



RAPID COMMUNICATION

Long-term results of endosurgical and open surgical approach for Zenker diverticulum

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Abstract

AIM: To assess the effectiveness of minimally invasive versus traditional open surgical approach in the treatment of Zenker diverticulum.

METHODS: Between 1976 and 2006, 297 patients underwent transoral stapling ($n = 181$) or stapled diverticulectomy and cricopharyngeal myotomy ($n = 116$). Subjective and objective evaluations of the outcome of the two procedures were made at 1 and 6 mo after operation, and then every year. Long-term follow-up data were available for a subgroup of patients at a minimum of 5 and 10 years.

RESULTS: The operative time and hospital stay were markedly reduced in patients undergoing the endosurgical approach. Overall, 92% of patients undergoing the endosurgical approach and 94% of those undergoing the open approach were symptom-free or were significantly improved after a median follow-up of 27 and 48 mo, respectively. At a minimum follow-up of 5 and 10 years, most patients were asymptomatic after both procedures, except for those individuals undergoing an endosurgical procedure for a small diverticulum (< 3 cm).

CONCLUSION: Both operations relieve the outflow obstruction at the pharyngoesophageal junction, indicating that cricopharyngeal myotomy has an important therapeutic role in this disease independent of the resection of the pouch and of the surgical approach. Diverticula smaller than 3 cm represent a formal contraindication to the endosurgical approach because the common wall is too short to accommodate one cartridge of staples and to allow complete division of the sphincter.

INTRODUCTION

Surgical resection has represented the therapy of choice for Zenker diverticulum for many decades. Only during the second half of the last century it was recognized that correction of the functional obstruction caused by the upper esophageal sphincter is an important component of the surgical procedure^[1,2]. Recent developments in minimally invasive surgery have led to the use of endoscopic stapling devices to divide the septum between the esophagus and the pouch in order to relieve the outflow obstruction at the pharyngoesophageal junction^[3,4], but no very long-term follow-up data (> 10 years) have been reported yet with this procedure. The aim of this retrospective study was to compare the late outcome of the endosurgical and open surgical approach for Zenker diverticulum.

MATERIALS AND METHODS

Subjects

Three-hundred and seventy consecutive patients underwent surgery for symptomatic Zenker diverticulum between 1976 and 2006 in our institution. During this 30-year study period, a variety of surgical procedures were performed, including transoral stapling ($n = 181$), diverticulectomy and myotomy ($n = 167$), diverticulopexy and myotomy ($n = 12$), myotomy alone ($n = 5$), diverticulectomy alone ($n = 4$), diverticulum invagination ($n = 1$). Since 1992, when endostaplers became available for laparoscopic surgery^[3,4], transoral endostapling has become the preferred approach to the treatment of pharyngoesophageal diverticulum in our institution. The outcomes of the two most common and recently performed techniques, i.e., transoral endostapling ($n = 181$), and stapled open resection plus cricopharyngeal myotomy ($n = 116$), form the basis of this report.

Preoperative workup included barium swallow, upper

gastrointestinal endoscopy, and esophageal manometry in the majority of patients. At endoscopy, the depth of the diverticulum (cm) was measured from the upper esophageal sphincter to the bottom of the pouch. The remaining esophagus was examined for the presence of associated disease. A thin guide-wire inserted at the end of the endoscopic examination was often used to assist in positioning the manometric catheter. More recently, pharyngoesophageal transit scintigraphy was performed pre- and postoperatively in individuals undergoing the endosurgical approach. The patients were kept on a clear liquid diet the day before the operation. Whenever necessary, especially in elderly individuals, intravenous antibiotics, intensive respiratory physiotherapy, and nutritional support were administered before surgery.

Technique of transoral endostapling

The operation was routinely performed under general endotracheal anesthesia. The surgeon was sitting behind the patient's head. The hypopharynx was entered with a modified Weerda diverticuloscope (*Storz*) which was gently advanced right behind the endotracheal tube until the cervical esophagus was reached. A 5 mm wide-angle 0° telescope connected to a cold-light source and a video-camera allowed to insert the instrument under vision with a magnified vision of the operative field on a television screen. By slowly withdrawing the instrument, the septum between the esophagus and diverticulum was identified and centered in the operative field. The two self-retracting valves of the diverticuloscope, which can be approximated and angulated to fit the patient's hypopharyngeal anatomy, were allowed to enter the diverticulum and esophageal lumen, respectively. The length of the diverticulum (cm) was measured using a graduated rod. This maneuver also allowed to straighten the pouch and to elongate the common wall. An ETS 35 linear endostapling device (*Ethicon Endo-surgery*) was used to divide the septum. The anvil was placed in the lumen of the diverticulum and the cartridge into the lumen of the cervical esophagus. The instrument jaws were approximated across the septum in the midline before firing. With a single application of the endostapler, the posterior esophageal wall was sutured to the wall of the diverticulum, and the tissue was transected between three rows of staples on each side. Multiple stapler applications might be necessary according to the size of the diverticulum. Electrocoagulating endosurgical scissors might be used to complete the section at the distal end of the staple line. After removal of the stapler, the two wound edges retracted laterally due to the division of the cricopharyngeal muscle. A gastrographin swallow study was performed on the first postoperative day. The patient was then allowed to drink and eat a soft diet and discharged from the hospital.

Technique of open diverticulectomy and cricopharyngeal myotomy

The operation was performed under general anesthesia, local anesthesia, or C5-C6 superselective spinal anesthesia. The patient was positioned supine on the operating table with a small pillow under the shoulders. The head was hyperextended and slightly turned to the right side.

The skin incision, centered at the level of the cricoid cartilage, was made along the anterior border of the left sternocleidomastoid muscle. The subcutaneous tissue and platysma were divided. The pharynx and cervical esophagus were exposed by retracting the sternocleidomastoid and carotid sheath laterally, and the larynx and thyroid gland medially. The omohyoid muscle, middle thyroid vein, and inferior thyroid artery were divided. Care was taken not to injury the recurrent laryngeal nerve which runs in the tracheoesophageal groove. The diverticulum was identified, grasped with Duval forceps, and retracted cephalad. The loose connective tissue surrounding the pouch was dissected to identify its neck on the posterior pharyngeal wall. The transverse fibers of the cricopharyngeal muscle could be seen just below the neck of the diverticulum. At this point, right-angle forceps could be used to develop a dissection plane inferiorly between the muscularis and mucosa, and myotomy was performed using curved scissors for a length of about 5 cm on the cervical esophagus. The edges of the muscle were gently separated until the underlying mucosa was exposed. A Foley catheter inserted through the mouth and progressively withdrawn with the balloon inflated might be useful to distend the pharyngoesophageal junction during division of the muscle layer. The diverticulum was then transected using a TA 30 linear stapler (*Tyco*). A gastrographin swallow study was routinely performed on postoperative d 2 before resuming a soft diet.

Follow-up

Patients were scheduled for an office visit at 1 and 6 mo after operation. Generally, a barium swallow study was obtained at the 1 year office visit and whenever dysphagia, pharyngo-oral regurgitation, or aspiration symptoms occurred. Patients were regularly interviewed by letter or by phone every year throughout the follow-up, and also invited to volunteer for upper gastrointestinal endoscopy and esophageal function studies.

Statistical analysis

A 2-tailed Student *t* test for paired values was used when appropriate for data analysis. $P < 0.05$ was considered statistically significant. Values are expressed as mean \pm SD.

RESULTS

The main demographic and clinical data and the outcome of the patient population are reported in Table 1. One patient died of pulmonary embolism during the postoperative period, giving an overall mortality rate of 0.3%. With the endosurgical approach there were 8 conversions (4.4%) to open surgery due to difficult exposure of the septum and in one of these individuals a mucosal tear occurred during insertion of the endostapler. One transient left recurrent palsy and 1 wound hematoma requiring surgical revision occurred in patients undergoing the open approach; there were also 2 leaks from the staple line treated conservatively and healed within two weeks. The hospital stay was markedly reduced in patients undergoing the endosurgical approach.

Eight patients in the endosurgical group (4.4%) com-

Table 1 Demographic data, clinical features and outcome in the patient population

	Transoral stapling (<i>n</i> = 181)	Stapled resection + myotomy (<i>n</i> = 116)
Age (median/range)	64/37-95	62/30-84
Male/female ratio	3.5:1	2.7:1
Dysphagia (%)	100	100
Aspiration (%)	23	19
Hiatal hernia/GERD (%)	9	12
Weight loss (%)	32	17
Pouch size - cm (median,range)	4/2.5-8	4/1-9
Regional anesthesia (<i>n</i>)	0	15
Mean operative time (min)	19	70
Postop. mortality (%)	0	0.8
Leaks from staple line (%)	0	1.7
Recurrent nerve palsy (%)	0	0.8
Dental injuries (%)	1.1	/
Conversions (%)	4.4	/
Mean hospital stay (d)	3	8
Reoperation (%)	4.4	1.7
Lost to follow-up (% patients)	9.9	18.1
Median follow-up (mo)	27	48
Asymptomatic (% patients)	92	94

plained of persistent postoperative symptoms requiring an endosurgical procedure in 5, laser treatment by flexible endoscopy in 2, and open surgery in 1. Two patients in the open approach group (1.7%) required reoperation due to a recurrent diverticulum. Follow-up data were available for 257 patients (86.8%). Overall, 92% of patients undergoing the endosurgical approach and 94% of those undergoing the open approach were symptom-free or significantly improved after a median follow-up of 27 and 48 mo, respectively. Pre- and postoperative manometric data in the two groups of patients are reported in Table 2. Radionuclide studies were performed in a subgroup of patients (*n* = 15) undergoing the endosurgical approach and showed a statistically significant reduction of upper esophageal residual activity at 1 min compared with preoperative values ($P = 0.006$).

Long-term follow-up data were available for a subgroup of patients at a minimum of 5 and 10 years after the endosurgical and open procedure. Most patients were asymptomatic after both procedures, except for those undergoing an endosurgical procedure for a small diverticulum (< 3 cm) (Table 3).

DISCUSSION

It is currently believed that inadequate opening of the upper esophageal sphincter, resulting from fibrosis of the cricopharyngeal muscle, considerably increases hypopharyngeal intrabolus pressure and leads to formation of a pulsion (Zenker's) diverticulum^[5-7]. It is for this reason that surgical resection or suspension of the pouch performed without a concomitant myotomy may fail to relieve dysphagia and to prevent complications or recurrence of the diverticulum. Cricopharyngeal myotomy creates a weak area in the muscle over which pharyngeal pressure can be distributed during swallowing^[8-13]. Transoral stapling of the septum interposed between the esophagus and

Table 2 Comparison of pre- and postoperative manometric data

	Endosurgical (<i>n</i> = 43) Pre/post	Open (<i>n</i> = 24) Pre/post
Pharyngeal pressure (mmHg)	47.9/42.4	36.4/34.3
UES resting pressure (mmHg)	52.4/31.5 ^b	38/20 ^b
U.E.S. residual pressure (mmHg)	3.4/2	6.2/0.7 ^a
UES length (cm)	2.5/2.3	3.1/2.4 ^a

^a $P < 0.05$, ^b $P < 0.01$.

Table 3 Late clinical follow-up results expressed as proportion of asymptomatic patients

	Endosurgical	Open
	> 3 cm	< 3 cm
5 yr, <i>n/n</i> (%)	44/47 (93.6)	4/8 (50)
10 yr, <i>n/n</i> (%)	29/35 (82.8)	2/6 (33.3)
		30/31 (96.7)
		16/19 (84.2)

diverticulum leads to a similar physiological effect and the only difference is that this latter procedure does not remove the pouch itself but creates a common cavity^[3].

Treatment of Zenker diverticulum is indicated, regardless of its size, to relieve the disabling symptoms of oropharyngeal dysphagia and pharyngo-oral regurgitation, and to prevent the life-threatening complication of aspiration pneumonia and lung abscess which commonly occur in the elderly population. The poor nutritional intake associated to the swallowing disorder and the tendency of the pouch to progressively enlarge represent the additional arguments in favor of early treatment. Pill-entrapment in the pouch is a further concern in patients with serious comorbidities who receive life-saving drug therapy^[14]. Development of a squamous-cell carcinoma is a possible, although rare, long-term complication^[15].

The results of this study show that both the transoral and surgical procedures are safe and effective in the treatment of Zenker diverticulum. Although it may be unfair to compare the more recent series of transorally treated patients with the historical cohort of surgically treated patients, it appears that the endosurgical approach has some distinct advantages. Unlike the traditional surgical approach, which varies depending on the preference of the individual surgeon, the endoscopic approach is focused on the upper esophageal sphincter. In fact, stapling the septum interposed between the pouch and cervical esophagus allows the creation of a common cavity with simultaneous section of the upper esophageal sphincter. Compared to the conventional surgical operation, the advantages of endostapling include absence of skin incision, shorter operative time, minimal or absent postoperative pain, quicker resumption of oral feeding, and shorter hospital stay^[16]. An additional advantage of this approach is expected in patients who have undergone surgery in the left side of the neck or present with recurrent diverticulum after a conventional operation^[17]. In such circumstances, the open approach may pose a major technical challenge to the surgeon and is associated with a high risk of recurrent nerve injury or leakage from the suture line.

The endoscopic approach may prove difficult in patients with cervical osteoarthritis, and in those with a reduced opening capacity of the mouth. The best indication to this procedure is represented by medium-sized diverticula in which at least two staple cartridges can be applied and an adequate cricopharyngeal myotomy can be achieved. Diverticula smaller than 3 cm in depth represent a formal contraindication to the endosurgical approach because the common wall is too short to accommodate one cartridge of staples and to allow complete division of the sphincter. This would result in an incomplete myotomy causing persistent dysphagia as it occurred in our series. Although the postoperative outcome of these patients, who are often elderly and compromised, suggests a greater comfort and a quicker recovery compared to the conventional operation, it should be taken into account that the endosurgical approach requires a general anesthesia. Therefore, in patients with excessive operative risk, a conventional operation carried out under regional anesthesia still remains the procedure of choice.

At present, there is no evidence from high quality randomised controlled studies to establish which procedure is superior. It is clear that both operations relieve the outflow obstruction at the pharyngoesophageal junction, indicating that cricopharyngeal myotomy has an important therapeutic role in this disease independent of the resection of the pouch and of the surgical approach. Future trials may indicate the role of a tailored approach in the management of Zenker diverticulum^[18]. Based on the findings of this study, we conclude that the endosurgical approach is as safe and effective as the open surgical procedure, provided that at least the entire length of the stapler cartridge (3 cm) can be applied to the septum. A small diverticulum limits access to the stapler head and it may not be possible to perform an adequate myotomy.

COMMENTS

Background

The aim of surgery in Zenker diverticulum is to relieve outflow obstruction at the pharyngo-esophageal junction. This requires the performance of a cricopharyngeal myotomy and/or the resection of the pouch.

Research frontiers

It has been shown that effective surgery can be performed either through a transoral approach or through a transcervical approach.

Innovations and breakthroughs

The advent of laparoscopic instruments has represented a major technological advance in surgery over the past 15 years. Using a 5 mm telescope connected to a video-camera it is possible to insert a diverticuloscope through the mouth and divide the septum between the esophagus and Zenker diverticulum with an endostapler.

Applications

The transoral approach is increasingly used in the treatment of Zenker diverticulum. Compared to the conventional surgical operation the advantages of endostapling include shorter operative time, less postoperative pain, quicker recovery, and shorter hospital stay. Best long-term results are expected in patients with a > 3 cm pouch.

Peer review

This is an interesting review of the authors' experience. The authors report on a large series of patients with Zenker diverticulum ($n = 297$). In this retrospective study, the transoral endosurgical approach ($n = 181$) was compared with a historical group of patients undergoing open diverticulectomy ($n = 116$). A subgroup of patients were followed up for 5 and 10 years, respectively.

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