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ORIGINAL ARTICLE

Retrospective Cohort Study

Long-term outcome and quality of life after transoral stapling for Zenker diverticulum

Luigi Bonavina, Alberto Aiolfi, Federica Scolari, Davide Bona, Andrea Lovece, Emanuele Asti

Luigi Bonavina, Alberto Aiolfi, Federica Scolari, Davide Bona, Andrea Lovece, Emanuele Asti, IRCCS Policlinico San Donato, Division of General Surgery, Department of Biomedical Sciences for Health, University of Milan, 20097 Milano, Italy
Author contributions: Bonavina L designed the study; Aiolfi A, Scolari F and Bona D drafted the manuscript; Aiolfi A, Bona D, Scolari F, Lovece A and Asti E collected and analyzed the data; Bonavina L and Aiolfi A edited the final manuscript.

Correspondence to: Luigi Bonavina, Professor, IRCCS Policlinico San Donato, Division of General Surgery, Department of Biomedical Sciences for Health, University of Milan, Piazza E Malan 2, San Donato Milanese, 20097 Milano, Italy. luigi.bonavina@unimi.it
Telephone: +39-2-52774621
Fax: +39-2-52774622
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Abstract

AIM: To investigate long-term results and quality of life after transoral stapling of Zenker diverticulum.

METHODS: The data of all patients admitted to our institution for the surgical treatment of Zenker diverticulum were entered into a prospective database. Demographics, symptoms, intraoperative and post-operative data, morbidity, time to oral feeding, and length of hospital stay were recorded. All patients underwent upper gastrointestinal endoscopy and a barium swallow study to measure the length of the diverticulum from the apex of the septum to the bottom of the pouch. Transoral stapling was performed using a Weerda diverticuloscope under general anesthesia. Over time, the technique was modified by applying traction sutures to ease engagement of the common septum inside the stapler jaws. Perioperative variables, symptoms, long-term outcome, and quality of life were analyzed. The operation was considered successful if the patient reported complete remission (grade 1) or marked improvement (grade 2) of dysphagia, regurgitation, and respiratory symptoms. Statistical analysis was performed using Statistical Package for Social Science (SPSS, Version 15, SPSS, Inc., Chicago, IL).

RESULTS: Between 2001 and 2013, the transoral approach was successfully completed in 100 patients with a median age of 75 years. Patients with a larger ($\geqslant$ 3 cm) diverticulum were older than those with a smaller pouch ($P < 0.038$). Complications occurred in 4% of the patients but there was no mortality. A statistically significant improvement of dysphagia and regurgitation scores ($P < 0.001$) was recorded over a median follow-up of 63 mo. Similarly, a significant decrease in the median number of pneumonia episodes per year ($P < 0.001$) was recorded after surgery. The overall long-term success rate of the procedure was 76%. The success rate of the operation was greater in patients of 70 years of age or older compared to younger individuals ($P = 0.038$). Use of traction sutures on the septum was associated with an improved success rate compared with the standard procedure ($P = 0.04$). All items of the health related quality of life questionnaire were significantly higher compared to baseline ($P < 0.05$).

CONCLUSION: Transoral stapling is safe and effective. The operation significantly improves patients' quality of life. It appears that elderly patients with large diverticula significantly benefit from the procedure and that the modified surgical technique including traction sutures can further improve the success rate.

Key words: Zenker diverticulum; Dysphagia; Aspiration pneumonia; Cricopharyngeal myotomy; Diverticulectomy; Transoral stapling; Flexible endoscopy; Short-form health survey questionnaire

Core tip: Transoral stapling was introduced 20 years ago as an alternative to standard open cricopharyngeal myotomy and diverticulectomy for the treatment of Zenker diverticulum. Long-term results after this operation have seldom been reported and quality of life data are lacking. Between 2001 and 2013, 100 patients underwent transoral stapling under general anesthesia. Perioperative variables, symptoms, long-term outcome, and quality of life were analyzed. The median follow-up was longer than 5 years. The success rate of the operation was significantly greater in patients of 70 years of age or older compared to younger individuals. All items of the health related quality of life questionnaire were significantly higher compared to baseline.

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INTRODUCTION

Zenker diverticulum is a relatively rare disease, with an annual incidence of about 2 cases per 100000, and occurs most often in elderly men[1]. The transoral approach to the pharyngoesophageal diverticulum was first described almost a century ago by Mosher *et al*[2] who performed an endoscopic diverticulotomy with the blade of a knife. Electrocautery or laser have been used later on, but failed to gain consensus because of the risk of perforation[3]. The transoral approach using a stapler to divide the septum between the esophagus and the diverticulum was first described by Collard *et al*[4], Martin-Hirsch *et al*[5], and Narne *et al*[6] in 1993 to overcome the limitations and increase safety of the endoscopic approach. Subsequent studies have confirmed the safety and effectiveness of this operation[7-17]. The goal of this report was to review the long-term results and the quality of life of patients with Zenker diverticulum who have been treated with the transoral stapling operation in a single center.

MATERIALS AND METHODS

The data of all patients admitted to our institution for the surgical treatment of Zenker diverticulum were entered into a prospective database. Demographics, symptoms, intraoperative and postoperative variables, morbidity, time to oral feeding, and length of hospital stay were recorded. An upper gastrointestinal endoscopy and a barium swallow study were routinely performed to measure the length of the diverticulum from the apex of the septum to the bottom of the pouch and to exclude the presence of concomitant esophagogastric disorders. A questionnaire on symptoms was administered to grade the severity of dysphagia on a scale of 1 (absent) to 4 (liquid diet only). Regurgitation and respiratory symptoms such as cough, hoarseness, and episodes of pneumonia were recorded as to their frequency on a scale of 1 (absent) to 4 (daily). Preoperative quality of life was evaluated according to the short-form health survey questionnaire (SF-36), an instrument designed to characterize a person's view of health and quality of life[18,19]. Evaluation of the results was done by attributing scores to each question. A change of more than five scale points on any of the eight domains of the SF-36 is considered to be clinically relevant[20]. Each dimension was analyzed separately. The body mass index, the Mallampati and Cormack scores, the distance (in mm) between upper and lower incisors, the thyromental distance, and the distance from incisors to the upper esophageal sphincter were recorded. The Mallampati score is determined by the direct visibility of tonsils, uvula, and soft palate[21]. The Cormack score is based on the laryngeal view during direct laryngoscopy[22]. Postoperatively, an office visit was scheduled within 6 mo after surgery. Patients were then interviewed yearly by letter or by phone. A barium swallow study and an upper gastrointestinal endoscopy were performed at 1 year and during the follow-up whenever dysphagia, regurgitation, or other symptoms occurred. At the last follow-up, postoperative residual symptoms were assessed and quality of life was compared to preoperative values. The degree of postoperative satisfaction was also evaluated using a scale of 1 to 4. The operation was considered successful if the patient reported complete remission (grade 1) or marked improvement (grade 2) of dysphagia, regurgitation, and respiratory symptoms. The Statistical Package for Social Science (SPSS, Version 15, SPSS, Inc., Chicago, IL) was used for data analysis. Quantitative variables were expressed as mean ± SD or median (range). Fisher's exact test was performed for categorical data. Ordinal and quantitative variables

Table 1 Comparison of rate of patients with preoperative and postoperative grade 3-4 symptoms

Symptoms	Pre	Post	*P*
Dysphagia	75.6%	8.3%	0.001
Regurgitation	59.1%	7.5%	0.001
Respiratory symptoms	38.1%	7.8%	0.001

were analyzed by Wilcoxon test. The Kaplan Meier method was used to calculate the recurrence rate. $P < 0.05$ was considered significant.

Statistical analysis

The operation was performed under general anesthesia with orotracheal intubation and with the patient in the supine position. The technical details of the procedure have been described elsewhere[23]. Briefly, a bivalved Weerda diverticuloscope (Karl Storz, Tuttlingen, Germany) was introduced in the cervical esophagus and then withdrawn until the common septum was identified. The septum was divided using a linear endostapler (ETS 35 mm, Ethicon Endosurgery, Cincinnati, OH). Over the past five years, one or two full-thickness traction sutures were routinely applied at the apex of the common septum using a laparoscopic suturing device (Endostitch, Covidien, Norwalk, CT) to improve visualization and purchase of the septum within the stapler jaws.

RESULTS

Between July 2001 and April 2013, 116 patients with Zenker diverticulum were admitted to our Department. Three of these patients with a very small pouch (1-2 cm) underwent primary cricopharyngeal myotomy and are excluded from this study. The other patients were all considered eligible for transoral stapling. In 13 (11.5%) of the 113 patients, who are also excluded from the present study, the procedure required conversion to an open diverticulectomy combined with cricopharyngeal myotomy. Patients undergoing uneventful transoral approach had a larger mouth opening as assessed by the incisor distance (45 ± 7 mm *vs* 34 ± 6 mm, $P = 0.001$) and a longer thyromental distance (96 ± 9 mm *vs* 85 ± 15 mm, $P = 0.02$) compared to individuals requiring conversion to open surgery. The BMI, the Mallampati and Cormack scores, and the distance between incisors and the upper esophageal sphincter were similar in both groups.

Overall, 100 patients (57 males, 43 females) with a median age of 75 years (range 24-90 years) successfully underwent transoral stapling. The median diverticulum length was 3.5 cm (range 2-6 cm). Patients with a larger (≥ 3 cm) diverticulum were older than those with a smaller (< 3 cm) pouch (63.5 ± 14 years *vs* 78.8 ± 7.6 years, $P = 0.038$).

Table 2 Outcome of the operation according to clinical and operative variables *n* (%)

	Success rate	*P*
Age groups (yr)		
< 70	35 (65.7)	0.038
> 70	65 (84.6)	
Diverticulum size (cm)		
< 3	31 (54.9)	0.033
> 3	69 (88.4)	
Endostitch use		
No	49 (68)	0.04
Yes	51 (85)	

Intraoperative complications consisted of two dental lesions and one minor lip laceration. There were two postoperative complications (2%), atrial fibrillation in one patient and mediastinal abscess necessitating trans-cervical drainage in the other. Most patients started eating on the first postoperative day and were discharged on the second postoperative day.

At the latest follow-up, which was completed in 94 of the 100 patients, a significant decrease in the rates of grade 3-4 symptoms was reported (Table 1). Furthermore, in twelve octogenarian patients who presented preoperatively with recurrent episodes of pneumonia as the predominant symptom, a decrease in the median number of pneumonia episodes per year from 4.3 to 1.1 was recorded ($P < 0.001$). Overall, 84% of the patients were highly satisfied with the outcome (grade 1-2), whereas 10 (10.6%) were unsatisfied (grade 4). A further 5 (5.4%) patients, who were scored as grade 3, admitted that despite some residual or recurrent symptoms they would give consent to the operation if the decision had to be made again. Over a median follow-up time of 63 mo (range 12-139 mo), the long-term success rate of the operation was 76%. Patients' age, size of the diverticulum, and use of traction sutures significantly affected the outcome of the operation (Table 2).

Twenty-four patients complained of recurrent symptoms after a median follow-up time of 13 mo (range 2-60 mo). Among these patients, 14 refused further treatment due to mild symptoms, 3 required open diverticulectomy and cricopharyngeal myotomy, and 5 successfully underwent redo stapling without morbidity. The recurrence rate was higher in patients with a diverticulum < 3 cm (32% *vs* 11%, $P = 0.04$). Interestingly, these patients were significantly younger than patients with larger diverticula. The recurrence rate was lower in patients who underwent the modified surgical technique with the use of traction sutures (15% *vs* 32%, $P = 0.008$). Similarly, in the subgroup of patients with a diverticulum < 3 cm, there was a trend toward a lower recurrence rate when the traction suture was used (24% *vs* 38.9%, P = NS).

Assessment of quality of life parameters according

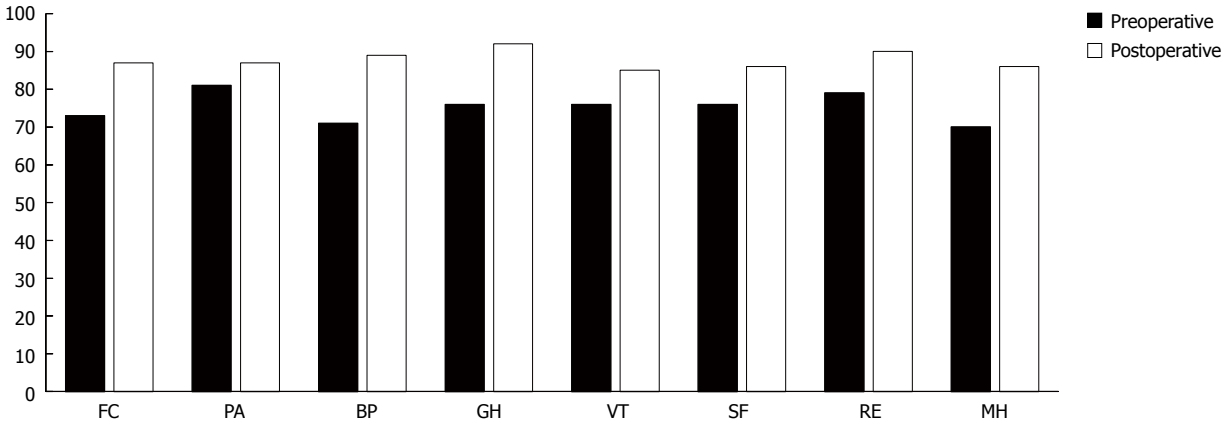

Figure 1 Preoperative and postoperative quality of life according to the 36-item short-form health survey health questionnaire. All items were significantly higher compared to baseline ($P < 0.05$ *vs* baseline). FC: Functional capacity; PA: Physical aspect; BP: Bodily pain; GH: General health; VT: Vitality; SF: Social function; RE: Role emotional; MH: Mental health.

to the eight domains of the SF-36 showed a statistically significant effect of the operation on the items functional capacity, physical aspects, pain, general health, vitality, social aspects, emotional aspects, and mental health. All scores were significantly higher at the last patient follow-up compared to preoperative assessment (Figure 1).

DISCUSSION

This study confirms that transoral stapling is a safe, effective and repeatable procedure for Zenker diverticulum[24]. Manometric and scintigraphic studies from our group had shown that transoral stapling of the septum can restore pharyngoesophageal physiology by decreasing hypopharyngeal intrabolus pressure[25]. Potential advantages of the transoral approach include low morbidity, short length of hospital stay, and similar medium-term outcome compared with open diverticulectomy and cricopharyngeal myotomy. The higher long-term recurrence rate is offset by the lower morbidity and the ease by which the procedure can be successfully repeated. However, no prospective clinical trials are available and clear evidence to prove which surgical method is more effective is still lacking[26]. A recent retrospective review showed that the results of transoral stapling may decline over time and the outcome may be worse in patients with small diverticula in whom a complete cricopharyngeal myotomy is unlikely to be performed[27]. In some patients, an unfavorable anatomy and/or technical difficulties in positioning the diverticuloscope preclude optimal visualization and engagement of the septum in the stapler. The conversion rate in our series was 11.5%, and we found that only the degree of mouth opening and the thyromental distance were significantly associated with conversion of the procedure to open surgery through a left cervical incision.

The long-term outcome analysis in our patients showed an overall success rate of 76%. This is comparable to other smaller series with shorter follow-up time[28]. Over the past five years we have modified our transoral technique by applying to the septum one or two full-thickness traction sutures. The average gain in length of stapled tissue provided by the traction sutures was 1 cm. This suggests that the transoral approach is suitable also for patients with a diverticulum of 2-3 cm as measured intraoperatively. The use of traction sutures was safe, did not increase operative time, and was associated with a significant reduction of the symptom recurrence rate compared with the standard technique.

In the present study we have also evaluated the effect of transoral stapling on patients' quality of life using the SF-36 questionnaire. A significant improvement of all 8 items was recorded. To our knowledge, objective quality of life assessment before and after transoral stapling for Zenker diverticulum has not been previously reported in the literature.

In the future, transoral stapling should be prospectively compared with interventional flexible endoscopy, especially in the management of patients with small (< 3 cm) diverticula. At present, both techniques appear safe and effective, but long-term results of the flexible endoscopic approach are still lacking[29-33].

In conclusion, first-line minimally invasive treatment of Zenker diverticulum by means of transoral stapling appears to be safe and provides symptom control and good quality of life in the long-term follow up. The low morbidity associated with the operation makes this procedure suitable and of special interest for the elderly patient population.

COMMENTS

Background

Transoral stapling was introduced 20 years ago as an alternative to standard open cricopharyngeal myotomy and diverticulectomy for the treatment of Zenker diverticulum. Long-term results after this operation have seldom been reported and quality of life data are lacking.

Research frontiers

The research hotspot is to investigate a minimally invasive method to effectively relieve dysphagia and prevent aspiration in this patient population.

Innovations and breakthroughs

Use of traction sutures during the transoral procedure allowed the improvement of engagement of the septum in the stapler and increased the success rate of the operation especially in patients with a small pouch. The study also shows that quality of life was significantly increased in these patients after operation.

Applications

The transoral stapling procedure is an effective up-front therapy for Zenker diverticulum and provides symptom control and good quality of life in the long-term follow up. The low morbidity associated with the operation makes this procedure suitable and of special interest in the elderly patient population.

Terminology

Zenker diverticulum is an outpouching of the pharyngo-esophageal junction commonly diagnosed in elderly patients. It causes dysphagia, regurgitation, rumination, halitosis, and aspiration. Transoral stapling is a safe and effective treatment, and consists of sectioning the septum interposed between the esophagus and the diverticulum.

Peer review

The authors report on the long-term outcome of 100 patients with Zenker diverticulum treated over 12 years by transoral stapling. In the course of the recruiting period, a technical modification was introduced and traction sutures were used to improve engagement of the septum in the stapler. The message is certainly important and interesting for the medical community. Indeed, the results of the procedure appear to be better in elderly patients with larger diverticula. It remains to be seen in a prospective study whether transoral stapling with a rigid scope and interventional flexible endoscopy will show a similar outcome.

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