Effect of laparoscopic angle of His reconstruction in the treatment of patients with gastroesophageal reflux disease and hiatal hernia

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Gastroesophageal reflux disease (GERD) is caused by esophageal dysfunction resulting in reflux of gastric and duodenal contents into the esophagus, which leads to a series of symptoms.1 The incidence of GERD in East Asia ranges from 2.5% to 7.8%.2 Hiatal hernia (HH) refers to the upper part of the stomach protruding into the chest through the esophageal hiatus. HH is closely related to GERD and can play a role in the development and increased incidence of GERD.3 The surgical treatment of patients with GERD and HH includes HH repair and Nissen, Toupet, or Dor fundoplication (DF). However, post-operative complications have been associated with fundoplication, including dysphagia and abdominal distension, which reduce the benefit of fundoplication.

To minimize the risk of post-operative complications of fundoplication, we adopted a new anti-reflux operation, namely the angle of His reconstruction (HR) to treat patients with concomitant GERD and HH in this study. The technique of HR was adapted from a previous study where it was used to prevent gastroesophageal reflux in patients with achalasia following Heller myotomy.4 In the present study, a prospective investigation of the anti-reflux efficacy of HR compared with fundoplication was conducted for patients with GERD and HH (age ≥18 years) in the Department of Intervention of the First Affiliated Hospital of Zhengzhou University between November 2012 and February 2019. Patient exclusion criteria were as follows: prior operations of the esophagus or stomach, gastropathy, achalasia, superior mesenteric artery compression, psychiatric disorders, other comorbidities, and pregnancy. The study was registered in the Chinese Clinical Trial Register (No. ChiCTR2000035225), and each patient gave written informed consent before enrollment in the study.

The study design was as follows: each patient completed the reflux diagnostic questionnaire (RDQ), 24-h multichannel intraluminal impedance-pH monitoring, high-resolution manometry, and gastroscopy before surgery. Then, as directed by patient preference, laparoscopic HH repair combined with HR or fundoplication was performed. Operative time, intra-operative blood loss, and length of post-operative hospital stay were recorded. Follow-up evaluation within 1.5 years following surgery included post-operative symptoms and treatment, specifically including patients who were hospitalized for surgical complications. Moreover, at 1.5 years post-operatively, the patients were requested to complete the RDQ again. Finally, the total effective rate (TER) of each type of operation was calculated according to an evaluation standard.5

The surgical technique of laparoscopic HH repair and HR was as follows: under satisfactory general endotracheal anesthesia, the patient was placed in reverse Trendelenburg position with the lower extremities abducted. A Veress needle was inserted close to the ribcage and a pneumoperitoneum was insufflated. A trocar was inserted at the upper border of the umbilicus, and four additional trocars were inserted into the upper abdomen. The liver was retracted, and the hernia contents were withdrawn down into the abdominal cavity. The hepatoepiploic ligament was opened, and the phrenic-esophageal fascia and proximal lesser curvature of the stomach were dissected to expose the diaphragmatic crura and lower esophagus. The hernia sac was repaired using an interrupted suture. The HR was then performed by fixation of the right wall of the lower esophagus to the right crus of the diaphragm and maintaining the length of the abdominal esophagus that was >4 cm. The gastric

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Data were presented as mean with standard deviation, or median (range) for continuous variables, and as number (percentage) for categorical variables. Categorical data were compared using the \(\chi^2\) test. Pre-operative and post-operative-symptom scores were compared using a Wilcoxon signed-rank test. Four-group comparisons were made using a one-way analysis of variance followed by the Bonferroni correction or Kruskal–Wallis test as appropriate. \(P < 0.05\) was deemed statistically significant using IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA).

The study comprised 810 patients, grouped according to the surgical procedure: 30 underwent Nissen fundoplication (NF), 124 underwent Toupet fundoplication (TF), 351 underwent DF, and 305 underwent HR. There were no significant differences in age, gender, body mass index, disease duration, acid regurgitation, use of proton pump inhibitor, DeMeester score, or HH length among the four groups (all \(P > 0.05\)). There was a significant difference in heartburn between the DF and HR groups (\(P < 0.05\)). The pre-operative characteristics of patients in the four groups are shown in [Supplementary Table 1, http://links.lww.com/CM9/B80].

The operative procedures for all the patients were successful in all four groups, and no pneumothorax, subphrenic abscess, esophageal rupture, gastric rupture, or peri-operative death occurred. Notably, however, there were significant differences in operative time, intra-operative blood loss, and post-operative hospital stay among the four groups (all \(P < 0.05\)). Intra-operative blood loss in the TF group (22.9 ± 7.6 mL) was less than in the NF group (\(P < 0.008\)). In the DF group, operative time (60.7 ± 20.8 min) and intra-operative blood loss (18.8 ± 8.1 mL) were lower than in the TF and NF groups (all \(P < 0.008\)). In the HR group, operative time (52.9 ± 20.3 min), intra-operative blood loss (7.0 ± 2.5 mL), and post-operative hospital stay (4.7 ± 1.2 days) were lower than in the fundoplication groups (all \(P < 0.008\)). The operative details of the four groups are shown in Supplementary Table 2 [http://links.lww.com/CM9/B80].

Within 1.5 years post-operatively, five patients in the NF group (5/30; 16.7%), 15 patients in the TF group (15/124, 12.1%), 25 patients in the DF group (25/351, 7.1%), and two patients in the HR group (2/305, 0.7%) were hospitalized due to surgical complications. Post-operative dysphagia was present in 21 patients: 3, 7, and 11 in the NF, TF, and DF groups, respectively. Post-operative abdominal distention was diagnosed in 19 patients: 3, 6, 9, and 1 in the NF, TF, DF, and HR groups, respectively. Post-operative upper abdominal pain was present in 14 patients: 2, 4, 7, and 1 in the NF, TF, DF, and HR groups, respectively. According to the results of gastroscopy and X-ray barium meal examination, seven patients had cardiac stricture: two, two, and three in the NF, TF, and DF groups, respectively. All readmitted patients were treated medically including acid inhibitors, antacids, and gastric-motility-promoting drugs. Cardiac strictures were treated by balloon dilatation. After these treatments, the surgical complications were alleviated or disappeared in all patients.

At 1.5 years post-operatively, the RDQ was completed again by 27, 100, 286, and 244 patients in the NF, TF, DF, and HR groups, respectively (some patients were lost to follow-up). Compared with pre-operative-symptom scores, the acid reflux and heartburn scores post-operatively were decreased in all groups (all \(P = 0.000\); Supplementary Table 3, http://links.lww.com/CM9/B80). In addition, the TERs in the NF, TF, DF, and HR group were 88.9%, 89.0%, 89.2%, and 86.9%, respectively. No significant difference was found in the TER among the four groups (\(P > 0.05\)).

There are a number of normal anti-reflux barriers that include the function of the esophageal hiatus, the pressure of the lower esophageal sphincter (LES), length of the abdominal esophagus, and angle of His. The anatomic abnormality of HH could reduce the LESP and even might cause the disappearance of the angle of His, which diminishes the function of the anti-reflux barrier, thereby causing GERD. HH repair that corrects the anatomic abnormality of esophageal hiatus and fundoplication that increases the LESP through gastric-fundus wrap, is an option for such patients who do not respond to medicine, who suffer from adverse drugs effects, or who wish to stop taking drugs.\(^{[1]}\) Although fundoplication is well-known to
be efficacious as an anti-reflux treatment, some patients can develop severe post-operative complications including dysphagia, abdominal distension, and cardiac stricture. Therefore, an equally effective alternative to fundoplication would be an important consideration.

In this study, the principal goal of HR was to achieve a near-zero angle of His and lengthening of the abdominal esophagus to restore the damaged anti-reflux barrier. The critical findings were as follows: (1) patients underwent HR successfully, which indicated that the procedure was safe; (2) the operative time, intra-operative blood loss, and post-operative hospital stay in the HR group were significantly lower than in the fundoplication groups; (3) patients who underwent HR had a lower rehospitalization rate caused by surgical complications; and (4) at 1.5-year follow-up, acid regurgitation and heartburn scores in all four groups were lower than the corresponding pre-operative scores, and there was no significant difference in the TER among the four surgical groups. A reasonable conclusion, therefore, was that HR and fundoplication had similar, excellent anti-reflux efficacy.

However, some limitations of this study should be considered. (1) Few patients had extra-esophageal symptoms, so there was no comparison of pre-operative and post-operative extra-esophageal symptom scores. (2) The lack of comparison of pre-operative and postoperative objective indices, such as the DeMeester score and LESP, might have allowed bias in evaluating the effect of surgical treatment. (3) This was a single-center prospective non-randomized cohort study; therefore, in the future, a multicenter, large-sample, randomized clinical trial would be needed.

In conclusion, laparoscopic HH repair and HR were safe and effective in the treatment of patients with GERD and HH. Due to the advantages of less invasiveness and a lower incidence of surgical complications, HR might offer a new choice of surgical therapy.

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Conflicts of interest
None.

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