Comparative study between laparoscopic Nissen fundoplication with and without endoscopic mucosal resection in the management of Barrett's esophagus

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Background
Barrett's esophagus (BE) is a metaplastic lesion in the distal esophagus that results from chronic irritation with gastric contents in the course of reflux disease. The relative risk of developing esophageal adenocarcinoma in patients with BE appears to be 30-fold higher than normal individuals. Antireflux operations may offer the possibility of treating the cause by restoring the anatomic barrier responsible for guarding against irritating effects of gastroduodenal content on the distal esophagus. Laparoscopic floppy Nissen fundoplication (LNF) is considered the most effective among these procedures. Endoscopic mucosal resection (EMR) is now an established therapy for early eradication of BE and prevention of progression to dysplasia.
Aim
The purpose of this research was to evaluate the effect of adding EMR technique before LNF for the treatment of gastroesophageal reflux disease complicated by BE without dysplasia.
Patients and methods
A prospective randomized study was performed on 36 patients complaining of chronic reflux with endoscopic Barrett's changes from July 2017 to July 2019, with a minimum of 18 months of follow-up at Ain Shams University Hospitals. In group A (18 patients), floppy LNF was done alone, and in group B (18 patients), floppy LNF was done preceded by EMR. Clinical outcomes were collected preoperatively and postoperatively, namely, the reflux symptoms, dysphagia score, and rate of regression/progression or recurrence of Barrett's epithelium in each group.
Results
Symptomatic esophageal stricture that needed endoscopic dilation was noted during the 3-month follow-up in seven (38.8%) patients in group B, compared with one (5.5%) patient in group A (P<0.001). Both interventions showed significant improvement of reflux symptoms during the whole follow-up period. Collectively at the end of the study, six (33.3%) patients had recurrence of Barrett's mucosa in group A, and one (5.5%) patient failed to achieve complete regression of Barrett's mucosa in group B (P=0.035).
Conclusion
Although a higher rate of dysphagia was associated with EMR combined with LNF, EMR seems to be a safe modality, with a high rate of success in complete eradication of BE in symptomatic patients with gastroesophageal reflux disease when combined with floppy NF. This combined treatment had a decreased rate of recurrence of Barrett's epithelium compared with LNF alone.

Keywords:
Barrett's esophagus, endoscopic mucosal resection, gastroesophageal reflux disease, Nissen's, fundoplication

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Introduction

Barrett's esophagus (BE) has been generally accepted as a complication of chronic and severe gastroesophageal reflux disease (GERD) and may be a premalignant condition in which the squamous epithelium that lines the distal esophagus is replaced by metaplastic columnar epithelium [1].

GERD and BE are reportedly related to a high risk of esophageal adenocarcinoma (BE cancer) [2,3].

Usually considered multifactorial, the pathophysiology of GERD may be attributed to increased abdominal pressure, crural orifice disruption, presence of hiatal hernia, and dysfunction of the lower esophageal

sphincter (LES), with transient LES relaxation playing a potentially significant role [4].

Although often managed with lifestyle modifications and pharmacologic treatment such as proton pump inhibitors (PPIs), up to 40% of patients have persistent GERD symptoms despite medical therapy, and life-long PPI use has been shown to possess negative consequences [5,6].

Surgery remains one of the foremost effective treatments for GERD refractory to medical management. The traditional standard surgical operation has been transabdominal laparoscopic fundoplication, which involves hiatal hernia reduction (if present), cruroplasty, and a complete (Nissen) or partial (Toupet/Dor) wrap of the stomach around the esophagus. In the past decade, several alternative endoscopic interventions have emerged including radiofrequency ablation (RFA), transoral incisionless fundoplication, and gastroesophageal junction plication, most of which lack substantial long-term efficacy data and often require costly special equipment [7].

One relatively new endoscopic technique is endoscopic mucosal resection (EMR), which was first discovered in 2003, after a patient reported improvement of reflux symptoms following EMR for BE [8].

Patients with BE periodically undergo endoscopic examinations to detect early dysplastic changes. Treatments currently accepted include clinical treatment with PPI, endoscopic ablation through cryotherapy, laser therapy, photodynamic therapy, multipolar electrocoagulation, argon plasma coagulation, radiofrequency, EMR, and fundoplication [9].

The goal of our study is to emphasize the efficacy of adding mucosal resection before Nissen's fundoplication in the management of BE without dysplasia.

Patients and methods

A prospective randomized study was done on 36 patients experiencing chronic reflux associated with BE who presented to the outpatient clinics of Ain Shams University hospitals in the period from July 2017 to July 2019. Patients were randomized according to the closed envelop method. The results of floppy Laparoscopic Nissen fundoplication (LNF) and the same technique preceded by EMR of Barrett mucosa were compared.

A comprehensive assessment program was carefully structured so that a disciplined routine was followed in each patient. All patients were preoperatively and postoperatively evaluated. Ethical approval was taken from Ain Shams University ethical committee, and a written consent was taken from every patient after explanation of all the details of the operation, advantages, disadvantages, realistic expectations, and with the possibility of conversion to open surgery and all the possible intraoperative, early, and late postoperative complications. Surgeries were done by the same surgical team throughout the study. Patients were informed about the risks of possible dysplastic changes and malignant transformations.

Inclusion criteria included all adult patients experiencing chronic reflux associated with BE without dysplasia on histopathology and who did not undergo any previous antireflux procedure or endoscopic eradication therapy (EET) for BE and were able to continue follow-up for 18 months.

Exclusion criteria were patients who were unfit for general anesthesia, previous major upper abdominal surgeries or midline exploratory surgeries, and pregnant females.

Full detailed history was taken, and examination was done for every patient, including (a) dysphagia for solids and liquids; (b) regurgitation of acid contained food (on lying down and standing up); (c) respiratory complications (nocturnal cough and aspiration), (d) history of smoking, alcoholism, and diabetes; and (e) history of PPIs intake.

Investigations were done for all patients including (a) upper gastrointestinal endoscopy: comments on esophageal peristalsis, LES, esophagitis, length of Barrett mucosa, hiatal hernia, and biopsy taken for histopathology; (b) barium study: to detect reflux and the presence or absence of hiatal hernia; (c) esophageal manometry high-resolution manometry (HRM): used for evaluation of LES pressure, esophageal peristalsis, and effective clearance; and (d) esophageal pH monitoring.

Operative steps

Patients were placed supine, under general anesthesia, with split-leg and reverse Trendelenburg position. Inflation of the abdomen was done with Veress needle. Four operative ports (two of them 10 mm and the others were 5 mm) were placed under direct vision. Liver retractor was placed through the epigastric port (S shaped). Dissection started through pars

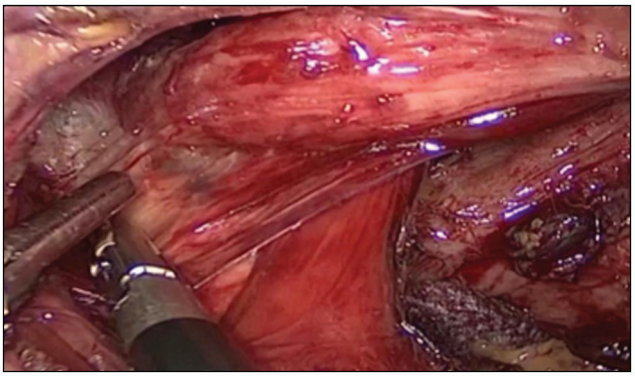
flaccida using ligasure scalpel, followed by dividing the phrenoesophageal ligament and peritoneum overlying the abdominal esophagus all around, preserving vagi nerves. Division of the short gastric vessels, starting at the inferior pole of the spleen to the exposed left crus of the diaphragm was done. The fundus was mobilized by dividing the short gastric vessels and all fundal attachments, and then mobilization of the distal part of mediastinal esophagus was performed (Fig. 1). The gastroesophageal hiatus was closed posteriorly with interrupted ethibond 2-0 sutures (Fig. 2). The posterior fundus was passed behind the esophagus from left to right to complete 360° full wrap after application of bougie (36 Fr) (Fig. 3). Three seromuscular sutures were placed from left to right starting from up downward suturing the fundus to itself. After finishing the antireflux procedure, the area was inspected for bleeding. After hemostasis, a drain was inserted to the left side of the fundus, and the liver retractor was removed. The port sites were then closed.

For group B, surgery was preceded by EMR over one or more sessions until all Barrett mucosa was excised. Surgery followed the last session by 3–4 weeks. EMR was performed under general anesthesia using standard video-endoscopes in our endoscopy unit at El-Demerdash Hospital and Ain Shams Specialized Hospital. Overall, 5–15 ml of diluted epinephrine solution (1 : 200 000) was injected into the submucosa to elevate the mucosa (Fig. 4). With the introduction of commercially available EMR kits, EMR was performed using the rubber band, which was applied, and the Barrett mucosa was cut beneath with the snare (Figs 5 and 6). After EMR, patients were advised to take their PPI twice daily, to remain on a clear liquid diet for the next 24 h, and to avoid use of anticoagulants, antiplatelet agents, and NSAIDs for a week depending on the risk of bleeding. EMR procedures were all performed on an outpatient basis unless in exceptional circumstances (i.e. bleeding during the procedure).

Outcome measures

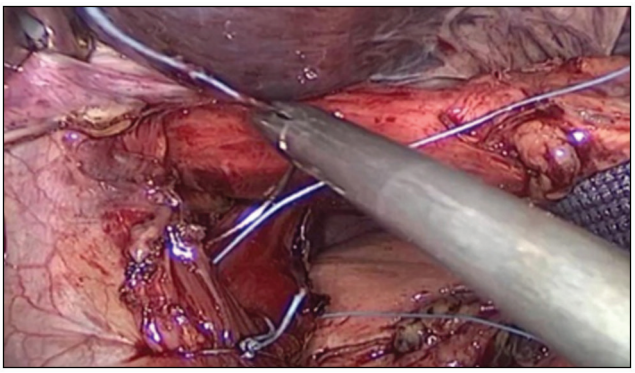
Clinical evaluation was carried out at baseline and at 1, 3, 6, 12, and 18 months after surgery, using a modified DeMeester symptom scoring system (Table 1), in which each patient was evaluated according to the presence of three symptoms: dysphagia, regurgitation, and heart burn. For each symptom, a score from 0 to 3 was attributed, depending on its severity. Then, for each patient, a clinical global score equal to the sum of these symptoms scores was finally assessed, and the reduction of each symptom severity after

Figure 1



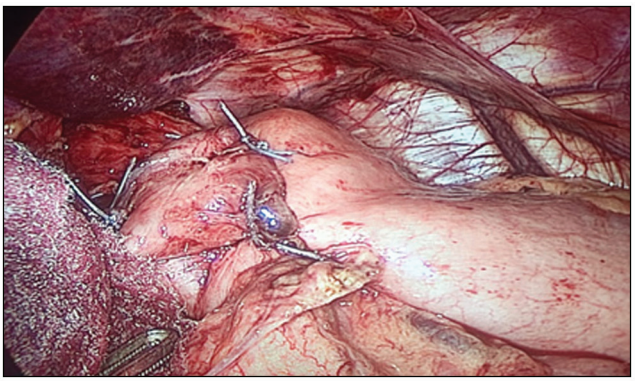
Hiatal dissection.

Figure 2



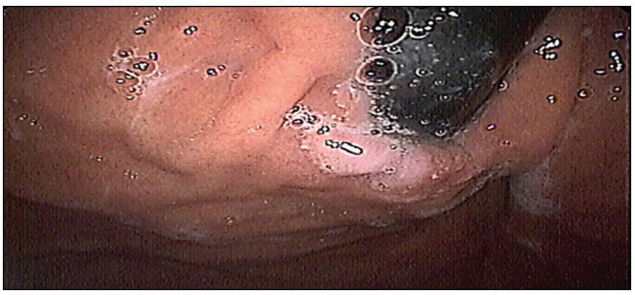
Hiatal closure.

Figure 3



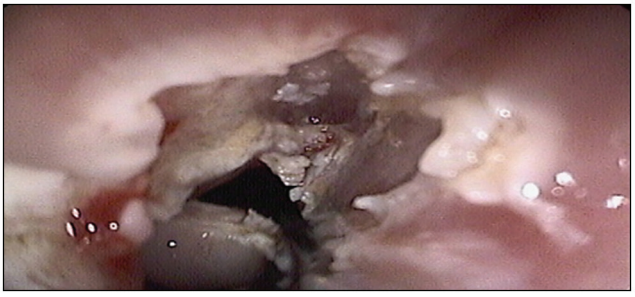
Floppy 360 wrap.

Figure 4



Diluted solution injection.

Figure 5



The mucosa was snared beneath the rubber band.

Figure 6

Lesion extraction.

Table 1 Modified DeMeester score

	0	None
Dysphagia	1	Occasional transient episodes
	2	Require liquids to clear
	3	Impaction requiring medical attention
	0	None
Heart burn	1	Occasional brief episodes
	2	Frequent episodes requiring medical treatment
	3	Interference with daily activities
	0	None
Regurgitation	1	Occasional episodes
	2	Predictable by posture
	3	Interference with daily activities

the surgery was then investigated. The aim in group A was to achieve complete regression of Barrett mucosa, whereas the aim in group B was to achieve no recurrence of Barrett mucosa again through endoscopic follow-up at sixth, 12th, and 18th month with biopsy of any suspected Barrett mucosa. A comparison was done between the preoperative and postoperative 1, 3, 6, 12, and 18 months regarding DeMeester scores for dysphagia, regurgitation, and heart burn. LES pressure by HRM and pH monitoring were done for all patient preoperative but only redone postoperatively in cases with complications. The follow-up was done at our outpatient clinic for surgery and at the endoscopy unit.

Statistical analysis

Data were collected tabulated and exported to the Statistics Open for All (SOFA), version 1.5.3 (Paton-Simpson and Associates Ltd, Auckland, New Zealand). The quantitative data were presented as median with SD, whereas qualitative variables were presented as number and percentages. The comparison of qualitative data was done by using χ^2 test, whereas in case of quantitative data, it was done by using independent t test or paired t test. P value less than or equal to 0.05 was considered significant.

Results

Preoperative, intraoperative, and postoperative parameters were finalized systematically in all patients. Upper endoscopy was done at third month for patients who complained of postoperative dysphagia.

Patients' characteristics

Table 2 summarizes the patients' demographic data and preoperative parameters. The study was done on 36 patients, comprising 22 (61%) males and 14 (39%) females. The overall mean age was 48.69 ± 7.9 years (range, 35–62 years), with no significant difference observed between group A (49.5 ± 7.59 years) and group B (47.89 ± 8.34 years) (P=0.548). The upper gastrointestinal tract endoscopy detected incompetent cardia in all patients and presence of esophagitis in five patients in group A and in four patients in group B. Patients with short-segment Barrett were 12 and 13 in groups A and B, respectively, whereas long-segment Barrett were 6 and 5, respectively. The existence of hiatal hernia was confirmed by upper endoscopy and upper gastrointestinal barium study, being 11 and 10 patients, in groups A and B, respectively. All differences in the preoperative parameters and DeMeester scores were nonsignificant between both groups.

Intraoperative: all operations were done laparoscopically without conversion. There was no noticeable difference between both groups, as the same operation was done. The average duration of the intervention was 104 ± 12.8 min in group A versus 106 ± 15.3 min in group B, with nonsignificant P value of 0.674. Blood loss was negligible, and transfusions were not needed in both groups. No major intraoperative complications occurred in both groups. In group B, EMR was done once in 11 patients and twice in seven patients (five with long-segment Barrett and two with short-segment Barrett) with time ranging from 22 to 35 min/session. Regarding EMR, three patients had minor bleeding during the procedure, controlled with Argon Electro-Coagulation, and no postprocedure sequalae occurred. No events of esophageal perforation were experienced in our study.

Postoperative outcomes

The average hospitalization time for group A was 2.5 ± 0.62 days, whereas in group B, it was 2.8 ± 0.70 days, with nonsignificant *P* value of 0.788. There were no major postoperative complications (Tables 3–5).

Follow-up

The follow-up period for all patients was 18 months, with follow-up at first, third, sixth, 12th and 18th month postoperatively (Figs 7–9). At first month, there was observed dysphagia in both groups; dysphagia score for group A was 2.22±.55, whereas for group B was 2.33±.6, with nonsignificant *P* value of 0.563.

At third month, there was significant difference in dysphagia score, being more in group B (2.33 ± 2.48) than in group A (1.5 ± 0.61), with *P* value less than 0.001. A total of seven patients in group B and one patient in group A experienced severe dysphagia that required upper endoscopy with planned esophageal dilatation.

At sixth month, upper endoscopy was done for all patients. Group A showed regression of Barrett mucosa in 12 patients and persistence of Barrett mucosa with the same length as measured preoperatively in six patients; biopsy showed no dysplasia. Recurrence was observed in one patient with newly developed Barrett islands in group B, with no dysplasia after biopsy. After revision of preoperative data of this patient, he had long-segment Barrett mucosa, and recurrence occurred mostly owing to incomplete resection of whole mucosa. Another session of EMR was needed to resect the newly developed lesion after fair results of manometry

Table 2 Patients' demographic data and perioperative parameters

	Group A (*N*=18)	Group B (*N*=18)	*P* value
Male	10	12	0.494
Female	8	6	
Age	49.5 ± 7.59	47.89 ± 8.34	0.548
Smoking (Y/N)	6	7	0.728
History of alcoholism (Y/N)	2	1	0.546
Diabetes (Y/N)	6	4	0.456
Preoperative use of PPI (Y/N)	15	12	0.248
Preoperative pH study	24.61 ± 2.15	22.67 ± 3.82	0.068
Median (IQR)			
Esophagitis [*n* (%)]	5	4	0.700
Manometry			
LES resting pressure (mmHg)	10.88 ± 1.14	10.72 ± 1.27	0.712
Abnormal peristalsis [*n* (%)]	3	2	0.629
Effective clearance, % (mean±SD) (s)	91.72 ± 8.33	92.28 ± 7.1	0.826
Hiatus hernia	11/8	10/8	0.899
<2 cm	7	8	
3 cm	3	2	
>3 cm	1	0	
Length of Barrett			
1–3 cm	12	13	0.962
3–6 cm	6	5	
Dysphagia score	1.5 ± 0.7	1.44 ± 0.7	0.815
Regurgitation score	2.05 ± 0.64	2.33 ± 0.48	0.151
Heart burn score	2 ± 0.48	2.11 ± 0.58	0.538
Global score	5.55 ± 1.2	5.89 ± 1.18	0.400

IQR, interquartile range; LES, lower esophageal sphincter; N, No; PPI, proton pump inhibitor; Y, yes.

Table 3 Postoperative parameters

	Group A (*N*=18)	Group B (*N*=18)	*P* value
OR time	104 ± 12.8	106 ± 15.3	0.674
Hospital stay	2.5 ± 0.62	2.8 ± 0.70	0.788
Mean dysphagia score	1.72 ± 0.46	2.11 ± 0.47	0.017
Mean regurgitation score	0.556 ± 0.62	0.944 ± 0.72	0.092
Mean heart burn score	1 ± 0.48	1.11 ± 0.32	0.424
Mean global score	3.28 ± 0.826	4.0 ± 0.84	0.013
Gas bloat	14	13	0.700
Postoperative esophageal dilatation	1	6	0.035

and pH monitoring. Of the seven patients who had dysphagia at third month in group B, three developed recurrent severe dysphagia interfering with their lifestyle that required another session of esophageal dilatation after fair results of manometry.

Table 4 Follow up of Barrett mucosa in group A

Group A (*N*=18)	Regression	Persistence	Progression with dysplasia
6 months	12	6	0
12 months	12	6	0
18 months	12	3	3

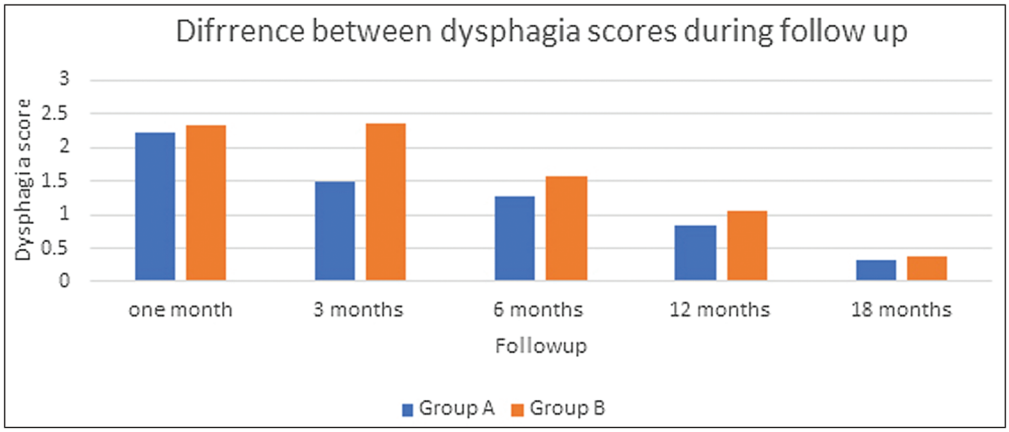
Table 5 Comparison between complete regression of mucosa in group A and no recurrence in group B after 18 months of follow-up

Group A (*N*=18)	Group B (*N*=18)	*P* value
12	17	0.035

At 12th month, upper endoscopy showed the same results observed in the third month in both groups regarding BE. Persistence of Barrett mucosa was seen in the same six patients in group A with no progression and no dysplasia after biopsy. No cases with severe dysphagia were observed.

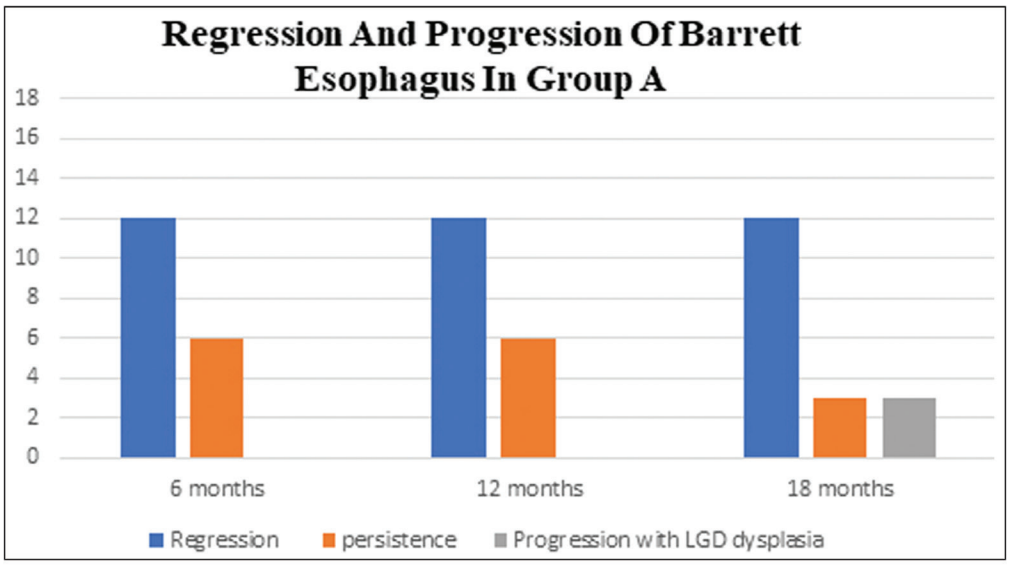
At 18th month, follow-up upper endoscopy was done. In group A, the same 12 patients who showed complete regression of Barrett mucosa in the previous endoscopic follow-up still had complete regression. Of the six patients who had a stationary course, three showed persistent Barrett mucosa with the same length measured preoperatively, with intestinal metaplasia with no dysplastic change after biopsy and histopathology. However, the other three patients developed new islands of Barrett mucosa, with progression in the

Figure 7



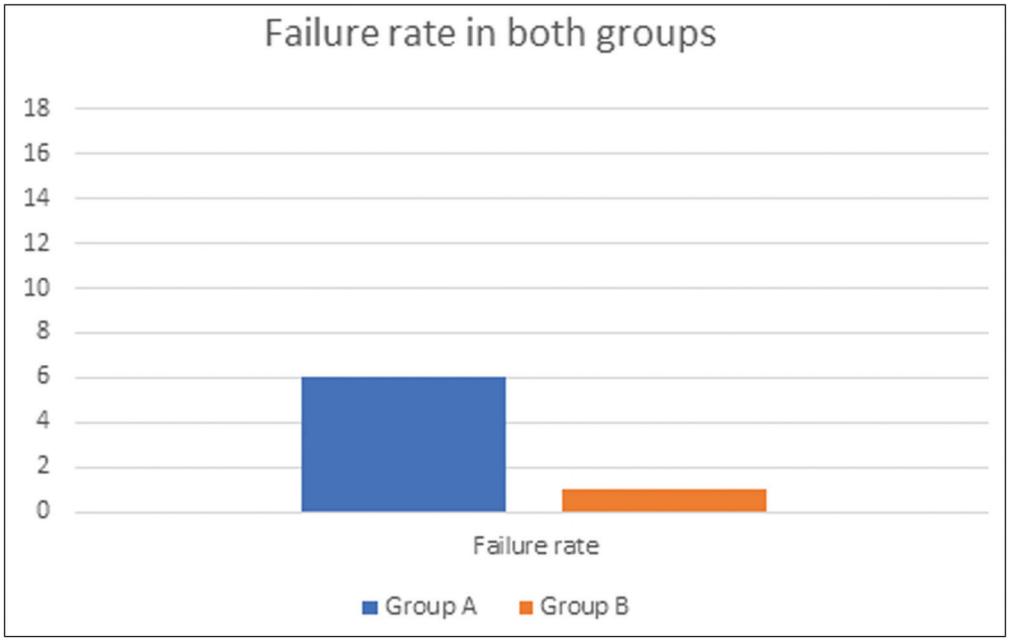
Difference between mean dysphagia scores during follow-up.

Figure 8



Endoscopic findings in group A during follow-up.

Figure 9



Failure rate in both groups.

length of Barrett segment. After biopsy was taken, the three patients showed low-grade dysplasia (LGD). No patients had recurrence in group B. For the six patients in group A who failed to achieve complete regression after the planned follow-up period, HRM and pH monitoring were redone. The preoperative data were revised, and all of them had long-segment Barrett. The six patients had relatively normal values of LES pressure, and pH monitoring and EMR were done for them.

The mean scores for postoperative regurgitation and heart burn during follow-up were insignificant in both groups, with *P* values of 0.092 and 0.424, respectively. The mean postoperative dysphagia score and global score during the whole study was significant between both groups, with a *P* value of 0.017 and 0.013. Both groups experienced postoperative gas bloat symptom, with nonsignificant *P* value of 0.700.

Discussion

BE is a complication of long-standing gastroesophageal reflux, resulting in the replacement of the normal squamous lining of the distal esophagus by columnar epithelium containing specialized intestinal metaplasia [10].

When one thinks about the perfect solution for the patients with BE, consideration must be taken upon solving not only the consequence but also the cause [11].

The risk of adenocarcinoma developing in a patient with uncomplicated BE (intestinal metaplasia of the esophagus) has been estimated to be about four per 1000 patient-years [12]. If BE is complicated by high-grade dysplasia, then the risk of cancer increases about 10 folds [13]. The goal of treatment in patients with BE is to obtain a complete regression of this precancerous condition [14].

To the best of our knowledge, no previous literature studies had assessed the effect of antireflux surgery preceded by EMR on the complete eradication of intestinal metaplasia (CE-IM) in patients with BE.

The aim of our study was to assess the efficacy of Nissen fundoplication in complete regression of Barrett metaplasia compared with itself with adding preoperative eradication of Barrett mucosa using EMR technique. The study was conducted on 36 patients, with 18 patients in each group. Results of postoperative endoscopic findings and rate of stricture formation leading to dysphagia were charted.

Regarding postoperative endoscopic findings after 18 months of follow-up, we experienced 12 (66.7%) patients succeeded to obtain complete regression of Barrett mucosa and six (33.3%) patients failed to achieve complete regression of Barrett mucosa after LNF alone (Table 4), whereas 17 (94.5%) patients had no newly developed Barrett mucosa and one (5.5%) patient detected with recurrence of Barrett mucosa in combined LNF and EMR (Table 5). Overall,

three (16.7%) patients in group A developed LGD. All seven (19.4%) patients who failed to achieve the goal of complete eradication of Barrett in both groups had preoperative long-segment Barrett with nearly equal preoperative parameters, keeping in mind the decreased rate of failure in EMR+LNF owing to the dual effect on Barrett mucosa and the role of EMR in eradication of intestinal metaplasia by resecting the diseased mucosa.

LNF has been considered as more effective than medical treatment for preventing cancer in BE. However, long-term follow-up after fundoplication alone in patients with BE is unsatisfactory, and detection of LGD should become the current aim of inspection [15].

The role of LNF in regression of BE has been discussed in many literature studies. Gurski *et al.* [16], Oelschlager *et al.* [17], and others have obtained histologic regression of Barrett's epithelium in approximately one-third of the patients after successful antireflux surgery.

Sharma *et al.* [18] have published an interesting paper on the effect of different treatments including antireflux surgeries on the natural history of LGD. They defined the outcome of patients with LGD, reporting 42% of regression to nondysplastic intestinal metaplasia after at least 1 year of follow-up, with an incidence of cancer of 0.6% for year, in accordance with the 0.2–1.9% reported in the literature.

A study done by Bamehriz *et al.* [19] confirms the finding that LNF resulted in complete loss of intestinal metaplasia in eight (38%) of 21 patients and partial regression in one patient.

The role of LNF in BE is prevention of esophageal exposure to carcinogenic bile and acid reflux, which seems to be most effective in patients with short-segment BE [19]. The relation between success rate of LNF and the length of Barrett was discussed in the study done by Bowers *et al.* [20]. They reported that patients with short-segment (<3 cm) BE were more likely to have regression of Barrett's segment after antireflux surgery than those with long-segment (>3 cm) disease. EMR is a new modality, offering good results in managing Barrett mucosa with low rate of recurrence and complications in experienced endoscopist hand [8]. Most of the literature studies describe the role of EMR as monotherapy or combined with other EET, such as RFA and argon plasma coagulation. Few studies explain the role of EMR after failure of antireflux surgeries. Lopes *et al.* [21] and Pouw *et al.* [22] reported neoplasia recurrences after EMR for BE with high-grade dysplasia and early malignancy in 12% (five of 41) and 9% (three of 34) over the courses of their respective surveillance periods. Manner *et al.* [23] characterized a subset of 21 patients with 'low-risk' submucosal invasion after endoscopic resection for early Barrett's carcinoma and followed them up over a mean period of 62 months and found recurrent cancer in 28%.

Skrobic *et al.* [24] performed endoscopic procedures after laparoscopic fundoplication in 56 patients with BE. Complete endoscopic resolution of BE was observed in 83.92% of patients (86.84% IM and 77.77% LGD). Likewise, Komanduri *et al.* [25] aimed to determine the effectiveness and durability of EET under a structured reflux management protocol. Of 221 patients enrolled, an overall CE-IM of 93% was achieved within 11.6 ± 10.2 months.

In 2015, Johnson *et al.* [26] performed a multi-institutional retrospective review of patients undergoing endotherapy followed by Nissen fundoplication. A total of 49 patients underwent RFA±EMR followed by Nissen fundoplication. The rate of complete remission of dysplasia was 62.5%.

In our study, we considered the high rate of recurrence in LNF group was attributed to the persistence of preoperative risk factors like obesity, smoking, male sex, and long-segment Barrett. Results from our study also emphasize the importance of keeping patients in surveillance programs after achieving CE-IM, being consistent with recent reports [27–29].

Regarding our rate of stricture formation and dysphagia, we noticed that the incidence of dysphagia increased in EMR and LNF group in comparison with LNF alone. The highest incidence of significance was after 3 months of procedure (Table 6 and Fig. 8), as seven (38.8%) patients had severe dysphagia in EMR+LNF group, whereas one (5.5%) patient in LNF group. They required endoscopic dilatation. Of the previous seven patients in EMR+LNF group, three returned after 3 months with recurred symptoms of severe dysphagia and needed another session of endoscopic dilatation.

The increased incidence of dysphagia in our study in combined EMR+LNF was reported by Lewis *et al.* [30]. They demonstrated that resection of at least 50% of the esophageal mucosal circumference was reported to be strongly associated with stricture formation by a retrospective analysis of EMR monotherapy for BE.

Table 6 Dysphagia scores during follow-up

	Group A (*N*=18)	Group B (*N*=18)	*P* value
Dysphagia at 1 month			
Mean±SD	2.22±0.55	2.33±0.60	
Mild	1	1	0.563
Moderate	12	10	
Severe	5	7	
Dysphagia at 3 months			
Mean±SD	1.5±0.61	2.33±0.48	
Mild	9	1	<0.001
Moderate	8	10	
Severe	1	7	
Dysphagia at 6 months			
Mean±SD	1.28±0.46	1.56±0.78	
Mild	13	11	0.203
Moderate	5	4	
Severe	0	3	
Dysphagia at 12 months			
Mean±SD	0.83±0.54	1.05±0.64	
Mild	17	11	0.258
Moderate	1	4	
Severe	0	0	
Dysphagia at 18 months			
Mean±SD	0.33±0.49	0.39±0.0.608	
Mild	3	5	0.763
Moderate	0	1	
Severe	0	0	

Moreover, Chennat *et al.* [31] presented a large study on EMR of BE with curative intent and reported higher rates of symptomatic stenosis.

Alvarez *et al.* [32] reported the rate of symptomatic stenosis in both the focal EMR group (average of two resections per EMR procedure) and the (stepwise) radical EMR group (average of five resections per EMR procedure). No symptomatic stenosis occurred in the focal EMR cohort, whereas 48% of patients in the radical EMR cohort developed symptomatic stenosis.

The short-term incidence of dysphagia we experienced after LNF was also emphasized by Khan *et al.* [33], as they reported a risk of short-term dysphagia in 10–40% following Nissen fundoplication.

In a study done by Zilberstein *et al.* [34], dysphagia symptom was intermittent and tended to disappear within 30 days after the procedure, without the need for specific or new intervention.

In our study, the finding of increased incidence of dysphagia in EMR+LNF group seemed to be owing to excessive scarring at the lower end of the esophagus, which was resolved by esophageal dilatation. The low incidence of dysphagia occurred with LNF alone may be owing to proper selection of patients, HRM, and doing wrap over bougie (36 Fr).

Conclusion

EMR done before Nissen's Fundoplication is a safe modality, with higher rate of success compared with Nissen's fundoplication alone in complete eradication of Barrett mucosa in symptomatic patients with GERD, especially those with long-segment BE. Close follow-up for patients with Barrett is mandatory for early diagnosis of any dysplasia or malignant transformation.

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