Chinese Medical Journal®

Long-term outcomes of peroral endoscopic myotomy in achalasia patients with a minimum follow-up of 7 years

Wen-Gang Zhang, Ning-Li Chai, Ya-Qi Zhai, En-Qiang Linghu, Hui-Kai Li

Department of Gastroenterology, Chinese People's Liberation Army General Hospital, Beijing 100853, China.

There was an enormous increase in reports confirming the safety and efficacy of using peroral endoscopic myotomy (POEM) to treat achalasia since the pioneering of the technique in 2010.[1] However, the reports focused on short to medium-term follow-ups, and data on long-term outcomes of POEM for achalasia were very limited. It still remains unknown whether the satisfactory short-term outcomes are long lasting. Additionally, some achalasia patients receiving POEM noted that they could benefit from post-operative dietary recommendations that would be helpful for symptom remission. Therefore, this study aimed to determine the long-term treatment outcomes of using POEM to treat achalasia, and to assess post-operative Eckardt scores over this period. We also crafted a set of post-POEM dietary recommendations according to the feedback from achalasia patients who underwent this treatment to achieve better symptom remission for post-POEM patients.

This retrospective study was approved by the Ethics Committee of the Chinese People's Liberation Army (PLA) General Hospital, and informed consent was obtained from all patients. As shown in Supplementary Table 1, http://links.lww.com/CM9/A195 and in Supplementary Figure 1, http://links.lww.com/CM9/A199, a total of 39 patients with achalasia successfully underwent POEM at the Digestive Endoscopic Center of the Chinese PLA General Hospital from December 2010 to June 2012. Of the 39 patients, a follow-up more than 7 years was obtained via phone for 32 patients by June 2019. The remaining seven patients were lost to follow-up.

Patients were admitted and fasted for 48 h before undergoing POEM. They had to undergo a gastroscope procedure before POEM to ensure that there was no food residue remained in the esophagus lumen. During the procedure, patients were kept in a supine position with the right shoulder elevated, and general anesthesia was administered with electrocardiograph, respiration, blood pressure, and oxygen saturation monitoring. The basic steps of POEM were described briefly: entry, submucosal tunneling, myotomy, wound closure.[1] X-ray or chest and abdomen computed tomography were carried out routinely to evaluate any gas-related complications. Patients were monitored for any other complications such as delayed hemorrhage and pulmonary infection. After 3 days' fast post-operatively, a liquid diet was followed for 1 day, then a soft diet and finally a regular diet was resumed 1-month post-POEM. Post-operative medications, including a double-dose proton pump inhibitors (PPI) and antibiotics, were prescribed, with the PPI required for at least 4 weeks.

Patients were scheduled for a follow-up visit at 3, 6, and 12 months post-operatively. Gastroscopy was performed to examine for post-POEM esophagitis and to assess wound healing. Additionally, high-resolution manometry and an X-ray barium meal were conducted if possible. During the final follow-up in June 2019, symptoms were evaluated using the Eckardt score. Specifically, the change of Eckardt score over time, the change in post-operative weight, and any beneficial dietary habits were recorded. Treatment success was defined as an Eckardt score of 3 or less. Of note, the Eckardt score (maximum score = 12) is the sum of the symptom scores for dysphagia, regurgitation, and chest pain (absent = 0, occasional = 1, daily = 2, with every meal = 3), plus weight loss (no weight loss = 0, <5 kg = 1, 5–10 kg = 2, >10 kg = 3). Dietary suggestions were incorporated into post-POEM dietary recommendations if they were reflected by more than ten patients.

All statistical analyses were performed in the Statistical Package for the Social Sciences software, version 17.0 (SPSS Inc., Chicago, IL, USA). Variables were expressed as mean or median, and analyzed by paired-samples Student's

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Quick Response Code:

Website: www.cmj.org

DOI: 10.1097/CM9.0000000000000735

Correspondence to: Dr. En-Qiang Linghu, Department of Gastroenterology, Chinese People's Liberation Army General Hospital, Beijing 100853, China
E-Mail: linghuenqiang@vip.sina.com

Chinese Medical Journal 2020;133(8)

Received: 31-01-2020 **Edited by:** Yuan-Yuan Ji

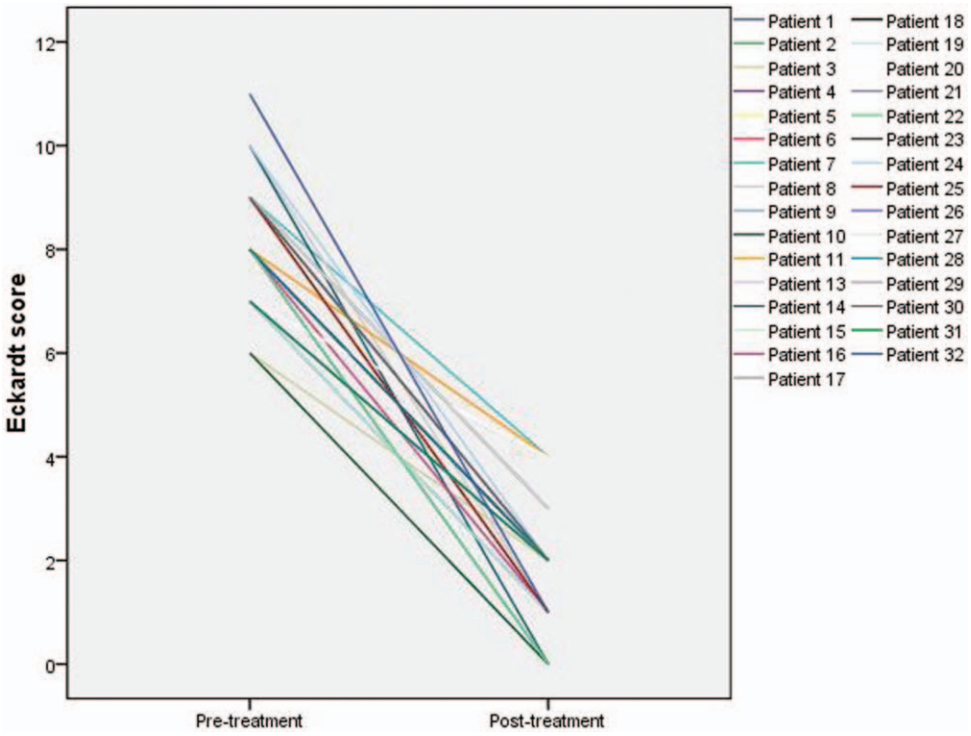

Figure 1: The change of Eckardt score of the 32 achalasia patients with follow-up at June 2019.

t test or Wilcoxon rank-sum test. All reported *P* values were two-tailed, and *P* values of <0.05 were considered statistically significant.

As shown in Supplementary Table 1, http://links.lww.com/CM9/A195, the study cohort consisted of 16 men and 16 women, aged 19 to 58 years (mean 38.6 years). The 32 patients experienced symptoms for a median value of 24.0 months (6.0–240.0 months). Four patients had previously undergone treatment.

All 32 patients successfully underwent POEM. The operation took 65.0 min (46.0–305.0 min). The median length of tunnel and myotomy was 12.0 (9.0–14.0) and 7.5 cm (6.0–9.0 cm), respectively. Gas-related adverse events, which included pneumothorax, mediastinal pneumatosis, and subcutaneous pneumatosis, occurred in seven patients (22%). The patients with pneumothorax complained of dyspnea, and thoracic close drainage was performed for them. The other patients who experienced gas-related adverse events showed no other clinical effects, and the pneumatosis disappeared spontaneously without additional treatment in 2 or 3 days. Clinical reflux adverse events were found in 12 (38%) patients, and their symptoms improved after taking a PPI orally for 2.5 months.

Of the 32 patients, 28 (88%) achieved treatment success, which is defined as a post-operative Eckardt score ≤3 at a follow-up 88 months post-surgery (median, 84–103 months). The median Eckardt score decreased from 7.0 (6.0–10.0) immediately post-operatively to 2.0 (0.0–4.0) ($P < 0.05$) [Figure 1; Supplementary Table 1, http://links.lww.com/CM9/A195]. Of the 28 patients who were treated successfully, 18 (64%) had no change in Eckardt score over time, 2 (6%) had a reduced Eckardt score, and 8 (29%) had an increased Eckardt score [Supplementary Figure 1, http://links.lww.com/CM9/A199, Supplementary Tables 2, http://links.lww.com/CM9/A196, and 3, http://links.lww.com/CM9/A197]. Of the four patients who did not respond to treatment, two had a stable Eckardt score during follow-up, and the remaining two had an increased score. Out of all 32 patients, a total of ten had an increased Eckardt score post-operatively at 36 months (median, 6–72 months). A total of 15 patients had paired high-resolution manometry (HRM) before and after treatment, and the remaining 17 patients did not undergo HRM after POEM because of the discomfort related to the procedure or for personal reasons. The mean pre-operative and post-operative lower esophageal sphincter pressures were 39.5 (17.7–66.7) and 22.5 (7.1–44.8), respectively, indicating a statistically significant decrease after POEM ($P < 0.05$) [Supplementary Table 1, http://links.lww.com/CM9/A195]. Of the 32 patients, 21 (66%) gained a median of 10 kg (5–25 kg) in weight after a minimum of 7 years. Ten (31%) had no change in weight, and one (3%) had an 8 kg decrease in weight.

The post-POEM recommendations mainly include the following points: (1) alternate between eating and drinking water when consuming dry food; (2) walk for 10 to 30 minutes following dinner; (3) allow at least 4 h between dinner and falling asleep; and (4) avoid chili pepper, seafood, and liquor. These four items were proposed by 15, 13, 10, and 10 patients, respectively.

Many papers have confirmed excellent short or medium-term outcomes of using POEM to treat achalasia. However, the long-term stability of symptom remission resulting from POEM is still unknown. The present study confirmed that the long-term outcomes of treating achalasia with POEM are satisfactory with an 88% treatment success rate after a follow-up of 7-years or more post-surgery. Recently, Zhou *et al*[2] reported an 87% clinical success rate of POEM for achalasia after a 5-year follow-up, and this result is consistent with ours. Additionally, the 88% treatment success rate that we found is also comparable to the long-term outcomes of laparoscopic Heller myotomy.[3] Besides, the overall change in weight reflected the ability of POEM to improve the nutritional status of achalasia patients.

It is worth noting that the Eckardt score increased in some cases during the follow-up period [Supplementary Table 4, http://links.lww.com/CM9/A198]. Out of the 32 patients, ten had an increased Eckardt score at 36 months (median, 6–72 months). This result indicates a slight worsening of symptoms at 36 months (median, 6–72 months) following POEM, findings which are also supported by Ezra *et al*.[4] Therefore, it is necessary to continue to examine the long term outcomes of achalasia patients treated with POEM.

This study found a rate of 38% for clinically adverse reflux events [Supplementary Table 1, http://links.lww.com/CM9/A195]. Previous studies showed different overall rates of gastroesophageal reflux disease and/or reflux esophagitis ranging from 5.0% to 72.2%.[5] This could be explained by two factors. First is the definition of post-POEM clinical reflux adverse events – defined by base symptoms, 24-h pH monitoring, and endoscopy data in different studies. Second are the differences in operation techniques.

This study summarized a set of post-POEM dietary recommendations according to the feedback from achalasia patients undergoing POEM. Theoretically, the first item contributes to smoother passage of foods past the esophagus-gastric junction. The second and third items reduce food and gastric acid reflux, particularly at night. The fourth item protects from the influence of irritating foods. Further studies are required to confirm the efficacy of these post-POEM dietary rules.

The main limitation of this study lies in the general nature of retrospective and non-controlled studies. We found that the long-term outcomes of using POEM to treat achalasia are satisfactory, although the increasing Eckardt score from a portion of patients during the follow-up period should be noted. We hypothesize that POEM can improve the nutritional status of achalasia patients, and along with post-POEM dietary suggestions, it may benefit patients' post-operative symptom remission.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflicts of interest

None.

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How to cite this article: Zhang WG, Chai NL, Zhai YQ, Linghu EQ, Li HK. Long-term outcomes of peroral endoscopic myotomy in achalasia patients with a minimum follow-up of 7 years. Chin Med J 2020;133:996–998. doi: 10.1097/CM9.0000000000000735