

Clinical outcomes in the surgical treatment of esophageal leiomyoma: A retrospective evaluation of 13 cases

Özofagus leiomyomunun cerrahi tedavisinde klinik sonuçlar:
13 olgunun geriye dönük değerlendirilmesi

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ABSTRACT

Background: In this study, we aimed to evaluate the surgical outcomes after enucleation of esophageal leiomyomas and present the feasibility of enucleation using video-assisted thoracoscopic surgery.

Methods: The medical records of 13 patients (8 males, 5 females; mean age 45.9 years; range, 30 to 69 years) who underwent open or thoracoscopic surgery for an esophageal leiomyoma between April 2007 and June 2019 were retrospectively reviewed. The patients were evaluated with regard to age, sex, presenting symptoms, duration of symptoms, size and localization of tumors, diagnostic methods, surgical methods, conversion to open surgery, morbidity and mortality, discharge time, and follow-up period.

Results: Of the patients, four were operated via thoracotomy and nine via video-assisted thoracoscopic surgery. Enucleation was successfully completed with thoracoscopy in five patients. Four patients required conversion to thoracotomy. In the early postoperative period, two of these four patients developed complications and underwent re-thoracotomy. A solitary leiomyoma was detected in all, but one patient (multiple). The mean size of the tumors was 68.4 mm. Complications were seen in only one patient during follow-up and no recurrence was observed in any patient.

Conclusion: Our study results indicate that thoracoscopic enucleation of esophageal leiomyoma is a safe, feasible, and effective technique in selected patients and conversion to open surgery can be easily done for any reason during the procedure.

Keywords: Enucleation, esophageal leiomyoma, minimally invasive surgery, video-assisted thoracoscopic surgery.

ÖZ

Amaç: Bu çalışmada, özofagus leiomyomlarının enükleasyonu sonrasında cerrahi sonuçlar değerlendirildi ve video yardımcı torakoskopik cerrahinin uygulanabilirliği sunuldu.

Çalışma planı: Nisan 2007 - Haziran 2019 tarihleri arasında özofagus leiomyomu nedeniyle açık veya torakoskopik cerrahi uygulanan 13 hastanın (8 erkek, 5 kadın; ort yaş 45.9 yıl; dağılım 30-69 yıl) tıbbi kayıtları retrospektif olarak incelendi. Hastalar yaş, cinsiyet, mevcut semptomlar, semptomların süresi, tümörlerin büyüklüğü ve yerleşim yeri, tanı yöntemleri, cerrahi yöntemler, açık cerrahiye dönme, morbidite ve mortalite, taburculuk zamanı ve takip dönemi açısından değerlendirildi.

Bulgular: Hastaların dördüne torakotomi ve dokuzuna video yardımcı torakoskopik cerrahi uygulandı. Beş hastada torakoskopi ile enükleasyon başarılı bir şekilde tamamlandı. Dört hastada torakotomiye dönülmesi gerekti. Ameliyat sonrası erken dönemde bu dört hastanın ikisinde komplikasyon gelişti ve yeniden torakotomi uygulandı. Bir hasta (multipl) dışında hastaların tümünde soliter leiomyom tespit edildi. Tümörlerin ortalama büyüklüğü 68.4 mm idi. Takip süresinde yalnızca bir hastada komplikasyon gelişti ve hastaların hiçbirinde nüks gözlenmedi.

Sonuç: Çalışma sonuçlarımız özofagus leiomyomun belirli hastalarda torakoskopik enükleasyonunun güvenli, uygulanabilir ve etkili bir yöntem olduğunu ve işlem sırasında herhangi bir nedene bağlı olarak kolaylıkla açık cerrahiye dönülebileceğini göstermektedir.

Anahtar sözcükler: Enükleasyon, özofagus leiomyomu, minimal invaziv cerrahi, video yardımcı torakoskopik cerrahi.

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Esophageal leiomyoma is a benign tumor of the smooth muscle layers which involve the muscularis propria and, although it is very rare, it is the most common benign intramural tumor of the esophagus.^[1,2] It constitutes approximately 70% of benign tumors of the esophagus and 10% of all gastrointestinal leiomyomas.^[1-4]

Most patients with esophageal leiomyomas are often asymptomatic and these benign lesions affect males more than females. Esophageal leiomyomas grow slowly and are usually discovered incidentally during radiological or endoscopic examination or when they cause symptoms due to their size. The most common symptoms are dysphagia and non-specific chest and retrosternal pain. Regurgitation, epigastric tenderness, dyspnea, and weight loss are observed less frequently.^[2-4]

Asymptomatic or smaller lesions can be monitored periodically. Surgical treatment is usually indicated in patients with symptoms and a larger tumor size (>2 cm) or when it is necessary to obtain a pathological diagnosis to exclude malignancy.^[5]

Enucleation is accepted as the standard surgical method for the treatment of esophageal leiomyomas. Although thoracotomy is still widely used for enucleation, minimally invasive methods have gradually replaced traditional methods in recent years. Surgical options for minimally invasive enucleation of leiomyomas are video-assisted thoracoscopic surgery (VATS), robotic-assisted thoracoscopic surgery (RATS), submucosal tunneling endoscopic resection (STER) or endoscopic submucosal tunneling dissection (ESTD).^[5-21]

In this study, we aimed to evaluate the surgical outcomes after enucleation of esophageal leiomyomas and present the feasibility of enucleation using VATS.

PATIENTS AND METHODS

The medical records of 13 patients (8 males, 5 females; mean age 45.9 years; range, 30 to 69 years) undergoing open or thoracoscopic surgery for an esophageal leiomyoma between April 2007 and June 2019 at Health Science University, Süreyyapaşa Chest Disease and Chest Surgery Training and Research Hospital, Department of Thoracic Surgery were retrospectively reviewed. In order to draw attention to the role of esophageal diseases in the differential diagnosis of chest diseases, the patient was discussed several times with pulmonologists. Patients who were suspected to have esophageal-related pathologies were referred to our clinic.

The patients were evaluated with regard to age, sex, presenting symptoms, duration of symptoms, size and localization of tumors, diagnostic methods, surgical methods, conversion to open surgery, morbidity and mortality, discharge time, and follow-up period. Patients who were suspected to have leiomyoma based on the results of upper gastrointestinal endoscopy or chest computed tomography (CT), performed either as part of a routine health screening or to evaluate thoracic/gastrointestinal symptoms, were referred to our outpatient clinic. All patients underwent comprehensive preoperative evaluations which included direct chest radiography, chest CT scan, and flexible esophagogastroduodenoscopy (FEGD). Thoracic CT was performed to identify the number and diameter of the tumor and its relationship with the surrounding structures, to exclude the possibility of malignant and distant metastasis, and to determine the feasibility for thoracoscopic surgery. Flexible esophagogastroduodenoscopy was performed at Medeniyet University Göztepe Training and Research Hospital, Department of Gastroenterology. Endoscopic ultrasound (EUS) was requested to assist in the diagnosis in three patients. Although endoscopic biopsy was not recommended in our institution, there was one patient who underwent biopsy via EUS in another institution.

Following the radiographic diagnosis of the patients, a decision of surgical treatment was made based on several conditions including the presence of symptoms, evidence of an increase in tumor size, and the need to confirm the pathological diagnosis. The choice of the surgical procedure mainly depended on the localization, position, size of the tumors, and surgeons' preference. The right side of the chest was the preferred method to approach lesions located in the middle and upper esophagus. If the tumor was located in the distal lower thoracic esophagus, the left-side approach was chosen.

A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Operative technique

Thoracotomy approach

The patient was placed in lateral decubitus position and, following double lumen intubation, the operation was performed via a posterolateral thoracotomy incision of approximately 10 cm in length. In terms of the surgical technique, the outer esophageal muscle was gently incised longitudinally to reveal the lesion. Dissection was performed to separate and remove the leiomyoma from the underlying submucosa, taking

care to preserve the integrity of the esophageal mucosa. A 28- or 32-Fr chest tube was placed in the seventh intercostal space (ICS).

Thoracoscopic approach

The patient was placed in the lateral decubitus position and the VATS procedure was performed under general anesthesia with double-lumen intubation. A 10-mm skin incision was made over the seventh or eighth ICS on mid-axillary line for the thoracoscope. A 10-mm 30-degree thoracoscope was routinely used during the procedure. A 3-cm utility incision (without the use of a rib spreader) was placed in the fourth or fifth ICS on the posterior axillary line. Another 10-mm trocar was placed in the fourth or fifth ICS on the anterior axillary line for the retraction of the lung.

Video-assisted thoracoscopic surgery guided enucleation was performed using the same surgical principles as the open surgical approach. The location of the tumor was determined by palpation under

thoracoscopy. After determining the localization of the tumor, the mediastinal pleura was incised longitudinally and a myotomy was performed over the tumor. The tumor was removed gently to prevent mucosal damage. A 28- or 32-Fr chest tube was placed through the endo camera port for postoperative drainage (Link to the demonstrative video clip of Case 5: Minimally Invasive Surgery in Esophageal Leiomyoma; <https://www.youtube.com/watch?v=3l-jk2VAiOo>).

After open or thoracoscopic enucleation, intraoperative air insufflation (from the proximal part of the esophagus via nasogastric tube) was performed to confirm the integrity of mucosa due to the possibility of mucosal injury during procedure.

The integrity of the nodule with the fibrous capsule was checked and the muscle layer was re-approximated using absorbable sutures.

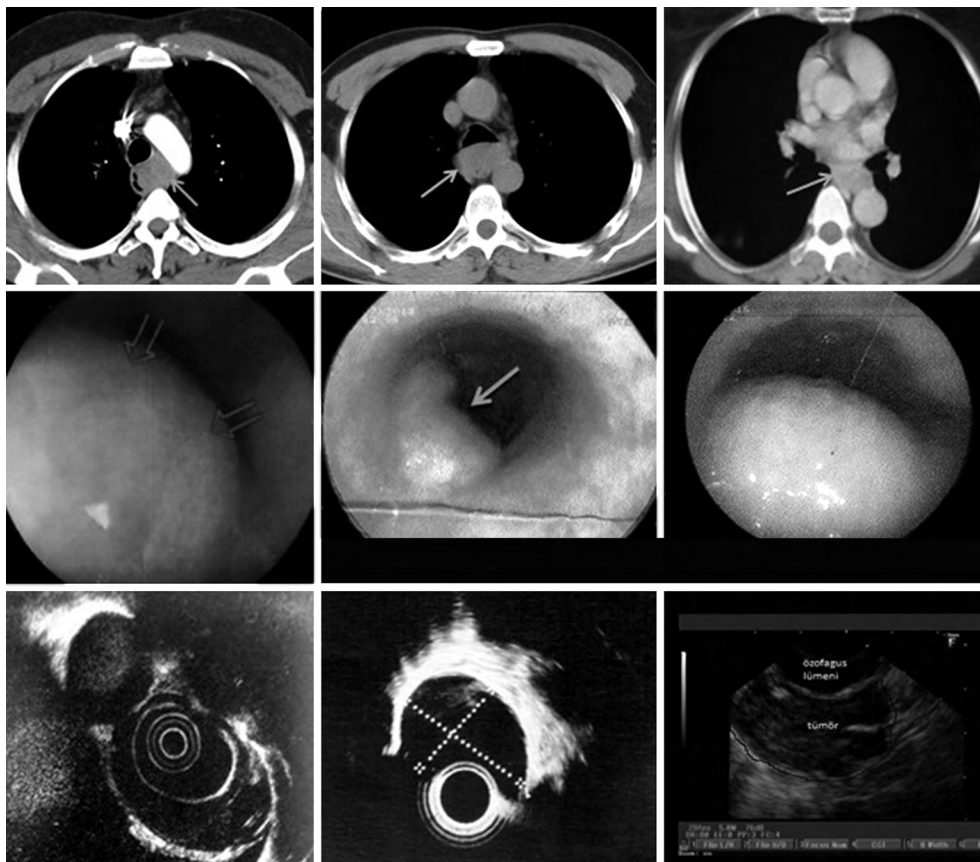


Figure 1. Computed tomography, flexible esophagogastroduodenoscopy, and endoscopic ultrasound images.

Postoperative management and follow-up

A leakage test with methylene blue was performed during the postoperative period depending on the patient's recovery status (If mucosal repair was performed, the leakage test was performed on the fifth postoperative day. Otherwise, it was performed on the first postoperative day) to check the integrity of the mucosa after enucleation. Enteral feeding was started after the leakage test, and the chest drain was removed the next day. The patients were allowed to have a normal diet following a liquid diet for three days and a soft diet for a week.

Chest X-ray was taken every three months within the first year and every six months thereafter. Computed tomography scan was taken at the end of the first year and in the following years, if necessary.

Statistical analysis

Clinical outcomes were collected retrospectively and all analyses were performed using IBM SPSS version 24.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics for continuous variables were reported as mean $\pm$ standard deviation (SD) with 95% confidence interval (CI) and were compared using Mann-Whitney U test. The findings were analyzed in terms of sex, age, duration of symptom, comorbidity, size and localization of tumors, operation time, conversion rate, hospitalization duration and follow-up period.

RESULTS

Symptoms at the time of presentation were dysphagia (46.2%) and chest pain (15.3%). Five patients (38.5%) were asymptomatic, and their tumors were discovered incidentally during radiologic examinations. The mean duration of preoperative symptoms was 6.10 (range, 1 to 12) months.

Diagnostic procedures including chest radiography, chest CT scan, and FEED were performed for the patients. Submucosal lesions were detected by FEED in all patients and the esophageal mucosa was found to be normal. In addition, EUS was also helpful for the diagnosis of esophageal leiomyomas in three patients. The CT scan, FEED, and EUS visual images of our patients are shown in Figure 1.

A solitary leiomyoma was detected in all, but one patient (multiple). The mean size of the tumors was 68.4 (range, 30 to 110) mm. The size of the majority of tumors was >30 mm. There were five (38.5%) measuring between 30 and 50 mm, and eight (61.5%) measuring >50 mm. The tumors were primarily located in the middle esophagus. In total, two (15.3%) tumors were located in the upper esophagus (<23 cm from the incisors), and 11 (84.6%) tumors were located in the middle esophagus (23 to 32 cm from the incisors). In our series, there was no tumor located in the lower esophagus. Demographic data of the patients are presented in Table 1.

Surgeries were performed through a right-sided approach due to the localization of the tumors in the

Table 1. Demographic and clinical characteristics of patients (n=13)

Characteristics	n	%	Median	Range
Age (year)			45.9	30-69
Sex				
Male	8			
Female	5			
Symptom				
Dysphagia	6	46.2		
Chest pain	2	15.3		
Asymptomatic	5	38.5		
Duration of symptoms (month)			6.1	
Tumor location				
Upper third	2	15.3		
Middle third	11	84.6		
Lower third	0	0		
Size (mm)			68.4	
30-50	5	38.5		
>50	8	61.5		

middle and upper esophagus. Tumor enucleation was achieved in 100% of the patients with no need for esophageal resection. A total of 13 patients underwent surgery initially via thoracotomy (n=4) or VATS (n=9). The reasons for the enucleation decision via thoracotomy rather than VATS in four patients were unsuitable localization, presence of intense pleural adhesions, large tumor size, non-consideration of leiomyoma in differential diagnosis, and presence of multiple lesions. The mean operation time was approximately 120 min in the thoracotomy group and 75 min in the VATS group.

Enucleation was successfully completed with thoracoscopy in five patients. Four patients required conversion to a thoracotomy during thoracoscopy. Of the four conversions, one was due to the lack of surgical experience in the first patient of the series, two were due to a mucosal injury, and one was due to the difficulty in localization of the tumor. The causes of mucosal injury were technical difficulties in tumor dissection caused by its size or inappropriate localization. Primary repair was performed by conversion to thoracotomy.

Specimens in different sizes of leiomyomas are shown in Figure 2.

We experienced postoperative complications in two patients including postoperative bleeding in one patient and prolonged air leak in the other. Postoperative re-thoracotomy was required for these two patients who were unable to be completed enucleation with VATS and subsequently underwent thoracotomy. No intra- or postoperative mortality was observed in any of the patients. The mean hospitalization duration was 5.5 (range, 3 to 7) days. No intensive care unit support was needed for any patient. In all cases, diagnosis of leiomyoma was confirmed postoperatively by immunohistochemical staining. The median follow-up was 87.5 (range, 3 to 150) months. All patients did generally well without dysphagia, reflux or other related symptoms during the follow-up period, except for one patient. In the long-term, esophageal dilatation and hypomotility developed in a patient with multiple lesions. However, it did not cause any problems. No recurrence was observed during routine follow-up. The results of surgical management are shown in Table 2.



Figure 2. Specimens of various sizes of leiomyomas.

Table 2. Results of surgical management (n=13)

Variables	n	%	Median	Range
Surgical procedures				
Thoracotomy	4	30.8		
VATS + thoracotomy	4	30.8		
VATS	5	38.4		
Operation time (approximately min)				
Thoracotomy	120			
VATS	75			
Conversion rate		44.4		
Causes of conversion				
Lack of surgical experience	1			
Mucosal injury	2			
Difficulty of localization	1			
Side (right)	13			
Early complications				
Hemorrhage	1			
Prolonged air leakage	1			
Hospital stay (days)				
Thoracotomy	7			
VATS	3			
Mortality	0			
Follow-up (month)			87.5	3-150
Late complication (Thoracotomy-multiple lesion)	1			
Recurrence	0			

VATS: Video-assisted thoracoscopic surgery.

DISCUSSION

Esophageal leiomyoma is an uncommon benign tumor of smooth muscle origin. It is often diagnosed incidentally during routine examination or screening of upper gastrointestinal pathologies. More than 50% of leiomyomas are asymptomatic.^[11] Symptoms are uncommon until the tumor has reached a size of ≥ 5 cm, and the most common symptoms are dysphagia and chest pain.^[19] In our study, as the mean tumor diameter was large (68.4 mm), tumors were generally symptomatic. Similarly, dysphagia and chest pain were observed more frequently in our patients.

Imaging modalities to visualize esophageal leiomyomas include chest radiography, chest CT scan, FEGD, and EUS. Computed tomography can demonstrate the extent of extraluminal involvement of the soft tissue mass and presence of extrinsic compression, while FEGD provides excellent direct visualization of the mucosa and confirms the presence of a submucosal tumor protruding into the lumen of the esophagus. Therefore, FEGD should be performed

in lesions thought to be associated with the esophagus on CT. Endoscopy detects submucosal and mucosal repulsion or normal mucosa.^[2-4] Endoscopic ultrasound may be useful in characterizing these benign lesions. It provides information about the localization, size, and structure of the lesions in the esophageal wall.^[13] However, endoscopic ultrasound-guided fine needle aspiration is not recommended in leiomyoma cases as it may cause adhesion between the mucosa and the lesion and consequently increase the operation difficulty and the possibility of mucosal injury.^[13] There is also a natural risk of infection of the procedure. In our study, we utilized chest radiography, CT scan, and FEGD in all patients. Three patients, two of whom were performed at an external center before admission to our clinic, underwent EUS for the diagnosis of the lesion. In our study, CT and FEGD were mostly enough to make the diagnosis.

Esophageal leiomyomas are typically localized within the middle or distal esophageal wall and are usually seen as a solitary lesion.^[2-4,20] Since there is less smooth muscle in the upper third of the esophagus,

they are rarely encountered in this localization. In our study, two tumors were located in the upper esophagus and 11 tumors were located in the middle esophagus. Only one patient had multiple lesions. The first case of multiple esophageal leiomyoma in the Turkish literature was reported by Kiral *et al.*^[22] and all of them were located in the thorax. Therefore, right-sided approach to leiomyomas with thoracic localization is appropriate, except for leiomyomas located at the lower end of the esophagus close to the esophagogastric junction.^[15] For the right-sided approach in VATS, it is important that the tumor grows particularly into the same pleural cavity. Therefore, preoperative CT scan should be examined carefully.

Malignant degeneration is very rare in leiomyomas. There is no consensus on the management of leiomyomas. Some authors have advocated that surgery is not necessary in small (<15 to 20 mm) and asymptomatic leiomyomas and that these patients should be followed periodically.^[7] In contrast, some others have argued that the tumor should be removed, even if the lesion is small and asymptomatic.^[5,8,10-21] In our opinion, surgery should be considered, even if there is no symptom of esophageal leiomyomas, except for asymptomatic small (<20 mm) tumors. Since the only and definitive treatment is surgery and as the lesion grows, the surgical procedure becomes more difficult, the complication rate increases and the differential diagnosis cannot be made definitively. In the differential diagnosis, esophageal cancer, gastrointestinal stromal tumor, vascular rings, aortic aneurysm, lymphadenopathy, mediastinal cyst, tumor, and other pathologies should be considered.^[23,24]

The presence of symptoms, a size greater than 3 to 5 cm, or a rapid increase in the lesion size are the indications for surgical removal of leiomyomas. Open enucleation mainly via thoracotomy or laparotomy has long been the standard treatment. However, over the past 25 years, thoroscopic, laparoscopic, endoscopic, and hybrid procedures have replaced the open surgical approach in referral centers.^[19]

Leiomyomas have a benign clinical course and typically do not relapse after surgery. All patients with symptomatic tumors should be advised excision or enucleation of the tumor. Resection can be considered in exceptional cases such as giant leiomyomas or leiomyomatosis that cannot be removed by enucleation.^[25] A lesion larger than 10 cm is termed as a giant leiomyoma. Even giant lesions can be removed effectively and safely with VATS.^[17] In our series, we had two patients of these sizes.

Limited myotomy and simple enucleation is the classic definition for the removal of leiomyoma. Surgical principles include a longitudinal myotomy over the mass, blunt dissection to separate the tumor from the mucosa, avoidance of mucosal damage, and closure of the overlying muscle wall. Particularly in large lesions, the muscle layer of the esophagus should be sutured against the possibility of pseudodiverticulum following enucleation.^[10]

Since the first successful thoroscopic enucleation was performed in 1992,^[11] thoroscopic approaches have been increasingly used. The first successful enucleation via VATS in our clinic was performed in 2009. This is probably the first successful minimally invasive esophageal leiomyoma enucleation in Turkey and the first publication reported in the Turkish literature.^[9] Previous studies have shown that VATS is an advantageous method over traditional surgical techniques due to less postoperative pain, rapid recovery, shorter hospital stay, and rapid return to daily living activities.^[8,11-13,16] However, thoracotomy may be required in cases with a large tumor size, irregular tumor shape, difficult tumor localization, and technical limitation. In lesions expanding to the left side behind the esophagus, the esophagus can be hung with a tape and the procedure can still be performed via VATS. In our series, the duration of surgery and hospital stay were shorter in the VATS group than the thoracotomy group. The complication rate in the early postoperative period was also lower in the VATS group than the thoracotomy group.

There is no established treatment protocol for the choice of open or VATS approaches. Every case of leiomyoma which is considered eligible for minimally invasive approach should be initiated via VATS. Conversion is possible to open approach when there is a technical limitation, in tumors less than 1.5 cm, and presence of a complication or safety concern.^[7] In a VATS leiomyoma enucleation study of 63 cases, the rate of conversion to thoracotomy was reported as 11%.^[11] In our VATS series (n=9), this rate was 44.4%. The discrepancy can be attributed to the operations performed by different surgeons, limited number of patients, and lack of enough experience. In our study, VATS was performed by two ports and one utility incision. In their study, Claus *et al.*^[26] reported that they successfully performed thoroscopic enucleation using carbon dioxide insufflation in 10 patients with prone position and single lumen endotracheal intubation. Using this method, both position and artificial pneumothorax were created. Also, there are case reports of enucleation with RATS in the

literature.^[20] Although RATS has superior technical features than VATS, its disadvantages include not being available in every center and its high cost.

With the development of endoscopic techniques in recent years, endoscopic operations including STER and ESTD can provide both a definitive histological diagnosis and a minimally invasive therapeutic approach. Both are both used in the treatment of upper gastrointestinal submucosal tumors. These procedures maintain mucosal integrity and lead to rapid healing free of pleural and/or abdominal infection.^[5,21] In the first of two studies (n=126; n=52 VATS and n=74 ESTD) comparing ESTD / STER and VATS methods, the lesion size was found to be less than 40 mm. In the other study, the lesion size (n=31; n=13 VATS and n=18 STER) was 35 to 55 mm. Despite the large size of these lesions, ESTD / STER was found to be as effective and safe as the VATS method. In addition, it was more advantageous than VATS in terms of postoperative pain, hospital stay, and cost.^[5,21]

As with all procedures related to esophageal surgery, perforation control after leiomyoma enucleation must be performed carefully in both the intra- and postoperative period. If perforation develops during VATS, it can be repaired in this way. If it is considered that it cannot be repaired by this method, conversion to open surgery is possible. In a study of 142 cases (n=79 thoracotomies and n=63 VATS), mucosal injury occurred in 20 patients (23%) (n=9 thoracotomies and n=11 VATS).^[11] This finding is consistent with our study (n=1 thoracotomy and n=2 VATS).

This study has several limitations including small sample size, retrospective design, and lack of a control group. Therefore, further multi-center, large-scale, prospective, randomized-controlled studies are needed to confirm these findings.

In conclusion, despite a limited number of patients in this study, our experience indicates that thoracoscopic enucleation of esophageal leiomyoma is a safe, feasible, and effective technique in selected patients. Based on these findings, we recommend thoracoscopic enucleation for each esophageal leiomyoma which is considered to be feasible depending on the size, localization, and quantity of the tumor. It is also important to emphasize that the procedure can be performed effectively and safely by experienced surgeons in the centers where minimally invasive surgery is performed routinely.

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REFERENCES

1. Mutrie CJ, Donahue DM, Wain JC, Wright CD, Gaissert HA, Grillo HC, et al. Esophageal leiomyoma: a 40-year experience. *Ann Thorac Surg* 2005;79:1122-5.
2. Yalçinkaya İ. Özofagusun benign tümör, kist ve duplikasyonları. *Toraks Cerrahisi Bülteni* 2011;2:312-22.
3. Yalçinkaya İ. Özofagusun benign tümör, kist ve striktürleri. In: Ökten İ, Kavukçu HŞ, editörler. *Türk Göğüs Cerrahisi Derneği. İstanbul: İstanbul Tıp Kitabevi; 2013. p. 1393-408.*
4. Yalçinkaya İ. Benign özofagus tümörleri. In: Yüksel M, Eraslan Balcı A, editörler. *Göğüs Cerrahisi "Kırmızı Kitap". İstanbul: Nobel Tıp Kitabevi; 2015. p. 933-40.*
5. Li QY, Meng Y, Xu YY, Zhang Q, Cai JQ, Zheng HX, et al. Comparison of endoscopic submucosal tunneling dissection and thoracoscopic enucleation for the treatment of esophageal submucosal tumors. *Gastrointest Endosc* 2017;86:485-91.
6. Yavuzer S, Ökten I, Güngör A. Esophageal leiomyomas; case reports and review of the literature. *J Ankara Medical School* 1991;13:81.
7. Choi SH, Kim YT, Han KN, Ra YJ, Kang CH, Sung SW, et al. Surgical management of the esophageal leiomyoma: lessons from a retrospective review. *Dis Esophagus* 2011;24:325-9.
8. Luh SP, Hou SM, Fang CC, Chen CY. Video-thoracoscopic enucleation of esophageal leiomyoma. *World J Surg Oncol* 2012;10:52.
9. Varer P, Yalçinkaya İ, Kutlu CA. Özofagus leiomyomunun torakoskopik enükleasyonu. *Türk Gogus Kalp Dama* 2013;21:516-9.
10. Aydın Y, Yamaç Y, Aksoy M, Eroğlu A. Approach to esophageal leiomyoma: a report of eight cases. *Türk Gogus Kalp Dama* 2013;21:706-11.
11. Shin S, Choi YS, Shim YM, Kim HK, Kim K, Kim J. Enucleation of esophageal submucosal tumors: a single institution's experience. *Ann Thorac Surg* 2014;97:454-9.
12. Ziyade S, Kadioğlu H, Yediyildiz Ş, Büyükpınarbaşı N, Soysal Ö. Leiomyoma of the esophagus: open versus thoracoscopic enucleation. *Türk J Med Sci* 2014;44:515-9.
13. Wang YX, Zhang J, Liu Y, Liu Y, Chu XY, Lu ZS, et al. Diagnosis and comprehensive treatment of esophageal leiomyoma: clinical analysis of 77 patients. *Int J Clin Exp Med* 2015;8:17214-20.
14. Kang SK, Yun JS, Kim SH, Song SY, Jung Y, Na KJ. Retrospective analysis of thoracoscopic surgery for esophageal submucosal tumors. *Korean J Thorac Cardiovasc Surg* 2015;48:40-5.
15. Ben-David K, Alvarez J, Rossidis G, Desart K, Caranasos T, Hochwald S. Thoracoscopic and Laparoscopic Enucleation of Esophageal Leiomyomas. *J Gastrointest Surg* 2015;19:1350-4.
16. Ramos D, Priego P, Coll M, Cornejo Mde L, Galindo J, Rodríguez-Velasco G, et al. Comparative study between open and minimally invasive approach in the surgical management of esophageal leiomyoma. *Rev Esp Enferm Dig* 2016;108:8-14.

17. Chen X, Xi Y, Wang H, Tan L. Minimally invasive surgery for giant esophageal leiomyoma: a case report & review of the literatures. *J Thorac Dis* 2017;9:E26-E31.
18. Xu H, Li Y, Wang F, Wang W, Zhang L. Video-assisted thoracoscopic surgery for esophageal leiomyoma: A ten-year single-institution experience. *J Laparoendosc Adv Surg Tech A* 2018;28:1105-8.
19. Milito P, Asti E, Aiolfi A, Zanghi S, Siboni S, Bonavina L. Clinical Outcomes of Minimally Invasive Enucleation of Leiomyoma of the Esophagus and Esophagogastric Junction. *J Gastrointest Surg J Gastrointest Surg* 2020;24:499-504.
20. Tomulescu V, Stanescu C, Blajut C, Barbulescu L, Droc G, Herlea V, et al. Robotic Approach in Benign and Malignant Esophageal Tumors; A Preliminary Seven Case Series. *Chirurgia* 2018;113:202-9.
21. Tan Y, Lv L, Duan T, Zhou J, Peng D, Tang Y, et al. Comparison between submucosal tunneling endoscopic resection and video-assisted thoracoscopic surgery for large esophageal leiomyoma originating from the muscularis propria layer. *Surg Endosc* 2016;30:3121-7.
22. Kırıl H, Küpeli M, Yalçinkaya İ. Özofagusun multipl dev leiomyomları. *Türk Gogus Kalp Dama* 2012;20:641-4.
23. Türkyılmaz A, Karapolat S, Seyis KN, Tekinbaş C. Atypically shaped esophageal leiomyoma mimicking lymphadenopathy. *Türk Gogus Kalp Dama* 2016;24:596-8.
24. Bilgi Z, Dericioğlu O, Ömercikoğlu H, Çetinkaya Ç, Batırel HF. Video-assisted thoracoscopic removal of esophageal leiomyoma in a patient with aberrant right subclavian artery. *Curr Thorac Surg* 2017;2:20-2.
25. Gupta V, Sinha SK, Vaiphei K, Lal A. Esophageal resection for giant leiomyoma. *J Cancer Res Ther* 2015;11:651.
26. Claus CM, Cury Filho AM, Boscardim PC, Andriguetto PC, Loureiro MP, Bonin EA. Thoracoscopic enucleation of esophageal leiomyoma in prone position and single lumen endotracheal intubation. *Surg Endosc* 2013;27:3364-9.