

Clinical relevance and prognostic value of radiographic findings in Zenker's diverticulum

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Abstract The aim of this study was to evaluate the clinical relevance and prognostic value of preoperative and postoperative oesophagography in patients with Zenker's diverticulum. The medical records of 155 patients who underwent surgical treatment (with an endoscopic or transcervical approach) for Zenker's diverticulum between 1992 and 2010 in a tertiary referral centre were retrospectively evaluated. The size of the diverticula on oesophagography, recognizable muscular septum, and protection of the diverticulum were assessed relative to the surgical procedures performed. The incidence of diverticular remnants on postoperative oesophagography was also assessed relative to the surgical procedure. It was investigated whether the detection of a residual pharyngeal pouch and filling of it with contrast medium were related to the patients' immediate postoperative symptoms and the development of symptomatic recurrence. Larger diverticula (Brombart III–IV) were manageable significantly more often with endoscopic procedures ($P = 0.007$). Residual diverticulum and filling with contrast medium were strongly associated with prolonged dysphagia immediately postoperatively ($P = 0.005$ and $P = 0.009$, respectively).

However, these parameters failed to correlate significantly with a symptomatic recurrence. Preoperative oesophagography proved to be extremely important for surgical planning, with the surgeon's personal preference seeming to be the driving indicator in many cases. Postoperative oesophagography is only useful for excluding postoperative complications in the immediate postoperative phase and did not have a prognostic value as to a recurrence of the disease.

Introduction

It is generally thought that fluoroscopic oesophagography is the mainstay of diagnostic evaluation in patients with dysphagic symptoms, as they make it possible to diagnose structural changes as well as motility disorders in the oesophageal tract [1]. The structural changes that can be detected with barium oesophagography include Zenker's diverticulum as a cause of dysphagia. In these cases, oesophagography provides valuable information about the individual anatomy of the pharyngeal pouch [2]. In the immediate postoperative phase, oesophagography can exclude complications [3] such as fistula, so that the patient can resume an oral diet. In the present authors' view, head and neck surgeons should be able to evaluate the valuable information provided by preoperative and postoperative oesophagography to optimize treatment planning and patient counselling [2]. Surprisingly, however, the literature includes only sparse data on the radiographic evaluation of patients before and after Zenker's diverticulum surgery.

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The aims of the present study were to evaluate the information provided by preoperative oesophagography regarding the feasibility of endoscopic management of diverticula and to identify any correlation between radiologic findings on postoperative oesophagography and the patients' symptoms in the immediate postoperative phase, as well as the likelihood of recurrence. The study provides a statistical analysis of what is, to the best of our knowledge, the largest patient sample to date in the relevant literature.

Patients and methods

The study was based on a review of the medical files for patients who underwent surgical treatment for Zenker's diverticulum at an academic tertiary referral centre (the Department of Otolaryngology, Head and Neck Surgery, University of Erlangen-Nuremberg, Germany) between 1992 and 2010.

In total, 182 patients were identified; 27 patients with insufficient data (17 with no available pre- or postoperative oesophagography, 10 with inadequate clinical data) were excluded from the study cohort. The mean age of the excluded patients was 64 years (range 47–81 years). A total of 155 patients were included in the analysis, with 96 men (61.9 %) and 59 women (38.1 %). The male to female ratio was 1.6:1. The patients' mean age was 68 years (median 71 years, range 40–96 years). The mean follow-up was 61.8 months (median, 60 months; 4.8–144 months). Endoscopic laser-assisted diverticulotomy (ELAD) was performed in a total of 101 of the study patients (65.2 %), while 54 patients (34.8 %) underwent primary transcervical surgery. Oesophagography was carried out preoperatively and 6–7 days postoperatively. Preoperatively, the patient was asked to swallow a suspension of barium sulphate a number of times whilst standing in different positions (anteroposterior, oblique and lateral), and fluoroscopic images were taken at a rate of 7.5 frames per second. On the basis of the preoperative oesophagogram, the diverticula were classified into two categories in accordance with the Brombart classification (Table 1) [4]: small pharyngeal pouches (Brombart I–II) and large pharyngeal pouches (Brombart III–IV). Postoperatively, oesophagography was performed with a non-ionic iodine-containing water-soluble contrast agent. The patient was fed via a nasogastric tube and given B-lactam antibiotics until the oesophagography had excluded an oesophageal fistula. Laboratory tests were carried out only if there was a clinical suspicion of an abscess or mediastinitis.

The study examined the relationship between the size of the pharyngeal pouch on the preoperative oesophagogram and the feasibility of endoscopic surgery. ELAD and

Table 1 Brombart's [4] classification for Zenker's diverticulum

Stage	Definition
I	Longitudinal axis 2–3 mm, "thorn-like diverticulum"
II	Longitudinal axis of 7–8 mm, "club-like diverticulum"
III	Caudally oriented axis of >1 cm in length
IV	Compression of oesophagus

transcervical surgical modalities were also compared in relation to residual Zenker's diverticulum on the postoperative oesophagograms. It was investigated whether a residual pharyngeal pouch and filling of it with contrast medium on postoperative oesophagography were associated with the patients' symptoms (prolonged dysphagia or odynophagia) in the immediate postoperative phase and with the likelihood of recurrence.

Statistical analyses were carried out using the *t* test and Chi-squared test. The statistics programme SPSS for Windows, version 18 (IBM SPSS Inc., Armonk, New York, USA) was used for the analysis. A *P* value of <0.05 was considered to be statistically significant.

Results

Overall, endoscopic procedures were chosen significantly more frequently ($P = 0.007$) in larger diverticula (Brombart III–IV) than in Brombart I–II pharyngeal pouches (Figs. 1, 2). One exception is illustrated in Fig. 3, where oesophagography showed a large pharyngeal pouch with a horizontal course that would possibly be unfavourable for an endoscopic procedure. Small residual pouches at the level of the former Zenker's diverticulum were identified on postoperative oesophagography in 40 patients (37 after ELAD, 3 after transcervical surgery; $P = 0.000$). Among these 40 patients with pouch remnants on postoperative oesophagography, only 5 (12.5 %) developed symptomatic recurrent Zenker's diverticulum, 20–52 months after the initial surgery. Among the 40 patients with a residual pouch on postoperative oesophagography, 21 had a persistent contrast filling in the residual diverticular sac (21/40, 52.5 %). Only 3 of 21 patients with contrast medium filling in the residual sac suffered recurrent diverticulum later on (14.3 %). On the contrary, patients with residual pouches had relevant symptoms (dysphagia or odynophagia) significantly more often in the immediate postoperative phase in comparison with those without a residual pharyngeal pouch ($P = 0.005$). Patients in whom the remaining pouch filled with contrast medium had relevant symptoms significantly more often in the immediate postoperative phase ($P = 0.009$). The analysis showed that a residual sac on oesophagography in the immediate

postoperative phase was not associated with symptomatic recurrences of Zenker's diverticulum ($P = 0.276$). Persistent filling of the residual sac with contrast medium on oesophagography in the immediate postoperative phase also did not correlate with a symptomatic recurrence of Zenker's diverticulum ($P = 0.294$).

Discussion

According to the existing literature, the only curative approach for patients with Zenker's diverticulum is surgical treatment [5], which allows complete and lasting resolution of the symptoms. The minimally invasive approach with endoscopic (microscopic) guidance, currently regarded as the treatment of first choice for Zenker's diverticulum [6–8], still competes with transcervical surgery, which in a considerable proportion of cases appears to be the only reasonable form of therapy [5, 9, 10]. The choice of approach is determined by clinical criteria (such as the anticipated ability to expose the diverticular sac endoscopically, protrusion of the upper teeth, mobility of the cervical spine, position of the larynx and depth of the fundus of the diverticular sac), surgeon's preferences and also based on the oesophagographic findings [6, 9].

The present analysis tried to demonstrate the significance of preoperative barium oesophagography for the choice of surgical approach, planning of the operation and optimization of patient counselling. Larger diverticula (Brombart III–IV) were exposed more easily and endoscopic surgery was possible in them significantly more often than smaller pharyngeal pouches (Fig. 1). The problem with small lesions (Brombart I–II) could be that due to their shorter muscular septums and the poor protection of the diverticular sac by the dorsal oesophageal wall, it is relatively difficult to perform an adequate myotomy via endoscopy in many cases without a risk of perforation [6] (Fig. 2). In such cases, it could be safer to

perform a cricopharyngeal myotomy using an open approach. Tsikoudas et al. [2] reported, consistently with the present results, that endoscopically operated diverticula with a long muscular septum (Brombart III–IV) were associated with better clinical outcomes (in terms of the complication rate and need for further management) than smaller diverticula. Jaramillo et al. [11] similarly note that cases in which the pharyngeal pouch is short are not suitable for endoscopic forms of treatment. Of course, it should be emphasized that the surgeon's personal preference (according to training, experience and expertise) is of major importance and often seems to be the driving indicator of the surgical approach.

The extent to which the pharyngeal pouch is protected by the dorsal oesophageal wall can be estimated using the course of the diverticular sac on barium oesophagography. In principle, larger diverticula have a vertical course (Fig. 1) and are therefore better protected by the posterior oesophageal wall. However, there are some exceptions to this general principle that are of major clinical relevance. Figure 3 shows a barium oesophagogram of a persistent Zenker's diverticulum (Brombart III) in a patient who presented with regurgitation and halitosis 8 months after endoscopic surgery for Zenker's diverticulum. Oesophagography clearly showed a large pharyngeal pouch with a horizontal course and impaired passage of contrast medium. A large, horizontally protruding diverticular sac was found during intraoperative endoscopy. Only thin scar tissue at the beginning of the free oesophageal wall was detected instead of an obvious muscular septum. The persistence of dysphagia symptoms in this case appeared to be mainly due to retention of food in the persistent sac. Transcervical resection of the pharyngeal pouch was performed and the patient has since been symptom free. This "food-trapping" mechanism may be the cause of symptoms in patients with prolonged retention of contrast medium in the pharyngeal pouch and impaired passage into the oesophagus (Fig. 3), even after adequate prior surgery.

Fig. 1 Zenker's diverticulum (Brombart IV), showing a vertical course of the diverticulum muscular septum and pharyngeal pouch (white arrow), with good protection through the oesophageal wall

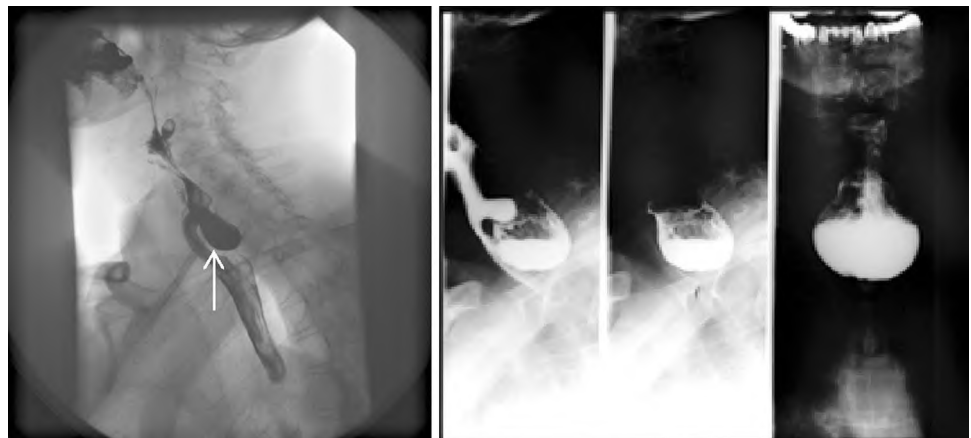


Fig. 2 Zenker's diverticulum (Brombart II), showing an almost *horizontal* course of the muscular septum (*white arrows*)

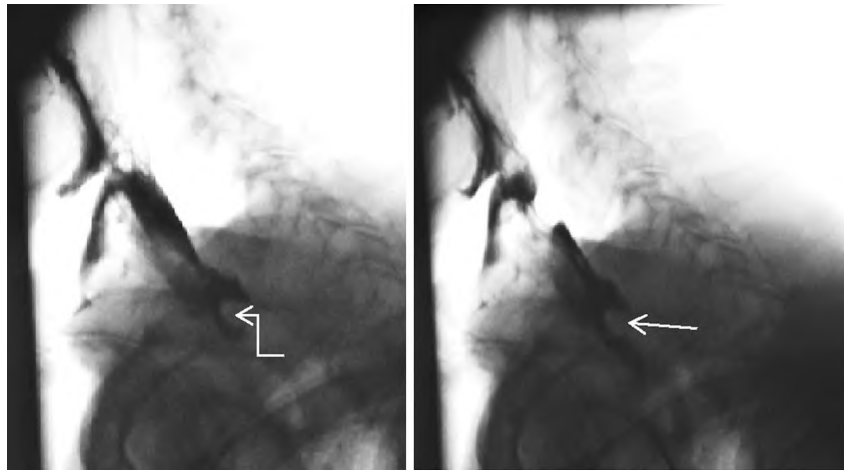
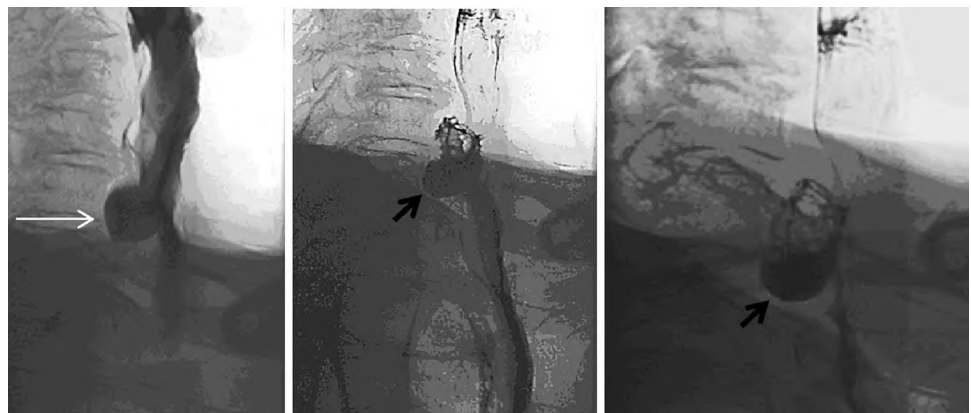


Fig. 3 Recurrent Zenker's diverticulum (Brombart III), showing a *horizontal* course of the pharyngeal pouch (*white arrow*), with relatively poor protection through the oesophageal wall. The retained contrast medium in the pharyngeal pouch could not be swallowed, despite multiple swallowing efforts by the patient (*black arrows*)



Oesophagography in the immediate postoperative phase was carried out in our department to document an uneventful postoperative course and rule out complications [3] (e.g. fistula), and thus allow the patient to resume an oral diet. Pharyngocutaneous fistulae were observed in two of our study cases (1.3 %) and resolved spontaneously with delay of oral food intake. Besides that, a variety of secondary findings have been described at postoperative oesophagography: slight anterior deviation of the posterior hypopharyngeal and oesophageal wall (probably due to postoperative oedema) [12], cricopharyngeal 'rings', 'webs' or 'bars', slight narrowing of the lumen [13] and significant lowering in the height of the muscular septum, especially after endoscopic procedures [14]. Residual pouch tissue may often be visible during the postoperative examination, but the pouch usually empties rapidly due to division of the partition wall and the cricopharyngeal fibres [14].

Another aim of the present study was to investigate the possible correlation between radiographic findings on postoperative oesophagography and clinical symptoms in the immediate postoperative phase and to examine the prognostic value of these parameters in relation to possible recurrences. The mechanism of dysphagia in the immediate

postoperative phase is unclear in patients with Zenker's diverticulum. It could reasonably be assumed that surgical trauma to the oesophageal wall and soft tissue in the neck (in cases of transcervical surgery) might offer a sufficient explanation for such symptoms. If that were true, however, it could be expected that all patients with Zenker's diverticulum would experience dysphagia immediately after surgical treatment. The present analysis showed that the 40 patients with pouch remnants had prolonged dysphagic symptoms in the immediate postoperative phase significantly more often statistically ($P = 0.005$). In addition, retention of contrast medium in the sac correlated highly significantly with postoperative dysphagic symptoms ($P = 0.009$). It thus appears that a residual pharyngeal pouch, especially one with contrast medium retention, may be responsible for postoperative dysphagic symptoms in the majority of cases. In these cases, rapid resumption of oral nutrition after radiographic exclusion of a fistula might lead to worsening of dysphagic symptoms due to food retention in the residual sac. Delaying the resumption of an oral diet might therefore possibly facilitate healing of surgical trauma, with gradual atrophy of the residual Zenker's diverticulum.

The present analysis also shows that pouch remnants on postoperative oesophagography are not associated with later symptomatic recurrence of the disease. As mentioned previously, neither a residual sac on oesophagography in the immediate postoperative phase ($P = 0.276$) nor its persistent filling with contrast medium ($P = 0.294$) was associated with symptomatic recurrence of Zenker's diverticulum. In many cases, a pouch remnant immediately postoperatively can be reasonably attributed to incomplete myotomy of the cricopharyngeal muscle [11], which is often detected after endoscopic procedures [15]. The case shown in Fig. 3 suggests that a pharyngeal pouch may persist postoperatively despite an adequate myotomy of the cricopharyngeal muscle in individual cases. The patient in this case had a residual diverticulum after two endoscopic transections of the muscular septum to the level of the diverticular fundus. The cause of the symptoms was thought to be persistent and recurrent food retention with dilation of the diverticular wall (the "food trap" mechanism), leading to insufficient shrinking of the pouch. The present analysis thus shows that residual pouches are not significantly associated with the development of symptomatic recurrences and therefore do not represent evidence of unsuccessful surgical treatment. The presence of a residual sac on postoperative oesophagography thus does not appear to justify early surgical revision, even when there are persistent dysphagic symptoms. In many cases, there may be a slow process of gradual fibrosis of the residual dysfunctional cricopharyngeal muscle or atrophy of the pouch remnant over the course of time. This finding contrasts with the report by Hadley et al. [14], who state that subtle distinguishing features between the preoperative and postoperative swallows (such as reduced height of the partition wall, ease of contrast medium passage down the oesophagus and the level of medium supported in the residual pouch) make it possible to distinguish between successful and unsuccessful surgery. The study only included three patients. The present study, with a statistical analysis of 155 cases, shows that postoperative oesophagography should only be carried out to exclude a fistula and does not have any prognostic value. In accordance with the recommendations presented by Van Overbeek [16], it is preferable to judge the success of the operation on the basis of clinical criteria over a course of time.

Conclusion

This analysis attempted to show the importance of preoperative oesophagography for choosing the surgical approach, for surgical planning and for optimizing counselling for patients with Zenker's diverticulum before surgery. Larger diverticula (Brombart III–IV) were found

to be manageable using endoscopic procedures significantly more often, due to the vertical course of the diverticular muscular septum and the adequate dorsal protection provided by the oesophageal wall. Prolonged retention of contrast medium in the residual pharyngeal pouch and impaired passage into the oesophagus may suggest a possible "food-trap" mechanism, and transcervical resection of the sac should be seriously considered preoperatively in such cases. It seems, though, that the surgeon's experience and preferences play a major role in the choice of the surgical technique. Postoperative residual Zenker's diverticula were observed significantly more often after endoscopic procedures, but oesophagography did not make it possible to distinguish between successful and unsuccessful surgery and did not have any prognostic value for recurrences. Postoperative oesophagography should therefore only be used to exclude a fistula and allow careful resumption of oral food intake.

Conflict of interest None.

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