Minimally invasive resection of benign esophageal tumors

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Objective: Benign tumors of the esophagus are uncommon. Traditionally, resection has required thoracotomy or laparotomy. In this study we present our experience with resection of these tumors using a minimally invasive approach.

Methods: A retrospective review of patients who underwent resection of benign esophageal tumors between 1990 and 2005 was conducted. Operative approach, tumor size, and outcomes after surgery were recorded.

Results: Twenty patients were identified (leiomyoma: n = 15; stromal tumor: n = 3; granular cell tumor, n = 1; schwannoma: n = 1). Four patients underwent an open approach (right thoracotomy); the remainder were resected using minimally invasive techniques (thoracoscopy, n = 9; laparoscopy, n =7). There were no postoperative leaks or other major complications after surgery. Two patients required repair of a mucosal injury during resection. Mean tumor size in the open group was 8.1 cm (range 7–10 cm) compared with 3.5 cm (range 0.9–8 cm) in the minimally invasive group. Median length of stay was 5.5 days in the open group compared with 2.75 days in the minimally invasive group. Five patients subsequently required fundoplication for worsening (n = 3) or new-onset (n = 2) gastroesophageal reflux disease after tumor resection.

Conclusions: Minimally invasive resection of benign esophageal tumors is technically safe and associated with a shorter length of stay compared with open approaches. Although no specific cutoff for size could be identified, most tumors greater than 7 cm were removed by thoracotomy. The subsequent development of reflux may be related to the esophageal myotomy required for resection.

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Benign tumors of the esophagus are rare. Leiomyoma is the most common benign tumor, accounting for more than 80% of cases. However, its incidence on autopsy studies has been estimated to be between 0.005% and 5.1%[1,2]; thus, it is 50 times less common than esophageal cancer. Other benign esophageal tumors, such as gastrointestinal stromal tumors, schwannomas, lipomas, and granular cell tumors, are extremely rare.

Because of the rarity of benign esophageal tumors, few centers have developed significant experience with them. Traditional options for treatment have been observation for smaller tumors or surgical resection for tumors that are larger or symptomatic. Although resection can be performed through a thoracotomy or laparotomy with low morbidity,[3,4] recent case-series have also documented the feasibility of a minimally invasive approach.[5-8] These tumors would seem to be ideally suited to minimally invasive techniques, given that they are often small and can be enucleated from the esophageal wall. Documentation of the safety and efficacy of this approach is important, because alternative therapies such as endoscopic resection[9] and ethanol injection[10] have also been described.

Patients and Methods

A review of the pathology database at the University of Pittsburgh Medical Center was conducted to identify all patients who underwent resection of a benign esophageal tumor

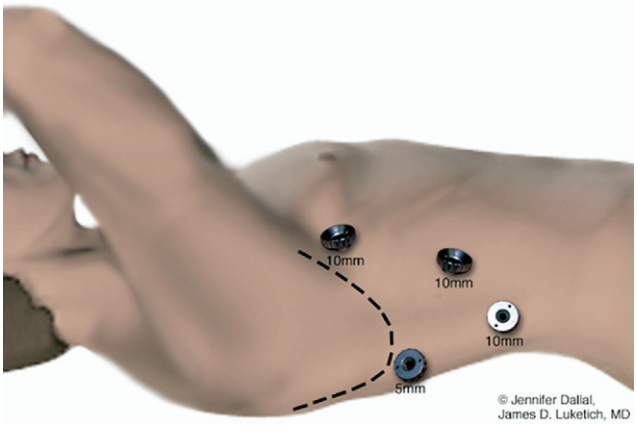

Figure 1. Port placement for thoracoscopic resection of benign esophageal tumors.

between 1990 and 2005. This study was approved by the institutional review board at the University of Pittsburgh. Demographic features, presenting symptoms, operative approach, and complications were recorded. Patients who underwent both open and minimally invasive resection (thoracoscopy or laparoscopy) were included.

Operative Approach

Our preference has been to resect benign esophageal tumors through a minimally invasive approach. Resection through a laparotomy of thoracotomy has generally been reserved for tumors greater than 7 cm in size. Although distal thoracic tumors may be enucleated through a transhiatal approach, we prefer to expose these tumors through the right side of the chest. Tumors located at or near the gastroesophageal junction are approached laparoscopically. Our technique for minimally invasive resection of these tumors has been described in detail previously,[11] but will be briefly outlined below.

Thoracoscopy

The patient is intubated with a double-lumen tube. Before the patient is turned to the left lateral decubitus position, on-table endoscopy is performed by the surgeon to confirm the location of the tumor. The scope is left in the proximal esophagus so that integrity of the mucosa can be confirmed after resection.

The port placement is similar to what we use for minimally invasive esophagectomy (Figure 1). The camera port is placed by a cutdown technique in the eighth intercostal space, mid-axillary line. A 5-mm port is placed at the eighth or ninth intercostal space, posterior to the posterior axillary line, for the ultrasonic coagulating shears (US Surgical, Norwalk, Conn). A 10-mm port is placed in the anterior axillary line at the fourth intercostal space and is used to retract the lung anteriorly with a fan retractor. The last 5-mm port is placed just posterior to the tip of the scapula and is used for retraction and countertraction by the surgeon. The surgeon stands at the back of the patient; the assistant with the camera and retractor stands at the front.

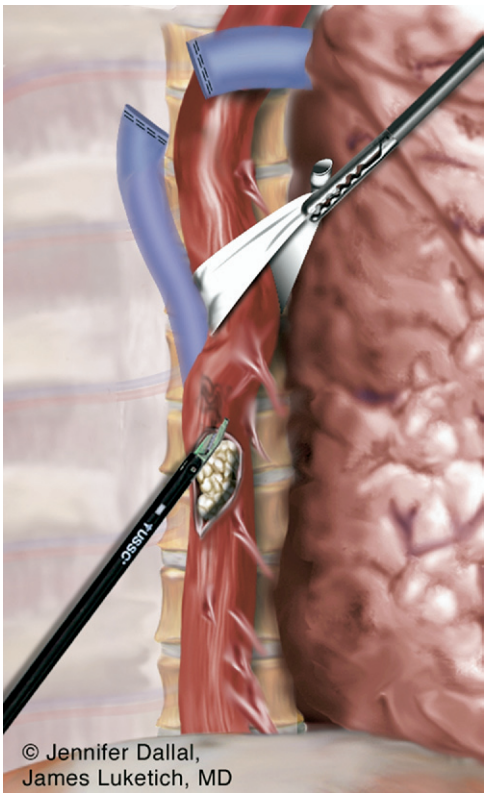

Figure 2. A myotomy exposes the underlying tumor. A Penrose drain may be used to expose left-sided tumors from the right side of the chest.

Often, the diaphragm may prevent adequate exposure of tumors in the distal esophagus. In this case a suture is placed through the central tendon of the diaphragm and pulled out through the chest wall using an Endoclose device (US Surgical). In this way the diaphragm is retracted caudally without the need for an assistant. The inferior pulmonary ligament is then divided using ultrasonic shears to completely mobilize the lung from the esophagus. If the tumor is not immediately visible, the flexible esophagoscope can be placed adjacent to the tumor to delineate its location. In some cases, a 54F bougie is placed to accentuate the location of the tumor and facilitate dissection, Next, the mediastinal pleura that overlies the esophagus is divided. If necessary, the esophagus can be circumferentially mobilized for exposure of the tumor. A Penrose drain is then placed around the esophagus, and if necessary, the esophagus can be rotated to some degree so the tumor is visible (Figure 2).

A myotomy is then performed over the tumor, taking care to preserve the main vagal trunks (Figure 2). The plane between the tumor, muscularis propria, and underlying submucosa is developed (Figure 3). In some cases it is useful to place a retracting suture in the tumor. By grasping this suture, one can lift the tumor off the submucosa and develop the proper dissection plane. The tumor is enucleated and removed with a specimen bag. The integrity of the mucosa is then inspected with the endoscope. If necessary the

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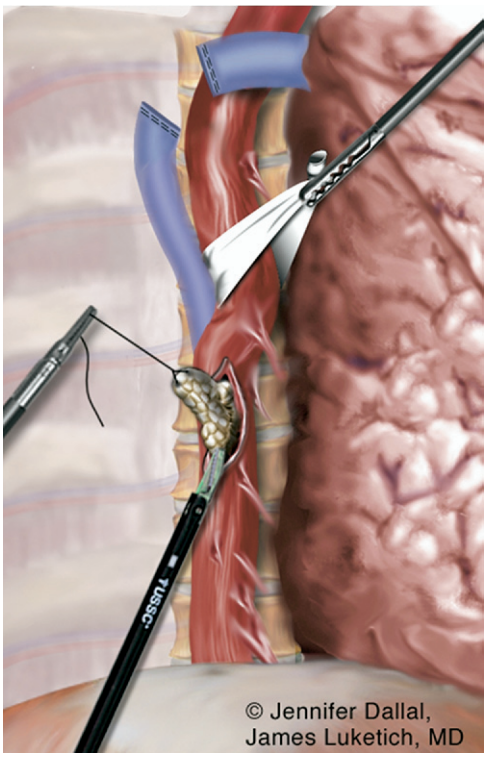

Figure 3. The tumor is enucleated from the muscularis propria of the esophagus, preserving the integrity of the submucosa.

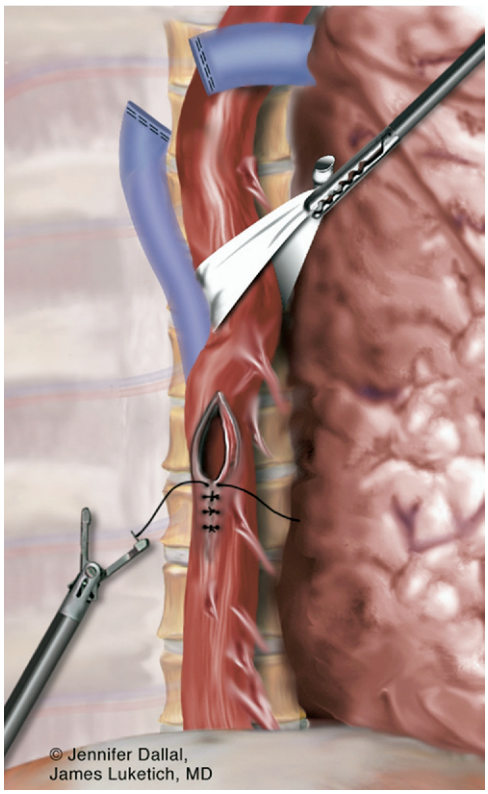

Figure 4. The myotomy is then closed to prevent formation of a diverticulum at the resection site.

esophagus may be submerged underwater and the lumen insufflated with air. If a small leak is identified it is repaired primarily. The longitudinal muscle layer is then reapproximated using 2-0 Surgidac stitches (Figure 4). The ports are closed in a standard fashion, and a 28F chest tube is placed. The chest tube is removed the following day after the barium swallow has been reviewed. We do not routinely place a nasogastric tube.

For those patients who underwent an open approach, a standard posterolateral thoracotomy incision was used, with division of the latissimus dorsi and sparing of the serratus anterior muscle. Tumor enucleation and closure of the myotomy were then performed as described.

Laparoscopy

We use 5 ports in our standard configuration for all laparoscopic foregut surgery. The distal esophagus is mobilized by dividing the gastrohepatic ligament, identifying the right and left crura, and dividing the short gastric vessels. The fat pad is then mobilized off the gastroesophageal junction so the tumor can be identified. Resection is then performed as described above, by performing a myotomy, enucleating the tumor, and then closing the myotomy using interrupted stitches. A standard Nissen fundoplication is then performed to address the development of gastroesophageal reflux that may occur with disruption of the lower esophageal sphincter.

Results

Patients

Twenty patients were identified. There were 10 women and 10 men, with a median age of 53 years (range 27–66 years). Among these patients, tumor resection was the primary indication for surgery in 15 (75%). In the remainder (25%), the tumor was incidentally discovered during surgery performed for another indication, such as repair of a giant paraesophageal hernia (n = 1), Heller myotomy for achalasia (n = 1), or fundoplication for reflux (n = 3). The location of the tumor, presenting symptoms of those undergoing operation solely for tumor removal, and the operative approach are listed in Table 1.

The most common symptom of patients with symptomatic tumors was chest pain (n = 9). Other common symptoms were dysphagia (n = 8) and regurgitation (n = 4). As expected, the mean tumor size was larger in those patients who were symptomatic. In this group the mean tumor size was 5.3 cm (range 2-10 cm). In contrast, the mean tumor size was 2.1 cm (range 0.9-4.3 cm) among patients whose tumors were incidentally discovered during surgery (P = .03).

TABLE 1. Characteristics of twenty patients undergoing resection of benign esophageal tumors

	No. of patients
Location	
Middle third	8
Lower third	6
Gastroesophageal junction	6
Presenting symptoms*	
Chest pain	9
Dysphagia	8
Regurgitation	4
Approach	
Thoracotomy	4
Thoracoscopy	9
Laparoscopy	7
Associated procedures	
Fundoplication	4
Reduction of paraesophageal hernia	1
Heller myotomy	1
Pathology	
Leiomyoma	15
GIST	3
Schwannoma	1
Granular cell tumor	1

GIST, gastrointestinal stromal tumor. *Among the 15 patients who underwent operation solely for tumor resection.

Preoperative Workup

Standard preoperative evaluation included a barium swallow and endoscopy to confirm the presence of normal mucosa overlying the tumor. We do not routinely recommend endoscopic ultrasound or biopsy of tumors that appear to be benign on endoscopy. However 5 patients were referred to our center after a biopsy had already been performed.

Operative Approach and Complications

Our preference has been to resect these tumors using minimally invasive techniques. However, an open approach was favored for larger tumors (>7 cm). As a consequence, the mean tumor size in the open group was 8.1 cm (range 7-10 cm) compared with 3.5 cm (range 0.9-8 cm) in the minimally invasive group ($P = .001$). Nonetheless, we have resected larger tumors with minimally invasive surgery (4 patients whose tumors were 5, 6, 7, and 8 cm). Among those who underwent minimally invasive resection, there were no conversions to an open procedure.

Two of the 5 patients who had a previous biopsy required repair of a mucosal injury during tumor resection. In both cases the injury was recognized intraoperatively and repaired without sequela. No mucosal injuries occurred in patients whose tumors had not been biopsied. There were no postoperative leaks or other major complications after surgery. Only 2 patients experienced perioperative complications in this series. One patient had atrial fibrillation after laparoscopic resection of a 4-cm leiomyoma. One patient underwent thoracoscopic resection and was discharged on the second postoperative day. He was readmitted on the fifth postoperative day for pneumonia. The median length of stay was 5.5 days in the open group (range 4–6 days) compared with 2.75 days (range 2–7) in the minimally invasive group ($P = .002$).

Pathologic Diagnosis

Leiomyoma was the pathologic diagnosis in 15 patients. In each of these patients the tumor arose from the muscularis propria of the esophagus, and all of these tumors were histologically benign. In 3 patients a gastrointestinal stromal tumor was diagnosed by staining of the *c-kit* protein with immunohistochemistry. One patient each had a schwannoma and a granular cell tumor.

Follow-up and Postoperative Gastroesophageal Reflux

The median follow-up period for these patients was 6 months (range 1-45 months). Within this period, no patient had a recurrence of esophageal tumor. However, 5 patients have subsequently undergone fundoplication for new-onset (n = 2) or worsening (n = 3) gastroesophageal reflux. These 5 patients underwent laparoscopic fundoplication (Nissen = 4, Toupet = 1) at a median of 17 months after tumor resection. Notably, 4 of these 5 patients had a mid-esophageal tumor that was resected through a transthoracic approach. The fifth patient underwent laparoscopic resection of a 7-cm leiomyoma that was located within the distal third of the esophagus. A fundoplication was not performed at that time.

The size of the resected tumor (and thus the length of myotomy required for resection) did not seem to affect the development of postoperative reflux. Among the 9 patients who underwent a transthoracic resection, the average tumor size of those who subsequently required fundoplication was 4.8 cm, compared with 6.6 cm among those who did not.

Among the 5 patients who required subsequent fundoplication, tumor resection was probably an antecedent cause in 2. In these 2 patients, reflux significantly worsened after surgery. In 1 patient, a distal esophageal tumor was resected thoracoscopically. Subsequent manometry showed an amotile distal esophagus and a hypotonic lower esophageal sphincter. The other patient had undergone laparoscopic resection of a 7-cm leiomyoma at the gastroesophageal junction. Postoperative manometry showed normal peristalsis in the body of the esophagus but a hypotonic lower esophageal sphincter. In the remaining 3 patients, reflux seemed to be unrelated to tumor resection. In these patients, reflux developed 2 to 3 years after tumor resection and manometry before fundoplication was normal.

Reflux developed in 1 additional patient after resection of a 7-cm mid-thoracic leiomyoma. Manometry also showed impaired peristalsis of the body of the esophagus; however, her symptoms were adequately controlled with antisecretory medications.

Discussion

There are several options for the management of benign tumors of the esophagus. These include observation, endoscopic tumor ablation, and resection through an open or a minimally invasive approach. A hallmark of these tumors is that they typically arise from the muscularis propria of the esophagus, with a normal overlying mucosal layer. As such, these tumors are often able to be enucleated while preserving the integrity of the submucosa.

On occasion, however, a leiomyoma may arise from the smooth muscle of the muscularis mucosa.[12,13] These tumors are more likely to protrude into the lumen of the esophagus, and they may assume a pedunculated morphology because the tumor will move with each swallow. It is in this setting that endoscopic strategies have been proposed as an alternative to surgical resection. The technique for endoscopic resection is similar to that used for resection of colonic polyps: The lesion is lifted off the submucosa by the injection of saline and is removed with a polypectomy snare.[14] Removal of larger lesions may be addressed with the use of a suction-cap device.[15] Hemostasis is then obtained using the argon plasma beam or endoscopic clips. To date, experience with this technique has been limited in the Western hemisphere. In a representative series from Germany, 20 patients with submucosal esophageal tumors (as determined by endoscopic ultrasound) were resected endoscopically.[12] No major complications occurred, although subsequent surgery was required in 2 patients whose tumors were not completely removed endoscopically. The mean tumor diameter was relatively small (17 mm, range 8–34 mm). Six patients had minor bleeding that was controlled during the initial endoscopy. All patients underwent a second-look endoscopy 4 hours after the initial procedure; delayed bleeding was noted in 2 of these patients.

Experience with endoscopic removal is far more extensive in Asia, and these techniques have been modified to allow removal of tumors located in the muscularis propria. For example, a technique has been described in which deep tumors of the esophagus are exposed by first stripping the mucosa endoscopically. The tumor can then be enucleated by using an electrocautery snare and a coagulation electrode. In a large series from Korea,[16] 25 patients had benign tumors of the esophagus removed using this technique, and there were no major complications such as bleeding or perforation. A modified technique using an insulated-tip electrosurgical knife has been used to endoscopically resect tumors as large as 6 cm.[17]

Within this context, it is important to document the safety and efficacy of minimally invasive surgery to treat these lesions. Although the technology for endoluminal treatment of esophageal disease has expanded greatly, experience with endoscopic resection of benign tumors is limited, particularly for the larger leiomyomas that tend to be symptomatic and arise from the muscularis propria. In contrast, the surgical treatment of these tumors is technically straightforward, particularly in centers with experience in laparoscopic Nissen fundoplication and Heller myotomy.

The present report is the largest series to date on the treatment of these tumors using minimally invasive surgical techniques. We also included those patients treated with open surgery during the same period. Although our preference has been to approach the extremely large tumors with open surgery, we have also been successful in removing these tumors thoracoscopically (up to 8 cm). We have also demonstrated a shorter length of stay among those who underwent minimally invasive resection compared with open resection. No major complications occurred in either the open or minimally invasive group. Two patients did require repair of a mucosal perforation after tumor enucleation. It is not surprising that the tumors of both these patients had been biopsied preoperatively.

However, we have also observed that several patients required subsequent fundoplication for the treatment of reflux. It is possible that the myotomy required for tumor enucleation interfered with the ability of the esophagus to clear physiologic reflux because of impaired peristalsis. In the present series, 3 of these patients had preexisting reflux before tumor resection, and it is likely that these patients would have required fundoplication regardless of the myotomy required for removal of the leiomyoma. In the remaining 2 patients, 1 had resection of a large leiomyoma located just proximal to the gastroesophageal junction. Most likely the myotomy required for tumor resection disrupted the lower esophageal sphincter, leading to reflux. The final patient had an 8-cm tumor that was resected thoracoscopically. Severe postoperative reflux developed in this patient, and fundoplication was required 3 years later. In this case reflux was likely related to the esophageal dysmotility that developed after tumor resection.

There are some technical points that should be emphasized in the management of these tumors. The first is the benefit of intraoperative endoscopy, which allows for careful examination of the mucosa after the tumor has been enucleated. In 2 patients we noted mucosal injury after resection; in each case this was repaired thoracoscopically without complication. Endoscopy is especially valuable for patients whose tumor has been biopsied and fibrosis between the tumor and the submucosa may be anticipated. Second, we have found that placing a traction suture in the

tumor is useful to allow the correct plane of dissection to be identified. Alternatively, one can grasp the tumor, although this may lead to fragmentation of the tumor. Others have proposed inflating a balloon within the lumen of the esophagus to push the tumor away from the submucosa.[18] We have on occasion inserted an esophageal bougie, which has the same effect. Third, our preference is to approach all thoracic tumors through the right chest. Tumors that are predominantly on the left side of the esophagus can still be resected through the right chest by rotating the esophagus after mobilization. The exposure from the right chest is familiar to our group from our experience with minimally invasive esophagectomy. Also, the entire length of the thoracic esophagus can be visualized from the right chest, unobstructed by the heart or the aorta.

Conclusions

We have shown that minimally invasive resection of benign esophageal tumors is technically feasible, although an open approach should be considered for larger tumors or when technical difficulty is encountered. In experienced hands, the minimally invasive approach is associated with minimal complications and a shorter length of stay compared with open surgery. Gastroesophageal reflux may develop postoperatively in a proportion of patients, and this emphasizes the need for careful follow-up in this group of patients.

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