# Five-Year Outcomes of Laparoscopic Hiatal Hernia Repair With Dor Fundoplication Versus Endoscopic Microcurrent Radiofrequency for Gastroesophageal Reflux Disease: A Retrospective Cohort Study

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AIM: This study aims to compare the long-term efficacy of laparoscopic hiatal hernia repair with Dor fundoplication (LHRF) and endoscopic microcurrent radiofrequency (EMRF) in the treatment of Gastroesophageal Reflux Disease (GERD).

METHODS: This study retrospectively analyzed 340 patients who underwent LHRF and EMRF treatment at our hospital between January 2016 and January 2019. Of these, 160 patients underwent LHRF (surgical group), and 180 patients underwent EMRF (endoscopic group). Baseline information, Gastroesophageal Reflux Disease Health-Related Quality of Life (GERD-HRQL) scores, proton pump inhibitor (PPI) use, patient satisfaction, complications, reintervention rates, and other clinical data of both groups were collected and compared.

RESULTS: At 6 months after treatment, GERD-HRQL scores were markedly reduced compared with baseline in both groups. Repeated-measures analysis of variance (ANOVA) demonstrated significant effects of group, time, and group $\times$ time interaction (all $p < 0.001$). Over the 5-year follow-up period, GERD-HRQL scores remained consistently lower in the surgical group, whereas scores in the endoscopic group showed a gradual increase from the third postoperative year onward. Regarding PPI use, the discontinuation rate was significantly higher in the surgical group than in the endoscopic group at 6 months ($p = 0.028$), 1 year ($p = 0.027$), 3 years ($p = 0.021$), and 5 years ($p = 0.017$). Patient satisfaction scores were also significantly higher in the surgical group than in the endoscopic group ($p < 0.001$). In addition, the surgical group experienced nine complications, predominantly transient dysphagia, while the endoscopic group reported 11 complications, including six cases of transient chest pain and five cases of nausea. The difference in overall postoperative complication rates between the two groups was not statistically significant ($\chi^2 = 0.238$, $p = 0.626$). Regarding reintervention, three patients in the surgical group (4.76%) required further treatment, mainly due to wrap disruption. In the endoscopic group, five patients underwent reintervention: two cases of EMRF failures required LHRF, and three required repeat EMRF. The difference in reintervention rates between the two groups was not statistically significant ($\chi^2 = 0.133$, $p = 0.715$).

CONCLUSIONS: LHRF demonstrates clear clinical benefits and long-term efficacy in the treatment of GERD, providing evidence to inform the selection of surgical approaches and overall clinical treatment strategies.

**Keywords:** Gastroesophageal Reflux Disease; laparoscopic hiatal hernia repair; Dor fundoplication; endoscopic microcurrent radiofrequency; long-term efficacy

## Introduction

Gastroesophageal Reflux Disease (GERD) is a digestive disorder characterized by the reflux of gastric and duodenal contents into the esophagus, oral cavity, or lungs, and causes symptoms or complications [1]. It is a common upper gastrointestinal disorder that primarily presents with symptoms such as acid regurgitation, heartburn, and substernal pain [2]. Abnormal pressure at the gastroesophageal junction and lower esophageal sphincter caused by hiatal hernia is currently regarded as a crucial pathogenic factor of GERD [3]. Hiatal hernia is prevalent across Western countries, with an estimated incidence of approximately 18.1–27.8% [4]. In comparison, the reported incidence rate of GERD is 51.2% in Greece [5] and 3.1% in China [6]. The three primary clinical treatment approaches for GERD are (1) pharmacological therapy, (2) surgical intervention, and (3) endoscopic treatment. However, pharmacological therapy is limited by the less-than-satisfactory efficacy [7] and the elevated risk of complications attributable to long-term use, such as chronic atrophic gastritis and intestinal infections [8]. Therefore, surgical treatment is gaining traction as a suitable management approach for GERD.

Laparoscopic fundoplication is a traditional surgical approach for GERD and has become the "gold standard" for its management [9,10]. Utilization of laparoscopic Dor fundoplication can minimize the incidence of postoperative complications, such as dysphagia and bloating [11]. Laparoscopic hiatal hernia repair is a minimally invasive procedure that restores the anatomical structure of the di-

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aphragmatic hiatus and enhances the anti-reflux effect when combined with fundoplication [12]. Despite the effectiveness of the surgical approach in reflux symptoms control, the emergence of minimally invasive endoscopic microcurrent radiofrequency (EMRF) procedure has garnered the attention of the clinical communities, and this technique has been increasingly used in GERD treatment [13,14]. The EMRF procedure remodels the muscle structure of the lower esophageal sphincter (LES) and reduces its compliance, thereby decreasing transient LES relaxations. In addition to being minimally invasive, EMRF is lauded for its ease of operation and the proven long-term efficacy for GERD [15,16]. Liu *et al*. [17] reported that EMRF treatment for GERD not only alleviates reflux esophagitis but also reduces the incidence of complications. Particularly, EMRF demonstrates superior efficacy in protecting muscular layer and mucosa from injury, but its anti-reflux effect is inferior to that of fundoplication [18]. Although several studies have been conducted, the long-term efficacy of laparoscopic hiatal hernia repair with Dor fundoplication (LHRF) versus EMRF for treating GERD remains controversial. Therefore, a comparative long-term efficacy evaluation of LHRF versus EMRF for the treatment of GERD is warranted.

This study retrospectively evaluates the long-term efficacy of LHRF and EMRF in the treatment of GERD by analyzing patients' baseline characteristics, Gastroesophageal Reflux Disease Health-Related Quality of Life (GERD-HRQL) scores, proton pump inhibitor (PPI) use, patient satisfaction, complications, and reintervention rates. The findings aim to inform the selection of surgical approaches and guide clinical treatment strategies for GERD.

## Methods

*Study Subjects*

This study retrospectively analyzed the clinical data of 340 patients with GERD treated at PLA Rocket Force Characteristic Medical Center between January 2016 and January 2019. The inclusion criteria were: (1) age 18–80 years; (2) chronic GERD symptoms (>6 months); and (3) objective evidence of GERD, defined as abnormal 24-hour pH monitoring and/or erosive esophagitis on endoscopy. The exclusion criteria were: (1) previous gastric or esophageal surgery; (2) severe cardiopulmonary disease precluding surgery; (3) Barrett's esophagus with dysplasia or esophageal carcinoma; (4) paraesophageal hernia; and (5) severe esophageal dysmotility. The inclusion and exclusion criteria were applied to all eligible patients before final enrollment in the study.

Depending on the treatment type, the sample was divided into the surgical group that received LHRF ($n = 160$) and the endoscopic group that received EMRF ($n = 180$). Follow-up data were collected through scheduled outpatient visits and review of the hospital electronic medical records. When necessary, additional information was obtained by telephone contact. Five-year outcome data were successfully obtained for all included patients, and no patients were lost to follow-up for the primary outcome assessment.

All patients provided informed consent for the surgical plan. The study was approved by Ethics Review Committee of PLA Rocket Force Characteristic Medical Center (No. KY2023028).

*Surgical Methods*

Laparoscopic Hiatal Hernia Repair With Dor Fundoplication

The herniated stomach was first reduced into the abdominal cavity. An ultrasonic scalpel was then used to mobilize the left triangular ligament and the extrahepatic left lobe of the liver, and to divide the esophageal and hepatogastric ligaments, while carefully avoiding injury to the vagal branches and the esophageal wall. The lower esophagus, the diaphragmatic crura adjacent to the cardia, and the fundus were fully exposed, leaving a 3 cm space. A drain was placed and looped once around the esophagus, then gently tightened to retract the distal esophagus downward and to the left, allowing full visualization of both crura. The crura were shortened and sutured to reduce the esophageal hiatus, leaving a 1.5 cm gap between the final stitch and the esophagus. For the hernia ring that exceeded 5 cm, a tension-free mesh repair was performed, ensuring the mesh overlapped the hernia margins by about 2 cm and was secured with a hernia fixation device. In Dor fundoplication, the fundus was fully mobilized and wrapped from the left side of the esophagus to its anterior aspect, creating a 180° wrap of the esophagus. Interrupted sutures (2–3 stitches) were placed between the fundal edge and the right diaphragmatic crus. At the end of the procedure, based on the patient's coagulation status and overall clinical condition, an intra-abdominal drain was placed beneath the left lobe of the liver and brought out through a subcostal incision along the left anterior axillary line.

Endoscopic Microcurrent Radiofrequency

The patient was positioned in the left lateral position. One electrode pad was placed on the right buttock and connected to the Stretta radiofrequency generator (MER-200GA, Harbin Meidun Medical Equipment Co., Ltd., Harbin, China). Using the gastroscope, the distance from the incisors to the squamocolumnar junction (Z-line) was measured. A guidewire was introduced through the gastroscope biopsy channel and advanced into the duodenum, after which the gastroscope was withdrawn. The radiofrequency catheter was then advanced into the esophagus using the guidewire, which was then removed. The treatment planes and number of applications were determined as follows: planes were selected at 2.0, 1.5, 1.0, and 0.5 cm above the Z-line; at the Z-line; and at 0.5, 1.0, and 1.5 cm below the Z-line. Each plane was treated twice at 0° and twice after a 45° rotation. The balloon catheter was then

positioned at the selected planes, inflated to the appropriate pressure, and the electrode needles were deployed by operating the switch on the radiofrequency catheter handle, allowing them to penetrate the esophageal wall. After confirming electrode impedance values on the radiofrequency generator display, the generator was activated. The radiofrequency tip temperature was set to 85 °C, while ensuring the mucosal surface temperature did not exceed 45 °C. The mucosa was cooled and protected by a precooled water flush system, and treatment was automatically stopped if temperature or impedance exceeded the normal range. Each application lasted 60 s. After the procedure, patients were allowed to take a liquid diet 6 hours postoperatively and could resume normal activities as tolerated.

### *Data Collection*

The following clinical data were collected: patients' age, sex, duration of GERD, and other baseline information. Outcomes assessed included GERD-HRQL scores, PPI use, patient satisfaction, complications, and reintervention rates. Postoperative complications included transient dysphagia, defined as an intermittent sensation of food obstruction or delayed esophageal passage resolving within 3 months without requiring intervention. Reintervention was defined as any additional surgical or endoscopic procedure required due to recurrent or persistent GERD symptoms. In the LHRF group, this included radiologically or endoscopically confirmed wrap disruption. In the EMRF group, treatment failure was defined as persistent GERD symptoms requiring continued proton pump inhibitor (PPI) therapy or additional intervention. This study used the original 9-item GERD-HRQL scale developed by Velanovich *et al.* [19]. Each item was scored from 0 to 5, with a total score ranging from 0 to 45; lower scores indicate better quality of life. This instrument covers the following aspects: severity of heartburn; severity of heartburn when lying down or standing; postprandial heartburn severity; dietary changes caused by heartburn symptoms; impact of heartburn on sleep; difficulty swallowing; whether swallowing causes pain; and the effect of medication on daily life. Each item is rated from 0 to 5 points based on its degree (0 = no symptoms; 1 = symptoms noticeable, but not bothersome; 2 = symptoms noticeable and bothersome, but not every day; 3 = symptoms bothersome every day; 4 = symptoms affect daily activities; 5 = symptoms are incapacitating, unable to do daily activities). Lower scores indicate better quality of life. The overall satisfaction score for the surgical outcome was rated from 0 (dissatisfied) to 10 (satisfied), with higher scores indicating greater satisfaction.

### *Statistical Analysis*

This statistical analysis was conducted using the SPSS 23.0 version software (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was employed to assess the normal distribution of continuous variables. All the inter-group comparisons of the measurement data were subjected to normality assessments. Normally distributed data were analyzed using the independent samples $t$-test, while those that did not conform to the normal distribution were analyzed using the Mann–Whitney $U$ test. Normally distributed data are expressed as mean $\pm$ standard deviation (SD), while those that do not follow a normal distribution are represented by median and interquartile range (M [Q1, Q3]). Expressed as counts and percentages, data of categorical variables were compared using the chi-squared test. The comparison of repeated measurement data was conducted using two-factor repeated measures analysis of variance (ANOVA). The Kaplan–Meier method and log–rank test were used to analyze the recurrence rate of symptoms. Propensity score matching (PSM) was performed to minimize the effect of potential confounders. Confounders, as presented in Table 1, along with baseline imbalanced variables, were used to calculate the propensity scores. Matching was conducted at a ratio of 1:1 using a caliper width of 0.2 standard deviations of the logit of the propensity score. Symptom recurrence was analyzed using Kaplan–Meier curves, and the comparisons were conducted using the log-rank test. A $p$-value $< 0.05$ was considered statistically significant.

## Results

### *Baseline Characteristics Before and After PSM*

The study enrolled 340 patients in total, with 160 in the surgical group and 180 in the endoscopic group. There were no significant differences between the two groups in terms of sex, age, body mass index (BMI), duration of GERD, LES pressure, GERD-HRQL scores, or daily PPI use ($p > 0.05$). The size of hiatal hernia in the surgical group was significantly larger than that in the endoscopic group ($p < 0.001$). The baseline characteristics of the two groups before PSM are shown in Table 1. After PSM, the surgical and endoscopic groups each included 63 patients, with all baseline characteristics well-balanced (Table 2).

### *Follow-up Results*

All 126 patients in the two groups were followed for up to 5 years. In the surgical group, quality of life steadily improved over the 5-year postoperative period. However, in the endoscopic group, GERD-HRQL scores began to rise from year 3 onward, indicating a gradual decline in quality of life (time $\times$ group interaction, $p < 0.001$) (Table 3). Fig. 1 shows that quality of life in the surgical group remained significantly higher than in the endoscopic group over a 5-year follow-up period, while the endoscopic group experienced gradual deterioration starting from the third year. Regarding the use of PPI, the discontinuation rate in the surgical group was significantly higher than that in the endoscopic group at 6 months, 1 year, 3 years and 5 years after the treatment ($p < 0.05$) (Table 4). Patient satisfaction scores were also significantly higher in the surgical group than in the endoscopic group ($p < 0.001$) (Ta-

**Table 1. Comparison of baseline characteristics between the two groups before PSM.**

| Index | Surgical group ($n$ = 160) | Endoscopic group ($n$ = 180) | $\chi^2$/$t$/z | $p$ |
|---|---|---|---|---|
| Sex (male/female) | 75/85 | 85/95 | 0.004 | 0.949 |
| Age (years) | 54.80 ± 6.16 | 54.42 ± 6.29 | 0.561 | 0.575 |
| BMI (kg/m$^2$) | 25.05 ± 2.18 | 25.40 ± 2.35 | 1.420 | 0.157 |
| Duration of GERD (years) | 5.00 ± 1.02 | 5.20 ± 1.50 | 1.452 | 0.148 |
| LES pressure (mmHg) | 7.70 ± 2.10 | 7.50 ± 2.30 | 0.834 | 0.405 |
| Hiatal hernia (cm) | 1.70 (1.10, 2.12) | 0.90 (0.70, 1.10) | –12.178 | <0.001 |
| GERD-HRQL scores | 30.51 ± 3.59 | 31.22 ± 5.52 | 1.422 | 0.156 |
| Daily PPI use [n (%)] | 155 (96.88%) | 172 (95.56%) | 0.401 | 0.527 |

Abbreviations: BMI, body mass index; GERD, Gastroesophageal Reflux Disease; GERD-HRQL, Gastroesophageal Reflux Disease Health-Related Quality of Life; LES, lower esophageal sphincter; PPI, proton pump inhibitor; PSM, propensity score matching.

**Table 2. Comparison of baseline characteristics between the two groups after PSM.**

| Index | Surgical group ($n$ = 63) | Endoscopic group ($n$ = 63) | $\chi^2$/$t$/z | $p$ |
|---|---|---|---|---|
| Sex (male/female) | 36/27 | 36/27 | 0.000 | 1.000 |
| Age (years) | 55.93 ± 6.48 | 54.33 ± 5.76 | 1.469 | 0.144 |
| BMI (kg/m$^2$) | 24.96 ± 1.96 | 25.55 ± 2.06 | 1.645 | 0.103 |
| Duration of GERD (years) | 4.98 ± 1.11 | 5.30 ± 1.52 | 1.357 | 0.177 |
| LES pressure (mmHg) | 7.73 ± 2.06 | 7.62 ± 2.32 | 0.274 | 0.784 |
| Hiatal hernia (cm) | 1.10 (1.00, 1.10) | 1.10 (1.00, 1.15) | –0.159 | 0.873 |
| GERD-HRQL scores | 30.84 ± 3.41 | 30.97 ± 5.79 | 0.150 | 0.881 |
| Daily PPI use [n (%)] | 60 (95.24%) | 59 (93.65%) | 0.000 | 1.000 |

ble 5). In addition, in terms of complications, nine patients (14.29%) in the surgical group experienced adverse events, primarily transient dysphagia, whereas 11 patients in the endoscopic group reported complications, including six with transient chest pain and five with nausea. The difference in overall postoperative complication rates between the two groups was not statistically significant ($\chi^2$ = 0.238, $p$ = 0.626) (Table 6). Regarding reintervention, three patients (4.76%) in the surgical group required additional treatment, mainly due to wrap disruption. In the endoscopic group, five patients underwent reintervention, including two cases of EMRF failure requiring LHRF and three cases requiring repeat EMRF. The difference in reintervention rates between the two groups was not statistically significant ($\chi^2$ = 0.133, $p$ = 0.715) (Table 7). Symptom recurrence also did not differ significantly between the two groups ($p$ = 0.994) (Fig. 2).

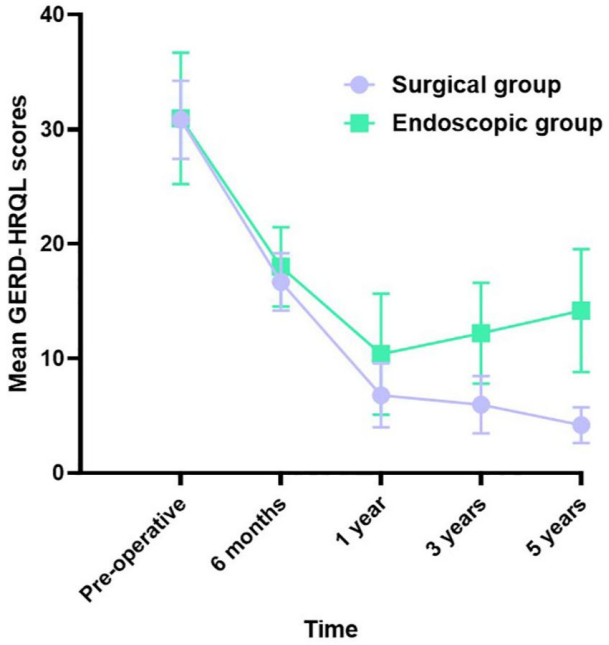


**Fig. 1. Changes in GERD-HRQL scores over the 5-year follow-up period in the two groups.** Note: The data are presented as the mean ± standard deviation at each follow-up time point (preoperatively, as well as 6 months, 1 year, 3 years, and 5 years postoperatively). Abbreviation: GERD-HRQL, Gastroesophageal Reflux Disease Health-Related Quality of Life.

## Discussion

GERD is a clinically prevalent gastrointestinal disorder, and its pathogenesis is associated with impairment of the esophageal mucosal barrier, relaxation and dysfunction of the lower esophageal sphincter. It mainly presents with heartburn and acid regurgitation; in severe cases, dysphagia may occur, significantly impacting patients' daily lives [20]. Because of its chronic course and recurrent symptoms, which severely reduce patients' quality of life, GERD is regarded as an important public health issue and one of the current focal and hotspot topics in gastroenterology.

**Table 3. Comparison of GERD-HRQL scores between the two groups at various time points before and after treatment.**

| Groups | GERD-HRQL scores | | | | |
|---|---|---|---|---|---|
| | Preoperatively | 6 months postoperatively | 1 year postoperatively | 3 years postoperatively | 5 years postoperatively |
| Surgical group ($n$ = 63) | 30.84 ± 3.41 | 16.68 ± 2.51 | 6.79 ± 2.79 | 5.98 ± 2.50 | 4.19 ± 1.55 |
| Endoscopic group ($n$ = 63) | 30.97 ± 5.79 | 18.00 ± 3.50 | 10.38 ± 5.33 | 12.21 ± 4.41 | 14.19 ± 5.41 |
| $F_{inter\text{-}group}/P_{inter\text{-}group}$ | | | 187.635/<0.001 | | |
| $F_{time}/P_{time}$ | | | 730.082/<0.001 | | |
| $F_{interaction}/P_{interaction}$ | | | 31.227/<0.001 | | |

**Table 4. Comparison of PPI use between the two groups at various time points before and after treatment.**

| | Surgical group ($n$ = 63) | | Endoscopic group ($n$ = 63) | | $\chi^2$ | $p$ |
|---|---|---|---|---|---|---|
| | None | Daily | None | Daily | | |
| Preoperatively | 3 (4.76%) | 60 (95.24%) | 4 (6.35%) | 59 (93.65%) | 0.000 | 1.000 |
| 6 months postoperatively | 15 (23.81%) | 48 (76.19%) | 5 (7.94%) | 58 (92.06%) | 4.814 | 0.028 |
| 1 year postoperatively | 23 (36.51%) | 40 (63.49%) | 11(17.46%) | 52 (82.54%) | 4.874 | 0.027 |
| 3 years postoperatively | 39 (61.90%) | 24 (38.10%) | 25 (39.68%) | 38 (60.32%) | 5.366 | 0.021 |
| 5 years postoperatively | 58 (92.06%) | 5 (7.94%) | 47 (74.60%) | 16 (25.40%) | 5.714 | 0.017 |

**Table 5. Comparison of postoperative satisfaction scores between the two groups.**

| | Surgical group ($n$ = 63) | Endoscopic group ($n$ = 63) | $t$ | $p$ |
|---|---|---|---|---|
| Satisfaction scores | 8.16 ± 1.55 | 6.54 ± 1.89 | 5.260 | <0.001 |

**Table 6. Comparison of postoperative complications between the two groups.**

| Groups | $n$ | Complications | | | Any complication (yes/no) |
|---|---|---|---|---|---|
| | | Transient dysphagia | Transient chest pain | Nausea | |
| Surgical group | 63 | 9 (14.29%) | 0 (0.00%) | 0 (0.00%) | 9/54 |
| Endoscopic group | 63 | 0 (0.00%) | 6 (9.52%) | 5 (7.94%) | 11/52 |
| $\chi^2$ | | | | | 0.238 |
| $p$ | | | | | 0.626 |

**Table 7. Comparison of postoperative reintervention between the two groups.**

| Groups | $n$ | Reintervention | | | Any reintervention (yes/no) |
|---|---|---|---|---|---|
| | | Wrap disruption | EMRF treatment failure + LHRF | Repeat EMRF | |
| Surgical group | 63 | 3 (4.76%) | 0 (0.00%) | 0 (0.00%) | 3/60 |
| Endoscopic group | 63 | 0 (0.00%) | 2 (3.17%) | 3 (4.76%) | 5/58 |
| $\chi^2$ | | | | | 0.133 |
| $p$ | | | | | 0.715 |

Abbreviations: EMRF, endoscopic microcurrent radiofrequency; LHRF, laparoscopic hiatal hernia repair with Dor fundoplication.

With ever-evolving lifestyle-related habits and dietary patterns, the incidence of this condition has risen steadily, and in clinical practice, management in most patients cannot be satisfactorily achieved with medication alone. A follow-up study showed that most patients with chronic GERD experienced symptomatic improvement after two years of drug therapy [21]. However, clinical experience shows that even with daily PPI use, some GERD patients continue to suffer from persistent reflux symptoms. Therefore, surgical intervention and endoscopic Stretta radiofrequency treatment are important options for GERD patients. Because studies on the efficacy and long-term outcomes of LHRF versus EMRF remain scarce, we conducted a comparative study of these two methods in GERD patients.

Sui *et al*. [22] demonstrated that the utilization of endoscopic Stretta radiofrequency was accompanied by a reduction in the GERD-HRQL scores and improved quality of life in patients with GERD. Nasr *et al*. [23] revealed that laparoscopic hiatal hernia repair with fundoplication can be used to manage hiatal hernias and alleviate symptoms or complications associated with GERD. Our study showed that at 6 months postoperatively, both the surgical and endoscopic groups experienced marked reductions in GERD-HRQL scores, as well as improvements in quality of life. Moreover, patients in the surgical group continued to experience quality-of-life gains over the subsequent 5 years, whereas GERD-HRQL scores of the endoscopic group began to rise from the third year postopera-

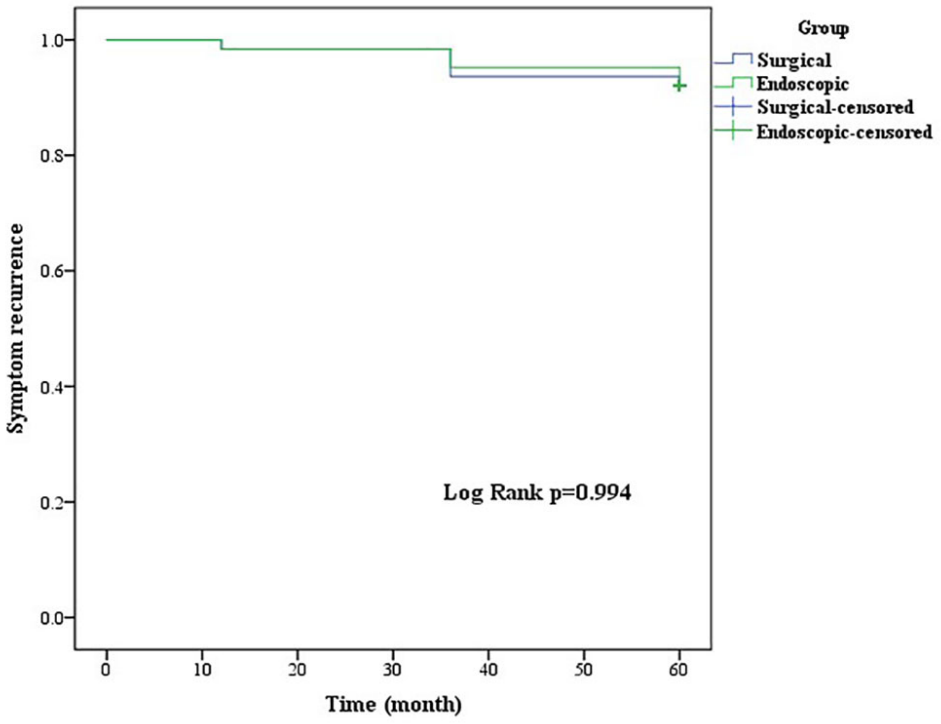


**Fig. 2. Kaplan–Meier curves of time to symptom recurrence in the surgical and endoscopic groups.**

tively, indicating a gradual decline in the subjects' quality of life. The efficacy of EMRF declined after 3 years, possibly due to the loss of collagen remodeling and attenuation of LES stiffening. By contrast, LHRF appears to offer more durable outcomes, likely owing to the anatomical reconstruction of the hiatus and the stability conferred by the suture band. These findings indicate that for patients seeking long-term symptom relief, especially those with hiatal hernia, LHRF may represent the more reliable therapeutic option. LHRF offers several advantages, including enhanced imaging visualization, excellent illumination, and high-resolution identification of vascular and neural structures, allowing precise operation within narrow, confined spaces. Intraoperatively, the hiatus can be repaired according to its size, leaving a 1.5-cm space around the esophagus to ensure postoperative esophageal patency [24,25]. The Dor procedure involves a 180° fundic wrap, does not require division of the short gastric (fundal) vessels, and preserves small branches of the vagus nerve as much as possible. This approach has a minimal impact on surrounding anatomical structures and more closely preserves normal physiological anatomy [26,27].

The PPI discontinuation rate is an objective and significant indicator for evaluating the efficacy of anti-reflux treatment. After endoscopic radiofrequency treatment, patients' PPI use decreased, and satisfaction at 6 and 12 months postoperatively reached 92.59% and 96.30%, respectively [17]. Contrary to earlier findings, a 5-year follow-up showed that, compared with LHRF, EMRF treatment was associated with lower rates of PPI discontinuation and reduced patient satisfaction. Discontinuation of PPI is not merely a change in medication use, but rather represents a substantive control of reflux symptoms. The lower discontinuation rate of PPI in patients receiving the EMRF treatment indicates that a significant proportion of patients still rely on medication to control reflux symptoms during long-term follow-up, consistent with the observed increase in GERD-HRQL scores in this group following the treatment. Patients undergoing LHRF reported significantly higher satisfaction scores, consistent with both GERD-HRQL scores and the PPI discontinuation rates. Patient satisfaction thus provides a comprehensive measure, reflecting the degree of symptom relief, improvements in quality of life, and the overall evaluation of the treatment process.

Advancements in minimally invasive endoscopic technologies have prompted significant improvements in endoscopic radiofrequency therapy and expansion of its range of applications. Under endoscopic guidance, a radiofrequency treatment catheter is inserted into the esophagus and radiofrequency energy is delivered via electrodes to the gastroesophageal junction from multiple angles and directions. The thermal effect promotes collagen proliferation in the lower esophageal sphincter, leading to thickening and increased pressure of the sphincter, while also inactivating vagal nerve receptors, thereby reducing transient LES relaxations and producing an anti-reflux effect [28]. In this

study, the patients treated with EMRF did not experience any reflux complications after the operation. Similarly, the patients who underwent LHRF also did not report any reflux issues. In addition, the results of this study also showed that the incidence of transient dysphagia, transient chest pain, and nausea did not differ significantly between the two groups. However, subjects in the two groups present with different complication profiles: The surgical group receiving LHRF predominantly experienced transient dysphagia, which might be caused by the local stenosis at the repaired hiatus due to the surgery. Generally, no specific treatments are administered as most cases of transient dysphagia may resolve over time. The endoscopic group that received EMRF treatment mainly presented with transient chest pain and nausea, which might be related to the damage during the treatment and the postoperative inflammatory response. The intergroup difference in reintervention rates was also not statistically significant, indicating that both treatment approaches had comparable impacts on complications and the need for reintervention in GERD patients. However, while the overall reintervention rates were similar, the underlying causes and nature of the reintervention were significantly different between the two groups. In the surgical group receiving LHRF, three cases involved wrap disruption. This suggests that, to ensure surgical firmness and durability, careful selection of materials, precise surgical techniques, and early postoperative management to minimize increased abdominal pressure are critical factors in mitigating the risk of reintervention. In the endoscopic group that received EMRF treatment, two patients required LHRF due to treatment failure. This indicates that endoscopic radiofrequency therapy may have limitations in altering the structure and function of the lower esophageal sphincter, especially in patients with large hiatal hernias or severe anatomical abnormalities, where it may be insufficient as a sole therapy. In addition, these two treatment methods are not simply parallel or alternative approaches; rather, they represent distinct therapeutic strategies for different clinical indications.

Although achieving a 100% follow-up rate was relatively rare in longitudinal clinical studies, this research attained it through a single-center design, strict inclusion criteria, and a proactive follow-up strategy. Despite that, several limitations of this study deserve our attention. First, the data were sourced from a single hospital, which may limit the generalizability of the findings. Second, the study employed a retrospective design. Third, the sample size was small, and the range of adverse events assessed was relatively limited. Fourth, the choice of surgical procedure was influenced by patients' anatomical characteristics and personal preferences, introducing potential selection bias, particularly with respect to the incidence of hiatal hernia. Hence, future research should involve multicenter prospective studies, randomized controlled trials, and larger sample sizes to more accurately assess the clinical utility of LHRF and EMRF, thereby ensuring the reliability and scientific rigor of the results and providing guidance for the clinical treatment of GERD.

## Conclusions

Compared with endoscopic microcurrent radiofrequency, LHRF was associated with better long-term GERD-HRQL scores and higher PPI discontinuation rates over the 5-year follow-up period. Although both treatments provided symptom relief in the short term, GERD-HRQL scores in the endoscopic group showed a gradual increase during long-term follow-up. These findings suggest that LHRF may provide more sustained long-term benefits. Further studies are needed to clarify the role of patient selection factors, including the presence of hiatal hernia, in optimizing treatment outcomes. Therefore, our results may provide clinical reference for treatment decision-making in GERD.

## Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

## Author Contributions

FW and YZ designed the research study and wrote the first draft. THL performed the research. YZ and ZWH analyzed the data. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

## Ethics Approval and Consent to Participate

This study has been approved by Ethics Review Committee of PLA Rocket Force Characteristic Medical Center (No. KY2023028) and strictly adheres to the Declaration of Helsinki. The patients included in the study have signed the informed consent form.

## Acknowledgment

Not applicable.

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## Conflict of Interest

The authors declare no conflict of interest.

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