Surgical experience of the national institution in the treatment of Zenker’s diverticula

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INTRODUCTION

Zenker’s diverticulum (ZD) is a mucosal herniation of the hypopharynx at the posterior intersection of the upper border of the cricopharyngeus and inferior pharyngeal constrictor muscle fibers, an area referred to as Killian’s dehiscence.1,2,3 At this site, the oblique fibers of the inferior constrictor meet the transversely oriented fibers of the cricopharyngeus muscle to produce an area vulnerable to hernia formation.4,5 Epidemiologic data of pharyngeal diverticula are sparse.6 The prevalence of ZD among the general population is believed to be between 0.01% and 0.11%, with the majority of patients diagnosed being in their sixth to eighth decade of life.7

The pharyngeal pouch is typically seen protruding to the left side. Anatomically, this may be explained by the potential space between the concavity of the cervical esophagus and the left carotid artery compared to the right side. Strangely enough, it has also been found to be determined by the handedness of the patient!8 The exact cause of diverticula at this location has been debated in the previous paper.

Treatment for ZD is indicated for all symptomatic patients with or without associated complications. Exceptions to this are morbidly ill patients and those with minimal symptoms. A dilemma that exists in pathophysiology of pharyngeal pouches makes it more difficult for surgeon to choose a proper type of operation for ZD.9 Surgical resection has represented the therapy of choice for ZD for many decades, as it was believed that the pouch itself constituted the disease.10 Only during the second half of the last century it was recognized that correction of the functional obstruction caused by the UES is an important component of the surgical procedure.11 Today the objective of the operation is to remove the effects of restrictive myopathy affecting the UES.

If the dysfunctional sphincter causes severe symptoms or if there is a symptomatic minute diverticulum present, extensive myotomy is completed over the pharyngoeso-
phageal junction. When a diverticulum is present, cricopharyngeal myotomy remains the essential focus of treatment and the diverticulum, seen predominantly as complication of the dysfunction, is either suspended or resected. In this paper we wish to review our 8-year experience in the management of ZD.

We will assess our diagnostic approach, the different surgical procedures and present our early and long term results, and further we will highlight what we think is a key point in making the proper diagnose and treatment choice.

MATERIALS AND METHODS

Study population

Fifty-two patients at Department of Esophagogastric Surgery, First Surgical University Hospital in Belgrade underwent surgery for symptomatic Zenker diverticulum in the period between 2000 and 2009. During this 8-year study period, a variety of surgical procedures were performed, including cricopharyngeal myotomy alone, and myotomy combined either with diverticulopexy or diverticulectomy. A prospective database (Microsoft Excel) of patients with Zenker diverticulum was established at our Institution in the year 2000.

The data consisted of clinical features, endoscopic and radiological findings, and also surgical details, complications and postoperative follow up, followed by addition of stationary manometry and 24-hour dual pH metry findings since 2003.

Preoperative workup

The severity of two dominating symptoms of Zenkers diverticulum, dysphagia and regurgitation were evaluated by using a modified scale according to Patti and colleagues. Even though this questionnaire is originally created in order to perform an evaluation of achalasia symptoms, we find it useful and easy to assess in patients with ZD. This questioner was conducted before, and 6 months, 1 and 2 years after the surgery.

Preoperative investigations also included general physical examination, radiology, endoscopy and when possible stationary manometry. The usual complete physical evaluation should focus particularly on pulmonary function, which may be compromised from repeated aspiration. The diverticulum itself is generally diagnosed by a barium swallow examination. (Figure 1) A complete upper gastrointestinal series is preferable, but is often limited because the patient is unable to swallow sufficient barium to adequately distend the esophagus.

At upper gastrointestinal endoscopy, the depth of the diverticulum can be measured from the upper esophageal sphincter to the bottom of the pouch. The remaining foregut should also be examined for the presence of associated disease or to exclude cancer in the diverticulum especially in the older age group of patients. Endoscopic findings of hiatal hernia and erosive esophagitis were also included in the data base.
positioned sensor proximal to HPZ according to Castel et al.\textsuperscript{15} A commercial software program (Polygram 98 Esophageal Manometry Application) was used for the interpretation of manometric traces and for data analysis. 24 hour ambulatory esophageal dual pH metry was performed before the surgery in several patients, but if it was not possible we conducted it after the surgery with the patient’s consent.

Acid-suppressing medications, if taken, were discontinued to 7 days before the study. 24 hour pH monitoring was carried out by positioning distal pH electrode (Medtronic Multi-use Slimline catheter) 5 cm above LES which was previously defined by esophageal manometry, and the proximal pH electrode in cervical esophagus. The data were recorded by a portable data-logger (Medtronic Digitrapper 400 pH II) for 24 hours.

The DeMee-ster composite acid score was computed using Medtronic Polygram 98 pH Testing Application, and abnormal intraesophageal pH was defined as a score 15.0. 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.

Surgical algorithm in the treatment of Zenker’s pouch Pharyngoesophageal diverticula or pouches can be divided according to their size into the following three groups: minute, established and large. According to their size surgical treatment differs.\textsuperscript{16}

a) Minute diverticula (1 cm) - A very small diverticulum, when symptomatic is treated only by an extended cricopharyngeal myotomy. Once the myotomy is performed, the minute diverticulum disappears and becomes a part of the freed mucosa.

b) Established diverticula (1 - 4 cm) - With the diverticulum freed and uplifted a pharyngo-cryo-esophageomyotomy is performed. The diverticular tip is positioned retropharyngeal as high as possible and suspended with several stitches to the prevertebral fascia.

c) Large diverticula (4 cm) - If the diverticulum is too large to uplift and place between the pharynx and prevertebral fascia, after a pharyngo-cryo-esophageomyotomy a resection of the diverticulum using stapling devices is performed.

Technique of open surgical procedure

The operation is performed under general anesthesia, while the patient is positioned supine on the operating table with a small pillow under his shoulders. The head is hyperextended and slightly turned to the right side. The skin incision, centered at the level of the cricoid cartilage, is performed along the anterior border of the left sternocleidomastoid muscle, averaging 8 to 10 cm in length. The subcutaneous tissue and platysma are divided with special attention paid to the haemostasis. The pharynx and cervical esophagus were exposed by retracting the sternocleidomastoid and carotid sheath laterally, and the larynx and thyroid gland medially, without using sharp medical devices.

Care was taken not to injury the recurrent laryngeal nerve which runs in the tracheoesophageal groove. (Figure 2). The omohyoid muscle, middle thyroid vein, and inferior thyroid artery are commonly divided. (Figure 3) During the surgical procedure the following anatomical structures need to be protected: a) the recurrent laryngeal nerve, that runs in the groove between the trachea and esophagus, b) the external laryngeal nerve, that runs deep to the superior thyroid artery, c) descending hypoglossal nerve and d) cervical cutaneous nerve.

After approaching the pharyngoesophageal junction the diverticulum is identified, grasped with soft forceps, and retracted cephalad. The diverticulum sometimes may not be obvious because it is covered with fascia and applied to the esophagus. (Figure 4) Gentle dissection will reveal its borders. The loose connective tissue surrounding the
pouch is dissected to identify its neck on the posterior pharyngeal wall. In most instances the transverse fibers of the cricopharyngeal muscle (CP) could be seen just below the neck of the diverticulum.

The dissection must be kept close to the diverticulum at all times until its neck is reached. A complete dissection of the diverticulum is performed and the neck is meticulously displayed. At this point a nasogastric tube is inserted. When the diverticulum is completely dissected and freed from the surrounding tissue, it is uplifted and the myotomy is started at the point of cervical esophagus. Using scalpel or curved scissors a cervical esophageal mucosa is exposed.

Right-angle or plane forceps could be used to develop a dissection plane between the muscularis and mucosa, and myotomy was performed using curved scissors for a length of about 5 cm on the cervical esophagus, because the striated muscle of the esophagus shares the same pathologic abnormalities as the CP. After initially transecting the longitudinal and circular fibers of the cervical esophagus, the CP is transected, up to the distal base of the diverticulum. (Figure 5)

The muscle fibers are often seen to extend onto the body of the diverticulum itself, and division of these fibers is performed to free the entire collar of the sac. Lateral dissection to the left and right of the pouch allows proximal extension of the myotomy onto the hypopharyngeal wall. Two centimeters of hypopharyngeal muscle are usually transected.

Diverticulopexy is usually performed by uplifting the tip of the diverticulum using a soft forceps and retracting it as far as possible towards the prevertebral fascia. Fixation of the diverticulum to the prevertebral fascia or posterior pharyngeal wall was performed using 4 to 5 interrupted 3-0 monofilament sutures in the longitudinal manner. Care is taken not to leave the collar of the sac in dependent position. The lumen of the diverticulum should not be punctured by sutures to avoid contamination. (Figure 6)

Large diverticula are resected by using a stapling device. Before stapling, a bougie can be inserted via the mouth to prevent a stricture. Mostly the diverticulum can be transected using a TA 30 linear stapler. A linear stapler is placed transversely 1 cm above the collar of the diverticulum. (Figure 7)

This may occasionally prove cumbersome if proper eversion of the posterior wall is difficult. An angulated stapler can be used for easier application. The diverticulum is transected with a 1 cm rim of collar tissue left distal to the stapled line. The diverticulectomy sight and a myotomy area are left wide open without the need for additional muscular coverage.

A 7-cm Penrose drain is inserted, and should not lie against the esophagus or carotid vessels. The subcutaneous space and platysma are closed with interrupted 3/4-0 polyglycolic sutures. The skin is closed with a partially subcuticular 3-0 skin suture. Patients are mobilized immediately. Nasogastric tube is removed as soon as active peristalsis is documented usually on the first postoperative day. The drain is removed after 24 to 48 hours if there is less than 20 ml of drainage. In patients with diverticulopexy on the second postoperative day the liquids are allowed. The first drink should be in the attendance of a physician and with the patient in a sitting position. Soft food is allowed on days 3 through 7, before resuming normal eating. On the other hand, in patients with diverticulectomy an oral intake is not allowed before the 7th postoperative day.

Follow-up

Patients were scheduled for an office visit at 1, 3 and 6 months and after one and two years after the 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 volun-
RESULTS

During an 8-year study period, ranging between January 2000 and January 2009, a total of 52 patients with established Zenker’s diverticula were included in this review. There was a predominance of male gender, with 34 male and 18 female patients, with median age of 58.3 years, ranging from 36 to 82 years. Preoperatively a symptom questioner was conducted in all patients. Dysphagia was present in 92%, and was a leading symptom in 86% of patients. Based on the modified dysphagia and regurgitation scale median preoperative values were 3.2, with a predominance of third grade.

Regurgitation occurred in 74% of patients, with median preoperative grade 2.8. Incidence of preoperative aspiration was 38%, and complaints of fetor ex ore were noted in 56% of patients. Barium swallow examination presented a leading diagnostic tool, and it was conducted in all patients. Complete upper GI radiography was performed in 90% of patients.

Preoperative upper GI endoscopy was a standard diagnostic tool from year 2000. It was attempted in all and completed in 42 patients (53.8%). Incidence of hiatal hernia, predominantly type I, among these patients was very high (35 patients, 83.3%). Signs of reflux esophagitis were noted in 28 endoscopically evaluated patients (66%). Based on the LA classification there was a strong predominance of grade A which was present among 20 patients.

Stationary esophageal manometry was conducted in 32 patients. An increased basal UES pressure was present in 12 of them (37.5%), whereas more often we met diagnostic criteria of impaired UES relaxation which we found in 21 patients (65%). Discoordination between pharyngeal contraction and UES relaxation occurred in 42% of patients. Dual 24-hour esophageal pH metry was performed in 24 patients. Among those, positive values of DeMeester’s composite acid score in both distal and cervical esophagus were found in 14 patients, while 6 more patients had pathologic reflux measured in distal esophagus, not followed with positive values of acid score in proximal esophagus.

Median values of DeMeester’s composite acid score were 24.9 in distal and 19.6 in cervical esophagus regarding the total number of pH metry evaluated patients. As for those who had positive pH metry findings median values of acid score were 38.1 in distal and 27.3 in cervical esophagus. A variety of surgical procedures were performed, including myotomy alone (n = 2), diverticulopexy and myotomy (n = 36) and diverticulectomy and myotomy (n = 14). Leading surgical option in the treatment of Zenker’s diverticulum in our Institution was the combination of diverticulopexy and cricopharyngeal myotomy which we performed in 69.2%, while 26.9% underwent diverticulectomy and cricopharyngeal myotomy.

All procedures were intra and postoperatively completely uneventful. Both postoperative in-hospital stay and fasting period were significantly longer in patients who underwent resection of the pouch. We have not encountered any cervical salivary fistula among our patients. Most frequent early postoperative complication was recurrent laryngeal nerve palsy and it was present in 7 patients. Full recovery of recurrent laryngeal nerve function was observed in period ranging from 3 months to 1 year, and it completely resolved in all of the patients with this complication (Table 1).

Symptomatic outcome was evaluated regularly 6 months after surgery. Recurrence of dysphagia was noted in 6 patients in this period. Out of these, 4 patients were operated with combination of diverticulopexy and myotomy, and two of them had a combination of diverticulectomy and cricopharyngeal myotomy. Spontaneous resolution of dysphagia was observed in all 6 patients in the period ranging up to one year after the operation. Although patients reported lower symptom grade than preopera-
tively, regurgitation occurred in 4 patients, and in all of them diverticulopexy was performed. Yearly telephone or office interview were carried out in 74% of patients regularly throughout the period of 3 years after surgery. Excellent or satisfactory results were reported in 50 (96.15 %) of these patients.

**DISCUSSION**

Zenker diverticulum is a pulsion diverticulum occurring due to an outflow obstruction caused by a noncompliant fibrotic cricopharyngeal sphincter. Treatment of Zenker diverticulum is always 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.17

In most patients with Zenker’s diverticula their symptoms may range from globus sensation to complete esophageal obstruction. Oropharyngeal dysphagia with regurgitation is the classic presenting complaint and can occur regardless of the size of the diverticulum, and in our study was present in up to 92%.

The reason for dysphagia being the most prominent symptom is owing to the fact that the openings of ZD are often aligned facing the axis of the pharynx so that the food particles preferentially enter into the diverticulum, potentially causing compression of the adjacent esophageal lumen. The actual genesis of Zenker’s diverticulum remains unclear despite the centuries of investigations and different theories.

Among others, hypothesis about reflux mediated disorders at the level of the cricopharyngeal muscle recently has been advocated by several authors.18,19,20 Preoperative findings in our study clearly indicate that there is a strong bondage between the gastroesophageal reflux (GER) and the presence of pharyngeal pouches. The incidence of hiatal hernia, predominantly type I, in our study was very high (83.3%), while the signs of reflux esophagitis, mainly LA grade A, were noted in 66% of evaluated patients.

We also showed that DeMeester’s composite acid score was positive in distal esophagus and in hypopharynx in 41.66%, while 25% more patients had pathologic reflux measured only in the distal esophagus. Our results strongly suggest that presence of hiatal hernia and GERD may present a possible factor in the etiopathogenesis of ZD. Clearly, bigger number of patients is needed to conduct the proper statistical investigation. As noted in the previous paper of this issue, numerous surgical techniques have been developed to treat pharyngoesophageal diverticulum.

Transcervical resection of the diverticular pouch has been the procedure of choice as it was believed that the pouch itself constituted the disease. However, during the decades of investigations the concept was introduced that the diverticular sac was in fact the consequence of the disease, ie, a high pharyngeal pressure secondary to a lack of compliance of the cricopharyngeus muscle in relation to local fibrosis. 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 diverticula.21

Cricopharyngeal myotomy creates a weak area in the muscle over which pharyngeal pressure can be distributed during swallowing. Gutschow et al22 showed that resection of the diverticulum without myotomy predisposes to the development of a salivary fistula postoperatively and to the long-term recurrence of the pouch. This may be explained by the persistence of a high intrapharyngeal pressure that acts on the posterior pharyngeal wall just proximal to the upper esophageal sphincter.

Contrary, focus on the cricopharyngeal myotomy was also highlighted in the study of Colombo-Benkmann et al23 where the treatment option was made according to the intraoperative cricopharyngeal muscle morphological appearance. The authors conclude that there is no difference in the term of recurrent dysphagia, although the morphologic criteria used in this study have not been backed up by functional diagnostics data. In his commentary to this article Peters from the University of Rochester in the same journal sets several questions.

First, what were the criteria to determine whether the cricopharyngeal muscle was hypertrophied or not, and second, if cricopharyngeal dysfunction is not present to the extent that myotomy is required in patients with

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<td>DISTRIBUTION OF COMPLICATIONS IN RESPECT TO THE TYPE OF THE SURGICAL PROCEDURE</td>
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<td>Recurrent nerve palsy</td>
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<td>Salivary fistula</td>
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Zenker’s diverticula, why do they develop it in the first place? In the addition, several manometric studies indicated the necessity of myotomy showing that increased hypopharyngeal intrabolus pressures in the cricopharyngeal segment decrease to normal after a successful myotomy. In our study stationary manometry revealed an increased basal UES pressure in 37.5%, discoordination between pharyngeal contraction and UES relaxation in 42% and impaired UES relaxation in 65% of treated patients, which also strongly indicates the presence of cricopharyngeal dysfunction and importance of myotomy. In most of the studies regarding open procedures, best treatment outcomes are achieved in the group of patients in whom cricopharyngeal myotomy was combined with diverticulopexy, opposed to diverticulectomy. One of the advantages of the myotomy-pexy technique over resection of the sac is that in the former technique, the pharyngeal lumen is not opened unless inadvertently injured. This allows earlier oral feeding after the operation and shortens the hospital stay. However, no relevant study has been yet published to demonstrate superiority in terms of symptomatic relief of the myotomy-pexy technique over resection with myotomy. In both studies there were no deaths attributed to the operative treatment of Zenker’s diverticula, and as in the present study in the previous one the long term clinical results were more than satisfying. During the previous several decades, introduction of endoscopic techniques have also changed the treatment concept of ZD. Overall, today treatment options for ZD include open surgical, rigid endoscopic, and most recently, flexible endoscopic therapy. Endoscopic method in the treatment of Zenker’s diverticula has established itself over the years as safe and effective procedure. In comparing the treatment modalities,

### Table 2

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<th>Authors</th>
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Zenker’s diverticula in Serbia had risen more than threefold in the last two decades. Lot of things could be attributed to such high rise in incidence of Zenker’s diverticula in our country, but unfortunately most of them are highly speculative. The incidence of male/female ratio was 31/11, with the median age of 57.3 years, and compared to the present data, the results are almost the same (34/18, median age 58.3).

In the early 90-s of the XX century our Department published results of the surgical treatment of pharyngoesophageal diverticula in a 30-year period. In the period between 1962 and 1992 at our Department 42 patients have been operated due to Zenker’s diverticula. The first thing that is evident when we compare the present with the previous results is that the incidence of Zenker’s diverticula
most series show that the endoscopic and open approach are equally effective treatments. In addition, unlike the open techniques, which are very effective in relieving symptoms regardless of the diverticular size, it has been documented that the endoscopic techniques are poorly effective and therefore contraindicated in the presence of a diverticulum smaller than 3 cm in depth. The reason for such an approach is that the common wall is too short to accommodate one cartridge of staples and to allow complete division of the sphincter, because this would result in an incomplete myotomy causing persistent dysphagia. Consequently, it has been suggested that the endoscopic division should be reserved for patients with a large diverticulum, those with a history of previous neck operation because of risk of injury to the recurrent nerve, patients with a giant diverticulum that would require an extended upper mediastinal dissection from the neck, and those high-risk elderly patients who could benefit from a short-lasting procedure.

On the other hand the endoscopic approach may prove difficult in patients with cervical osteoarthritis, and in those with a reduced opening capacity of the mouth. Endosurgical approach also 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. There is a definitive learning curve with endoscopic procedures, and therefore higher success rates can be expected from larger series of patients. This is pointed out by Van Overbeek who achieved a low complication rate in one of the largest published series of 545 patients.

At present, there is no evidence from high quality randomized controlled studies to establish which procedure, open or endoscopic, is superior. It is clear that both operations relieve the outflow obstruction at the pharyngo-esophageal 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. Never the less, it is the future task of this Department to introduce in the standard practice an endosurgical approach to Zenker diverticula.

Although retrospective, our single center study demonstrates that open surgical treatment of Zenker’s diverticulum yields excellent symptomatic relief, and in experienced institutions represents a safe, effective and durable procedure.

SUMMARY

HIRURŠKO ISKUSTVO U LEĆENJU ZENKEROVOG DIVERTIKULUMA


Ključne reči: Zenkerov divertikulum, otvorena hirurgija, period praćenja

BIBLIOGRAPHY