




Thoracoscopic Thymectomy for Myasthenia Gravis: An Early Experience in Yemen

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Background: Thymectomy is an option for the treatment of myasthenia gravis (MG). While the open technique was most frequently performed in the past, nowadays the endoscopic approach has gained wide acceptance. Here we assessed our early experience in thoracoscopic thymectomy (TT).

Methods: This case series was retrospectively conducted at Al-Thawra Modern General Hospital and included all patients diagnosed with MG who underwent TT from January 2018 to January 2024.

Results: Our case series consisted of 13 predominantly female patients (61.5%), with a median age of 39.5 years. Surgeries typically lasted 50 ± 10.41 minutes, with the majority performed using a left-sided thoracoscopic approach ($n=10$, 77%). Immediate extubation was achieved in 10 patients (76%). Four patients experienced early postoperative complications (31%), including dyspnoea, prolonged intubation, chest infection, confusion, tracheostomy, and re-tracheostomy. There were 2 recorded deaths due to complications. Eleven patients were followed up for an average of 16.5 months, revealing that 54.5% achieved complete stable remission, 18% showed improvement with reduced symptoms and medications, and 27% remained unchanged.

Conclusion: Thoracoscopic thymectomy is feasible and effective procedure for the management of MG in Yemeni patients. The observed remission and improvement rates are promising and align with global experiences. It is recommended that with proper resources and expertise, similar minimally invasive surgical approaches can be implemented in resource-limited regions.

Plain language summary: This study was conducted to evaluate the use of thoracoscopic thymectomy (TT) for the treatment of myasthenia gravis (MG) at Al-Thawra Modern General Hospital. In this study, we included 13 predominantly female patients with a median age of 39.5 years. The most common symptoms experienced by the patients were generalized weakness and ptosis (drooping of the eyelids).

During the surgeries, which typically lasted around 50 minutes, we primarily used a left-sided thoracoscopic approach. We were successful in immediately removing the breathing tube in 10 out of 13 patients. However, four patients experienced early postoperative complications, including difficulties in breathing, longer intubation, chest infection, confusion, and the need for tracheostomy.

Out of the 13 patients, two unfortunately passed away due to complications. We followed up with 11 patients for an average of 16.5 months and observed that 54.5% of them achieved complete stable remission, meaning they had no MG symptoms and did not require any treatment for at least one year. Additionally, 18% of the patients showed improvement with reduced symptoms and medication usage, while 27% remained unchanged.

Based on our findings, we conclude that thoracoscopic thymectomy is a safe and effective procedure for managing MG in Yemeni patients. The remission and improvement rates we observed align with experiences from around the world. We believe that with appropriate resources and expertise, similar minimally invasive surgical approaches can be implemented in resource-limited regions.

Keywords: indications, early complications, thoracoscopic thymectomy, Yemen

Introduction

Myasthenia gravis (MG) is a chronic autoimmune neuromuscular disease characterized by varying degrees of weakness of the voluntary muscles of the body. This condition is caused by a breakdown in the normal communication between nerves and muscles due to antibodies that block or alter the function of acetylcholine receptors at the neuromuscular junction.^{1–3} The hallmarks of MG include muscle weakness, drooping eyelids, and difficulties with vision, speaking, swallowing, and breathing.⁴

The thymus gland is implicated in the pathogenesis of MG, particularly in patients with thymomas or thymic hyperplasia. Thymectomy, the surgical removal of the thymus gland, is performed to improve the weakness caused by MG. It is a well-established treatment modality that has been shown to improve symptoms and reduce the need for immunosuppressive medications.^{5,6}

Thoracoscopic thymectomy (TT) or video-assisted thoracoscopic surgery (VATS) offers several advantages over open surgery. These include shorter hospital stays, less postoperative pain, reduced blood loss, lower rates of blood transfusion, and quicker recovery times.^{7,8} In addition, the minimally invasive nature of VATS leads to better cosmetic outcomes and possibly lower overall healthcare costs.

Thoracoscopic thymectomy is utilized in various countries for the treatment of conditions like myasthenia gravis and thymoma. Research from different regions, such as Iran, Spain, and Asia, highlights the effectiveness and safety of thoracoscopic thymectomy in managing non-thymomatous myasthenia gravis.^{9–11} Additionally, the technique has been employed in the treatment of thymic carcinoma and other thymic pathologies in different countries, demonstrating its versatility and widespread acceptance in the surgical management of various thoracic conditions.¹²

Although MG is a known health concern globally, the prevalence and management of the disease in Yemen are not well documented. This study aimed to shed light on the early experience of TT for MG patients in Yemen, where healthcare resources may be limited. Understanding the outcomes of this minimally invasive procedure in a resource-constrained setting is crucial for providing valuable preliminary insights into the feasibility, and safety of TT in this specific context.

Patients and Methods

Study Design

This case series study was conducted retrospectively and assessed feasibility and efficacy of TT in Yemen by assessing surgical approach, surgical management outcomes, and complications.

Study Setting

The study was conducted at TMGH Sana'a City, Yemen, which served as the primary location for patient care and data collection.

Participants

Patients diagnosed with MG who underwent TT at TMGH between January 2018 and January 2024 were included in the study. Patients were selected based on the availability of medical records and meeting the inclusion criteria. Patients with thymoma showing extensive invasion of nearby structures or evidence of metastasis to distant organs, as confirmed by imaging studies, were excluded from the study due to the requirement for more extensive treatment approaches.

Data Collection

Retrospective data collection was performed using a structure questionnaire based on previous studies,^{8,13,14} by reviewing patients' medical records, including preoperative characteristics, surgical details, and postoperative outcomes. We adopted the MGFA Clinical Classification to identify the most severe pretreatment clinical classification status of each patient based on affected muscles with maximum severity as recommended by the Task Force Foundation.¹¹ This designation was made historically, serving as a reference point throughout the study. Any changes or worsening in the

patient's MG condition were appropriately reflected in the postintervention status determination, with the maximum severity remaining as the point of reference.¹⁵

Surgical Approach

Thoracoscopic thymectomy was performed using single lung ventilation with 3 ports and deep inhalational anaesthesia without muscle relaxing agents was applied. The side of work was determined on the basis of the presence of a thymic mass on either side of the anterior mediastinum. The dissection began anterior to the ipsilateral phrenic nerve and involved the complete removal of the thymus, including the mass, and the dissection of the pericardial fat pad with careful attention to avoid injury to the contralateral phrenic nerve. A chest tube was inserted at the end of the procedure, and early extubation of the patient was the primary goal.

Follow-Up

With an average of 16.5 months, follow-up of 11 patients was conducted by taking patients' contact information from their records and contacting them using a telephone, and to minimize potential observer bias, we ensured that the interviewer was not directly involved in the patients' care and had no predetermined expectations of positive outcomes. Patients were asked to describe their improvement after surgery and the time during which these symptoms improved. Those with partial or no improvement were also asked about the final improvement of their MG symptoms and if there was any reduction in their medication dosage.

For measuring patient improvement, we categorize them based on the definitions provided by the Myasthenia Gravis Foundation of America (MGFA) Post-Intervention Status, into three categories: Complete Stable Remission (CSR), representing those with no symptoms or signs of MG for at least 1 year and no therapy during that time; Change in Status (I), indicating patients with a substantial decrease in pre-treatment clinical manifestations or a sustained substantial reduction in MG medications; and Unchanged Status (U), comprising patients with no substantial change in pre-treatment clinical manifestations or reduction in MG medications.¹⁵ A substantial reduction in medication for myasthenia gravis (MG) was considered when there is a corresponding at least 50% decrease in the need for medications to control the symptoms of the disease.

Outcome Measures

The primary outcome measures in this study included the surgical approach (left or right side) for TT, the occurrence and type of postoperative complications, particularly respiratory complications, and other adverse events. Patient outcomes such as timing of extubation, duration of ICU stay, and overall hospital stay were assessed, along with the preoperative MGFA Clinical Class and improvement MGFA Post-Intervention Status (PIS) measurement of improvement in myasthenia gravis (MG) symptoms.

Data Analysis

Data were analyzed using IBM SPSS statistics, v. 28.0 (IBM Corp., Armonk, NY, USA), through which the required tests were used. Descriptive statistics are presented as frequencies and percentages. Multiple response analysis was used to determine the patients' presenting symptoms and early complications. The significance level was set at < 0.05.

Results

Demographic Characteristics and Clinical Presentation

The data analyzed involved 13 patients, with a majority of them being female (61.5%) and with an average age of 39.5 years. Among the patients, 2 (15.4%) had hypertension (HTN), 1 (7.7%) had diabetes mellitus (DM), and 1 (7.7%) had rheumatoid arthritis. The pretreatment clinical status of the patients was evaluated based on the MGFA clinical classification. The results revealed that 61% of the patients (8 individuals) presented with severe muscle weakness primarily affecting oropharyngeal and/or respiratory muscles (Class IVb), indicating significant impairment in functions like swallowing and breathing. Additionally, 15% of the patients (2 individuals) exhibited moderate weakness

predominantly in oropharyngeal and/or respiratory muscles (Class IIIb), suggesting a lesser degree of impairment compared to Class IVb. Another 15% of the patients (2 individuals) had moderate weakness primarily in limb and/or axial muscles (Class IIIa), potentially impacting their mobility and physical abilities. These findings, presented in Table 1, provide insights into the distribution and severity of muscle weakness in the study population.

On average, our patients had been living with MG for 56 months and experienced exacerbation periods lasting around 5 months. Prior to surgical treatment, 85% were on medication, predominantly pyridostigmine bromide. The preoperative regimen primarily included immunoglobulins, with neostigmine and hydrocortisone also commonly administered.

Operative Outcomes

The average operation time was 50 ± 10.41 minutes, with most surgeries lasting between 40 and 80 minutes (Table 2). The majority of surgical approaches were left-sided (92.3%), with only one case involving a right-sided approach. Thymus gland invasion occurred in 23.1% of patients, while 76.9% exhibited non-invasive characteristics. Most of the patients (61.5%) had masses averaging 3.99 cm by 3.44 cm in length and width, respectively, whereas 30.8% displayed hyperplasia with average dimensions of 8.93 cm by 7.35 cm. Only one individual showed normal tissue characteristics. Unilateral chest tube insertion was prevalent, with most patients (76.9%) receiving a tube on one side and the remaining requiring bilateral insertion (23%).

Surgical Outcomes

Of the 13 patients, four suffered complications such as prolonged intubation and mechanical ventilation, dyspnea, and chest infection (each at 31%), confusion and tracheostomy (both 23%), with a re-tracheostomy (8%) and mortality rate of 15%. Most were extubated either immediately post-surgery or by the first day post-op (76.9%). The average Intensive Care Unit (ICU) stay was 7.3 days, during which two patients passed away due to respiratory complications. Eleven patients progressed to the general ward, staying for an average of 3.64 days. Chest tubes remained for an average of 5.57 days. Overall, the mean hospital stay was 9.46 days, with most patients (61.5%) discharged by day six. Based on the MGFA Post-Intervention Status (PIS), a follow-up was conducted on 11 patients over an average duration of 16.5

Table 1 Demographic Characteristics and Clinical Presentation of Patients (n=13)

Case no.	Sex/Age	Comorbidity	Duration of MG symptoms (months)	Duration of exacerbation (months)	On medical treatment for MG	Type of drugs	MGFA clinical class
1.	F/45	None	18	8	Yes	Mestino; Redazol	IIIb
2.	M/52	HTN	24	7	Yes	Mestion; Prednisolone	IVb
3.	F/35	DM	48	4	Yes	mestion	IVb
4.	F/58	HTN	12	6	Yes	mestion	IVb
5.	M/54	None	180	3	Yes	Prednisolone	IIIb
6.	F/32	None	18	8	Yes	Mestion; Imuran	IVb
7.	M/33	None	12	2	Yes	Prednisolone; Immunoglobulin	IVb
8.	M/17	None	2	Non	No	–	IIa
9.	F/33	None	312	12	Yes	Mestion; Imuran	IIIa
10.	F/18	RA	24	2	Yes	mestion	IVb
11.	M/38	None	2	1	No	–	IIa
12.	F/43	None	2	2	Yes	Mestion	IVb
13.	F/55	None	18	4	Yes	Mestion; Prednisolone	IVb

Table 2 Intraoperative Data of the Studied Population

Case no.	Side of TT	Intraoperative finding	Invasion	Chest tube insertion	Operative time
1.	Left	Hyperplasia	No	Unilateral	50
2.	Left	Mass	Yes	Bilateral	80
3.	Left	Hyperplasia	No	Unilateral	50
4.	Left	Mass	No	Unilateral	50
5.	Left	Mass	Yes	Bilateral	60
6.	Left	Normal	No	Unilateral	40
7.	Left	Mass	No	Bilateral	45
8.	Left	Mass	No	Unilateral	40
9.	Left	Hyperplasia	No	Unilateral	50
10.	Left	Mass	No	Unilateral	45
11.	Left	Mass	Yes	Unilateral	45
12.	Right	Mass	No	Unilateral	45
13.	Left	Hyperplasia	No	Unilateral	50

months. The results revealed that within this group, 54.5% of patients achieved complete stable remission, indicating a significant improvement in their condition. Additionally, 18% of patients experienced a reduction in symptoms and were able to decrease their medication usage. However, 27% of patients did not show any change in their condition or treatment during the follow-up period (Table 3).

Table 3 Surgical Outcomes of Thoracoscopic Thymectomy (n=13)

Case no.	Postoperative complication	Time to extubation	LOS ICU	LOS Hospital	MGFA PIS	Mortality	Follow-up period (months)
1.	Chest infection; Confusion; Dyspnoea; Intubation with MV; Tracheostomy	Immediately	24	29	CSR	No	14
2.	Dyspnea; Intubation with MV; Tracheostomy; Re-tracheostomy	1st day	29	33	D of MG	Died	–
3.	None	Immediately	3	15	CSR	No	17
4.	None	Immediately	1	7	CSR	No	16
5.	None	1st day	5	35	Unchanged(U)	No	12
6.	None	Immediately	1	7	CSR	No	25
7.	Chest infection; Confusion; Intubation with MV; Dyspnea; Tracheostomy	1st day	20	26	D of MG	Died	–
8.	None	Immediately	1	8	Unchanged(U)	No	36
9.	None	Immediately	2	6	Unchanged(U)	No	20
10.	Chest infection; Confusion; Intubation with MV; Dyspnea	Immediately	7	17	Change in Status (I)	No	12

(Continued)

Table 3 (Continued).

Case no.	Postoperative complication	Time to extubation	LOS ICU	LOS Hospital	MGFA PIS	Mortality	Follow-up period (months)
11.	None	Immediately	1	3	Change in Status (I)	No	24
12.	None	Immediately	0.5	3	CSR	No	32
13.	None	Immediately	0.5	3	CSR	No	17

Discussion

Our study of 13 patients with MG revealed that 61.5% were female, with an average age of 39.5 years, aligning with research that MG predominantly affects women under 40 and men over 50.¹⁶ Additionally, prevalent comorbidities such as hypertension, diabetes mellitus, and rheumatoid arthritis were observed, reflecting MG's association with common conditions in an aging population.¹⁷

The clinical presentation in our study, which included generalized weakness, ptosis, dysphagia, and diplopia, aligned with known MG symptoms such as fluctuating muscle weakness that worsened with activity and improved with rest. Ocular and bulbar symptoms, such as visual problems and difficulty swallowing, are often reported as the first signs.^{4,18}

Regarding treatment and medication use before thymectomy, patients with low respiratory reserves or bulbar symptomatology are frequently treated with intravenous immunoglobulin (IVIG) or plasma exchange (PLEX) before the procedure, as noted in our study, with immunoglobulin as the most used medication. This is consistent with the current recommendations.¹⁹ Pyridostigmine bromide is commonly used as a first-line treatment to improve muscle weakness.²⁰

The thoracoscopic approach used in this study aligns with the literature suggesting that patients undergoing video-assisted thoracoscopic surgery (VATS) thymectomy achieve better surgical outcomes and fewer complications than those who opt for open thymectomy (OT).²¹ Our results, showing a predominantly left-sided approach and an average operation duration of 50 ± 10.41 minutes, indicate a less invasive and more efficient procedure. Studies have also highlighted benefits such as shorter hospital stays, and less intraoperative blood loss associated with thoracoscopic methods.^{7,8}

The complications observed in our cohort, including intubation/mechanical ventilation and re-tracheostomy, reflect the inherent risks associated with thymectomy. However, the overall complication rate for thoracoscopic thymectomy is reported to be approximately 12.2%, which is relatively low.²² Catastrophic complications are very rare, but intraoperative complications such as bleeding require immediate attention.^{23,24}

Two patients died postoperatively with a mortality rate of 15.4%, which is higher than that reported by several previous studies, where the mortality rate of thoracoscopic thymectomy was 0%–3.8%.^{25,26} The increased rate of mortality and morbidity in our study could be attributed to the intraoperative concomitant surgical invasion because one of the two patients with intraoperative invasion died after surgery. Another possible reason is the coincidence of surgeries during the outbreak of the COVID-19 pandemic.

The follow-up outcomes in our study showed that 54.5% of patients achieved complete stable remission (CSR), 18% experienced a change in status with reduced symptoms and medications, and 27% remained unchanged after an average period of 16.5 months post-thymectomy. These findings agree with published research indicating that thymectomy can lead to persistent improvement in symptoms and remission in patients with MG.²⁷

A long-term follow-up study of thymectomy for patients with MG showed that the rate of CSR was around 19%, with an additional 16% of patients symptomatically improving and requiring less medication after thymectomy.²⁸ Another study reported that CSR could be achieved in approximately 40% of ocular MG patients 5 years after thymectomy, especially if the onset age was 40 years or younger.²⁹ Although spontaneous remission is uncommon, guidelines suggest that thymectomy is valuable as a form of treatment for MG, with better outcomes when performed within 5 years from the onset of symptoms.³⁰ Furthermore, after a median follow-up of 2.9 years, a significant proportion of patients may

discontinue prednisone, and some achieve complete stable remission.³¹ Overall, these findings highlight the potential benefits of thymectomy in the management of MG and support the outcomes observed in our study.

Our study is limited by its small sample size and the lack of long-term follow-up, which are critical for assessing the full impact of thoracoscopic thymectomy on patient outcomes. These limitations are significant when considering the variability of myasthenic symptoms and the progression of MG over time. Additionally, the retrospective nature of our study and possibility of observer and patient bias when conducting follow-up of patient through phone call represent major limitation to this study. To mitigate this, we ensured that the interviewer was not directly involved in the patients' care and were not expecting a positive benefit. Nevertheless, we recognize the limitations associated with self-reported outcomes and the potential for recall bias.

Future studies should include larger cohorts with longer follow-up periods to better understand the long-term benefits and potential complications of thoracoscopic thymectomy. Research should also explore the efficacy of minimally invasive techniques compared to traditional open procedures and their impact on the quality of life of patients with MG.³²

Conclusion

Our study shows that thoracoscopic thymectomy is feasible and effective for treatment for myasthenia gravis in Yemen, yielding favorable early outcomes with many patients achieving complete stable remission. These results could encourage wider use of the procedure, enhancing MG management in areas with limited resources. Future research should also explore the efficacy of minimally invasive techniques compared to traditional open procedures and their impact on the quality of life of patients with MG.

Declaration on Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used [HyperWrite / summarization and improve text tools] to [summarize different long sections of the manuscript and improve text readability]. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Ethics Approval and Informed Consent

Approval from the ethical committee of TMGH was obtained before conducting the study. Patient privacy and confidentiality were ensured during data collection and analysis in adherence to ethical guidelines and principles of Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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Disclosure

The authors report no conflicts of interest in this work.

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