ANATOMIC DAMAGE OF THE LOWER ESOPHAGEAL SPHINCTER AFTER SUBTOTAL GASTRECTOMY

DANOS ANATÔMICOS AO ESFÍNCER ESOFÁGICO INFERIOR APÓS GASTRECTOMIA SUBTOTAL

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ABSTRACT – BACKGROUND: Dysfunction of the lower esophageal sphincter (LES), gastroesophageal reflux disease, and erosive esophagitis in patients undergoing subtotal gastrectomy are commonly recognized occurrences, but until now the causes remain unclear. AIM: The hypothesis of this study is that subtotal gastrectomy provokes changes on the LES resting pressure and its competence, due to the anatomical damage of it, given that the oblique “Sling” fibers, one of the muscular components of the LES, are transected during this surgical procedure. METHODS: Seven adult mongrel dogs (18–30 kg) were anesthetized and admitted for transection of the proximal stomach. Later, the proximal gastric remnant was closed by a suture. Intraoperatively, slow pull-through LES manometrics were performed on each dog, under basal conditions (with the intact stomach), and in the closed proximal gastric remnant. The mean of these measurements is presented, with each dog serving as its control. RESULTS: The mean LES pressure (LESP) measured in the proximal gastric remnant, compared with the LESP in the intact stomach, was decreased in five dogs, increased in one dog, and remained unchanged in other dogs. CONCLUSION: The upper transverse transection of the stomach and closing the stomach remnant by suture provokes changes in the LESP. We suggested that these changes in the LESP are secondary to transecting the oblique “Sling” fibers of the LES, one of its muscular components. The suture and closing of the proximal gastric remnant reanchor these fibers with more, less, or the same tension, whether or not modifying the LESP.

HEADINGS: Gastroesophageal reflux. Esophageal sphincter. Lower. Gastrectomy.
INTRODUCTION

In older and recent surgical literature, it is well recognized that a percentage of patients undergoing distal or subtotal gastrectomy may develop esophagitis or gastroesophageal reflux disease (GERD) postoperatively. Some authors have suggested that this is due to a dysfunction of the lower esophageal sphincter (LES), and although there are several theories, until now the cause of this dysfunction is not clear. In this experimental study, our hypothesis is that subtotal gastrectomy can modify LES pressure (LESP) as a consequence of anatomical damage to the LES, since the transverse transection of the stomach at the upper middle third cuts the oblique muscular fibers of the LES (Sling fibers), which are one of the muscular components of the LES.

METHODS

This experimental study was performed in seven adult mongrel dogs (2 females and 5 males) weighing 20–30 kg. This animal model has been used historically in experimental manometric studies of the LES, because the regional anatomy does not appear to show a muscle structure that satisfies the arbitrary definition of a sphincter, as a muscle “ring.” Therefore, constitutes a validated model of the LES in dogs is quite comparable to human anatomy and, manometric studies of the LES, because the regional anatomy has been used historically in experimental surgery.

In this experimental study, our hypothesis is that subtotal gastrectomy in mongrel dogs (2 females and 5 males) weighing 20–30 kg. These animals were anesthetized with intravenous thiopental sodium, intubated, and finally oxygenated intraoperatively for each dog and was taken as baseline, that is considered the final LESP for each withdrawal. Fundic gastric pressure was considered a zero reference. In the analysis of the results, each dog had its control.

RESULTS

The first manometric recording was the LES resting pressure intraoperatively for each dog and was taken as baseline, that is, with the abdomen open but with the stomach intact. The observed LESP ranged between 9.6 and 15.9 mmHg in six animals. One dog showed a basal pressure which was double these values (30.5 mmHg, Table 1).

Table 1 - Lower esophageal sphincter pressure measurement in each dog under experimental conditions (each dog had its control).

| Dog | Intact stomach LESP (mmHg), mean±SD | Closed gastric remnant LESP (mmHg), mean±SD |
|-----|-------------------------------------|-------------------------------------------|
| 1   | 15.5±2.1                           | 11.7±4.0                                  |
| 2   | 10.2±0.7                           | 7.5±1.0                                   |
| 3   | 13.3±0.4                           | 5.0±2.0                                   |
| 4   | 15.9±1.8                           | 11.6±2.8                                  |
| 5   | 14.5±5.0                           | 4.3±0.6                                   |
| 6   | 9.6±1.4                            | 9.3±3.0                                   |
| 7   | 30.5±1.0                           | 32.5±3.5                                  |

After closing the proximal gastric remnant with a continuous suture, a new manometry was performed, and changes in LESP were registered in each dog and were compared with basal pressure of the same dog. The final mean LESP observed was decreased in five dogs (Figure 2), remained unchanged in one dog (dog 6), and was greater than its baseline in one dog (dog 7).

DISCUSSION

This experimental study was designed to evaluate eventually changes in the LESP in dogs after transecting the proximal stomach, trying to reproduce the method in other reports in the literature that have studied LESP in patients before and after undergoing a distal gastrectomy.

Historically, a much-argued question that persists today has been to understand how the LES functions and to understand and accept its unique anatomy. For a long time, the existence of an anatomical LES has been questioned, because the regional anatomy does not appear to show a muscle structure that satisfies the arbitrary definition of a sphincter, as a muscle “ring.” Thus, without an anatomical correlation, but with the clear manometric demonstration of a gastroesophageal sphincter, a
The hypothesis proposed and tested in this experimental study is based on the anatomical structure of the LES described by Liebermann-Meffert et al. and verified by studies of our group. The LES is formed by two bands of muscles arranged almost perpendicularly which act in a complementary manner to close the cardia: the semicircular muscular fibers or “clasp” at the lesser curve and the oblique muscular fibers or “Sling fibers” on the side of the great curvature. The Sling fibers extend from the distal esophagus and proximal gastric fundus and run parallel to the lesser curve into the gastric antrum (Figure 1).

For this reason, the transverse transaction of the upper third of the stomach or even in its middle third, by necessity, cuts the oblique “Sling” muscular fibers and, therefore, one of the sphincter components is severely damaged. When gastrointestinal continuity is restored, via a gastroduodenal (Billroth I) or gastrojejunal anastomosis (Billroth II or Roux-in-Y), or the gastric remnant is closed (in this experimental study) by the suture, the oblique “Sling” fibers are reanchored. But this repair does not always restore either the symmetry or the tension of these fibers that existed before the transaction and remnant closure, which can modify the LES resting pressure.

Based on our results and the referred anatomical concepts, we maintain that it is possible to explain different effects on the LES sphincter, observed after distal gastrectomy. The oblique fibers in patients can be reanchored with three possible outcomes: (1) the same symmetry and tension as before the gastric transaction, thereby restoring the normal LES and function; (2) with less tension creating a hypotensive, eventually incompetent sphincter; or (3) the fibers may be sutured with greater tension and tightness, thus resulting in a hypertensive sphincter.

Some limitations of this investigation are the low number of dogs (only seven dogs), acute experimental conditions, specimens under general anesthetic, and lack of a control group.

**CONCLUSION**

Nevertheless, the findings of our experimental study in dogs appear to reproduce the clinical observations in men and give a reasonable explanation for different changes in LES resting pressure observed in patients after distal gastrectomy. We believe that these findings provide an anatomically and physiologically consistent answer to the old mystery of gastric surgery.

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