



New Look at Epiphrenic Diverticula

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Abstract. Twenty-five patients with epiphrenic diverticula were studied to clarify the mechanism for esophageal regurgitation and to evaluate methods of treatment. Esophagogastroduodenoscopy, esophageal motility, and cineradiographic studies were performed. With probes in the tubular esophagus and diverticula of two patients, motility and cineradiographic studies were performed simultaneously to correlate symptoms and pressure changes with movement of diverticular and esophageal contents. Nineteen patients were operated, and six relatively asymptomatic patients were not. There was no operative mortality, and the one esophageal fistula that occurred healed spontaneously. Results were excellent or good in 10 operated patients followed long term after resection or imbrication of the diverticula. Eight patients did not undergo myotomy. Results in four of these patients followed long term were excellent. Retrograde movement of diverticular contents into the esophagus depends on pouch volume and a pressure gradient between the pouch and the tubular esophagus after an esophageal contraction wave in the tubular esophagus has dissipated. The height of esophageal reflux and resulting symptoms depend on these factors and the lower esophageal sphincter pressure (LESP). Asymptomatic patients with an epiphrenic diverticulum do not require operation. Resection or imbrication of a diverticulum are the operative methods of treatment. We prefer the abdominal approach when this is possible. Myotomy is contraindicated when gastroesophageal reflux exists or the LESP is below normal.

Except for rare congenital diverticula that connect with the bronchial tree, esophageal diverticula are divided into those in the transition zone between the pharynx and the esophagus (Zenker's diverticula), midesophageal diverticula, and those in the lower third of the esophagus (epiphrenic diverticula). The definition of an epiphrenic diverticulum is inexact. When discovered, they are usually in the vicinity of the diaphragm. In that sense, they are epiphrenic. On the other hand, their orifice may be anywhere in the distal third of the esophagus. A small diverticulum in the distal esophagus might not qualify as an epiphrenic diverticulum until it enlarges and approaches the diaphragm. When an enlarging diverticulum acquires the status of an epiphrenic diverticulum is imprecise. The decision to operate and what operation to perform depends on the presence of symptoms and whether they are related to the diverticulum or to an underlying esophageal motor disorder.

Patients and Methods

Twenty-five patients with an epiphrenic diverticulum were studied. Ten of these patients were patients of colleagues. Twenty-three patients were men, and two were women. Their average (± 50) age was 59 ± 10 and the range was 45 to 73 years. Symptoms included regurgitation in 14 patients, substernal burning in 11, dysphagia in 10, chest pain in 4, aspiration in 3, cough in 3, and odynophagia in 1. Ten patients had a hiatal hernia, and one had esophageal ulceration.

Six patients observed at intervals demonstrated a diverticulum 14, 12, 6, 2, 1, and 1 year, respectively, after their initial examination (Fig. 1). The lower esophageal sphincter pressure (LESP) in two of these patients was normal before and after the diverticula developed. The epiphrenic diverticula in six patients were observed for 19, 10, 8, 5, 5, and 4 years, respectively, without increasing in size (Fig. 2). The diameter of the diverticular orifices of those patients operated on varied from 2 to 10 cm. The distance between the lower border of the orifices and the esophagogastric junctions varied from 3 to 10 cm. The saccular portion of all but one diverticulum lay in proximity to the diaphragm. Six patients had two diverticula in the distal esophagus.

Iatrogenic epiphrenic diverticula developed after esophageal myotomy in four patients. Myotomy was performed for diffuse spasm in two patients who also had a midesophageal diverticulum, for achalasia in one patient, and at the time of resection of a leiomyoma in one patient. The diverticula increased rapidly in size as was reported for similar diverticula [1, 2].

Six patients were not operated. Five patients were asymptomatic or refused surgery, and one was an unacceptable risk. Of the asymptomatic patients, two had iatrogenic diverticula, and one patient had two diverticula.

Operations were performed through the left chest in 15 patients and transabdominally in 4. Operations were done with a 40F bougie in the esophagus. A vascular clamp was placed across the diverticular neck, and the diverticulum was resected. Closure of the esophagus was made with a 4-0 Vicryl running suture placed underneath the clamp. The clamp was removed, and a second layer of Vicryl suture was used to reinforce the first. The esophageal muscle was approximated over the suture line with interrupted 4-0 silk. Operation was performed on 9 of the 10 patients who also had a hiatal hernia. Fundoplication was per-

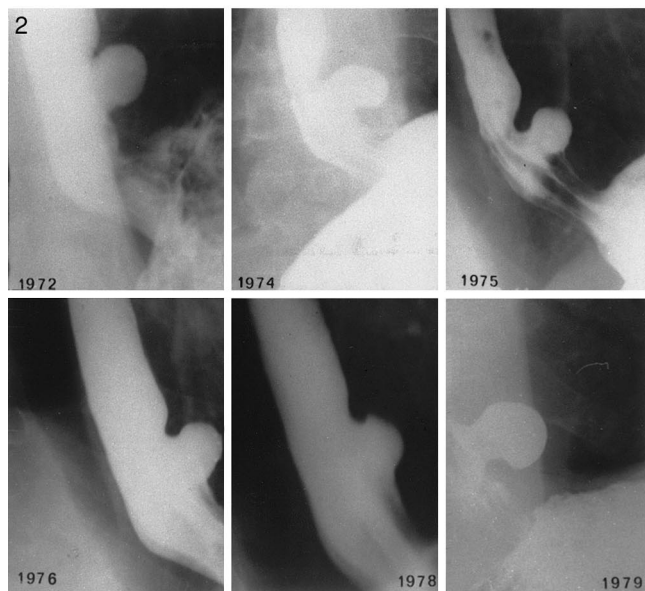
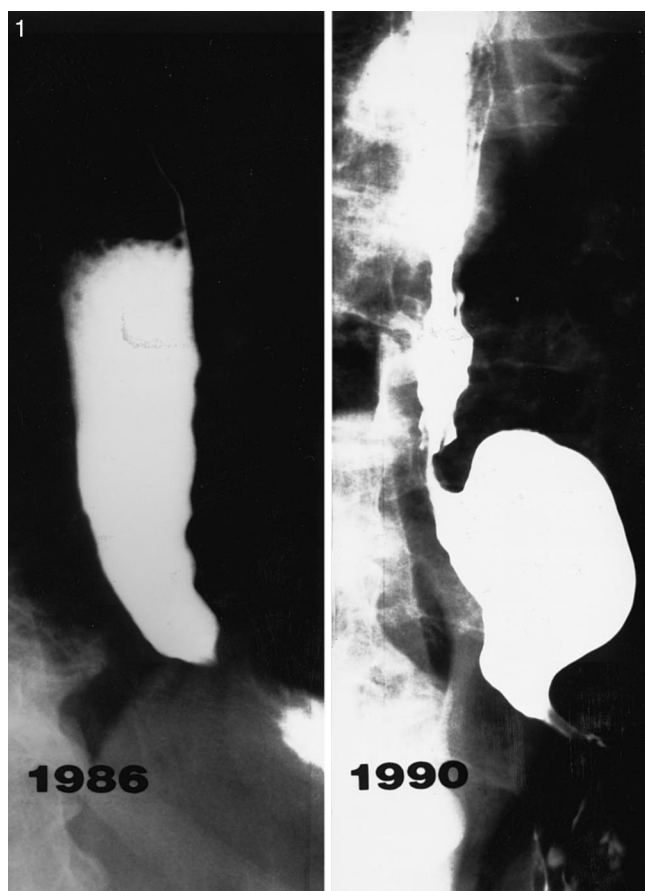


Fig. 1. Epiphrenic diverticulum seen on an esophagogram in 1990 was not present in 1984. It developed sometime between 1986 (left) and 1990 (right).

Fig. 2. This epiphrenic diverticulum did not change in size over the span of 7 years.

formed in seven and esophagogastrectomy in two of these patients. The operations are recorded in Table 1.

The LES was measured in 14 of the 19 patients undergoing

Table 1. Operations performed for epiphrenic diverticula.

| Operation | No. |
|--|----------------|
| Transthoracic approach | |
| Resection with myotomy | 5 ^a |
| Imbrication with myotomy | 1 ^a |
| Resection, no myotomy | 5 |
| Resection with myotomy and fundoplication | 3 |
| Gastroesophageal resection | 2 |
| Transabdominal approach | |
| Resection fundoplication, PCV, and myotomy | 1 |
| Resection fundoplication, PCV, no myotomy | 1 |
| Imbrication fundoplication, no myotomy | 1 |
| Imbrication, PCV, and no myotomy | 1 |

PCV: parietal cell vagotomy.

^aOne patient had two diverticula; one was resected, one imbricated.

operation. Sometimes it was difficult or impossible to pass the transducer beyond the orifice of the diverticulum. Esophageal motility studies were performed using NARCO Biosystems MMS200 with RPI 500 transducers (Division of International Biomedical, Houston, TX, USA). All patients underwent cineradiographic studies and esophagogastroduodenoscopy. Cineradiographic studies were performed and recorded with GE Stenoscope D6/D9 mobile surgical C-arm system with a super VHS cassette recorder. In two patients with transducers in the diverticula and the tubular esophagus above the diverticular orifices, simultaneous cineradiographic and manometric studies were undertaken. The effect of pressure changes in these areas on the movement of contrast material in and out of the diverticula was demonstrated and correlated with regurgitation.

Results

There was no operative mortality and one surgical complication. This was a fistula at the suture line that closed spontaneously. Nine patients had no follow-up evaluation beyond the early postoperative period. Eight patients who were followed 1 to 14 years did well. One patient operated on for a large iatrogenic diverticulum did poorly, and one patient died of squamous cell carcinoma 2 years after resection of the primary tumor located in a diverticulum.

Cineradiographic studies of swallowing in patients with an epiphrenic diverticulum demonstrated a portion of the bolus entering the diverticulum and a portion flowing distally toward the stomach. The amount of barium entering the stomach depended on the functional status of the LES. Simultaneous cineradiographic and motility studies performed in two patients during swallowing demonstrated that pressure increased in the diverticulum as it decreased in the tubular esophagus above the diverticular orifice. At the completion of the swallowing wave, pressure in the pouch was greater than that in the tubular esophagus. Whether the increased pressure was a passive increase due to distension of a diverticulum or an active increase due to muscular contraction is not known. The pressure in the pouch diminished as the diverticular contents moved back into the esophagus (Fig. 3). Symptoms related to epiphrenic diverticula depended in part on the height to which the diverticular contents were regurgitated. In some patients refluxed material reached the oropharynx and was aspirated. If the LES was relaxed or the orifice of the diverticulum was dependent at the time the pouch was emptying, some of

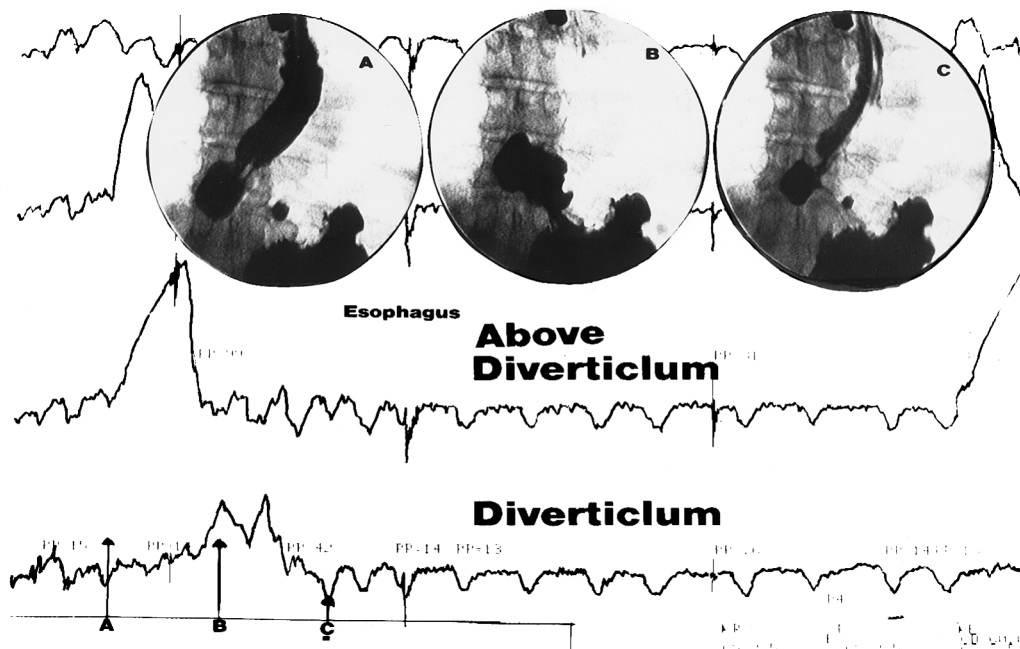


Fig. 3. Cineradiographic frames A, B, and C were made at the intervals marked on the tracing (A, B, C). A. After swallowing, barium enters the distal esophagus. At the same time, a contraction wave is beginning in the distal esophagus just above the diverticulum orifice. B. At the completion of the esophageal contraction wave, barium has entered the diverticulum or the stomach, and pressure in the diverticulum is maximum. C. Barium has refluxed from the diverticulum up the tubular esophagus. The diverticulum is partially empty, and pressure in the diverticulum has returned to baseline.

the contents flowed into the stomach, leaving less to regurgitate cephalad.

The movements of contents between esophagus and diverticulum described above were observed in all 18 patients we studied. Regurgitation was accentuated when patients were in the prone position and was inhibited by the Valsalva maneuver. Reflux of material from the pouch into the esophagus stimulated secondary esophageal contraction waves that propelled the esophageal contents caudally. This resulted in a to-and-fro movement of esophageal contents in and out of a diverticulum. Each time the esophageal contents moved toward the diverticulum, a portion also entered the stomach until eventually the esophagus and diverticulum were nearly empty.

Results of Various Management Strategies

No Operations Performed

Five of six unoperated patients were followed 4, 5, 6, 12, and 19 years, respectively. The diverticula remained unchanged in size in three patients followed 5, 6, and 19 years. The patient followed 6 years had no symptoms, and the patients followed 5 and 19 years had symptoms insufficient to warrant operation. One patient developed an iatrogenic diverticulum after resection of a leiomyoma. The patient's symptoms were minor, but because of the increasing size of the diverticulum during 4 years of follow-up operation was advised but was declined. One patient was followed for 12 years. The diverticulum became progressively larger and more symptomatic, but he declined operation.

Resection or Imbrication of Diverticulum without Myotomy

Five patients were operated transthoracically and three transabdominally (Table 1). In addition to removal of the diverticula, fundoplication or parietal cell vagotomy (or both) were each performed twice in the three patients operated transabdominally.

One patient developed an iatrogenic diverticulum after a long myotomy for diffuse spasm. Seven years after the original operation the diverticulum was partially resected, and the remainder was imbricated. This patient did poorly.

Three patients did well immediately after operation but were not followed subsequently. Four patients did well after operation for 1, 2, 5, and 13 years, respectively. In one of these patients no diverticulum was observed during 4 years of preoperative evaluation. He subsequently underwent transabdominal resection of a symptomatic epiphrenic diverticulum. The LES was normotensive but did not relax completely on swallowing. He did well for 1 year and then died of a myocardial infarction. One patient, operated transabdominally, underwent parietal cell vagotomy, resection of a diverticulum, and Hill fundoplication. After 2 years she was asymptomatic but had tertiary contractions. A third patient operated transthoracically was followed 5 years. He had a normotensive sphincter that relaxed satisfactorily preoperatively. His preoperative dysphagia was due partly to compression of the esophagus by the contents of a filled diverticulum. In one patient, no diverticulum was observed during 6 years of preoperative evaluation. A diverticulum and hiatal hernia then developed but remained unchanged in size for 10 years prior to transabdominal imbrication of the diverticulum and Nissen fundoplication. The LES was normotensive.

Resection of Diverticulum with Myotomy

Resection with myotomy was performed transthoracically in eight patients and transabdominally in one patient (Table 1). The diverticulum in the latter patient did not enlarge during the 8 years prior to operation. Five of nine patients had an associated hiatal hernia, and five had elevated LESP. Fundoplication was performed in three patients operated transthoracically, and fundoplication and parietal cell vagotomy were performed in the patient operated transabdominally. Four patients did well immediately after operation but were lost to follow-up.

The remaining five patients did well 1, 5, 7, 14, and 14 years, respectively, after operation. The patient observed for 1 year developed an iatrogenic diverticulum at the myotomy site 2 months after operation. It was significantly larger at 12 months, although symptoms were minimal. The patient followed 5 years was operated transthoracically and underwent myotomy for achalasia. Two patients followed 7 years and 14 years were operated transthoracically and transabdominally, respectively. They both had a hiatal hernia and underwent fundoplication and myotomy, although the patient operated transabdominally had a normal LES and probably did not require myotomy. One patient with two diverticula was operated transthoracically. The LES was hypertensive. The esophagus was dilated and tortuous. The large diverticulum was resected, and a smaller one was imbricated. Myotomy was performed for achalasia. The patient's symptoms improved, but the configuration of the esophagus remained unchanged for 14 years.

Resection of Distal Esophagus

The distal esophagus and a diverticulum were resected in two patients. In one patient esophagogastrectomy was performed to remove a squamous cell carcinoma in a large epiphrenic diverticulum. The diverticulum was known to have existed 9 years. The cancer was fatal 2 years after operation. The second patient had a hiatal hernia and a diverticulum. The attempt at diverticulectomy and myotomy was converted to esophagogastrectomy because of technical complications.

Iatrogenic Diverticula

Four patients developed an epiphrenic diverticulum after esophageal myotomy was performed for achalasia in one patient, diffuse spasm in two patients, and at the time of removal of a leiomyoma in one patient (Fig. 4). Three patients remained asymptomatic and declined reoperation even though the diverticula increased in size. The fourth patient, previously mentioned, developed a diverticulum during the first year after a long myotomy. It became progressively larger and more symptomatic. After 7 years of observation a portion of the diverticulum was resected, and the residual was imbricated. He did poorly and would have benefited from esophageal resection.

Multiple Epiphrenic Diverticula

Five patients had two epiphrenic diverticula. In each case, one was smaller than the other. One patient in the resection-with-myotomy group had the small diverticulum imbricated and the large one resected. Three patients had no operation performed. These four patients remained asymptomatic, and the size of the unresected diverticula was unchanged for 4 to 19 years. The fifth patient underwent myotomy, resection of the large diverticulum, and no treatment of the smaller one. We have no follow-up on this patient.

Pathology Studies

All layers of the esophagus were represented in all of the noniatrogenic diverticula. Individual layers were more distinct near the orifices than at the apices of the diverticula. The



Fig. 4. This iatrogenic epiphrenic diverticulum developed during the first year after a myotomy was performed to remove a leiomyoma in the distal esophagus.

mucosa was normal squamous epithelium, sometimes ulcerated at the apex of a diverticulum. The muscularis mucosa was thickened at the orifice of the diverticulum. Toward the apices it was thinner, more disorganized, and difficult to recognize. The submucosa was thick and fibrotic. It contained thick-walled blood vessels surrounded by chronic inflammation. The muscularis propria was grossly disorganized. It was sometimes unrecognizable in the diverticular apices using hematoxylin and eosin stain when it was visible using trichrome and muscle-specific antigen stains.

Discussion

Probably all diverticula in the tubular esophagus are pulsion diverticula, except for the rare congenital midesophageal lesion connected to the respiratory tract. Opinions differ as to whether epiphrenic diverticula are true [2, 3] or false [1, 4, 5] diverticula. All epiphrenic diverticula in this report possessed layers representative of each layer of the esophagus and were therefore true diverticula (Fig. 5). Failure to recognize the individual layers near the apices of diverticula may have led some investigators to classify epiphrenic diverticula as false rather than true diverticula. A fibrotic submucosa with many thick-walled blood vessels surrounded by chronic inflammatory cells were pathologic features of diverticula. These changes and the occasional squamous cell carcinoma observed in epiphrenic diverticula [6] and in Zenker's diverticula [7] may result from stasis and chronic irritation.

The origin of epiphrenic diverticula is speculative. At least six diverticula in this study were not congenital, as they developed during the period of study. Similar observations were made previously [4]. The reason diverticula increase in size is also unknown. Some large diverticula developed in as little time as 1 to 2 years. Diverticula in some of our patients and in those of

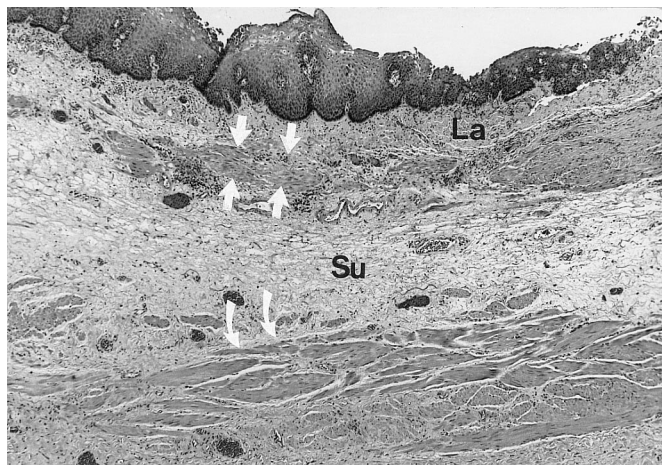


Fig. 5. The wall of an esophageal diverticulum is similar to the esophagus. It is composed of squamous epithelium, lamina propria (La), muscularis mucosa (straight arrows), submucosa (Su), and muscularis propria (curved arrows). (Hematoxylin and eosin, $\times 228$)

others [4, 8, 9] did not continue to enlarge after obtaining a significant size. One large diverticulum did not enlarge over a period of 19 years. The occurrence of diverticula in the absence of esophageal motor disorders and failure of diverticula to enlarge when LESPs were elevated suggested that epiphrenic diverticula were not always dependent on an esophageal motor disorder.

The hypothesis that epiphrenic diverticula resulted from pressure on the esophageal wall above an area of physiologic or organic partial esophageal obstruction such as achalasia, premature contraction of the LES, diffuse spasm, or other undiagnosed esophageal motor disorder was attractive [10]. The hypothesis was so persuasive that many surgeons recommended an esophageal myotomy [1, 5, 11, 12] whenever an epiphrenic diverticulum was resected. Universal myotomy is not innocuous and can cause iatrogenic epiphrenic diverticula or gastroesophageal reflux. An antireflux procedure is recommended after esophageal myotomy. If gastroesophageal reflux or below-normal LESP exists preoperatively, myotomy is contraindicated and fundoplication should be performed instead [3, 12, 14]. In our opinion, esophageal myotomy along with resection of a diverticulum should be done on an individual basis depending on the existence of an esophageal motor disorder [13].

An epiphrenic diverticulum should be resected if symptoms are related to the diverticulum. The abdominal route [15] is preferable to the transthoracic approach. It permits performance of Heller myotomy, parietal cell vagotomy, and Nissen fundoplication and allows access to the abdomen if required for other reasons. We had no operative mortality, although a 9% mortality rate has been reported [9, 12]. Esophageal fistula has been the major complication responsible for mortality. We had one such complication that healed spontaneously. We attribute this infrequency of fistulas to our method of esophageal closure.

As many as one-third of patients with an epiphrenic diverticulum are asymptomatic [6, 8]. Symptoms related to a diverticulum must be distinguished from those associated with an esophageal motor disorder or gastroesophageal reflux. Sym-

ptoms generally increase as diverticula become larger, but occasionally symptoms begin without an apparent increase in size. Regurgitation and dysphagia are the symptoms that most frequently lead to resection of epiphrenic diverticula. Simultaneous esophageal cineradiographic and motility studies is the best method to determine if there is a relation between the pouch and symptoms. Whether a diverticulum is symptomatic depends on the level to which its contents are regurgitated, which in turn is dependent on the volume of the pouch, existence of a pressure differential between the pouch and tubular esophagus, and increased LESP. In some cases dysphagia occurs when the weight of diverticular contents compresses the esophagus extraluminally.

Midthoracic diverticula rarely reach a large size, even though there is usually a high pressure area in the esophagus distal to the diverticular orifices. Esophageal contents move in and out of all esophageal diverticula, but symptoms of regurgitation related to midesophageal diverticula are infrequent, and these diverticula almost never require operation. Stasis is greater in epiphrenic and Zenker's diverticula than in midesophageal diverticula and may contribute to the occurrence of squamous cell carcinoma in these diverticula. Patients with long-standing, unoperated epiphrenic diverticula should therefore be kept under surveillance even if symptoms are insignificant.

Résumé

On a étudié les dossiers de 25 patients ayant un diverticule épiphrenique pour éclaircir le mécanisme de régurgitation oesophagienne et évaluer les méthodes thérapeutiques. Méthodes: On a réalisé une oesophagogastroduodénoscopie et des études cinématographiques, on a étudié la motilité oesophagienne. Par des sondes insérées dans l'oesophage et dans les diverticules chez deux patients, on a pu réaliser une étude de la motilité et une cinématographie simultanées pour corréliser les symptômes et les modifications de pression lors des mouvements du contenu diverticulaire et oesophagien. Résultats: Dix-neuf patients ont été opérés et six patients, pratiquement asymptomatiques, n'ont pas été opérés. Il n'y a eu aucune mortalité opératoire. On a observé une fistule oesophagienne qui a guéri spontanément. Les résultats à long terme ont été jugés excellents ou bons chez 10 patients ayant eu une résection ou une invagination. Huit patients n'ont pas eu de myotomie. Les résultats chez quatre de ces patients suivis à long terme ont été excellents. Conclusions: La régurgitation du contenu du diverticule dans l'oesophage dépend du volume de la poche diverticulaire et le gradient de pression entre la poche et l'oesophage lorsque l'onde de contraction était dissipée. La hauteur atteinte par le reflux oesophagien et les symptômes qui en ont résulté dépendent de ces facteurs ainsi que de la pression du sphincter inférieur de l'oesophage (LESP). Les patients asymptomatiques ayant un diverticule épiphrenique ne nécessitent pas d'opération. Une résection ou une invagination sont les interventions de choix. Nous préférons l'approche abdominale chaque fois que cela est possible. La myotomie est contre-indiquée lorsqu'on est en présence d'un reflux et que la pression du sphincter inférieur de l'oesophage est en dessous de la normale.

Resumen

Se completó un estudio sobre 25 pacientes con divertículos epifrénicos, destinado a clarificar el mecanismo de regurgitación esofágica y de evaluar los métodos terapéuticos. Métodos: se practicó esofago-gastroduodenoscopia y se realizaron estudios de motilidad esofágica y cineradiografía. Mediante la colocación de electrodos en el esófago tubular y en los divertículos en dos pacientes, se practicaron estudios de motilidad y cineradiográficos en forma simultánea para correlacionar los síntomas y los cambios de presión con el movimiento del contenido diverticular y esofágico. Resultados: 19 pacientes fueron operados y 6 pacientes, relativamente asintomáticos, no lo fueron. No se registró mortalidad operatoria y una fistula esofágica cicatrizó espontáneamente. Los resultados fueron excelentes o buenos en 10 pacientes operados y seguidos por un largo plazo luego de la resección o la imbricación de los divertículos. En 8 pacientes no se realizó miotomía, y en 4 de ellos los resultados a largo plazo fueron excelentes. Conclusiones: el movimiento retrógrado del contenido diverticular en el esófago depende del volumen de la bolsa y del gradiente de presión entre el interior del divertículo y el esófago tubular luego de que la onda de contracción en el esófago tubular se haya disipado. El grado máximo de reflujo esofágico y los síntomas consecuentes dependen de tales factores y de la presión en el esfínter esofágico inferior. Los pacientes con un divertículo epifrénico asintomático no requieren operación. El método quirúrgico de elección es la resección o la imbricación del divertículo. Nuestro grupo prefiere, en lo posible, el abordaje abdominal. La miotomía está contraindicada cuando existe reflujo gastroesofágico y la presión del esfínter esofágico inferior es normal.

References

1. Debas, H.T., Payne, W.S., Cameron, A.J., Carlson, H.C.: Pathophysiology of lower esophageal diverticulum and its implication for treatment. *Surg. Gynecol. Obstet.* 151:593, 1980
2. Duda, M., Serg, Z., Vojacek, K., Rocek, V., Rehulka, N.: Etiopathogenesis and classification of esophageal diverticula. *Int. Surg.* 70:291, 1985
3. Harrington, S.W.: The surgical treatment of pulsion diverticula of the thoracic esophagus. *Ann. Surg.* 149:606, 1949
4. Bruggemann, L.L., Seaman, W.B.: Epiphrenic diverticula: an analysis of 80 cases. *A.J.R.* 119:266, 1973
5. Allen, T.H., Clagett, O.T.: Changing concepts in the surgical treatment of pulsion diverticula of the lower esophagus. *J. Thorac. Cardiovasc. Surg.* 50:455, 1965
6. Fischer, M.J., Bond, J.F.: Carcinoma in a pharyngoesophageal diverticulum. *J. Thorac. Cardiovasc. Surg.* 53:500, 1967
7. Gawande, A.S., Batinchok, W., Barman, A.A., Mule, J.E.: Carcinoma within lower esophageal diverticulum. *N.Y. State J. Med.* 72:1749, 1972
8. Habein, H.C., Moersch, H.J., Kirklin, J.W.: Diverticula of the lower part of the esophagus. *Arch. Intern. Med.* 97:768, 1956
9. Benacci, J.C., Dechamps, C., Trastek, V.F., Allen, M.S., Daly, R.C., Pairolero, P.C.: Epiphrenic diverticulum: results of surgical treatment. *Ann. Thorac. Surg.* 55:1109, 1993
10. Vinson, P.P.: Diverticula of the thoracic portion of the esophagus: report of 42 cases. *Arch. Otolaryngol.* 19:508, 1934
11. Garcia, J.B., Bingochea, J.B., Wooler, G.H.: Epiphrenic diverticula of the esophagus: certain considerations about its surgical treatment. *J. Thorac. Cardiovasc. Surg.* 63:114, 1972
12. Fekete, F., Vonns, C.: Surgical management of esophageal thoracic diverticula. *Hepatogastroenterology* 39:97, 1992
13. Streitz, J.M., Glick, M.C., Ellis, F.H.: Selective use of myotomy for treatment of epiphrenic diverticula. *Arch. Surg.* 127:585, 1992
14. Evander, A., Little, A.G., Ferguson, M.K., Skinner, D.B.: Diverticula of the mid and lower esophagus: pathogenesis and surgical management. *World J. Surg.* 10:820, 1986
15. Jacobs, J.P., Konstantakos, A.K., Levi, J.U., Zeppa, R.: Transabdominal resection of esophageal epiphrenic diverticula: an approach worthy of consideration. *Contemp. Surg.* 45:135, 1944