Perforation risk in esophageal endoscopic mucosal resection with ligation: an experimental study with two ligator models

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ABSTRACT

Objective: endoscopic mucosal resection with ligation (EMR) is considered an efficient, safe method for the treatment of some esophageal, gastric and colorectal tumors. We conducted this study using a porcine model in order to compare the safety of esophageal EMRL with two multiband ligation systems, since many centers only use these ligator models in EMRL (commercialized for varix ligation).

Methods: eight pigs were used, which were submitted to 23 esophageal resections without previous injection. Ten resections were conducted using the Six Shooter Saeed model, and 13 resections used the Speedband Superview Super 7 model. The technique was also compared by making random cuts either above or below the band.

Results: five perforations occurred, all of them using the Speedband model. This represents 38.5% of total in the Speedband model group. No perforation occurred when using the Six Shooter model (p = 0.046). On the contrary, no significant differences were found regarding frequency of perforation when cutting above or below the band.

Conclusions: esophageal EMRL using the Speedband model without previous injection leads to perforation in a high percentage of cases in an experimental animal model. Further studies are required to find out whether a previous injection may increase the safety of this technique with this ligator model.

Key words: Risk of perforation. Experimental study. Ligator model.

INTRODUCTION

Endoscopic mucosal resection (EMR) or mucosectomy has been a focus of attention for different working teams, which consider it an efficient and safe method for the treatment of some gastrointestinal tumors. It has been mainly used for the treatment of early carcinomas and...
flat adenomas, either esophageal, gastric or colorectal, as well as for Barrett’s severe esophageal dysplasia (1-5). It has also been described as a safe method for the excision of some submucosal tumors (6-9).

There are different EMR modalities but there is something common to all of them and a previous step to extirpation, which consists of lifting and detaching the mucosa where the lesion is embedded. In order to do so four techniques are commonly used with some variations (10,11). The simplest one is the injection of saline (or some other substance) to form a cushion underneath the mucosa (inject and cut). In another technique, post injection the mucosa is subjected to traction using a grasping forceps, but this requires double-channel endoscopes (inject, lift and cut). The other two techniques consist of suctioning the mucosa (and normally a part of the submucosa), and they have been used with or without previous injection: in one of the cases a transparent plastic cap that is fitted to the tip of the standard endoscope is used (cap-assisted endoscopic mucosal resection –EMRC–). The last technique consists of placing a band like those used for the treatment of esophageal varices, and then a resection is conducted. This latter technique for endoscopic mucosal resection with ligation (EMRL) has been carried out with different multiband models both in the stomach and the esophagus, and has also been described with the cut either above or below the band (4,6-9,12-19).

In order to assess the safety of the technique, specifically with regard to likeliness of perforation, we conducted an animal study with two multiband ligator models. Furthermore, we compared the safety of the technique when cutting above or below the band. These multiband models are the most frequently used in the ligation of esophageal varices in Spain.

MATERIAL AND METHODS

Animals

Eight hybrid pigs of the Lage White breed with a weight veering between 12 and 25 kg were used. In order to conduct the EMRL all animals were anesthetized using ketamine and azaperone to induce anesthesia. They were intubated and anesthesia was maintained with sevoflurane (0.5-1%) and 50% oxygen, whereas analgesia was maintained with remifentanil in perfusion. One month later the animals were sacrificed by means of the intravenous administration of CIK, after being anesthetized using the previously described method (or after endoscopy if perforation occurred during mucosectomy). All procedures were carried out in the operating room at Experimental Surgery Unit, Juan Canalejo Hospital (Official Registry No. as a Center allowed to use animals for experimentation: 15002 AE), and were conducted in accordance with National and European regulations regarding production and use of experimentation animals.

Materials

The following endoscopes were used: Olympus CV-145 (Olympus Optical Co. Ltd. Tokyo Japan) and Fujinon EVE S200 (Fuji Photo Optical Co. Ltd. Saitama Japan).

An electrosurgery Valleylab Force 2 Unit was also used (Valleylab. Boulder CO. USA).

Two multiband ligator models were used: Speedband Superview Super 7, which includes 7 bands (Boston Scientific. Microvasive. Natick MA. USA), and Six Shooter Saeed, whose cylinder includes 6 bands (Wilson Cook Medical. Limerick, Ireland). The Speedband model has a conic shape with a proximal internal diameter of 10.42 mm, a distal diameter of 9.42 mm, and a length of 17.90 mm. The Six Shooter model has an almost cylindrical shape with a proximal internal diameter of 11 mm, a distal diameter of 9.42 mm, and a length of 14 mm. In figure 1 both devices –without bands– can be seen.

EMRL procedure

Once the endoscope was introduced, sites to place the bands throughout the esophagus were randomly chosen. After applying suction by using negative pressure the bands were placed in a standard manner without previous saline injection. Resection with a polypectomy snare was carried out by applying a blend current above and below the band. These multiband models are the most frequently used in the ligation of esophageal varices in Spain.

Fig. 1. Comparation of two ligator models when the bands were re tidal. There is a difference in the length of the two models. A: Speedband Superview Super 7; B: Six Shooter Saeed.

Statistical methods

The bands used in each animal were of a single model. In order to assign each animal a multiband model, its choice was made in a consecutive way, beginning at random with the Six Shooter. A descriptive analysis of the incidence of perforation was carried out in accordance with study conditions. Re
Results are shown as percentages and confidence intervals. In order to compare the occurrence of perforation according to various variables Fisher’s exact test was used. Significant values of p < 0.05 were obtained. Tests were conducted using a bilateral approach. The statistical analysis was carried out using the SPSS 12.0 software for Windows.

RESULTS

Results are shown in table I. Twenty-three interventions were carried out in total (13 with Speedband bands and 10 with Six Shooter bands), of which 5 had perforation (21.7%; 95% IC: 8.4-41.8%). In all cases in which perforation occurred bands were of the Speedband model. Out of the total number in which bands of this model were used perforation occurred in 38.5% of cases (5/13) (95% IC: 15.7-65.9%) as opposed to none of the procedures in which Six Shooter bands were used (95% IC: 0-25.9%), which involves a statistically significant difference (p = 0.046). The immediate endoscopic view of a perforation can be seen in figure 2.

<table>
<thead>
<tr>
<th>Model</th>
<th>Pig no.</th>
<th>Resections</th>
<th>Cut</th>
<th>Perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedband</td>
<td>2, 4, 6, 8</td>
<td>13</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Six Shooter</td>
<td>1, 3, 5, 7</td>
<td>10</td>
<td>6</td>
<td>4</td>
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A lower percentage of perforations was observed when the cut was made above the band (16.7%; 95% IC: 2.9-45 versus 27.3%; 95% IC: 7.4-57.8%), although this difference was not significant from a statistical point of view (p = 0.64).

DISCUSSION

Various EMR techniques have been increasingly used in the treatment of early esophagus carcinomas and severe dysplasia associated to Barrett’s esophagus, to the extent of being considered the standard therapeutic choice amongst endoscopic treatments (5). Its widespread use is due to a low rate of complications. EMRL has the advantage that endoscopists are familiarized with the device, as it is used in the ligation of esophageal varices.

In our Endoscopy Unit we have performed this technique for years, and have reported its usefulness in the resection of rectal carcinoids (20). Some of our patients suffered from pain during the procedure when applying a current with the polypectomy snare once the band was in place. Pain is attributed to the fact that part of the muscle layer pertaining to the rectum may have been ligated. In fact perforation has been described after the resection of a rectal carcinoid by EMRL (9). This led us to rethink the safety of the technique in the esophagus, which has a thinner wall, with some of the multiband ligation systems commercialized for the treatment of esophageal varices—the ones we use in our Endoscopy Unit.

In our research the high percentage of perforations seen drew our attention, as it seems to be in contrast with those reported by highly experienced groups (4,12-15, 17,18). The first reason that may partially explain this perforation rate lies in the fact that the esophageal wall of experimentation animals is thinner, since it has no carcinoma. However, the thickness of a dysplastic esophagus (associated with Barrett’s esophagus) should not be higher than that of a “healthy” esophagus, and there is plenty of experience without perforations in EMRL as used for the treatment of severe dysplasia (4,15,17).

Another reason that may account for these perforations is that our protocol did not include any injection prior to resection. In another experimental study in which the placement of bands with or without injection was fol-
lowed by a thoracotomy it could be verified that the entire esophageal wall was suctioned if no injection was used. In this study two out of three perforations occurred in the non-injected group (21). However, several studies with numerous patients have esophageal EMRL without injection, and mention perforation as an exceptional complication (13,15).

On the other hand the lack of injection does not account for the difference in perforations related to the model of ligator used. The only reason we may think of is the difference in the size of the cylinders of the two models, more precisely in their length, which is 28% bigger in the Speedband model. This is the model with which all perforations occurred. This model is frequently used in our Endoscopy Unit for the ligation of esophageal varices, and we have not had any perforations, so we are convinced that the ligator is safe for this indication. However, in the case of esophageal varices these are introduced in the cylinder when aspiration is applied, forming a “cushion” that prevents the introduction of the entire thickness of the esophageal wall.

Ell et al. have a lot of experience with another reusable multiband ligator model developed by his group –the Euroligator (22). With this system, which may incorporate up to 5 bands, they have obtained great results with a very low percentage of complications and without perforations (4,13,14,17). The same group has described that they also used the Speedband model, but an older version whose cylinder only included 3 bands and whose length was much shorter than that of the Speedband Super 7 model (4,14).

According to the results obtained in our study we feel compelled to issue a warning with regard to the frequency of esophageal perforation in experimental animals when performing an EMRL with the 7-band Speedband model. Additional research is required in order to find out whether a previous injection may decrease the risk of this complication.

REFERENCES