

# Is a minimally invasive approach for resection of benign cardiac masses superior to standard full sternotomy?

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## Abstract

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed was 'is a minimally invasive approach for resection of benign cardiac masses superior to standard full sternotomy?' A total of 50 papers were found using the reported search, of which, 11 represented the best evidence to answer the clinical question. The authors, country, journal, date of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. All 11 papers were retrospective studies, from which 4 were case-control studies comparing the minimally invasive approach with conventional full sternotomy, and 7 were case series. There were two minimally invasive techniques used, a right mini-thoracotomy and a partial hemi-sternotomy, the former being the most commonly used. The resection of benign cardiac masses is a low-risk procedure, with no mortality or conversions to full sternotomy reported. From the 4 case-control studies, cross-clamp time was similar in both groups, and only one report found a prolonged perfusion time with the minimally invasive approach. The incidence of major postoperative complications, including bleeding requiring reoperation (average from case-control studies: 0–4.5 vs 0–5.8%), renal failure (0 vs 0–10%) and prolonged ventilation (6–13 vs 11–19%), for the two approaches was similar. The incidence of postoperative stroke was better for the minimally invasive approach in one study (0 vs 14%,  $P = 0.023$ ). The main advantages of this technique are shorter intensive care unit (26–31 vs 46–60 h) and hospital stay (3.6–5.2 vs 6.2–7.4 days), the minimally invasive approach being significantly better in one and three reports, respectively. We conclude that minimally invasive resection of a benign cardiac mass using a right mini-thoracotomy approach can be performed with an operative morbidity and mortality at least similar to the standard full sternotomy approach. The information currently available for the minimally invasive approach for the resection of benign cardiac masses is limited and based only on retrospective studies and, therefore, prospective studies are required to confirm the potential benefits of minimally invasive surgery.

**Keywords:** Cardiac tumours • Cardiac masses • Minimally invasive cardiac surgery • Sternotomy • Review

## INTRODUCTION

A best evidence topic was constructed according to a structured protocol, fully described in the ICVTS [1].

## THREE PART QUESTION

In [patients undergoing resection of a benign cardiac mass] is [a minimally invasive approach] superior to [standard median sternotomy] in terms of [morbidity and mortality]?

## CLINICAL SCENARIO

A 60-year old woman with a history of controlled hypertension was admitted for transient right upper extremity weakness. As part of the workup for transient ischaemic attack, a transthoracic

echocardiogram performed revealed a large left atrial myxoma, and resection of the tumour is planned. Is a minimally invasive approach for resection of a benign cardiac mass worse, equal or better than standard sternotomy?

## SEARCH STRATEGY

Medline 1950 to August 2012 using the Pubmed interface: [(Title/Abstract) cardiac mass OR (Title/Abstract) cardiac masses OR (Title/Abstract) cardiac tumor OR (Title/Abstract) cardiac tumors OR (Title/Abstract) myxoma OR (Title/Abstract) papillary fibroelastoma] AND [(Title/Abstract) minimally invasive OR (Title/Abstract) mini-thoracotomy OR (Title/Abstract) mini-sternotomy OR (Title/Abstract) hemi-sternotomy OR (Title/Abstract) mini-thoracotomy OR (Title/Abstract) ministernotomy OR (Title/Abstract) hemisternotomy OR (Title/Abstract) mini thoracotomy OR (Title/Abstract) mini sternotomy OR (Title/Abstract) hemi sternotomy].

Table 1: Best evidence papers

Author, date, Journal and country Surgical approach Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Schilling <i>et al.</i> (2012), J Card Surg, USA [2]  Robotic-assisted right mini-thoracotomy Case-control (level 4)	Outcomes of 16 patients with atrial myxomas who underwent robotic-assisted resection were compared with those of 29 patients who had full sternotomy	In-hospital mortality Conversion to full sternotomy Bleeding requiring reoperation Postoperative renal failure Postoperative stroke Sternal wound infection Prolonged ventilation Blood products administered Perfusion time (mean $\pm$ SD) Cross-clamp time (mean $\pm$ SD) ICU length of stay (mean $\pm$ SD) Total hospital length of stay (mean $\pm$ SD) Tumour recurrence	0/16 (0%) vs 0/29 (0%), $P = NA$ None 0/16 (0%) vs 0/29 (0%), $P = NA$ 0/16 (0%) vs 3/29 (10%), $P = 0.54$ 0/16 (0%) vs 0/29 (0%), $P = NA$ 0/16 (0%) vs 0/29 (0%), $P = NA$ 1/16 (6%) vs 3/29 (11%), $P = 1.0$ 2/16 (13%) vs 7/29 (26%), $P = 0.30$ 91.3 $\pm$ 45.2 vs 96.8 $\pm$ 42.1 min, $P = 0.68$ 49.4 $\pm$ 37.6 vs 52.1 $\pm$ 39.6 min, $P = 0.82$ 30.9 $\pm$ 18.4 vs 47.7 $\pm$ 52.1 h, $P = 0.15$ 3.6 $\pm$ 0.8 vs 6.2 $\pm$ 5.1 days, $P = 0.05$ No follow-up	Retrospective nature of the study  Comparison with conventional sternotomy  Robotic-assisted excision of atrial myxomas had similar postoperative outcomes and shorter total hospital length of stay, when compared with standard median sternotomy
Panos <i>et al.</i> (2012), Ann Thorac Surg, Greece [3]  Video-assisted right mini-thoracotomy Case series (level 4)	10 patients underwent video-assisted minimally invasive resection of cardiac myxomas	In-hospital mortality Conversion to full sternotomy Postoperative complications PRBC's requirements Perfusion time (mean $\pm$ SD) Cross-clamp time (mean $\pm$ SD) ICU length of stay (mean $\pm$ SD) Tumour recurrence	None None None None 30 $\pm$ 15 min 25 $\pm$ 12 min 0.9 $\pm$ 0.2 days None (2–28 months follow-up)	Retrospective nature of the study  No comparison with standard approach
Pineda <i>et al.</i> (2011), Ann Thorac Surg, USA [4]  Right mini-thoracotomy Case-control (level 4)	Outcomes of 22 patients with benign cardiac masses who underwent excision through a right mini-thoracotomy were compared with those of 17 patients who had full sternotomy approach	In-hospital mortality Conversion to full sternotomy Postoperative complications Prolonged ventilation (>24 h) Bleeding requiring reoperation Postoperative stroke Postoperative renal failure Perfusion time (median, IQR) Cross-clamp time (median, IQR) ICU length of stay (median, IQR) Total hospital length of stay (median, IQR) Tumour recurrence	0/22 (0%) vs 0/17 (0%), $P = 1.0$ None 3/22 (14%) vs 4/17 (24%), $P = 0.42$ 2/22 (9%) vs 2/17 (12%), $P = 0.78$ 1/22 (4.5%) vs 1/17 (5.8%), $P = 0.85$ 0/22 (0%) vs 0/17 (0%), $P = 1.0$ 0/22 (0%) vs 1/17 (5.8%), $P = 0.24$ 78 (55–88) vs 57 (33–70) min, $P = 0.02$ 43 (30–64) vs 31 (23–47) min, $P = 0.20$ 27 (24–47) vs 60 (48–79) h, $P = 0.001$ 5 (4–6) vs 7 (6–8) days, $P = 0.03$ No follow-up	Retrospective nature of the study  Comparison with conventional sternotomy Excision of atrial myxomas through a right mini-thoracotomy had similar postoperative outcomes and shorter ICU and total hospital lengths of stay, when compared with standard median sternotomy
Iribarne <i>et al.</i> (2010), Ann Thorac Surg, USA [5]  Right mini-thoracotomy or hemi-sternotomy Case-control (level 4)	Outcomes of 38 patients with cardiac masses who underwent excision through minimally invasive approach were compared with those of 36 patients who had full sternotomy approach	In-hospital mortality Conversion to full sternotomy Prolonged ventilation (>24 h) Bleeding requiring reoperation Postoperative stroke Postoperative renal failure Perfusion time (mean $\pm$ SD) Cross-clamp time (mean $\pm$ SD) Total hospital length of stay (mean $\pm$ SD) 1-year mortality Tumour recurrence	0/38 (0%) vs 0/36 (0%), $P = 1.0$ None 5/38 (13%) vs 7/36 (19%), $P = 0.54$ 0/38 (0%) vs 1/36 (2.8%), $P = 0.48$ 0/38 (0%) vs 5/36 (14%), $P = 0.023$ 0/38 (0%) vs 0/36 (0%), $P = 1.0$ 77.0 $\pm$ 4.4 vs 68.0 $\pm$ 4.4 min, $P = 0.15$ 41.3 $\pm$ 4.1 vs 39.3 $\pm$ 3.5 min, $P = 0.71$ 5.2 $\pm$ 0.6 vs 7.4 $\pm$ 0.9 days, $P = 0.03$ 0/38 (0%) vs 1/36 (2.8%), $P = 0.48$ No information	Retrospective nature of the study  Comparison with conventional sternotomy  Excision of atrial myxomas through a right mini-thoracotomy had similar postoperative outcomes and shorter hospital length of stay, when compared with standard median sternotomy
Vistarini <i>et al.</i> (2010), Interact	Outcomes of 14 patients with a left atrial myxoma	In-hospital mortality Conversion to full sternotomy	None None	Retrospective nature of the study

Continued

Table 1: (Continued)

Author, date, Journal and country Surgical approach Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Cardiovasc Thorac Surg, Italy [6] Right mini-thoracotomy Case series (level 4)	who underwent excision through a right mini-thoracotomy are presented	Bleeding requiring reoperation Postoperative stroke Wound complications Perfusion time (mean ± SD) Cross-clamp time (mean ± SD) Total hospital length of stay Mean ICU length of stay 2-year mortality Tumour recurrence	1 (7%) 2 (14%) None 88 ± 57 min 49 ± 29 min Mean 8 days Mean 3 days 2 (14%) None (mean follow-up 24 months)	No comparison with standard approach
Russo <i>et al.</i> (2007), Heart Surg Forum, USA [7] Right mini-thoracotomy Case-control (level 4)	Outcomes of 16 patients with atrial masses who underwent excision through minimally invasive approach were compared with those of 18 patients who had full sternotomy approach	In-hospital mortality Conversion to full sternotomy PRBC units transfused Perfusion time (mean ± SD) Cross-clamp time (mean ± SD) ICU length of stay (mean) Total hospital length of stay (mean ± SD) 2-year mortality Tumour recurrence	0/16 (0%) vs 0/18 (0%), $P = 1.0$ None Mean 0.38 vs 0.35, $P = 0.93$ 76.5 ± 29.0 vs 70.5 ± 28.5 min, $P = 0.57$ 47.3 ± 27.7 vs 32.7 ± 22.3 min, $P = 0.14$ 26.2 vs 46.1 h, $P = 0.15$ 5.1 ± 2.8 vs 6.4 ± 2.8 days, $P = 0.18$ 0/18 (0%) vs 1/16 (5.6%), $P = 0.34$ None (2-year follow-up in 26/34 patients)	Retrospective nature of the study Comparison with conventional sternotomy Excision of atrial masses through a right mini-thoracotomy had similar postoperative outcomes when compared with standard approach Up to 1-year follow-up available
Hsu <i>et al.</i> (2006), Interact CardioVasc Thorac Surg, USA [8] Upper hemi-sternotomy Case series (level 4)	4 patients underwent excision through an upper hemi-sternotomy	In-hospital mortality Conversion to full sternotomy Postoperative complications Perfusion time Cross-clamp time Total hospital length of stay Tumour recurrence	None None None Mean 66 min Mean 35 min Mean 4 days No follow-up	Retrospective nature of the study No comparison with standard approach
Bossert <i>et al.</i> (2006), Interact CardioVasc Thorac Surg, Germany [9] Right mini-thoracotomy Case series (level 4)	77 patients with primary cardiac tumours, including 19 patients with benign tumours who underwent right mini-thoracotomy	30-day mortality Conversion to full sternotomy Perfusion time (median, IQR) Cross-clamp time (median, IQR) Tumour recurrence	0/19 (0%) vs 2/58 (3.4%), $P = 0.56$ None 91 (50–124) min 54 (22–65) min None (mean follow-up 5.1 years)	Retrospective nature of the study Limited comparison with conventional full sternotomy
Nordstrand <i>et al.</i> (2005), Heart Lung Circ, Australia [10] Upper hemi-sternotomy Case series (level 4)	2 patients underwent removal of a left atrial myxoma through an upper hemi-sternotomy	In-hospital mortality Conversion to full sternotomy Perfusion time Cross-clamp time ICU length of stay Total hospital length of stay Tumour recurrence	No deaths No conversions Mean 77 min Mean 36 min Mean 3.5 days Mean 11 days None (mean follow-up 3.1 months)	Retrospective nature of the study No comparison with standard approach
Ravikumar <i>et al.</i> (2000), Ann Thorac Surg, India [11]	5 patients underwent removal of a cardiac tumour through a partial sternotomy or a right mini-thoracotomy	In-hospital mortality Conversion to full sternotomy Complications Perfusion time Cross-clamp time	No deaths No conversions Stroke 1/5 (20%) Mean 91 min Mean 59 min	Retrospective nature of the study No comparison with standard approach

Continued

Table 1: (Continued)

Author, date, Journal and country Surgical approach Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Partial sternotomy or right mini-thoracotomy Case series (level 4)		Total hospital length of stay Tumour recurrence	Mean 7.8 days None (follow-up not specified)	
Ko and Tam (1998), <i>Ann Thorac Surg</i> , Taiwan [12]	3 patients underwent removal of a left atrial myxoma through a right mini-thoracotomy	In-hospital mortality Conversion to full sternotomy Complications Perfusion time Cross-clamp time	No deaths No conversions None Mean 111 min Mean 58 min	Retrospective nature of the study No comparison with standard approach
Right mini-thoracotomy Case series (level 4)		Total hospital length of stay Tumour recurrence	Mean 7.7 days (range: 5–12) None (mean follow-up 10.5 months)	

ICU: intensive care unit; PRBC: packed red blood cells; SD: standard deviation; IQR: interquartile range (25–75); NA: not applicable.

## SEARCH OUTCOME

Using the reported search, 50 papers were found. Articles that did not include information specifically on cardiac masses or tumours resection were excluded, as were review articles, letters to the editor and single case reports. Finally, 11 papers were identified as the best evidence to answer the initial question (Table 1).

## RESULTS

### Right mini-thoracotomy approach

In 1998, Ko *et al.* [2] first reported a case series of 3 patients who underwent removal of atrial myxomas through a right mini-thoracotomy. They reported no complications, conversion to full sternotomy or deaths, and none of the tumours recurred at 10.5 months' follow-up. In another early report in which 5 patients underwent minimally invasive atrial tumour excision via a right mini-thoracotomy (2 patients) or a partial sternotomy (3 patients), Ravikumar *et al.* [3] reported a complication rate of 20%, given by one postoperative stroke. Vistarini *et al.* [4] presented 14 patients undergoing a left atrial myxoma removal through a right mini-thoracotomy, and showed a similar complication rate, with 7 and 14% of the patients having reoperation for bleeding and postoperative stroke, respectively. At 2 years' follow-up, there were no recurrences.

Bossert *et al.* [5] published a series of 77 patients undergoing a cardiac tumour removal, including 19 patients with atrial myxomas who had a right mini-thoracotomy approach. Aortic cross-clamp and cardiopulmonary bypass times were longer in

the group of patients undergoing a minimally invasive approach, and although not statistically significant, 2 patients in the conventional sternotomy group died compared with none in the minimally invasive group.

The first case-control study of patient undergoing excision of atrial myxomas was reported by Russo *et al.* [6] Outcomes of 16 patients who had a right mini-thoracotomy were compared with those of 18 who had standard full sternotomy. No differences were noted between the two groups in transfusion requirements, intensive care unit (ICU) or hospital lengths of stay or in-hospital mortality. There were no conversion to full sternotomy, and at 2 years none of the patients had tumour recurrence. In 2010, the same group published the long-term data of 74 patients with resection of a cardiac mass (38 right mini-thoracotomy vs 36 conventional sternotomy) [7]. They demonstrated excellent outcomes of the minimally invasive approach, with no difference compared with the standard approach in regard to most of the postoperative complications and in-hospital and 1-year mortality. In fact, the minimally invasive approach was associated with a shorter hospital stay and lower postoperative strokes, which was related to an overall higher risk for stroke in their conventional sternotomy group, due to higher incidence of atrial fibrillation, thrombi and complex atrial reconstruction.

Our group reported the outcomes of 22 patients who underwent excision of a benign cardiac mass through a right mini-thoracotomy compared with those of 17 patients who had full sternotomy [8]. No difference in postoperative complications, including mortality, was found between groups. However, the minimally invasive approach was associated with a significantly shorter ICU and total hospital lengths of stay.

Panos and Myers [9] reported their results with a video-assisted right mini-thoracotomy approach for 10 patients with cardiac myxomas. They reported a short ICU length of stay, and

none of the patients had postoperative complications or tumour recurrence. Schilling *et al.* [10] published the outcomes of 16 patients with atrial myxomas resected through a robotic-assisted right mini-thoracotomy compared with 29 via a standard sternotomy. Patients in the minimally invasive group had a significantly shorter hospital length of stay, with similar postoperative morbidity and mortality.

### Partial upper hemi-sternotomy approach

For patients undergoing excision of cardiac masses through a partial hemi-sternotomy, there are limited data, with 3 case series being published [3, 11, 12]. The study by Ravikumar *et al.* [3], which included both partial hemi-sternotomy and right mini-thoracotomy, has already been discussed in the previous section. Hsu *et al.* [11] reported 4 patients with papillary fibroelastomas who had uncomplicated resection via a partial sternotomy. On the other hand, Nordstrand and Tam [12] reported 2 patients who had a left atrial myxoma removed through a partial upper hemi-sternotomy, and reported a prolonged hospital length of stay secondary to arrhythmias and pulmonary complications.

### CLINICAL BOTTOM LINE

For patients undergoing excision of a benign cardiac mass, minimally invasive surgery primarily by means of a right mini-thoracotomy is feasible and is at least as safe as conventional full sternotomy. It has been shown to be associated with shorter ICU and total hospital lengths of stay, with similar postoperative complications, mortality and tumour recurrence. However, due to the limited number of studies and their retrospective design, the results of minimally invasive surgery for the excision of cardiac masses should be confirmed by prospective studies with larger numbers of patients.

**Conflict of interest:** none declared

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