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Original Article

# COLLIS GASTROPLASTY ASSOCIATED TO PARCIAL OR TOTAL FUNDOPLICATION: EXPERIMENTAL STUDY

*Gastroplastia a Collis associada à fundoplicatura parcial ou total: estudo experimental*

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**ABSTRACT** – ***Background*** - Reflux esophagitis complicated by stenosis and shortening of the organ is a difficult disease to surgical treatment with frequent failure. The Collis gastroplasty associated with a partial or total fundoplication can be employed in this situation. ***Aim*** - To evaluate the technique of fundoplication with partial or total Collis gastroplasty in dogs. ***Methods*** - Seven dogs underwent a Collis-Lind (Group A) and four to Collis-Nissen (Group B) after myotomy of the gastroesophageal junction; reflux was evaluated with measurements of pH and pressures in the esophagogastric transition with microtransducer. ***Results*** - After myotomy reflux occurred freely in all animals. However, after Collis-Lind or Collis-Nissen procedures, it not ocurred spontaneously. The application of manual pressure on the stomach caused reflux in 28.5% of animals in Group A. The assessment of pressures in the surgical specimen showed no difference in the area of high pressure in both groups. ***Conclusion*** – The Collis-Lind and Collis-Nissen procedures prevent gastroesophageal reflux. The pressure measurements and the extension of the high pressure zone were similar in both groups.

**HEADINGS** – Esophagitis, peptic. Esophageal stenosis. Models, animal.

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**RESUMO** - ***Racional*** – A esofagite de refluxo complicada com estenose e encurtamento do órgão é doença de difícil tratamento cirúrgico com frequente insucesso. A gastroplastia a Collis associada à fundoplicatura parcial ou total pode ser empregada nesta situação. ***Objetivo*** - Avaliar a técnica da gastroplastia a Collis com fundoplicatura parcial ou total em cães. ***Métodos*** - Sete cães foram submetidos a Collis-Lind (Grupo A) e quatro a Collis-Nissen (Grupo B) após miotomia da junção esofagogástrica. O refluxo foi avaliado com medidas de pH e as pressões na transição esofagogástrica com microtransdutores. ***Resultados*** - Após a miotomia ocorreu refluxo livremente em todos os animais. Entretanto, após a operação de Collis-Lind ou Collis-Nissen o refluxo espontâneo não ocorreu. A aplicação de pressão manual sobre o estômago, promoveu refluxo em 28,5 % dos animais do Grupo A. A avaliação das pressões na peça cirúrgica mostrou que não houve diferença na zona de alta pressão, nos dois grupos. ***Conclusão*** - A operação de Collis-Lind ou Collis-Nissen impediu o refluxo gastroesofágico. As medidas das pressões e a extensão da zona de alta pressão foram semelhantes nos dois grupos.

**DESCRITORES** - Esofagite péptica. Estenose esofágica. Modelos animais.

## INTRODUCTION

Reflux esophagitis is a disease characterized by esophageal mucosa inflammation caused by repeated and prolonged refluxed gastro-duodenal contents contact into the esophagus[3]. Besides the lumen narrowing problem, another situation that may accompany transmural inflammatory changes, is acquired-short esophagus and cause of controversy in its diagnosis[10,26]. Mercer and Hill[19] believed that it has always been possible to obtain abdominal esophagus segment to an adequate surgical repair, while others have recognized this situation and emphasized the negative influence on surgical results[10,30]. At intra-operative assessment on eight different study centers, it had been about 20% the incidence of acquired short esophagus[18]. The ideal surgical treatment aims to restore a normal gastric transit and

prevent subsequent reflux[30]. By applying anti-reflux fundoplication techniques at shortened esophagus presence, treatment failure ocurrence is greater because the esophagogastric junction (EGJ) is in the abdomen under tension, impairing the lower esophageal sphincter action (LES), and slip can provoke EGJ to the chest, leaving valve involvement at the proximal stomach, not being effective in controlling reflux[1,7,26,34].

Collis described the gastroplasty operation in 1957[5], in which an esophagus elongation with the small gastric curvature was obtained and had the same esophagus caliber and its continuity, reaching one of the principles of antireflux surgery that is to obtain abdominal esophagus segment, keeping esophagus angle entry into the stomach, however, that proved to be insufficient, as it has been found symptoms recurrence[6]. Pearson, et al.[23], associated to a partial fundoplication gastroplasty at Belsey type. Henderson[12] preferred to associate with Nissen fundoplication type, obtaining better results in controlling reflux.

The technique described by Collis associated with fundoplication for the patients treatment with esophagitis and strictures that lead to the esophagus shortening reached the main proposed objectives today: there is the esophagus preservation, the lower sphincter is excised, the vagus nerves remain intact[24], it is obtained a sub-diaphragmatic neo-esophagus segment for an adequate repair[2,11], a tension elimination on the repair[2,23], it is used for inflamed tissue, and not fundoplication[2,21,22], and JEG angulation remains[18]. This is associated with low morbidity, mortality and anatomic hernia and reflux recurrence[27].

The operation principle has been used for patients with distal esophagus peptic stricture and consequent esophagus shortening, but now it has expanded the patients re-operating indication with recurrent reflux, or other factors predisposing to reflux[25], such as severe reflux esophagitis with or without stenosis, chronic obstructive pulmonary disease, obesity, a need for esophageal myotomy, scleroderma and large incarcerated hernias[21]. All these mentioned factors interfere with ordinary sutures used in surgeries and result in increased tension on the repair, damaging reflux correction[2].

The surgery advent through video-laparoscopy is now also employed by this route, and it is considered the first choice for severe shortened esophagus cases and with great difficulty for solving the reflux[3,31].

Considering the difficult esophagitis treatment, complicated with esophageal stenosis and shortening, along with a little experience with tubular esophagus stretching technique and small gastric curvature (Collis technique), associated to partial or total fundoplication, it has been planned an experimental study in dogs in order to test it when preventing reflux.

## METHODS

The study was approved by the Institute of Biology, Ethics and Animal Research, Unicamp, Protocol 1867-1.

It has been used 11 dogs with 10.6 kg weight average, all operated under general anesthesia with sodium pentobarbital and kept breathing positively and intermittently for oro-tracheal intubation Takaoka device.

The surgery started with a laparotomy, dissection and identification of the esophagus. For reflux occurrence, a myotomy was performed at the 4 cm extension in the anterior wall of the esophagus (3 cm) and stomach (1 cm) (Figure 1). Ligature was performed at the duodenum to prevent 0,9% saline solution (500 ml and 12N hydrochloric acid solution 1,2 ml) escape, adjusted to achieve 3.0 pH and confirmed by a Beckman pH meter, injected into the stomach through a gastrostomy with nº 8 urethral tube. After that, a Foley 12 catheter was raised toward the animal's mouth until the distal esophagus, for refluxed fluid collection analysis through its pH reading at universal indicator pH -0-14 Merck tape.

With existence reflux proof after longitudinal myotomy, the surgery proceeded with the esophagus elongation completion at a 4 cm span from the fundus to the esophagus, parallel with a French No. 8.5 probe Portex placed at it, in order to prevent neo-esophagus narrowing being created (Figure 2).

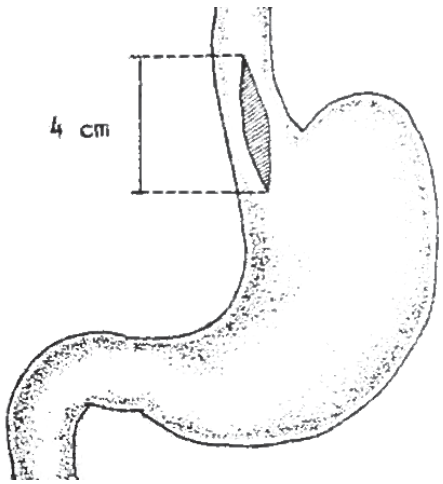


**FIGURE 1** – Esophagogastric junction myotomy

The animals were divided into two groups: Group A - in which the fundoplication was performed at 270º - Lind's procedure - (seven animals) (Figure 3) and Group B - in which the fundoplication was carried out at 360º - Nissen's procedure - (four animals) (Figure 4).

Upon gastroplasty and fundoplication completion, stomach acid pH solution was again placed and spontaneous reflux occurrence observed also forced

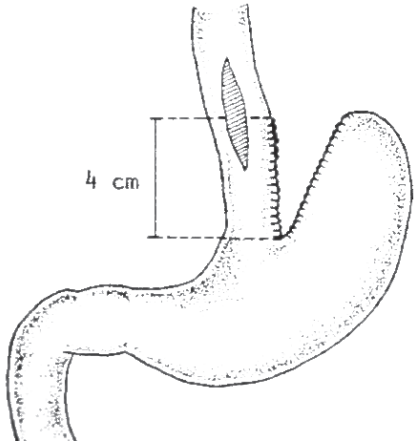


**FIGURE 2** – Collis's stretching

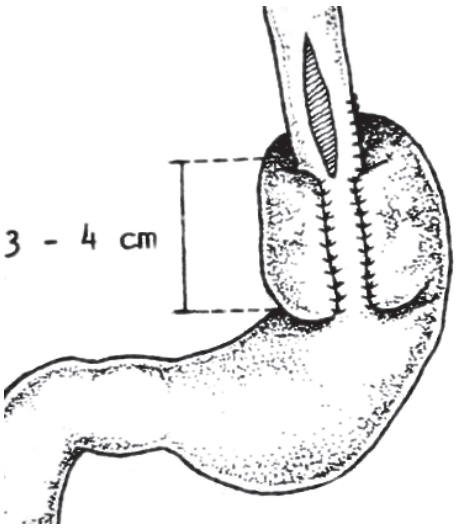


**FIGURE 3** – Collis-Lind

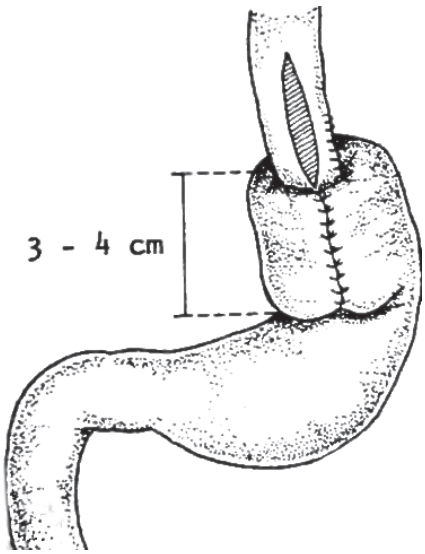


**FIGURE 4** – Collis-Nissen

by applying manual compression at the stomach and a collecting liquid could be flowed into the esophagus. Previously, the esophagus has been rinsed with saline to avoid errors reading the acid pH, previously documented and confirmed when reading universal pH indicator tape.

While the acid solution was infused into the stomach, middle of the volume was injected and recorded the maximum value. Reflux occurred or not spontaneously, manual pressure was employed on the gastric wall measuring intragastric pressure in cm of water through the gastrostomy tube connected to a water column and reflux occurrence being noted by Foley catheter placed at the distal esophagus and being measured its pH.

After testing for acid reflux had been made and recorded their findings, the surgical specimen was taken consisting of the distal esophagus, the neo-esophagus, stomach and duodenum following their junction.

The neo-esophagus perviability was tested by indicator and probe passage of the French 8.5 Portex examiner for proving the narrowing existence of it or not. The set was taken to the laboratory for pressure study that neo-esophagus could have surgically created by means of a catheter with an intragastric pressure micro-transducer being one of them, and others, in the area of stretching and fundoplication. For this test pressure, saline was injected into the stomach through the gastrostomy tube and measured the pressure changes at the two mentioned points. Also, manual pressure applying on the anterior stomach wall was carried out and the pressure changes were recorded at a graph paper for this exam itself. The slow and gradual micro-transducer catheter withdrawal was performed by measuring high pressure zone extent obtained with lengthening and fundoplication.

Statistical analysis was performed at the studied parameters with the Student T-test and Wilcoxon test, considering significant $p<0.05$ difference.

## RESULTS

Spontaneous reflux occurred in all dogs after the longitudinal EGJ myotomy with infused fluid average of 171.42 ml in group A and 187.5 ml in group B ($p> 0.05$). After esophagus stretching completion and fundoplication and fluid infusion partial or total performance into the stomach, there was no spontaneous reflux into the esophagus, with an infused volume average of 371.42 ml in group A and 425 ml ($p>0.05$) in group B.

The difference between the volume infused into both groups with myotomy and after the surgery, showed a significant difference ($p <0.05$), demonstrating that the myotomy is sufficient to induce gastroesophageal reflux (Group A - 171.42 ml/371,42 ml and Group B - 187.5 ml/425 ml).

With manual pressure application on the gastric wall, reflux occurred in two dogs in group A (28.5%) and none in Group B ($p> 0.05$). The mean intra-

gastric pressure obtained at the two groups showed no significant difference (p> 0.05) - (Group A - 27.14 cmH2O and Group B - 30 cmH2O).

The study of specimen stress-micro-transducer that was resected in group A showed the average pressure with infusion of saline solution into the stomach was 20 mmHg in stomach and 15 mmHg in gastroplasty, whereas in group B the average stomach was 15,66 mmHg and the gastroplasty 14.66 mmHg with p> 0.05 in the two measures. Comparison mean blood pressures into the stomach and at gastric wall between the two groups there was not any difference between them (p> 0.05).

When applied manual pressure on the gastric wall and evaluated the pressure changes into the stomach and gastroplasty, it has been found the following values: Group A - 23.75 mmHg and 15.75 mmHg, and Group B - 9.33 mmHg and 12.66 mmHg, a significant difference only when comparing intragastric pressure obtained in group A and B.

The high pressure zone extent measure obtained with fundoplication at group A was 3.25 cm and 3.66 cm at group B, they were not significantly different (p> 0.05).

## DISCUSSION

The experimental work as outlined was provided through 4 cm-myotomy completion at anterior EGJ wall, an expected reflux at all animals and then, a surgical technique effectiveness assessment.

Surgeries used to contain the reflux have been trying to restore lower esophageal sphincter (LES) competence, putting it into an intra-abdominal portion, and to correct possible defects at the gap region[3,20]. When there are intense inflammatory process existence and shortened esophagus, if surgery is performed by making an anti-reflux valve at a short or nonexistent abdominal esophagus segment, the fundoplication is under tension and there is a tendency to anatomic hiatus hernia recurrence and a reflux persistence[26].

A tube insertion with a small gastric curvature as proposed by Collis' esophageal lengthening in 1957 was well-accepted. The tube was about 7-9 cm length with stomach tube approaching without a significant fundoplication. With that, it was possible to stretch a functional distal esophagus while maintaining an acute entry angle between the esophagus and stomach[4,6].

Pearson, et al.[23] associated the esophagus stretching with a 240° fundoplication. Considering that not only the esophagus entry angle toward the stomach and abdominal esophagus segment were important, but by adding a fundoplication around the neo-esophagus a new valve mechanism has been created, as this uses to be a region free of inflammation, easier handling, less injury and failure risk in the long term. This technique benefits reached an intra-abdominal high pressure zone segment. LES was preserved and not destroyed or excised the vagus nerves kept intact with positive pressure action at the abdominal region[7,24].

Henderson[12] joined a gastric fundoplication at Nissen's manner, as their group's work with Collis-Belsey surgery found 44.6% of radiological reflux and 25.7% of significant symptoms, although only 1.5% of hiatus hernia recurrence.

Steichen[29] described Collis-Nissen surgery in 77 patients, which found 1.2% of hiatus hernia recurrence and no cases of radiological or symptomatic reflux. Thomas-Ridocci, et al.[33], comparing Nissen and Collis-Nissen surgeries, found better results with the second one with 6.6% and 0% of hiatus hernia symptoms recurrence and relapse 18% and 0%, respectively. Having the manometry being similar at both groups and pH showing reflux at 10% and 5% of the cases, respectively, it can be concluded that bariatric surgery with fundoplication was better, although these patients were more serious than those of another group. At this work, it has been chosen to conduct esophagus elongation study at a 4 cm span and an associated fundoplication for a length equally and virtually covering the entire tube.

Comparison of the two (partial or total) fundoplication types was performed as, in certain situations, it is necessary to employ a partial fundoplication. At an experimental study in cats, comparing Collis-Belsey and Collis-Nissen surgeries, it was clearly shown to be superior to total fundoplication for reflux at the containment[9]. At this work, reflux has occurred at 28.5% of the animals in the Collis-Lind surgery group; however, only at the test pressure on the gastric wall, which provides a facilitating factor for the reflux occurrence. In a regular situation, the reflux did not occur in any animal. So, the techniques are equivalent regarding to protection against spontaneous reflux. The literature data show the same remark in experimental or clinical studies[9,26,30]. Oliveira, et al.[20] performed partial (Lind) and total (Nissen) fundoplication in male rabbits and concluded that both cause an increase of LES pressure and length and his increase doesn't depend on the type of fundoplication performed.

The reflux evaluation occurrence by applying pressure on the stomach has been widely used in experimental studies and all showed an increase in intragastric pressure and stretching esophagus segment through the involved valve [16,24,28].

During surgery, the spontaneous reflux occurrence was observed with stomach compression through refluxed fluid collection into the esophagus and analysis with pH tape. However, the pressure study in the tube with the fundoplication was done in the resected specimen. It was used by Butterfield[4] into anatomical specimens taken from cadavers forming the distal esophagus, stomach and duodenum. Then, water was infused into the stomach with the duodenum

closed and no reflux into the esophagus. Nissen, Belsey, Hill and Thal-Hatafuku surgeries were performed and reflux occurrence was observed again. Reflux did not occur spontaneously when 250-mmHg pressure was arbitrarily applied into the stomach. At that work, the best techniques have been Nissen and Hill ones.

The most important considered factor at the reflux control has been to obtain a high pressure zone along the LES and its extension. Khan, et al.[15], when studying dogs, showed that surgical methods placing LES into the abdomen associated with engagement by gastric fundus lead to an increase in high-pressure zone and its extension.

Variations in pressure into the stomach and neo-esophagus with or without pressure on the gastric wall showed no significant difference between the two studied groups here, showing similar responses. At works of literature comparing the pressures between partial or total valve fundoplications, it has been showed a better response at the fundoplication[9,22].

High pressure zone extent has also no statistical difference between the two groups. So, any kinds of fundoplication are able to get a thread enough to contain the reflux. Ellis, et al. (1978)[9] at an experimental study also found similar results whenever evaluating high pressure zone extension at surgical Collis-Nissen and Collis-Belsey performance.

As a final surgery Collis information, associated with partial or total fundoplication, laparoscopic surgery can be performed by drawing the benefits of minimally invasive surgery, resulting in clinical series and satisfactory results when controlling reflux[13,14,17,31,32]. It can be, therefore, recommended for severe cases of shortened esophagus. The clinical studies show that the technique has a low symptom recurrence incidence and fewer failures when controlling reflux.

## CONCLUSION

Collis' gastroplasty associated to a partial (Lind) or total (Nissen) fundoplication, produced a high pressure zone that was similar in length and pressure in both groups.

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