Laparoscopic Total Fundoplication With Myotonic Crural Component: Surgical Technique And The Main Results

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Citation

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Abstract

Aim: To present and evaluate our surgical technique for laparoscopic total fundoplication with myotonic crural component (LTFMCC).Patients and Methods: This study included 72 patients with a confirmed diagnosis of gastroesophageal reflux disease (GERD) who underwent fundoplication and agreed to the new technique of laparoscopic fundoplication using LTFMCC. Patients were randomly divided into two groups. The first group (A, n = 30) underwent LTFMCC. After standard steps, our operative technique involved crurorаphy and fundoplication with suturing of the right and left diaphragmatic crura below the esophagus using two interrupted nonabsorbable 2-O stitches placed in the middle of the crura length. The hiatal orifice was divided into two parts: an upper window fixed to the esophagus and a lower window with left and right crura fixation to the anterior and posterior parts of the stomach fundus, respectively. There were no sutures between the posterior and anterior parts of the fundus, but this novel procedure creates a 360° fundoplication with a myotonic component. The second group of patients (B, n = 42) underwent standard laparoscopic Nissen total fundoplication (LTFN). The average age of patients was 45.9 ± 13.0 years in group A and 47.0 ± 11.1 years in group B (t = -0.38, p = 0.71). In group A, there were 20 men and 10 women whereas group B had 24 men and 18 women. Results: All LTFMCC procedures were successfully completed laparoscopically. Operation complexity and time of LTFMCC did not differ significantly from the standard laparoscopic Nissen fundoplication. The myotonic component relieves suture tension and provides tone for the fundoplication wrap. There were no serious intra- or postoperative complications or side effects. Mean postoperative hospital stay was 3 days.Conclusions: In our experience LTFMCC is a safe and effective procedure in the treatment of GERD.

INTRODUCTION

Laparoscopic fundoplication (LF) has shown significant advantages over traumatic laparotomy technique and is firmly established in the international surgical practice, becoming the standard of care for antireflux surgery for GERD [1]. However, the results of laparoscopic antireflux surgery for GERD do not fully meet modern requirements. Following surgery, approximately 41% of patients were taking some form of antacid medication, 23% were using proton-pump inhibitors (PPIs), and 3% required reoperation [2]. The most common symptom of GERD, heartburn, often re-occurs in patients who undergo partial fundoplication [3].

Therefore, some authors [4] recommended total fundoplication, which has a more pronounced antireflux effect for GERD with severe clinical or endoscopic signs. The main disadvantage of total compared to partial fundoplication is common postoperative dysphagia. The percentages of patients with dysphagia at 15 days, 3, 6, and 12 months after Rossetti fundoplication were 63%, 43%, 26%, and 10%, respectively; and following Nissen fundoplication were 33%, 23%, 7%, and 3%, respectively [5].

PATIENTS AND METHODS

This study included 72 patients with a confirmed diagnosis of gastroesophageal reflux disease, who underwent fundoplication at our hospital from 2003 to 2010. All patients who agreed to laparoscopic fundoplication with the use of the new technique (n = 72) were randomly divided into two groups. The first group (A, n = 30) underwent laparoscopic total fundoplication with myotonic crural component of the wrap (LTFMCC). In the second group (B, n = 42), the standard Nissen-type laparoscopic total fundoplication (LTFN) was used. The average ages in the two groups were: group A, 45.9 ± 13.0 years; and group B, 47.0 ± 11.1 years (t = -0.38, p = 0.71). In group A, there were 20 men and 10 women, whereas group B had 24 men

and 18 women.

Results of the operations were evaluated using radiography, endoscopy, DeMeester index, intraesophageal manometry, establishment of endoscopic gastroesophageal flap valve grade (GEFV) based on Hill et al. [5], and the health-related quality of life questionnaire GERD-HRQL [6]. All patients were asked to return a structured follow-up questionnaire. We present our results using a Visick grading scale on LTFN and LTFMCC after an observation time of 72.4 months (range 6-81 months).

Results for all patients were compared using the Student's t test, and chi-square (χ^2)-test as appropriate. The data are expressed as the mean ± standard deviation, with $p < 0.05$ considered statistically significant.

The protocol for the research project was approved by the ethical committee of the National Research Center of the Republic of Kazakhstan, where the work was done, and it corresponds to the provisions of the Declaration of Helsinki (as revised in Edinburgh 2000).

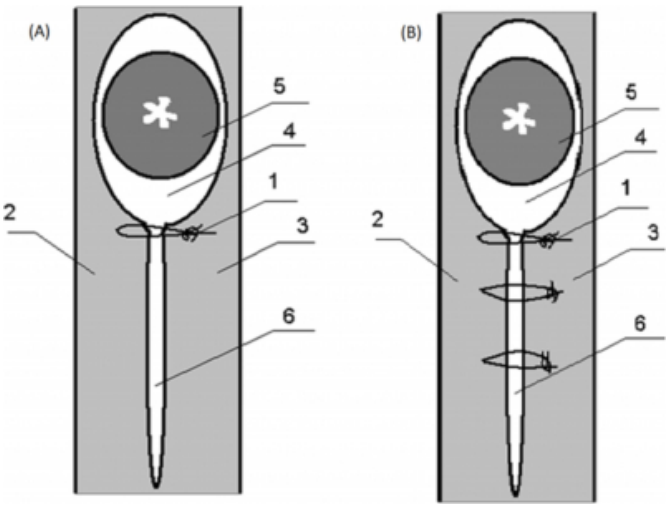
SURGICAL TECHNIQUE

Our surgical technique was based on prior anatomical and physiological experimental work. The experiments proved the existence of a peripheral reflex mechanism. During swallowing, enlargement of the esophagus triggers a selective inhibitory neuromuscular reflex on the diaphragmatic crura resulting in their relaxation [7, 8]. To confirm this phenomenon, these researchers electromyographically recorded decreased phrenic activity, depending on the enlargement of the esophagus. Direct stimulation of crural muscles revealed that, during esophageal dilation, there was complete relaxation of the esophageal-gastric connection, despite the continuous electrical stimulation of the crus aperture. This proves the existence of a peripheral relationship between the esophagus and diaphragmatic crura. In addition, it was established experimentally that the extension of the esophagus after an increase in the volume of a food bolus of more than 150ml leads to complete suppression of the muscle tone of the crura of the diaphragm.

Based on the above experimental results, we developed and introduced into clinical practice a new way of doing fundoplication. Figure 1 schematically shows the anatomy of the esophageal hiatus and the difference between the crurorraphy we developed and the traditional antireflux surgery. With the method we developed, the diaphragmatic crura at the hiatus are divided in two for suturing to the gastric fundus. This part of the hiatus is not sutured tightly, but used to regulate the created myotonic crural wrap.

Figure 1

Figure 1. Diaphragmatic crurorraphy with a decrease in diastasis between the crus to the esophagus. (A) Crurorraphy using LTFMCC, and (B) crurorraphy using LTFN.

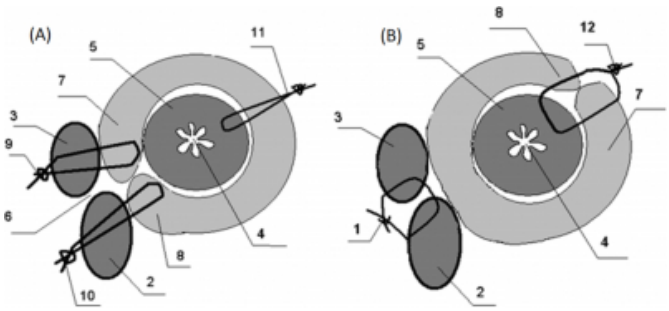


Key: 1, suture between the diaphragmatic crura; 2, right diaphragmatic crus; 3, left diaphragmatic crus; 4, hole in the hiatus around the esophagus; 5, esophagus; 6, lower half of the hiatal orifice.

After fixing the anterior and posterior parts of the gastric fundus to the left and right crus of the diaphragm, respectively, as shown in Figure 2, a complete (total) fundoplication with myotonic crural component of the wrap is formed (Fig. 2A). Unlike Nissen surgery (Fig. 2B), this is not closed and does not provide a direct cross-linking of the anterior and back walls of the gastric fundus. At this stage, the recovered angle created a block and ensured antireflux effect similar to posterior partial fundoplication. At the same time, conditions were created to prevent the rotation of the cardia at the stage of completion of the fundoplication wrap.

Figure 2

Figure 2. Schematical representation of the hemmed anterior and posterior walls of the gastric fundus. (A) Fundoplication using the newly developed LTFMCC, and (B) standard fundoplication by LTFN.

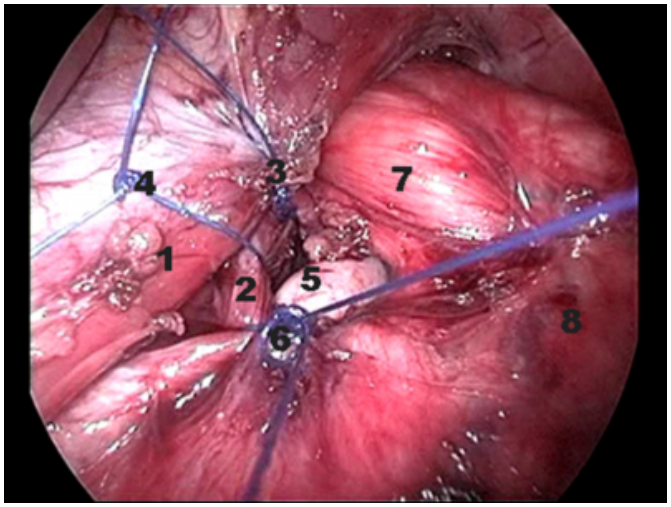


Key: 1, suture between the diaphragmatic crura; 2, right diaphragmatic crus; 3, left diaphragmatic crus; 4, lumen of the esophagus; 5, esophagus; 6, lower half of the hiatal opening; 7, posterior part of the gastric fundus; 8, anterior fundus; 9, suture between the back of the fundus and the left crus of the diaphragm; 10; suture between the right crus of the diaphragm and the anterior wall of the gastric fundus; 11, the fixing suture between the anterior wall of the esophagus and the fundoplication wrap with myotonic crural component; 12, suture between the anterior and posterior walls of the gastric fundus using the Nissen method.

Intraoperatively, it looks as follows. After posterior cruroraphy, initially the suture between the anterior part of the gastric fundus and the left crus of the diaphragm was created (Fig. 3).

Figure 3

Figure 3. Suture between the gastric fundus and the left crus of the diaphragm, after posterior cruroraphy.

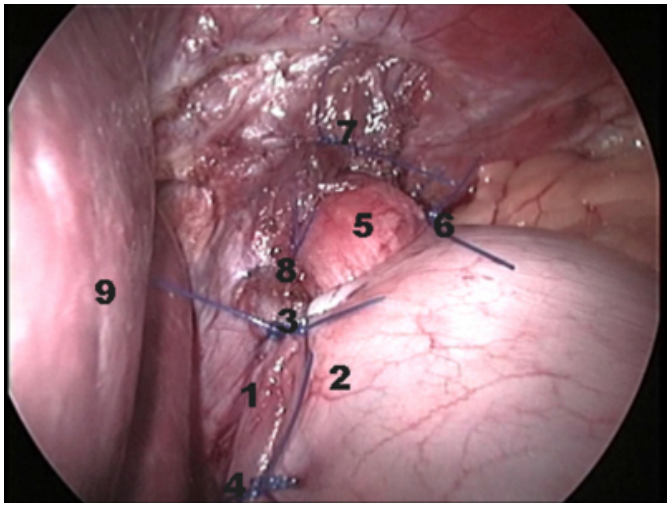


The numbers denote: 1, the right crus of diaphragm; 2, left crus; 3, first suture between the left and right crura (posterior cruroraphy); 4, second suture between the left and right crura; 5, posterior part of the gastric fundus; 6, knot suture between the fundus and the left crus; 7, esophagus; and 8, stomach.

Then the stitching between the anterior part of the gastric fundus and the right crus of the diaphragm was executed (Fig. 4). Two or three nonabsorbable sutures were used and finally we performed anterior cruroraphy.

Figure 4

Figure 4. Complete view of the LTFMCC

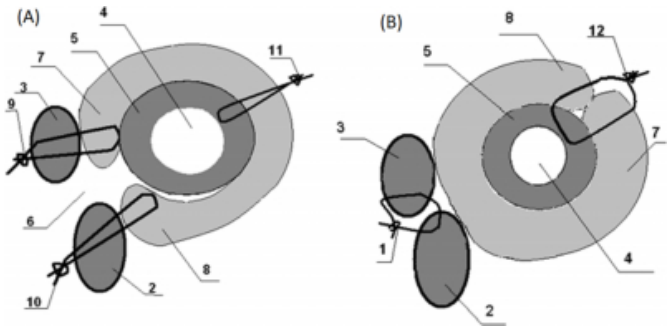


The numbers denote: 1, the right crus of the diaphragm; 2, anterior part of the gastric fundus; 3, first suture between the right crus and the anterior part of the fundus; 4, second suture between the right crus and anterior fundus; 5, esophagus; 6, second suture between the left crus and posterior part of the fundus; 7, anterior cruroraphy; 8, first suture between the left and right crura (posterior cruroraphy); 9, hepar.

Thus, the main difference from Nissen operations, in which both parts of the fundus of the stomach are sewn together directly to surround the esophagus, is that in our method each of the parts of the fundus is sewn to the muscle component of the wrap. This leaves the possibility of unhindered extension of the esophagus within the wraps. The advantage of our method is fully demonstrated in Figure 5.

Figure 5

Figure 5. Shown schematically: (A) Ability to expand the esophagus and the wrap during swallowing in LTFMCC and (B) Compression wrap of the esophagus during swallowing in LTFN.



The numbers denote: 1, the suture between the crus diaphragm; 2, right diaphragmatic crus; 3, left diaphragmatic crus; 4, lumen of the esophagus; 5, esophagus; 6, lower half of the hiatal opening; 7, posterior part of the gastric fundus; 8, anterior fundus of the stomach; 9, suture between the back of the fundus and the left crus of the diaphragm; 10, suture between the right crus of the diaphragm and anterior wall of the gastric fundus; 11, the fixing suture between the anterior wall of the esophagus and fundoplication wrap with myotonic crural component; 12, suture between the anterior and posterior walls of the fundus of the stomach using the method of Nissen.

Passage of food through the esophagus is due to the peristaltic wave, which normally can extend the lumen of the esophagus up to 2-3cm. In the absence of fundoplication wrap with myotonic crural component, expansion of the esophagus normally triggers the aforementioned peripheral reflex mechanism with neuromuscular inhibitory effect on the crura of the diaphragm, causing them to relax and allow the free passage of peristaltic waves into the stomach. After the peristaltic wave passes through, the esophagus relaxes and the inhibitory effect of the reflex mechanism is lifted, which ensures tight closure of the walls of the esophagus through the diaphragmatic muscle toning crus, thus pulling the fundoplication wrap along. The anatomical and physiological principles on which the fundoplication is developed are as follows:

1. Diaphragmatic crura are actively involved in the antireflux function of the lower esophageal sphincter (LES); and 2. Between the diaphragmatic crura and the distal esophagus, there is a reflex that provides unobstructed peristaltic waves to a food bolus.

RESULTS

All LTFMCC and LTFN procedures were completed by laparoscopy. The operation complexity and time for LTFMCC was not significantly different from the standard laparoscopic Nissen fundoplication. There were no serious intra-operative or postoperative complications in either group.

Postoperative quality of life, estimated by the GERD-HRQL questionnaire was better at 3 months after surgery in the LTFMCC group at 5.2 ± 0.7, due to a lower number of complaints after the operation, versus 9.2 ± 0.7 in the second group ($p < 0.05$). Similar results were obtained after one year with 4.7 ± 0.2 vs. 10.4 ± 0.9, respectively ($p < 0.05$).

The myotonic component provides a tension-free state for the sutures, the fundoplication wrap, and its tone. First-degree postoperative dysphagia was observed in two patients in group A after 1 month, compared to 18 (42.8%, $p < 0.05$) in group B. At 3 months, there was a tendency toward reduced frequency of dysphagia, which amounted to 3.3% in group A vs. 30.9% in the second group ($p < 0.05$). By 6 months, no dysphagia was observed in group A, but it persisted in four (9.5%) patients ($p > 0.05$) and three (7.14%) patients ($p > 0.05$) at 6 and 12 months, respectively. Return of heartburn after antireflux surgery, which was not observed in the first group, was identified in five patients (11.9%) in the second group for 3 months and several more at 6 months and 1 year. According to the definition, postoperative heartburn was observed in six patients (14.3%) in group B ($p > 0.05$) after 1 year.

Indicators of the restoration of anatomic relationships in the LES after surgery were radiological evidence pointing to the elimination of axial herniation and the establishment of 1-2 degrees of endoscopic GEFV status (based on Hill et al.) in 100% of patients who underwent the method we developed and 83.3% in the second group ($\chi^2 = 3.8$; $p=0.05$). DeMeester index decreased postoperatively to normal values in both groups, but a slightly larger reduction was observed in group A (12.1 ± 4.4) than in group B (14.6 ± 5.8, $p < 0.05$).

Despite the higher rates of intraesophageal pressure at rest, the developed technique, which amounted to 13.5 ± 0.1 vs. 10.8 ± 0.6mmHg in the second group, the frequency of dysphagia in the first group was significantly lower than when using the standard procedure within 6 months ($p > 0.05$). The best operative results by Visick grading were seen in the first group, with Visick grade1-2 in 100% of patients

vs. 80.95% in the second group ($\chi^2 = 4.6$; $p = 0.03$). Mean postoperative hospital stay was 3 days in both groups.

DISCUSSION

The main disadvantage of surgical treatment for GERD is the emergence of new problems such as difficulty in swallowing after the surgery in people who have surgery to relieve GERD symptoms [9]. The problem of dysphagia after the surgery and return of heartburn has led us to develop an alternative fundoplication technique, which provides a tension-free state for the wrap. This technique was compared to the standard Nissen operation.

In using laparoscopic Nissen fundoplication, we obtained similar data on postoperative dysphagia to the results of Contini et al. [10]. The proportion of patients with postoperative dysphagia observed after 3 months in the first group was 3.3% vs. 30.9% in the second group ($p < 0.05$). By 6 and 12 months, dysphagia was not observed in group A, but persisted in 4 patents (9.5%) at 6 months and in three patients (7.14%, $p > 0.05$) at 12 months in the second group. The main cause of dysphagia with Nissen fundoplication and Rossetti's method is the creation of a wrap in the form of a complete ring, which hinders extension of the esophagus under the wrap.

In the case of a free overlay fundoplication wrap for Nissen, there may be dehiscence of the cardia, which lowers the antireflux effect. In agreement with these points, the results of our endoscopic assessment of GEFV showed loose compression of the endoscope in the retroflexed position indicating a hiatus under the wrap of the cardia in patients who underwent the floppy Nissen procedure, in 16.7% of patients in the second group.

The myotonic crural component provides a controlled tension wrap. During swallowing, crural muscle relaxation occurs and thus relaxing the fundoplication mantle. Between meals, the lumen of the cardia is completely closed due to restoration of muscle tone of the crural component of the wrap.

Patient satisfaction after LTFN was rated as very good or good (Visick 1-2) in 80.95%. Following our antireflux procedure, in the first group, Visick 1-2 grading was at 100% of the operated patients. These results are comparable with those of other authors [11]. No major complications were encountered in our study either intra-operatively or postoperatively.

CONCLUSION

The absence of postoperative mortality, general surgical intra- and postoperative complications, and high efficiency in both groups indicate that our proposed method of fundoplication is a safe, atraumatic and acceptable treatment for GERD, similar to the standard Nissen method. Our method of fundoplication reduces postoperative dysphagia and re-occurrence of the symptoms of heartburn compared to the standard fundoplication.

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