were divided into two groups: Mini-MR and SMR. The Mini-MR group included 11 men and 19 women, with an age range of 27-85 years and a mean age of 55.87±12.45 years. The SMR group included 26 men and 39 women, with an age range of 17-82 years and a mean age of 56.94±12.88 years. There was no significant difference in the general clinical data between the two groups (P > 0.05). (Table 1)

Surgical procedures – Mini-MR Group: The patients underwent general anesthesia and double-lumen endotracheal intubation. The patient's right hand was suspended in the supine position on the head frame, and the right chest was raised by 30°.

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The skin and subcutaneous tissue in the right groin area were cut to expose the femoral artery and femoral vein. Heparinized. We used 5-0 prolene as a purse-string in the femoral artery and femoral vein and intubated the femoral artery and femoral vein. We established peripheral cardiopulmonary bypass (CPB). The fourth intercostal incision on the right thorax and axillary side was selected as the surgical route. We gradually incised the skin, subcutaneous tissue, muscle layer, and parietal pleura. The left ventricular drainage tube and CO2 inflation tube through the fourth intercostal space of the mid-axillary line were placed. Peripheral cardiopulmonary bypass and lower body temperature were started. Next, we placed a thoracoscope above the incision (third intercostal space). The pericardium was cut longitudinally 2 cm in front of the phrenic nerve. The pericardium was suspended, and the heart was exposed. A purse-string was made at the aortic root and insert a perfusion tube is used for heart protection solution. We used the GLAUBER blocking forceps through the 4th intercostal hole in the mid-axillary line to block the ascending aorta. After blocking the ascending aorta, myocardial perfusion was performed by perfusion of 4:1 oxygenated blood cardioplegia. The left atrium was entered via 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, and the pedicle was reinforced and sutured, and then washed thoroughly. The atrial incision was sutured using 4-0 Prolene. We rewarmed the body temperature and opened the GLAUBER blocking forceps. We waited for the heart to recover automatically or used an electric defibrillator to recover. The CPB was stopped after the circulation stabilized. The femoral vein cannula was removed, protamine-neutralized heparin was administered, and the femoral artery cannula was removed. The groin incision was then sutured. The pericardial cavity carefully was checked for no obvious bleeding, and the pericardium was sutured. The thoracic cavity was checked for no active bleeding, the thoracic drainage tube was placed, surgical instruments were checked, and the chest was closed layer by layer.

Surgical procedures – SMR Group: Sternotomy myxoma resection was performed using a standardized procedure.

Data collection: We observed intraoperative variables, focusing on CPB time, aortic cross-clamp time and operation time, and the size of myxoma, and determined the occurrence of sternotomy conversion. Postoperative variables included ventilator assistance time, duration of intensive care unit (CSICU) stay, postoperative drainage in the first 24h, 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, and death).

Statistical method: Statistical analysis was performed using SPSS 22.0. Independent-sample t-test analysis was used to compare the operation time, CPB time, cross-clamp time, myxoma size, CSICU stay, 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 complications, and mortality. $P < 0.05$ indicates that the difference is statistically significant.

RESULTS

The operation successfully was 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±44.18 min, CPB time was 77.07±28.05 min, and aortic cross-clamp time was 46.34±24.11 min. In the SMR group, the operation time was 229.92±39.27 min, CPB time was 69.46±24.81 min, and aortic cross-clamp time was 42.51±17.93 min. The myxoma excised in the Mini group was 45.37±19.48 mm long and 29.37±9.62 mm wide, while the myxoma excised by SMR was 50.02±16.18 mm long and 30.35±9.96 mm wide. There were no significant differences in the operation time, CPB time, and aortic cross-clamp time between the groups ($P > 0.05$). (Table 2)

When the Mini-MR group was compared with the SMR group, the CSICU stay time was 1.73±0.29d vs. 2.27±1.53d ($P = 0.008$), and postoperative ventilator assistance time was 13.05±4.98h vs. 17.07±9.52h ($P = 0.032$), postoperative hospital stays were 6.20±1.50d vs. 9.48±3.37d ($P < 0.001$), postoperative drainage for the first 24h was 38.93±69.62 ml vs. 178.25±153.06 ml ($P < 0.001$), and 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, two patients had pneumonia, one had a pleural effusion, and one had renal insufficiency. In the SMR group, one patient had a stroke, three had pneumonia, one had pleural effusion, nine had atrial fibrillation, one had renal insufficiency, and three had poor wound healing. The results showed that compared with the SMR group, the CSICU stay time, postoperative ventilator assistance time, postoperative drainage in the first 24h, 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, rate of pleural effusion, rate of new-onset atrial fibrillation, rate of renal insufficiency, rate of poor incision healing, rate of reoperation for hemostasis, and postoperative mortality were not significantly different between the two groups ($P > 0.05$). (Table 3)

DISCUSSION

The routine resection for a myxoma is SMR. With a long history, many studies have proven that it is safe and feasible [Shah 2015; Garatti 2012; Tasoglu 2009; Lee 2017]. However, SMR needs to split the sternum in the middle, which destroys the normal bone structure of the sternum and increases the pain experienced by the patient after operation. With the use of wire and bone wax, the risk of foreign body rejection is higher in SMR [Pradeep 2021; Chen 2019]. Additionally, obese patients or patients with diabetes are more prone to incision fat liquefaction or infection, resulting in a prolonged unhealed incision and leaving large scars [Peng 2019; Lv 2019]. In contrast, Mini-MR adopts a small right chest incision, the position of the surgical incision is hidden, and the appearance is better. On the one hand, Mini-MR does not require sawing

of the sternum, thus maintaining the stability of the sternum, which is beneficial to reduce postoperative thoracic deformity and related complications caused by weak wire fixation. On the other hand, because the normal structure of the sternum is maintained, patients who choose right thoracic small incision surgery will not experience pain caused by sternum dehiscence during breathing, which reduces postoperative pain and facilitates rapid recovery and early discharge.

In this study, compared with the SMR group, the Mini-MR group had a shorter operation time, longer aortic cross-clamp time, and longer CPB time, but the difference was not 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 operation is prolonged. The study by Dong et al. [Dong 2018] showed that compared with SMR, Mini-MR has a longer operation time, aortic cross-clamp time, and CPB time, but the difference was not significant. Mini-MR relies on special minimally invasive surgical instruments and requires the assistance of thoracoscopy. Thus, the surgeon performing Mini-MR has a learning curve. At the same time, because the assistance of thoracoscopy is needed, the cooperation of assistants also is very important. With the improvement in surgical proficiency, the time of minimally invasive aortic cross-clamping and CPB time will gradually shorten to the same time as that of median thoracotomy. Minimally invasive surgery greatly shortens the overall operation time because it does not require complicated chest closure to stop bleeding.

After cardiac surgery, patients immediately will be 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 assistance has been shown to be related to pulmonary complications,

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^2)	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 II/III	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; LVEDS, left ventricular end-systolic diameter; AF, atrial fibrillation; Mini-MR, minimally invasive myxoma resection; SMR, sternotomy myxoma resection. Values expressed as mean±SD, n (%), or n1/n2

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; SMR, Sternotomy myxoma resection. Values expressed as mean±SD

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, sternotomy myxoma resection. Values expressed as mean±SD, n (%)

*P < 0.05

length of stay in the hospital, and increased length of stay in CSICU [Wang 2013; Reddy 2007]. 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 also were greatly reduced. Early removal of tracheal intubation can reduce pulmonary complications, and a short stay in the CSICU allows the patient to be transferred to the general ward as soon as possible. This is conducive to postoperative recovery and shortens the hospital stay, thereby reducing the patient's overall expenses.

Massive postoperative drainage and blood transfusion are associated with several complications. Massive postoperative drainage leads to reoperation for hemostasis. Studies have shown that a red blood cell count greater than four units is an independent risk factor for lung infection [Solh 2006]. Another study showed that blood transfusion plays an important role in the process of acute kidney injury after cardiac surgery [Karkouti 2009]. 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 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 rates. In the SMR group, the mean drained volume was 178 ml, but the blood transfusion rate was as high as 63%. The main reason was that the SMR group had more bleeding during the operation. But because the gauze and suction device could not accurately calculate the blood loss during the operation, the postoperative blood transfusion demand increased.

Complications after cardiac surgery increase the risk of mortality. In this study, there was no difference in the rate of stroke, rate of pneumonia, rate of pleural effusion, rate of new-onset atrial fibrillation, rate of renal insufficiency, rate of poor incision healing, rate of reoperation for hemostasis, and postoperative mortality. This also indicates that Mini-MR does not increase the risk of postoperative complications compared with SMR. In addition, Mini-MR requires the establishment of a peripheral cardiopulmonary bypass, so it needs to free the femoral artery and femoral vein. Free femoral artery and vein may cause femoral artery dissection, thrombus, hemangioma, stenosis, etc. [Cheng 2011]. These did not occur during the surgery. The maturity of surgical techniques can prevent such complications.

CONCLUSION

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

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