Article published online: 2022-03-22

Head and Neck Cancer

Maximal Thymectomy via Mini Sternotomy with Pleural Preservation

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South Asian J Cancer 2022;11(3):229–234.

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Abstract

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Background There are different surgical techniques used for maximal thymectomy. Each technique has its own advantages and disadvantages. We propose a mini sternotomy with pleural preservation approach for complete maximal thymectomy.

Methods Over time range of 5 years, 32 patients with diagnosis of thymoma with or without myasthenia gravis (MG) underwent maximal thymectomy by mini sternotomy in our institute. Patient records were examined for the following parameters: age, sex, preoperative medication, symptoms of MG as per Myasthenia Gravis Foundation of America grading system, operating time, duration of postoperative ventilation, length of stay in the intensive care unit, overall length of hospitalization, and postoperative complications.

Results The mean age of patients in our study was 43.66. Sex ratio in this study was almost equal. Sixty-nine percent of patients were stage I thymoma according to Masaoka staging. Size of the tumor ranged from 3 to 8 cm with mean size being 4.54 cm. Complete resection with negative tumor margins was possible in all the cases. Four patients had intraoperative pleural injury out of which two patients required intercostal tube insertion. We did not have any serious postoperative complications with no perioperative mortality.

Conclusions Mini sternotomy allows maximal removal of thymus through a less invasive approach and is associated with a significantly smoother postoperative course, less overall complications, and good clinical outcome. It is a simple technique that can be performed by any thoracic and surgical oncologists especially in Indian subcontinent where facilities of video-assisted thoracoscopic surgery and robotic video-assisted thoracoscopic surgery are not available in all areas and are expensive.

Keywords

- thymectomy
- sternotomy
- thymic neoplasm, thymoma
- myasthenia gravis
- thoracic surgery, video-assisted
- surgery, robotic-assisted

Introduction

Thymoma, the most common neoplasm of the thymus gland, originates from its epithelial tissue. Thymomas are also the most common neoplasm of the anterior mediastinum in adults that account for ~50%.[1] The incidence of thymoma is 0.15 per 1,00,000 person years.[2] They have frequent association with various paraneoplastic syndromes with myasthenia gravis (MG) being most common.[1]

Maximal thymectomy is the main treatment for thymoma. The traditional approach is through a median complete sternotomy, but, recently minimally invasive approaches in the form of video-assisted thoracoscopic surgery (VATS) and robotic video-assisted thoracoscopic surgery (R-VATS) are

DOI https://doi.org/10.1055/s-0042-1743162 ISSN 2278-330X

How to cite this article: Patel G, Reddy BVK, Patil P, Maximal Thymectomy via Mini Sternotomy with Pleural Preservation. South Asian J Cancer 2022;11(3):229–234.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

increasingly being performed.[3–5] Each of these approaches have their own advantages and disadvantages. Complete median sternotomy though gives the best exposure but it is too morbid procedure considering the need of elective postoperative ventilation in few cases, higher doses of postoperative analgesia including opioids and it requires intercostal drain (ICD) tube insertion, if pleura is opened, which all adds to restriction of breathing efforts and leads to atelectasis. Complete transcervical approach leads to incomplete excision of gland and more complications. VATS, though is less painful procedure, requires bilateral approach for the completion of thymectomy, thus needing bilateral ICD tube insertion and it is difficult to excise the suprainnominate vein extension of the thymic gland, thus leaving some thymic tissue at the root of neck. R-VATS provides good exposure, but the cost and availability are a major drawback in India.

We propose a mini sternotomy with pleural preservation approach for complete maximal thymectomy. It has the advantage of adequate exposure of the entire thymus gland and the perithymic tissue with minimum morbidity by obviating the need of ICD tube insertion, no elective postoperative ventilation, lesser pain, and lesser incidence of respiratory complication. It does not have a steep learning curve as VATS and R-VATS without any need of special armamentarium, which can be done by any thoracic or surgical oncologist in remote places of the country.

Patients and Methods

Over time range of 5 years, 32 patients with diagnosis of thymoma with or without MG underwent maximal thymectomy by mini sternotomy in our institute. Inclusion criteria were the presence of thymoma stage I and II as per Masaoka staging, regardless of age or sex. Exclusion criteria were the presence of chest deformities, infiltrating thymoma, associated pulmonary and cardiac pathology, and the presence of a myasthenic crisis in a diagnosed case of MG.

Patient records were examined for the following parameters: age at surgery, patient sex, preoperative medication, medically optimized preoperative level of symptoms for MG patients according to Myasthenia Gravis Foundation of America (MGFA) grading system, operating time, duration of postoperative ventilation, length of stay in the intensive care unit, overall length of hospitalization, and postoperative complications.

Preoperative medications were administered till the morning of surgery, as prescribed by the neurologist.

During anesthesia, the administration of muscle blocking agents was avoided. Intravenous opioids were used cautiously. The operation was performed under general anesthesia using a single lumen tube.

A vertical midline skin incision is made starting just below the suprasternal notch up to the level of the third cartilage. The incision is carried down to the sternal periosteum. "L"-shaped mini sternotomy is made starting from the suprasternal notch up to upper border of third cartilage. With the sternum retracted, adequate visualization of the thymus and its cervical extensions is obtained. Thymus gland is first dissected off the innominate vein. Superior horns are resected from lower pole of thyroid bilaterally. Pleura is dissected off from both the hilum's and safeguarded. This is achieved by careful hand-controlled ventilation by anesthetist. Thymic tissue is then dissected off from the innominate vein till superior vena cava on right side and left pulmonary hilum on left side. Both phrenic nerves are identified and preserved. The inferior horns are dissected off the pericardium with its associated pericardial fat pad (►Figs. 1–3).

Complete removal of the thymus and perithymic tissue is done that includes tissue between the superior vena cava on right side, pulmonary conus and aortic arch on left side, lower pole of thyroid superiorly including superior horns of thymus, pericardial sac, and mediastinal pleura inferiorly that constitute maximal thymectomy.

Meticulous exploration in terms of completion of procedure and hemostasis is performed. Before closure, a 12 Fr negative pressure drain is placed in the anterior mediastinum. ICD is inserted only if there is major pleural injury. The sternum is then sutured with stainless steel threads. Further closure is done in layers to conclude the procedure. A full sternotomy to complete the operation was not needed in our series.

Successful postoperative management of these patients requires close cooperation among the neurologist, operating surgeon, nurses, and physiotherapists. Patients were extubated in the operating room if possible. The prerequisite was enough muscle power to breathe spontaneously with satisfactory gas exchange. After surgery, all patients were taken to the intensive care unit. Patients can have soft or full diet on the evening of surgery. In case of MG patients, preoperative medications are resumed as soon as the patient is started on oral feeds. Negative pressure drain is removed on third postoperative day depending on its measurement. A neurology team is responsible for the late follow-up; therefore, medications are adjusted according to the symptoms on outpatient basis.

Results

A total of 32 patients were enrolled in this study. Of these 32 patients, 30 patients were known case of MG and had anterior mediastinal mass in computer tomography (CT) scan. Rest was incidental anterior mediastinal mass that on CT-guided biopsy suggested of thymoma.

The mean age of patients was 43.66. Sex ratio was almost equal. There was no perioperative mortality.

Grades of myasthenia gravis as per MGFA:

Grade of MG	Number	Percentage
I	8	26.6
IIA	14	46.6
IIB	5	16.6
IIIA	3	10
≥IIIB	0	0
Total	30	100

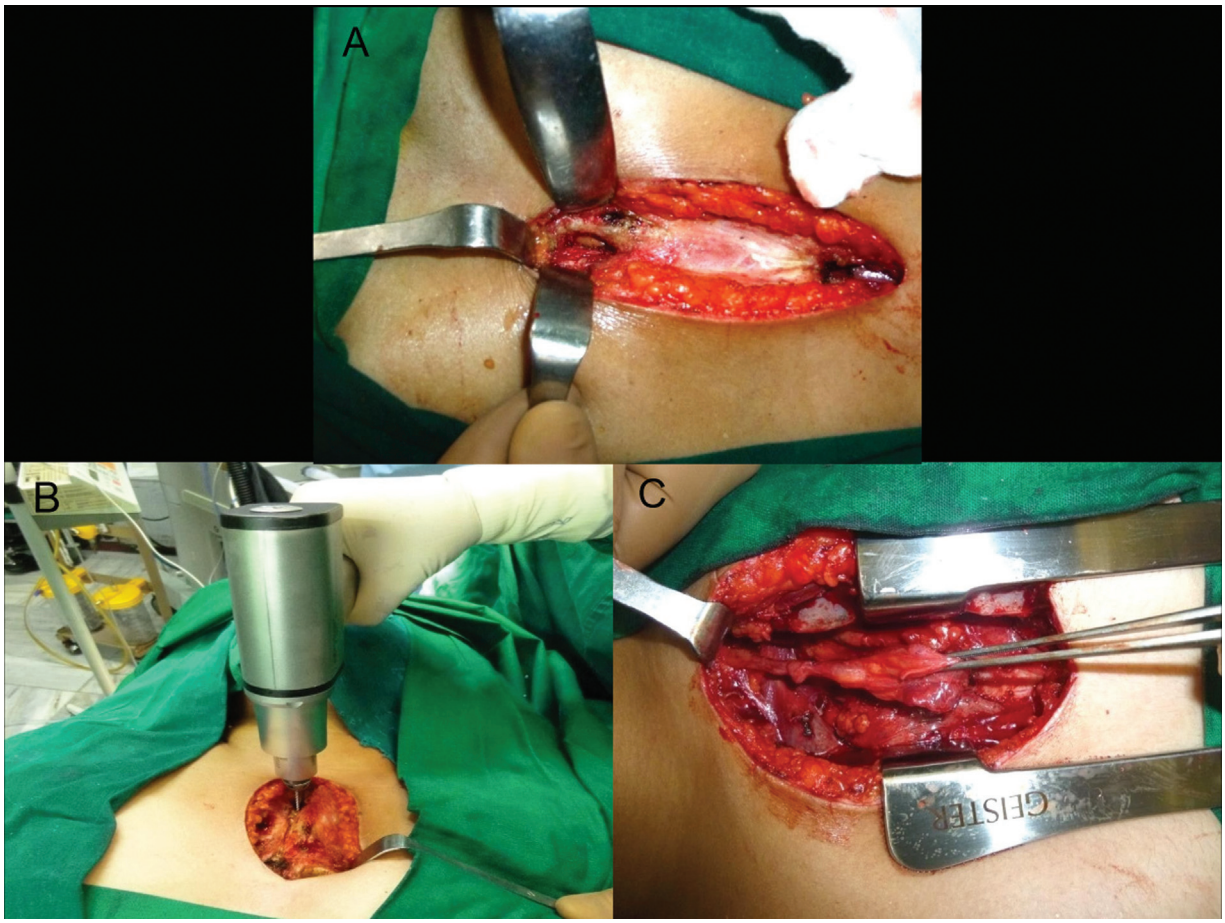

Fig. 1 (**A**) Exposure of sternum up to third rib space, safe guarding ipsilateral internal mammary artery before cutting bone; (**B**) performing partial sternotomy using motorized saw; (**C**) excision of thymus gland and perithymic tissue along with thyrothymic ligaments.

In the patients with MG, majority (46.6%) had Grade IIA symptoms as per MGFA, followed by Grade I and Grade IIB symptoms. None of the patients had Grade IIIB and severe symptoms.

Sixty nine percent of patients were stage I thymoma according to Masaoka staging. Size of the tumor ranged from 3 to 8 cm with mean size being 4.54 cm.

Complete resection with negative tumor margins was possible in all the cases. Four patients had intraoperative pleural injury out of which two patients required pleura and lung wedge resection and hence ICD tube placement. All patients were extubated in operating room and none required reintubation in postoperative period. The mean operating time was 139.7 minutes and mean intensive care and hospital stay were 4 and 8.2 days, respectively. Intraoperative blood loss was minimal and none of our patient required any blood transfusion.

We did not have any serious complications related to mini sternotomy; pain control was adequate with transdermal fentanyl patch (25 µg), no reoperation in our series, no postoperative bleeding, mediastinitis, pneumonitis or pneumonia, no serious collections in the subcutaneous space, good cosmetic results, and no diaphragmatic palsy was detected by postoperative roentgenogram. There was no residual pneumothorax or hemothorax.

Discussion

Thymoma, although is a rare disease, represents the most common primary mediastinal neoplasm in adults. Thymectomy is an important component in the treatment of thymoma and anterior mediastinal tumors, while stage and radical resection are considered as very important predictors of survival. Presence of MG is not an independent prognostic factor but may play a role in early detection of thymic tumors.[6] About one third are associated with MG and their resection significantly improves the symptoms of MG.

Since the first thymectomy reported in 1939,[7] there has been growing interest in developing minimally invasive approaches to reduce the morbidity of conventional sternotomy. The beneficial effect of thymectomy is thought to be maximized by the removal of all thymic tissue, including ectopic thymic tissue.[8,9] Hence, concern about obtaining less morbidity results should not reduce the ability to achieve radical resection of thymic tissue, which remains the primary objective of surgery.

Thymectomy may be performed by median sternotomy[10,11] (with or without a transcervical extension), partial sternotomy,[12] a transcervical incision,[13] transcervical incision combined to partial sternotomy,[14] and more recently, VATS and R-VATS.[15–19]

Fig. 2 (**A**) Postoperative bed after complete maximal thymectomy showing the bare innominate vein; (**B**) closure of the sternum using stainless steel wires; (**C**) closure of the skin with clips after insertion of negative pressure 12 Fr drain.

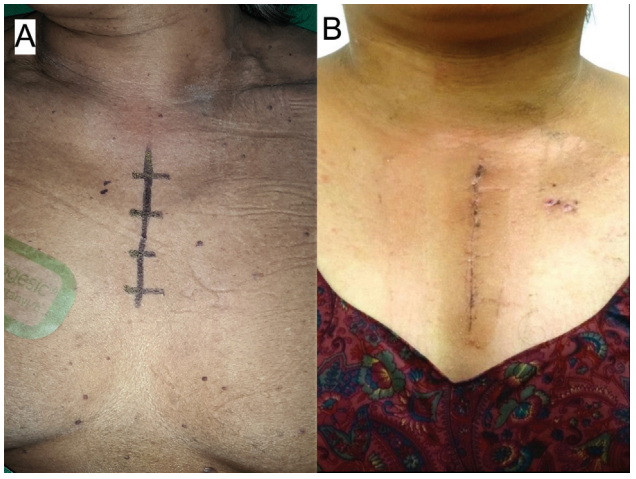

Fig. 3 (**A**) Incision planning for partial sternotomy approach; (**B**) postoperative scar after 1 month follow-up.

As with any of these techniques, the surgeon must excise complete thymic tissue. With the use of any above-described approach, the incision should be enlarged or the technique should be changed whenever there is the slightest chance of unsatisfactory resection. Removal should be deemed unsatisfactory whenever the thymus gland is torn by surgical traction or is withdrawn in pieces. In the largest retrospective analysis of thymectomy, 92% of patients achieved an R0 resection. Survival at 5 years for stage I, II, III, and IVa was 100, 98, 89, and 71%, respectively, and at 10 years was 100, 98, 78, and 47%, respectively. This study illustrated that complete microscopic resection is achievable in a large proportion of cases and that survival after an R0 resection was significantly higher, establishing that complete surgical resection is the best therapeutic modality for thymoma.[20] Similar results have been reported in other series.[21–24] The transcervical approach to perform thymectomy is a less invasive approach, with good aesthetic results and fast recovery. However, it definitely provides poorer visualization of the thymus and surrounding structures, especially in cases of thymoma, compared with total or partial longitudinal sternotomy.[25] Although in literature there are studies performing thoracoscopic unilateral hemi/partial thymectomy and even thymectomy with positive margins that is against the principle of oncology, we suggest future trials to know the different extents of resection for thymoma with respect to efficacy and safety.[26–28] In our series with mini sternotomy, R0 resection was achieved in all the patients with no recurrence in 5 years follow-up and reduction in dosage and drugs for MG treatment were also seen over the months postsurgery.

From technical point of view, unilateral VATS may give multiple challenges. Resection of tissue in the right cardiophrenic angle and within the confluence of the superior vena cava and innominate vein can be challenging using a left-sided approach, while a right-sided approach could limit resection of tissue in the left-sided cardiophrenic angle fat and/or at the level of the aortopulmonary window. Hence, maximal thymectomy via VATS or R-VATS will require bilateral approach with bilateral ICD tubes placement, thus increasing the morbidity. In our series, 93.75% of patients did not require any ICD placement.

The mean operative time taken together in few comparative studies between VATS and open thymectomy is 203.8 and 173.2 minutes, respectively.[28–32] Similarly in comparative studies between R-VATS and open thymectomy, the mean operative time taken together was 151 and 97.3 minutes, respectively.[33–36] This is possibly due to the more complex operative setup required for minimal invasive surgery, but has also been demonstrated to be as a result of the inevitable learning curve that comes with the use of these new techniques. Mean operative time in our series was 139.7 minutes.

As far as mean hospital stay and intensive care stay are concerned, VATS and R-VATS showed fewer days than transsternal approach. Few of comparative studies between VATS and open thymectomy show mean hospital stay of 8.4 and 12.2 days, respectively,[28–31] whereas studies between R-VATS and open thymectomy show 3.9 and 7.3 days, respectively.[33–36] Mean intensive care stay for open, VATS, and R-VATS thymectomy in various studies was 1.5, 1.4, and around 1 day, respectively.[28–31,37,38] In our series of mini sternotomy, mean intensive care stay and hospital stay were 4 and 8.2 days, respectively. Intensive care stay was more in our series to keep a check on myasthenic crisis as most of our patients were of MG (93.75%) and it was also as per the instructions from our neurology team.

Although inconsistently reported across the studies, there are certain potential complications associated with VATS and R-VATS including phrenic nerve injury and increase risk of pleural dissemination of tumor. These complications may be increased in the initial stages of the learning curve associated with VATS thymectomy and excessive manipulation of the thymoma in the restricted working space of the anterior mediastinum, making the tumor capsule more prone to tearing, as well as incision of the mediastinal pleura, which may facilitate seeding of tumor cells.[29,39,40] None of our patients had phrenic nerve injury or pleural dissemination of tumor, which is similar to other transsternal thymectomy studies.[29,41]

In our series, none of the patient had any complications in terms of excessive pain, postoperative bleeding, mediastinitis, pneumonitis, pneumonia, pneumothorax, hemothorax, no serious collections in the subcutaneous space, no reoperation or any diaphragmatic palsy detected in postoperative roentgenogram. In general, extubation is delayed for few hours with fear of patient not able to breathe because of pain or muscle weakness due to MG. But in our experience, mini sternotomy with pleural preservation, patients had no ICD tube insertion; hence, pain was controlled well that led to minimal respiratory restriction. All the patients in our series were extubated in the operating room and none required reintubation in the postoperative period.

Most of the studies have taken complete median sternotomy for comparison and hence it shows more complications in postoperative period than VATS and R-VATS. Furthermore, most of the authors use the VATS approach when the tumor diameter is less than 5 cm, not involving the innominate vein, with little or no evidence of invasion or compression of major mediastinal structures.[42] There is a great advantage to mini sternotomy for maximal thymectomy, as the possibilities of pain, wound infection, mediastinitis, pulmonary complications, and sternal destabilization/dehiscence are much lower than complete sternotomy and avoidance of ICD tube placement and its associated morbidities in compared with VATS and R-VATS.

Thus, trans-sternal approach is currently considered as the gold standard approach for thymic resection. However, interest has grown in minimally invasive surgical approaches, most notably VATS and R-VATS thymectomy. There are various comparison studies among these various approaches, but they have their own limitations as they are nonrandomized, observational in nature, with small sample sizes, and insufficient and/or inconsistent reporting of outcomes including long-term survival, recurrence rates, and postoperative complications. As mentioned before, most of the trials included complete median sternotomy rather than mini sternotomy that is less invasive and has far lesser morbidities than the complete sternotomy.

Conclusion and Recommendation

Although the number of patients is small, our data indicate that thymectomy through mini sternotomy allows maximal removal of thymus through a less invasive approach and is associated with a significantly smoother postoperative course and less overall complications. The clinical outcome is very encouraging. Mini sternotomy can be considered as minimal access, as it allows maximal thymectomy and improves the operative outcome in terms of pain control, hospital stay, and good cosmetic results. Additionally, it is a simple technique to perform, easy to teach and learn, and uses conventional surgical instruments. This approach deserves the attention of all thoracic and surgical oncologists especially in Indian subcontinent because of the ease of the procedure and where facilities of VATS and R-VATS are not available in all areas and are expensive.

Conflict of Interest

None declared.

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