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The Plication Technique to Enhance the Endoscopic Approach to Zenker’s Diverticulum

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Abstract
Endoscopic stapler approaches to Zenker’s diverticulum often yield a persistent diverticulum and recurrent dysphagia up to 20%. A novel technique to reduce the postoperative diverticulum is described. Eight consecutive patients with Zenker’s diverticulum who underwent endoscopic stapler diverticulotomy had adjunctive endoscopic plication of the diverticulum wall to functionally reduce the residual diverticulum size. On postoperative esophagram, there was no visible diverticulum in 4 of 7 patients (57%). The remaining 3 patients had a reduction in common wall of 76%, 50%, and 40% with a mean postoperative size of 1.0 cm. All patients had resolution or significant improvement in dysphagia. There were no complications or recurrences at a mean follow-up of 6.3 months. As an adjunct to endoscopic treatment of Zenker’s diverticulum, the plication technique can reduce diverticulum size. Further studies will determine if the plication technique affects long-term recurrence of endoscopic stapler approaches.

Keywords
Zenker’s diverticulum, endoscopic stapler, dysphagia

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Endoscopic stapler diverticulotomy is a popular approach for Zenker’s diverticulum due to its low morbidity, but studies have shown significant persistent dysphagia and recurrence up to 20%.1,2 Shah et al2 showed that the diverticulum common wall is significantly larger after stapler diverticulotomy compared to open approaches. These existing studies indicate the possibility that there is an association between the persistent diverticulum and the increased recurrence seen in the endoscopic stapler approach.

At our institution, the plication technique was developed as an adjunct to the endoscopic stapler approach to fold the residual diverticulum wall and reduce the postoperative common wall size. This case series details our methods and institutional experience with this novel technique and evaluates its efficacy in consecutive patients.

Methods
This study is a case series of adult patients with Zenker’s diverticulum who underwent endoscopic stapler treatment with the plication technique, which includes 8 consecutive patients from 2016 to 2017. Patients with recurrent Zenker’s diverticulum after prior endoscopic treatment were included. This study was approved by the University of Nevada School of Medicine Institutional Review Board.

Surgical Technique
All surgical procedures were performed by the senior author (R.C.W.). With the Weerda diverticuloscope, a standard endoscopic stapler (ECHelon FLEX EC45A; Ethicon, Somerville, New Jersey) with a vascular staple load is used to divide the diverticulum common wall. If there is significant residual diverticulum at the apex, this mucosa is grasped using cup forceps. The diverticulum wall is retracted superiorly and toward the surgeon, which effectively inverts the residual diverticulum into the esophagus. The endoscopic stapler is rotated 90 degrees from the orientation used to divide the common wall and then fired into the wall of the residual diverticulum just adjacent to the point of retraction before cutting between staple lines (see Figure 1). This plication is repeated 2 to 3 times at any remaining redundant areas to repeatedly fold the wall of the residual diverticulum and functionally reduce its size. Figure 2 demonstrates the intraoperative endoscopic view. In 1 patient early in the series, the folds of mucosa after

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plication were prominent and resected with endoscopic scissors after ligating the base with endoscopic suture. There were no complications in that patient, but in subsequent patients, the prominent folds of mucosa were left in place. On postoperative day 1, patients were started on a full liquid diet. A postoperative esophagram was obtained from 2 weeks to 2 months after surgery.

Results
A total of 8 patients underwent endoscopic stapler treatment of Zenker’s diverticulum with plication. See Table 1 for patient characteristics. All patients had preoperative esophagrams and 7 patients had postoperative esophagrams. The mean preoperative diverticulum size was $3.0 \times 1.7 \times 3.6$ cm (craniocaudal × anteroposterior × transverse) with a mean common wall of 2.8 cm (range, 1.6-5 cm). Postoperatively, 4 of 7 patients (57%) had no common wall and no evidence of diverticulum on esophagram. In those patients, there was an apparent dilation and funnel shape in the region of the prior diverticulum (Figure 3). The 3 patients with a residual common wall had a reduction of the common wall of 76%, 50%, and 40% (Table 1).

No patients had postoperative aspiration, esophageal perforation, hematoma, or mediastinitis. Seven of 8 patients had complete resolution of dysphagia symptoms. One patient, who was nil per os preoperatively due to aspiration, was tolerating a full liquid diet at 2 weeks postoperatively but was then lost to follow-up. At a mean follow-up of 6.3 months, there has been no recurrence of dysphagia.

Discussion
In treating Zenker’s diverticulum, the endoscopic stapler is unable to address the distal common wall or the redundant residual diverticulum. The plication technique folds the wall of the residual diverticulum, which functionally reduces its size. In this series, 4 of 7 patients also showed complete elimination of the diverticulum common wall.

The endoscopic stapler technique offers lower morbidity and shorter operative times than open approaches, but meta-analyses have shown an increased rate of recurrent dysphagia up to 18%.3,4 It is unknown why recurrence is higher with endoscopic stapler approaches. Jaramillo et al5 found that all patients had a persistent diverticulum after endoscopic stapler treatment, and two-thirds of patients had no change in the diverticulum postoperatively.

A study by Shah et al2 compared the postoperative common wall in 73 patients by 3 approaches: endoscopic stapler, laser, and open resection. They found a significant difference in postoperative common wall between the techniques. After the stapler technique, the mean postoperative common wall was 46% of the preoperative size, compared to 18% and 7% for the endoscopic laser and open techniques, respectively. In the current series, the mean postoperative common wall was 19% of the preoperative size.

A valid concern is whether the plication technique could increase the risk of adverse events. Although there is increased disruption of the esophageal wall, there have been no postoperative perforations or leaks in a small number of patients thus far. Zenker’s diverticulum can recur after several years, and therefore a longer term follow-up will be required to determine the true recurrence rate of the plication technique.

Conclusion
The plication technique reduces the Zenker’s diverticulum size as an adjunct to endoscopic treatment. The common wall was eliminated in 4 of 7 patients and significantly
reduced in the remaining patients. Future studies will determine if the plication technique affects long-term recurrence.

Acknowledgments
Illustration in Figure 1 by Robert C. Wang.

Table 1. Patient Characteristics.

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age, y</th>
<th>Sex</th>
<th>Prior Surgery</th>
<th>Preoperative CW Size, cm</th>
<th>Postoperative CW Size, cm</th>
<th>No. of Plications</th>
<th>CW Reduction, %</th>
<th>Dysphagia Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>73</td>
<td>Male</td>
<td>No</td>
<td>2.5</td>
<td>0.6</td>
<td>3</td>
<td>76</td>
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</tr>
<tr>
<td>2</td>
<td>56</td>
<td>Male</td>
<td>No</td>
<td>2.1</td>
<td>0</td>
<td>3</td>
<td>100</td>
<td>Resolved</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>Female</td>
<td>Stapler</td>
<td>1.6</td>
<td>0.8</td>
<td>4</td>
<td>50</td>
<td>Resolved</td>
</tr>
<tr>
<td>4</td>
<td>87</td>
<td>Female</td>
<td>No</td>
<td>4.0</td>
<td>0</td>
<td>2</td>
<td>100</td>
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</tr>
<tr>
<td>5</td>
<td>78</td>
<td>Male</td>
<td>Stapler</td>
<td>2.8</td>
<td>0</td>
<td>2</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>6</td>
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<td>Female</td>
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<td>2.0</td>
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</tr>
<tr>
<td>7</td>
<td>87</td>
<td>Male</td>
<td>No</td>
<td>5.0</td>
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<td>3</td>
<td>100</td>
<td>FLD^a</td>
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<tr>
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<td>Male</td>
<td>No</td>
<td>2.5</td>
<td>1.5</td>
<td>3</td>
<td>40</td>
<td>Resolved</td>
</tr>
</tbody>
</table>

Abbreviations: CW, common wall; FLD, full liquid diet.
^aPreoperatively, patient had severe aspiration necessitating nil per os and postoperatively achieved full liquids at 2 weeks but was then lost to follow-up.

Author Contributions
Harry H. Ching, study design, collected and analyzed data, drafted, revised article, final approval; Jacob B. Kahane, collected data, revised article, final approval; Nathaniel H. Reeve, collected data, revised article, final approval; Robert C. Wang, conceived the technique, study design, revised article, final approval.

Disclosures
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References