



Long-term symptom control after endoscopic laser-assisted diverticulotomy of Zenker's diverticulum

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ABSTRACT

Objective: To assess the long-term outcome after endoscopic laser-assisted diverticulotomy.

Methods: The medical files of patients who underwent endoscopic Zenker's diverticulum (ZD) surgery were reviewed retrospectively. Patients were interviewed using a questionnaire which assessed symptoms, other relevant disorders and satisfaction after the surgery.

Results: Mean follow-up period from 62 surgeries was 100 months (range 11–216 months). Follow-up data were obtained from 34 patients (response rate: 55%) in total. The surgery resulted in a significant reduction of symptoms (regurgitation, dysphagia and globus sensation). In four cases (12%) a postoperative impairment of swallowing solid food was reported, whereas, persisted difficulty of swallowing liquids was observed in two patients (6%). There was no reported case of impairment associated with everyday habits. The majority of patients were satisfied with the overall outcome of the surgery ($n = 31$, 91%).

Conclusion: The endoscopic laser-assisted diverticulotomy is an effective method of treating Zenker's diverticulum. The presented long-term results confirm that this technique offers a very high degree of symptom relief and patient's satisfaction.

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1. Introduction

The pharyngoesophageal or Zenker's diverticulum (ZD) is created by herniation of the mucosa and submucosa through the weak area of Killian's dehiscence in the pharyngoesophageal segment [1]. Abnormalities of the physiology of swallowing and local anatomical factors as well contribute to the development of ZD [2–4]. The treatment of ZD is surgical, whereby the task of the intervention is the complete division of the cricopharyngeal muscle bridge. Previously, various surgical methods used for the treatment of ZD were been evaluated in terms of surgical time, hospitalization time, complication rate and recurrence rate [5–7]. However, an important parameter of the success of the

treatment is the long-term symptom relief and patient's satisfaction after surgery. Long-term symptomatic outcome and patient's satisfaction are parameters that decline from the typical “hard data” that the clinicians are familiar with. However, these parameters reflect the success of the treatment in the eyes of the patient and the appreciated functional outcome. Health-related quality of life of the patient should be the primary goal of treatment. Thus, the use of patient's satisfaction surveys has increased and became more widely accepted as important data were used to determine patient functional outcomes [8].

The aim of this study was to evaluate the postoperative outcome of the surgery and the satisfaction of ZD patients treated with endoscopic laser-assisted diverticulotomy through a long-term follow-up.

2. Methods

The medical files and surgical reports of endoscopic laser-assisted ZD surgeries performed between 1983 and 2011 at an

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Table 1

Questionnaire on symptoms, other related disorders and patient satisfaction after treatment of Zenker's diverticulum (original in German, translation by the authors).

A. Questions about postoperative symptoms (to be answered with yes or no)	
1.	Did you suffer in the time after surgery or do you currently suffer from swallowing difficulties?
2.	Did you suffer in the time after surgery or do you currently suffer from fluid or food coming up into your mouth?
3.	Did you suffer in the time after surgery or do you currently suffer from foreign body feeling in the throat?
4.	Did you suffer in the time after surgery or do you currently suffer from sore throat?
5.	Did you or another person notice in the time after surgery or do you or another person currently notice bad breath from your mouth?
6.	Did you lose in the time after surgery or do you lose currently unwanted weight?
7.	Did you suffer in the time after surgery or do you currently suffer from irritation of the throat or cough?
8.	Did you suffer in the time after surgery or do you currently suffer from shortness of breath?
9.	Did you suffer in the time after surgery or do you currently suffer from increased salivation?
B. Questions about other related disorders (to be answered with yes or no):	
1.	Did you have in the time after surgery or do you currently have problems with intake of solid food and you think this is due to the surgery?
2.	Did you have in the time after surgery or do you currently have problems with intake of liquid food and you think this is due to the surgery?
3.	Did you have in the time after surgery or do you currently have problems with looking into the daily habits and you think this is due to the surgery?
4.	Did you have in the time after surgery or do you currently have problems with falling asleep or sleeping through the night and you think this is due to the surgery?
5.	Did you or your dentist have in the time after surgery noticed damages on your teeth and you or the dentist think this is due to the surgery?
C. Questions about patient's satisfaction (to be answered with yes or no):	
1.	Are you satisfied with your general condition after the surgery and currently?
2.	Are you satisfied with the overall outcome of the surgery?
3.	Would you propose the endoscopic laser-assisted diverticulotomy to a relative with the same diagnosis

academic tertiary referral center were reviewed retrospectively. The study was approved by the Ethics Commission of Cologne University's Faculty of Medicine. Patient data including age, sex, size of the diverticula and preoperative symptoms were analyzed. The second part of the study consisted of a telephone interview of the patients. For this purpose a questionnaire which assessed symptoms, other relevant disorders and satisfaction after the surgery was used. The telephone interview was carried out in the period March–April 2012 by one author of this study (M.F.). Data of these patients regarding surgical technique, length of hospital stay and related complications were already reported in a previous publication [5].

The diagnosis of ZD had been based on the control dynamic contrast radiography with diatrizoic acid (Gastrografin[®], Bayer Schering, Germany) of the hypopharynx and the esophagus. The size of the diverticulum was defined by the maximal depth of the diverticular sac on the preoperative dynamic contrast radiography.

The patients were treated using the carbon dioxide (CO₂) laser endoscopic–microscopic diverticulotomy in a standardized way using the spreadable diverticuloscope. A nasogastric tube for postoperative feeding was placed at the beginning of the intervention. Using an operating microscope (OPMI-MD; Zeiss, Germany) the cricopharyngeal bridge and the bottom of the diverticulum sac was exposed. A CO₂ laser device (Illumina 730, Heraeus Lasersonics Inc., Germany until 2001; Sharplan 1041S, Sharplan Lasers, Germany after 2001) was set on a working distance of 400 mm. Next step was to empty the diverticular sac from any food debris and then a moist swab was placed to protect the rest of mucosa from accidental laser injury. The muscular bridge was then transected in the midline using the CO₂ laser (2–8 W, super pulse mode) up to the last visible muscle fibers, without entering the mediastinal fat. More details to the surgical procedure are given in our previous publication [5].

Postoperatively and before removal of the tube in the postoperative phase, control dynamic contrast radiography was performed. All patients received intraoperatively intravenous antibiotics (usually ampicillin–sulbactam or clindamycin in the case of allergy to penicillin), which were continued at least until the removal of the nasogastric tube. A gastric protection therapy with proton pump inhibitor was applied as well.

In order to evaluate the postoperative symptom relief, other relevant disorders and satisfaction of the patients after surgery,

data were obtained through a telephone interview. For this purpose we developed a questionnaire that includes the main symptoms and disorders of patients with ZD. The questionnaire was formulated based on the Gastro-Intestinal Quality of Life Index (GIQLI) questionnaire but was adapted for patients treated for ZD (Table 1) [9].

Statistical analysis was completed using SPSS statistical software version 20 for Windows (SPSS Inc., Chicago, IL). Statistical analysis was performed using non-parametric tests. A *p*-value of <0.05 was considered statistically significant.

3. Results

A total of 72 patients underwent surgical treatment for Zenker's diverticulum in our institution between 1983 and 2011. Sixty-two patients (86%) received laser-assisted endoscopic surgery and 10 patients (14%) an open surgery through transcervical approach. All patients who underwent endoscopic laser-assisted diverticulotomy were included in this study (*n* = 62). The majority of patients were males (77%, *n* = 48), whereas, the females were represented with a smaller number of cases (23%, *n* = 14). The mean age of the study group was 66 years (range 43–82 years).

A total of five patients (8.1%) underwent more than one surgery because of symptomatic recurrence of the diverticulum. In three cases a single successful endoscopic revision operation was necessary; in two patients a second endoscopic revision was needed. One patient developed mediastinitis after the second endoscopic revision operation and therefore a third revision via transcervical approach was performed. Four more patients were operated for recurrence at our hospital after an initial surgical treatment of ZD at other institutions.

Reported preoperative symptoms included regurgitation, dysphagia, globus sensation, cough, loss of weight, sore throat, hypersalivation and dyspnea. Regurgitation was the most common preoperative symptom, presenting in 47 of the study patients (76%), followed by dysphagia in 42 patients (68%). The patients' symptoms are shown in an overview in Table 2.

The size of the diverticula ranged from 1 to 8 cm with a median size of 3.1 cm. The cases with a globus sensation generally presented with a smaller diverticulum sac (2.7 cm, *n* = 21) compared with patients without this symptom (3.4 cm, *n* = 41, *p* = 0.04). In contrast, there was no statistically significant

Table 2

Pre- and postoperative symptoms in study patients.

Symptom	No. of patients (%)		p Value
	Preoperative n = 62	Postoperative n = 34	
Regurgitation	47 (76)	8 (24)	<0.001
Dysphagia	42 (68)	5 (15)	<0.001
Globus sensation	26 (42)	4 (12)	<0.01
Cough	8 (13)	5 (15)	0.805
Weight loss	2 (3)	1 (3)	0.939
Sore throat	2 (3)	1 (3)	0.939
Halitosis	2 (3)	4 (12)	0.098
Hypersalivation	1 (2)	2 (6)	0.250
Dyspnea	1 (2)	1 (3)	0.663

Table 3

Patients' satisfaction and other related disorders' parameters after surgery in study patients.

Questionnaire parameter	No. of patients (%) n = 34
Parameters of other related disorders after surgery	
Impairment of swallowing solid food	4 (12%)
Impairment of swallowing liquids	2 (6%)
Problems with looking into the daily habits	0 (0%)
Sleep problems	2 (6%)
Problems with teeth	1 (3%)
Parameters of patients' satisfaction after surgery	
Satisfied with general condition	31 (91)
Satisfied with overall outcome	31 (91)
Therapy recommendation to a friend	34 (100)

difference for the other symptoms in terms of diverticulum size (regurgitation, $p = 0.63$; dysphagia, $p = 0.46$; cough, $p = 0.61$).

Follow-up data could be obtained from 34 patients (response rate: 55%) in total. One of these patients underwent endoscopic surgery three times because of symptomatic recurrence of the diverticulum. All other cases had surgery only once. The other patients were either not contactable, deceased or were not able to answer the questionnaire (e.g., dementia). The mean follow-up period (time between surgery and questionnaire) was 100 months (range 11–216 months).

In terms of the postoperative symptoms, a total of 8/34 patients (24%) complained of regurgitation in the long-term postoperative questionnaire. Dysphagia and cough were reported from five patients (15%), whereas globus sensation and halitosis were reported by four patients (12%). Further postoperative symptoms included hypersalivation in two cases (6%), and one patient each for weight loss, dyspnea and soar throat (3%). The surgery resulted in a significant reduction of regurgitation and dysphagia rate ($p < 0.001$), as well as of globus sensation rate ($p < 0.01$) (Table 2).

The evaluation of other related disorders (second part of the questionnaire, Table 3) revealed persisted impairment of swallowing solid food in four cases (12%), whereas difficulty of swallowing liquids was reported only from two patients (6%). Two more patients stated sleep disorders attributed to the ZD operation (6%). One patient reported reversible teeth problems in the form of loose teeth due to the surgical manipulations with the diverticuloscope (3%). There was no patient report associated with impairment of everyday activities.

The majority of patients were satisfied with the overall outcome of the surgery (31 patients, 91%). The same number of interviewed patients was satisfied with their general condition (31 patients, 91%) and all the patients would propose the endoscopic surgery to a relative with the same diagnosis (34 patients, 100%).

4. Discussion

The only definitive therapy of the ZD is surgical intervention. In current practice, the transoral endoscopic–microscopic diverticulotomy either with carbon dioxide (CO₂) laser or by using the stapling technique is the established treatment of choice. The transcervical approach via lateral collotomy remains an alternative method of treatment of ZD in cases of inadequate endoscopic exposure of the diverticulum or of other anatomic conditions and in some cases of recurrence. Each method has advantages and disadvantages, whereas, results regarding duration of surgery, time or oral intake, duration of hospital stay and complications rate for each method are reported in various studies [7,10–12]. Beyond these “hard data”, a main indicator of the intervention's success is the satisfaction of the patient and his long-term symptomatic outcome. Evaluation of surgical success by means of a subjective questionnaire more effectively reflects the efficacy of the procedure than objective methods such as postoperative esophagography [13].

The present study attempted to define and set the overall postoperative outcome after endoscopic laser-assisted diverticulotomy in a systematic way. We developed a questionnaire divided into three parts, that consecutively demonstrate the overall postoperative outcome (Table 1). The first section focuses on the complaints after surgery. Based on the symptoms, the patient was then asked to specify functional impairments, such as swallowing problems, sleep disorders or problems with looking into the daily habits. The satisfaction of the patient, determined with his statement about general condition and overall outcome was the last step of the evaluation. The last question of the questionnaire regarding therapy recommendation to a relative summarizes the overall satisfaction of the patient with the treatment. Similar to our approach, the Gastro-Intestinal Quality of Life Index (GIQLI) was used by Wirth et al. in order to compare endoscopic stapler-assisted diverticulotomy and open cricopharyngeal myotomy by transcervical approach, with regard to patient satisfaction and quality of life [14].

4.1. Complaints before and after surgery

The analysis regarding preoperative symptoms revealed similar results with previous studies [7,14,15]. The predominant symptoms of our patients were regurgitation and dysphagia in more than two-thirds of the cases, followed by globus sensation. An interesting finding of our study was that among patients who reported a globus sensation they also had a significant smaller diverticulum compared with those without this symptom. A possible explanation for this feature could be the absence of other more remarkable symptoms such as regurgitation and dysphagia in the case of a small diverticulum sac. Additionally, a small diverticulum limited in the narrow cervical space could cause an irritation of the hypopharynx which in turn could lead to this complaint. In contrast, a bigger sac descends up to the brighter mediastinal space, losing any contact with the sensitive structure of the hypopharynx.

In the present study, the endoscopic laser-assisted diverticulotomy has led to a significant reduction of the main symptoms. Regurgitation rate was reduced from 76% before to 24% after surgery, representing a reduction of 68%. The reduction of the dysphagia rate was 78% (from 68% to 15%) and globus sensation 71% (from 42% to 12%). Regarding other symptoms, no statistical difference was reported. This may be due to the small sample size associated with these particular symptoms.

Wirth et al. [14] reported a reduction of the symptoms' rates with an overall complete relief of symptoms in 83% regardless of the surgical technique. According to the study of Stoeckli and

Schmid [15] after endoscopic stapler-assisted diverticulotomy significant reduction of symptoms' rates was observed for almost all symptoms. In this study all symptoms except nocturnal cough improved significantly after surgery. For example regurgitation and dysphagia showed a reduction rate from 87% to 11% and from 87% to 36% respectively. Similarly, Palmer et al. [16] reported a significant reduction in all symptoms with the exception of dysphonia after application of endoscopic stapler-assisted diverticulotomy, with a reduction of regurgitation rate from 57% to 9% and an improvement in overall swallowing in 91% of the subjects.

4.2. Other related disorders

The great majority of patients of the present study reported no impairment of these parameters after surgery. Only 12% complained about an impairment of swallowing solid food postoperatively, whereas the rate of swallowing liquids impairment and sleep problems after the operation was 6%. No patient reported problems with looking into the daily habits.

In the study by Chang et al. [13] reported that in 90% of laser endoscopic diverticulotomy cases and 100% of open approach cases, patients achieved a normal or near-normal swallow result. The Mayo Clinic reported an excellent or good outcome in 93% of 888 patients treated with open surgery [17]. Palmer et al. [16] demonstrated a significant reduction in swallowing-related distress after stapler-assisted diverticulotomy.

4.3. Patients' satisfaction

The patient's satisfaction reflects the patients' overall "well-being" after the treatment. All patients who answered our questionnaire would propose the same procedure to a relative with the diagnosis of ZD. A total of 91% of the subjects stated "satisfied" with the overall result and their postoperative general condition. Our patient satisfaction results are consistent with previously published literature. Nyrop et al. reported a satisfaction rate of 92% using endoscopic laser-assisted diverticulotomy. This rate was 82.4 in the study of Van Eeden et al. [18,19]. In the study of Wirth et al. [14] a total of 91% of the endoscopic stapler group and all patients of the open approach group answered in the affirmative to the question 'Would you be willing to undergo surgery again'. In rating the overall satisfaction with the surgery on a 10-point scale (with 0 equivalent to "not at all satisfied" and 10 to "extremely satisfied"), the average satisfaction level in the study of Palmer et al. [16] was 7.68. After stapler-assisted diverticulotomy 27 out of 28 patients of the report of Stoeckli and Schmid [15] stated they did not regret their decision and would undergo the procedure again.

5. Conclusion

The endoscopic laser-assisted diverticulotomy is an established method in the treatment of ZD. The analysis of long-term symptomatic outcome and overall satisfaction are important components of the overall evaluation of the technique. The

presented long-term results confirm that this technique offers a very high degree of symptom relief and patients' satisfaction.

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References

- [1] Anagiotos A, Preuss SF, Koebke J. Morphometric and anthropometric analysis of Killian's triangle. *Laryngoscope* 2010;120:1082–8.
- [2] Anagiotos A, Preuss SF, Koebke J. Does the hypopharyngeal cavernous body protect the development of Zenker's diverticulum? *Auris Nasus Larynx* 2013;40:93–7.
- [3] Van Overbeek JJ. Meditation on the pathogenesis of hypopharyngeal (Zenker's) diverticulum and a report of endoscopic treatment in 545 patients. *Ann Otol Rhinol Laryngol* 1994;103:178–85.
- [4] Van Overbeek JJ. Pathogenesis and methods of treatment of Zenker's diverticulum. *Ann Otol Rhinol Laryngol* 2003;112:583–93.
- [5] Anagiotos A, Feyka M, Gostian A-O, Lichtenstein T, Henning TD, Guntinas-Lichius O, et al. Endoscopic laser-assisted diverticulotomy without versus with wound closure in the treatment of Zenker's diverticulum. *Eur Arch Otorhinolaryngol* 2013 [Epub ahead of print].
- [6] Helmstaedter V, Engel A, Huttenbrink KB, Guntinas-Lichius O. Carbon dioxide laser endoscopic diverticulotomy for Zenker's diverticulum: results and complications in a consecutive series of 40 patients. *ORL J Otorhinolaryngol Relat Spec* 2009;71:40–4.
- [7] Koch M, Mantsopoulos K, Velegrakis S, Iro H, Zenk J. Endoscopic laser-assisted diverticulotomy versus open surgical approach in the treatment of Zenker's diverticulum. *Laryngoscope* 2011;121:2090–4.
- [8] Bridoux V, Moutel G, Lefebvre B, Scotte M, Michot F, Herve C, et al. Reporting on quality of life in randomised controlled trials in gastrointestinal surgery. *J Gastrointest Surg* 2010;14:156–65.
- [9] Eypasch E, Williams JL, Wood-Dauphinee S, Ure BM, Schmülling C, Neugebauer E, et al. Gastrointestinal quality of life index: development, validation and application of a new instrument. *Br J Surg* 1995;82:216–22.
- [10] Adam SI, Pashkover B, Sasaki CT. Laser versus stapler: outcomes in endoscopic repair of Zenker diverticulum. *Laryngoscope* 2012;122:1961–6.
- [11] Verhaegen VJ, Feuth T, van den Hoogen FJ, Marres HA, Takes RP. Endoscopic carbon dioxide laser diverticulotomy versus endoscopic staple-assisted diverticulotomy to treat Zenker's diverticulum. *Head Neck* 2011;33:154–9.
- [12] Bock JM, Van Daele DJ, Gupta N, Blumin JH. Management of Zenker's diverticulum in the endoscopic age: current practice patterns. *Ann Otol Rhinol Laryngol* 2011;120:796–806.
- [13] Chang CW, Burkey BB, Netteville JL, Courey MS, Garrett CG, Bayles SW. Carbon dioxide laser endoscopic diverticulotomy versus open diverticulectomy for Zenker's diverticulum. *Laryngoscope* 2004;114:519–27.
- [14] Wirth D, Kern B, Guenin MO, Montali I, Peterli R, Ackermann C, et al. Outcome and quality of life after open surgery versus endoscopic stapler-assisted esophagodiverticulostomy for Zenker's diverticulum. *Dis Esophagus* 2006;19:294–8.
- [15] Stoeckli SJ, Schmid S. Endoscopic stapler-assisted diverticuloesophagostomy for Zenker's diverticulum: patient satisfaction and subjective relief of symptoms. *Surgery* 2002;131:158–62.
- [16] Palmer AD, Herrington HC, Rad IC, Cohen JL. Dysphagia after endoscopic repair of Zenker's diverticulum. *Laryngoscope* 2007;117:617–22.
- [17] Payne WS, King RM. Pharyngoesophageal (Zenker's) diverticulum. *Surg Clin North Am* 1983;63:815–24.
- [18] Nyrop M, Svendsstrup F, Jørgensen KE. Endoscopic CO₂ laser therapy of Zenker's diverticulum: experience from 61 patients. *Acta Otolaryngol Suppl (Stockh)* 2000;543:232–4.
- [19] Van Eeden S, Lloyd RV, Tranter RM. Comparison of the endoscopic stapling technique with more established procedures for pharyngeal pouches: results and patient satisfaction survey. *J Laryngol Otol* 1999;113:237–40.