Research Article

Retrospective Analysis of Patients with Zenker's Diverticula: A Single Center Analysis of 103 Cases with Zenker's Diverticula Undergoing Endoscopic Treatment, Including Analysis of the Changes in Swallowing-Related Quality of Life Post-Operatively using SWAL-QOL Questionnaires

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Abstract

Purpose: In this retrospective we evaluate swallowing dysfunction in patients with an established diagnosed of Zenker's diverticulum before and after endoscopic treatment using the SWAL-QOL Questionnaire. Besides, we investigate whether there are correlations between the symptoms, the size of the diverticulum and the SWAL-QOL score pre-operatively

Methods: We assessed the demographic, clinical, radiographic and operative characteristics of all 103 patients of whom 98 patients did undergo surgery. Besides we analysed the scores of pre- and postoperative SWAL-QOL Questionnaires that was completed by 69 patients.

Results: The mean age of our patients was 70 years (age range 35 – 101 years), and 66% of them were male. Dysphagia was present in 77%, followed by regurgitation in 61% and globus sensation in 37% of the patients.

Based on the measurements on barium swallowing imaging (n=100), diverticula were subdivided by size, showing 44% small, 23% intermediate, 25% large and 9% very large diverticula. We noticed a significant increase of the median preoperative total SWAL-QOL score (638/1100) to the post-operative total SWAL-QOL score (908/1100) (p<0.001), as well as a significant improvement in 10 of the 11 subscales.

Conclusion: This study reports a significant improvement in swallowing dysfunction after endoscopic treatment of Zenker's diverticulum as measured by the SWAL-QOL questionnaire. There was no significant association between size of the diverticulum and symptomatology or SWAL-QOL scores. We did find a significant association between SWAL-QOL score and the preoperative symptom weight loss, but not with the other symptoms.

INTRODUCTION

A Zenker's or hypopharyngeal diverticulum is an outpouching of the mucosa and submucosa in the posterior hypopharyngeal wall, just above the oesophageal inlet. It is believed that this diverticulum was first identified by Ludlow in 1769 [1]. However, it is named after the pathologist von Zenker, who was the first to describe the pathophysiology and clinical features of this pathology in 1878 [2]. Zenker's diverticula originate in the posterior wall of the hypopharynx, at the level of the pharyngo-

oesophageal transition. This location is known as Killian's triangle, a zone of weakness between the oblique fibres of the inferior constrictor (thyropharyngeal) muscle and the horizontal fibres of the cricopharyngeal muscle. During the swallowing act, a high pressure occurs at the level of this triangle, due to a difference in calibre between a wide hypopharynx and a relatively narrow oesophageal inlet. The increased hypopharyngeal intraluminal pressure contributes to the formation of these pulsion diverticula in this prone region [3-5]. Another contributing factor in the pathophysiology of Zenker's diverticula is the age of the patients, as there is a decrease in tissue elasticity and muscle tone with increasing age. Typically, this condition therefore presents at an older age, with a peak incidence between the seventh and eighth decade of life. Zenker's diverticula rarely occur below the age of 40 [5,6]. A recent cohort study of Uoti et al. [7], stated an annual incidence of 2.9/100.000 person-years. There is a predominance of the male sex [5,6].

Dysphagia is the most common presenting symptom, causing a high impact on quality of life as it disrupts eating and drinking. Other reported symptoms are regurgitation, aspiration, halitosis, weight loss, cough and globus sensation.

Multiple questionnaires have been developed to assess the impact of swallowing dysfunction on quality of life, including the MD Anderson dysphagia inventory (MDADI), the Eating assessment tool-10 (EAT-10), the Sydney Swallow Questionnaire and Dysphagia Handicap Index (DHI) [8-11]. However, the gold standard questionnaire now is the Swallowing Quality of Life questionnaire (SWAL-QOL) created by McHorney et al in 2000. This questionnaire is a 44-item tool that assesses 10 quality-of-life concepts. According to McHorney et al., quality of life can be obtained by the combination of following components: the ability to fulfil usual and desired physical, role, and social activities; the psychological effectiveness with which one performs usual and desired activities; satisfaction with health care services related to dysphagia treatment; and dysphagia symptom status [12-18].

Zenker's diverticula can be treated surgically both through external transcervical approach as well as through endoscopic approach [19-21]. The aim of surgery is to divide the common septum formed by the cricopharyngeal muscle between the oesophagus and the pouch. Endoscopic techniques include CO_2 laser, stapler and LigaSure technique or a combination of these procedures. Different diverticulum sizes require different techniques.

This study extends the database of an earlier published article by Colpaert et al. [15], with an addition of 78 new patients. To our knowledge, there is only one other report in the literature, besides the article of Colpaert et al., that uses the SWAL-QOL questionnaire in the follow-up of patients treated for Zenker's diverticulum [17].

The aim of this retrospective study is twofold. First, we evaluate swallowing dysfunction in patients with an established diagnosed of Zenker's diverticulum using the Dutch Swallowing Quality of Life (SWAL-QOL) Questionnaire. More specifically, we assess the evolution between the pre-operative (baseline) and post-operative reported scores. Secondly, we investigate whether there are correlations between the symptoms, the size of the diverticulum and the SWAL-QOL score pre-operatively.

METHODS

Design and setting

We conducted a retrospective chart review of the electronical medical records (EMR) of patients with an ICD-9 or ICD-10 code for Zenker's diverticulum (ICD-9-CM code 530.6 Diverticulum of oesophagus, acquired; ICD-10-CM code K22.5, Diverticulum of oesophagus, acquired) that presented at the department of Otorhinolaryngology at the Antwerp University Hospital between October 2008 and March 2021. We collected data on demographic characteristics, pre-operative symptoms, size of the diverticulum, surgical technique, surgical exposition and complications along with pre- and post-operative SWAL-QOL questionnaire results out of the patient files.

Ethical approval was not sought as this article is a retrospective study which does not contain any invasive interactions with human or animal subjects.

SWAL-QOL Questionnaire

The SWAL-QOL consists of 44 items grouped into 10 subscales assessing 8 concepts of dysphagia related to quality of life (General Burden, Eating duration, Eating desire, Food selection, Communication, Fear of eating, Social Functioning and Mental health) and 2 concepts of generic quality of life (Sleep and Fatigue). These 10 subscales account for 30 of the 44 items. Additionally there is a symptom-frequency scale containing 14 items, each of which is scored from 1 to 5. This scale on clinical symptoms can be represented in a single Symptoms score, bringing the total of subscales to 11. Each subscale is scored on a scale of 0-100, indicating an extremely impaired quality of life (score 0) versus no impairment (score 100) as experienced by the patient. With 11 subscales, this leads to a total score 1100 [14,18]. In general, patients in our centre are stimulated to fill in the Dutch SWAL-QOL questionnaire pre- and post-operatively themselves.

Data collection and analysis

We assessed the demographic, clinical, radiographic (diverticulum size) and operative characteristics of all 103 patients (baseline characteristics). Concerning the symptomatology we made a selection of five important symptoms: dysphagia, regurgitation, aspiration, weight loss, globus sensation. Other symptoms like cough and excessive phlegm were not included in this study.

We measured the Zenker's diverticula pre-operatively on barium swallow imaging (maximum pouch depth (anteroposterior) and maximum pouch height (craniocaudal) on lateral view). Next we evaluated the post-operative characteristics of all patients in whom the surgical procedure could be completed (n=98).

Wilcoxon signed rank test was used to compare the pre- and post-operative SWAL-QOL scores of all patients who underwent surgery. With regard to the complete case analysis, we consider only those patients who completed both pre- and post-operative SWAL-QOL (n=85). Since we are comparing 11 different subscales, we corrected for multiple testing using the Bonferroni-Holm correction.

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In the pre-operative data, we studied associations between the presence / absence of symptoms,size of the diverticulum and SWAL-QOL score A Mann-Whitney U test was used to compare the size of the diverticulum and SWAL-QOL total and subscores between patients with and without one of the symptoms. Bonferroni-Holm correction was used to correct for multiple testing.

For the correlation between QOL and size of the diverticulum, Spearman correlation coefficient was calculated.

As a quite some data was missing, especially for the SWAL-QOL questionnaires, we performed a sensitivity analysis with multiple imputation with chained equations. Twenty imputated datasets were generated using all available information and the results of the imputed data analyses were pooled.

Analyses and visualisation of the results were conducted in R (R Core Team, 2022) A p-value < 0.05 was considered statistically significant.

RESULTS

We included 103 patients in total for the baseline characteristics analysis. These patients presented at our otorhinolaryngology department with a confirmed diagnosis (on barium swallow examination) of Zenker's diverticulum and were scheduled for surgery. Intraoperatively, there was insufficient exposure of the diverticulum in 5 patients, which led to the decision to abort the procedure. This gives us a total of 98 patients for the post-operative analyses. Both pre- and post-operative SWAL-QOL questionnaire were completed by 69 of them.

The baseline characteristics (patient demographics, Zenker's diverticulum features, clinical symptoms) are shown in Table 1. The mean patient age at diagnosis was 70 years (age range 35 – 101 years). Sixty-six percent of the patients were male. Size of the diverticula was classified based on the maximum pouch height (craniocaudal) measured on lateral view of the barium swallowing imaging. Diverticula were subdivided into: 'small' (≤20mm), 'intermediate' (>20mm - 30mm), 'large' (>30mm - 40mm) and 'very large' (>40mm).

Swallowing imaging was available for 100 out of 103 patients, showing 44% small, 23% intermediate, 25% large and 9% very large diverticula. The clinical symptoms present at diagnosis are displayed as well in Table 1. Dysphagia was present in 77% of the patients, followed by regurgitation in 61% and globus sensation in 37% of the patients. Other symptoms documented at diagnosis were aspiration, weight loss and halitosis (Figure 1).

All the patients in the study were treated by endoscopic approach. Forty-three percent of the patients underwent stapler technique, 19% CO_2 laser technique, 18% LigaSure technique and 12% were treated by a combination of both stapler and CO_2 laser techniques. In our hospital we generally treated small diverticula with CO_2 laser technique, intermediate size diverticula with LigaSure technique and larger diverticula with stapler technique.

Eight of the 98 patients who underwent surgery, developed a complication. Post-operatively, 6 patients had a fistula to the mediastinum. Four of them could be managed conservatively with total parenteral nutrition via central catheter or nasogastric

Table 1: Baseline characteristics.

|	Total	Results
Gender - Male (%)	103	68/103 (66%)
Age at diagnosis: mean (sd)	103	70.8 (10.5)
Age at surgery: mean (sd)	103	71.1 (10.3)
Height craniocaudal (mm): med (min - max)	101	23 (6 - 78)
Classification size	101	
< 20mm (small)		44/404 (44%)
≥ 20-30mm (intermediate)		23/101 (23%)
≥ 30-50mm (large)		25/101 (25%)
≥ 50mm (very large)		9/101 (9%)
Max pouch depth (mm): med (min-max)	100	15 (2 - 63)
Symptoms	100	
Dysphagia		77/100 (77%)
Regurgitation		61/100 (61%)
Aspiration		24/100 (24%)
Weight loss		14/100 (14%)
Globus sensation		37/100 (37%)
Halitosis		5/100 (5%)
Coincidental finding		1/100 (1%)
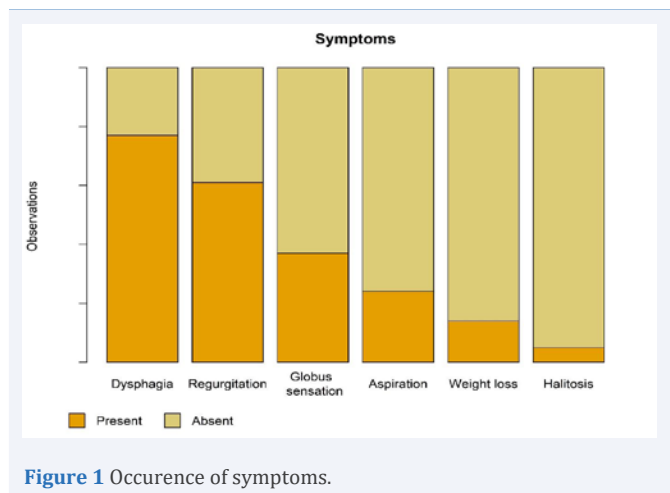
Figure 1 Occurence of symptoms.

tube feeding. Two patients required reoperation with closing of the fistula through external approach. Lastly 2 patients developed pneumonia post-operatively due to aspiration.

Perioperatively there was no proper exposition possible in 5 patients, so that the procedure was interrupted. These patients were referred to the Gastro-enterology department for flexible endoscopic cricopharyngeal myotomy.

Of all our patients, 7 required additional surgery after a symptom-free period due to recurrent pouch (7,1%).

When comparing the complication rate by surgical technique, we found that 5% of the patients treated with Stapler technique (2/44) and 5% treated with LigaSure (1/19) developed complications. The CO_2 laser technique showed a 25% complication rate (5/20). None of the patients treated with the

combination of Stapler and CO2 laser developed complications (0/12).

Due to the small number of patients with complications, further analyses for possible associations (with e.g. age, gender, size of diverticulum, type of surgery) was not performed.

The mean interval between the surgery and post-operative control (including the completion of the post-operative SWAL-QOL questionnaire) was 20 days (range 9 – 145 days). The median (Q1 – Q3) pre-operative total SWAL-QOL score was 638 (497 – 849) out of 1100. Post-operatively the median (Q1 – Q3) total SWAL-QOL score was 908 (712 – 1007) (Table 2). After correction for multiple testing, the total SWAL-QOL score and also 10 of the 11 subscales demonstrated a statistically significant improvement compared with pre-operative scores (p < 0.05). The only subscale that did not show statistically significant difference was "communication" (Figure 2). Similar results were found in the sensitivity analysis with multiple imputation.

Table 2: Evolution SWAL-QOL scores.

SWAL-QOL	N patients	Pre-op Med (Q1-Q3)	Post-op Med (Q1-Q3)	Difference Med (Q1-Q3)	P-value (Wilcox)	P-value (BH)
Total	69	638 (497 - 849)	908 (712 - 1007)	155 (41 - 341)	< 0.001	< 0.001
General burden	67	25 (12 - 50)	75 (50 - 100)	38 (13 - 62)	< 0.001	< 0.001
Food selection	68	50 (25 - 75)	75 (62 - 100)	16.5 (0 - 50)	< 0.001	< 0.001
Eating duration	67	38 (12 - 75)	75 (38 - 88)	18 (0 - 38)	< 0.001	< 0.001
Eating desire	68	73.5 (42 - 92)	83 (58 - 100)	0 (0 - 25)	0.012	0.024
Fear of eating	68	77.5 (61.5 - 100)	100 (75 - 100)	4 (0 - 25)	< 0.001	< 0.001
Sleep	68	62 (50 - 75)	81.5 (62 - 100)	12.5 (0 - 28.75)	< 0.001	< 0.001
Fatigue	69	75 (58 - 92)	83 (75 - 100)	0 (0 - 17)	0.008	0.023
Communication	69	88 (75 - 100)	100 (75 - 100)	0 (0 - 12)	0.14	0.14
Mental health	69	50 (35 - 65)	90 (60 - 100)	25 (5 - 50)	< 0.001	< 0.001
Social functioning	69	70 (40 - 95)	85 (70 - 100)	10 (0 - 35)	< 0.001	< 0.001
Symptoms	67	61 (48 - 70.5)	86 (75 - 95)	19 (5 - 35.5)	< 0.001	< 0.001
BHU= Bonferroni-Holm corrected p-values						

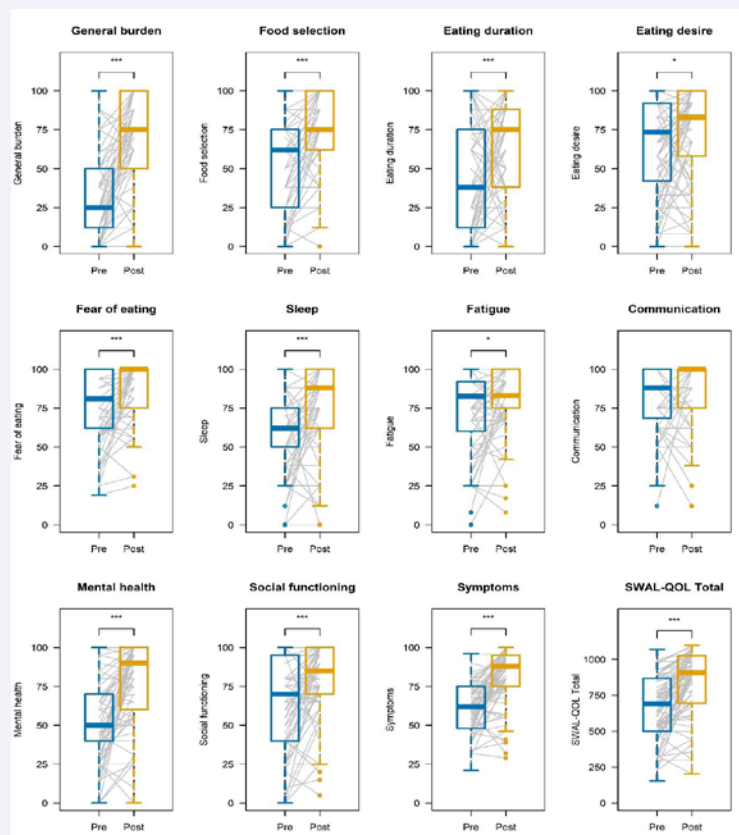**Figure 2** Boxplot comparison of pre- and postoperative total and all subscale scores.
* p< 0.05, ** p < 0.01, *** p < 0.001

Furthermore we explored the relation between symptomatology, the size of the diverticulum and quality of life. Presence of weight loss or regurgitation is associated with larger size of the diverticulum (respectively p-value of 0.011 and 0.042), using the Mann-Whitney U test. However after correction for multiple testing, these associations were no longer statistically significant. Other symptoms did not show a statistically significant association with diverticulum size (Table 3, Figure 3).

We noticed a significant association between weight loss and quality of life. Patients who presented with weight loss reported a significantly lower quality of life as measured by SWAL-QOL score (median SWAL-QOL score of 373) in comparison to patients without weight loss (median SWAL-QOL score of 730, p-value of 0.006). The presence of other symptoms was not significantly associated with a lower SWAL-QOL score (Table 4).

No significant correlation could be detected between the size of the diverticulum and SWAL-QOL score.

Sensitivity analysis for missing data did not change our findings.

DISCUSSION

Zenker's diverticula can cause a broad range of symptoms

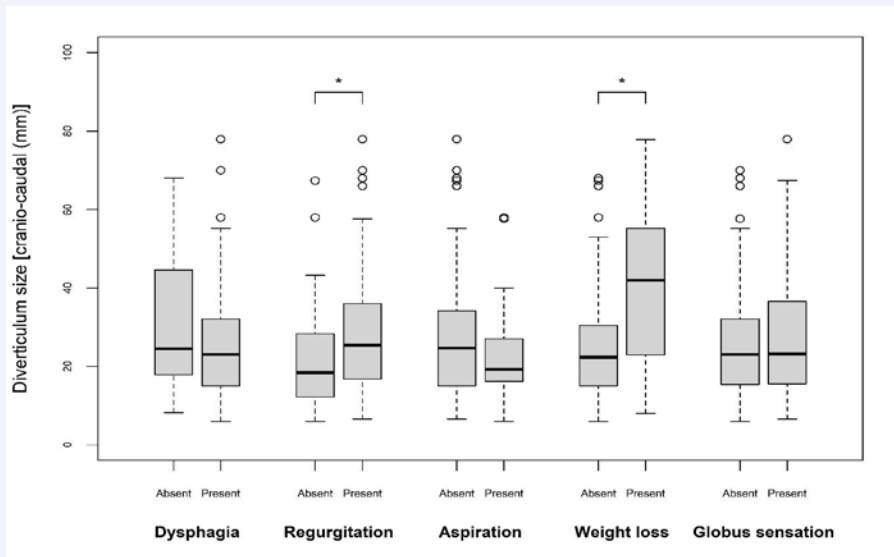| Diverticulum size	Symptom absent	Symptom present	P-value (MWU)	P-value (BH)
Table 3: Association between symptoms and diverticulum size (N = 100).				
Dysphagia				
Number	23	77		
Size craniocaudally: median (Q1-Q3)	25 (18 – 45)	23 (15 – 32)	0.12	0.37
Regurgitation				
Number	39	61		
Size craniocaudally: median (Q1-Q3)	18 (12 – 28)	25 (17 – 36)	0.042	0.17
Aspiration				
Number	76	24		
Size craniocaudally: median (Q1-Q3)	25 (15 – 34)	19 (16 – 27)	0.40	0.81
Weight loss				
Number	86	14		
Size craniocaudally: median (Q1-Q3)	22 (15 – 30)	42 (25 – 53)	0.011	0.054
Globus sensation				
Number	63	37		
Size craniocaudally: median (Q1-Q3)	23 (15 – 32)	23 (16 – 37)	0.82	0.82
BHU= Bonferroni-Holm corrected p-values MWU= Mann-Whitney U test corrected p-values				

Figure 3 Boxplots. Association between symptoms and diverticulum size.

Table 4 Association between symptoms and SWAL-QOL score (N = 85).				
SWAL-QOL	**Symptom absent**	**Symptom present**	**P-value (MWU)**	**P-value (BH)**
Dysphagia				
Number	19	66		
SWAL-QOL: median (Q1-Q3)	730 (551 -869)	698 (492 – 869)	0.41	1.00
Regurgitation				
Number	33	52		
SWAL-QOL: median (Q1-Q3)	738 (497 – 884)	669 (524 – 852)	0.64	1.00
Aspiration				
Number	67	18		
SWAL-QOL: median (Q1-Q3)	711 (513 – 883)	553 (510 – 750)	0.43	1.00
Weight loss				
Number	75	10		
SWAL-QOL: median (Q1-Q3)	730 (542 – 883)	373 (322 – 527)	0.001	0.006
Globus sensation				
Number	53	32		
SWAL-QOL: median (Q1-Q3)	690 (490 – 823)	723 (519 – 904)	0.22	0.87

affecting the quality of life of patients. Dysphagia is stated to be the most common complaint in patients with Zenker's diverticulum, having a high impact on the quality of life. In our study population 77% presented with this symptom, which corresponds to other findings in literature [16,19].

The paper of Colpaert et al. [15] described already in detail why the SWAL-QOL questionnaire can be considered a validated and standardized instrument for each patient who presents with Zenker's diverticulum. The SWAL-QOL scores on every subscale range from 0 (maximal negative benefit) to 100 (maximal positive benefit). The preoperative median total score (baseline) of 638 (497–849), indicating the perception of oropharyngeal dysphagia and diminished quality of life, significantly improved to 908 (712 – 1007) out of 1100 (p<0.001) after endoscopic treatment for Zenker's diverticulum. Analysis of the different SWAL-QOL subscales revealed that 10 subscales underwent a beneficial and statistically significant change between pre- and postoperative scores. This is more than our previous results where only 7 subscales showed improvement [15].

It is interesting to notice that especially the subscales scoring the lowest preoperatively (general burden, food selection, eating duration and mental health) are increasing sharply after the operation. No subscale is scoring below the level of 75 postoperatively. (Table 2)

The only subscale which did not significantly improve was 'communication'. This finding does not surprise us as Zenker's diverticula are not known to cause communication or speech problems. It does not surprise us therefore that this subscale has the highest preoperative score, moreover a score of 88.

However, this subscale has been incorporated into the questionnaire since the questionnaire is designed to score the quality of life of patients with general swallowing difficulties, and not specifically for patients with Zenker's diverticulum.

A modified SWAL-QOL questionnaire, like the one Napier et al. [17], used in their study by removing questions unrelated to pharyngeal pouches/cricopharyngeal spasm (in particular those related to food selection and communication in particular) could ameliorate patients' responses and generate more adequate disease specific data. To our knowledge, this is the only study, other than the study of Colpaert et al., that uses the SWAL-QOL questionnaire (in this case a modified version) in the follow-up of patients treated for Zenker's diverticulum [15].

A factor that might bias our results is the extended and highly varied time to post-operative control (and consequently the completion of the post-operative SWAL-QOL questionnaire), ranging from 9-145 days (median: 20 days). This wide variability in post-operative time might affect the way the patients fill in the questionnaire and consequently the results. Besides, we must keep in mind that a fairly large part of the patients (29/98) did not fill in both pre-operative and post-operative questionnaires, which left them out of the analysis.

The retrospective approach of collecting demographic data and presenting symptoms out of the medical history, limits us to the information that was available in the patient files. Moreover, we made a selection of only five important symptoms. Consequently the presence of other potential symptoms like cough and excessive phlegm were not investigated. In addition, it is possible that certain symptoms were not surveyed, as we did not use a standardized survey to question presenting symptoms.

No significant associations were found between the size of the diverticulum and the preoperative SWAL-QOL score or symptomatology. Clinically it is therefore important to know that the symptomatology and the severity of the patient's complaints are not proportional to the size of the diverticulum. These findings do not correlate to those of Ishaq et al. [22], who stated that there was a positive correlation between regurgitation and pouch depth.

We did find a significant correlation between the symptom 'weight loss' and the pre-operative SWAL-QOL score. Patients who presented with weight loss reported a statistically significant lower quality of life as measured by SWAL-QOL score (median SWAL-QOL score of 373) in comparison to patients without weight loss (median SWAL-QOL score of 730, p-value of 0.006). However, we did not objectivate this symptom by analysing changes in absolute weight (kilograms) or weight reduction relative to own body weight (in percentage) more specifically.

A limitation of the study is the fact that the endoscopic treatment for Zenker's diverticulum used in this study was not standardized. Besides, the majority of the operations was performed by the same surgeon, but part of them were also performed by two different surgeons. In general, we treated small diverticula with CO2 laser technique, intermediate size diverticula with LigaSure technique and larger diverticula with stapler technique. Perioperatively, however, techniques are sometimes adapted based on different factors, like exposition and depending on the surgeon.

Nevertheless, the limited amount of patients developing complications does not allow for further analysis on this data.

The relatively higher complication rate of 25% in CO_2 laser technique, could be caused by an often more difficult exposure, as we use this technique in smaller diverticula. Another factor is certainly the fact that the stapler seals off the pharyngeal mucosa immediately, whereas the laser does not. Third factor is that, with laser in smaller diverticula one tries to cut the muscle fibres of the cricopharyngeal muscle as deep as possible, de facto opening the mediastinum a little bit.Our recurrence rate of 7% was lower than reported in other studies like the study of Alwan et al. (19). Additional investigation on factors increasing the likelihood of recurrence was not performed in our study. It would be interesting in the future to explore these data further and see if we can find any predictive factors in a bigger patient sample.

CONCLUSION

This retrospective study reports a significant improvement in swallowing dysfunction after endoscopic treatment of Zenker's diverticulum as measured by the SWAL-QOL questionnaire. These results align with the earlier prospective study we conducted and confirm that this questionnaire is a beneficial tool to evaluate the symptomatology of patients with Zenker's diverticulum. No significant assocation between sizes of the diverticulum and symptomatology or SWAL-QOL scores was detected. We did observe a significant association between SWAL-QOL score and the presenting symptom weight loss (p<0.01), but not with the other symptoms.

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