Non-conventional surgical approach to achalasia: mucosectomy and endomuscular pull-through

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ABSTRACT

Aim: Transhiatal esophagectomy is a therapeutic option for the treatment of end-stage achalasia that avoids the complications of a thoracotomy. This technique, however, is still linked to some degree of morbimortality especially due to pleuromediastinal complications. Esophageal mucosectomy and endomuscular pull-through could avoid these complications. This study aims to evaluate the short and long-term outcomes of esophageal mucosectomy and endomuscular pull-through in a series of patients with advanced megaesophagus. Methods: We retrospectively studied 115 patients with end-stage achalasia that underwent esophageal mucosectomy and endomuscular pull-through. Digestive tract reconstruction was accomplished most times using the stomach through the muscular tunnel. Outcomes were evaluated in a short and long-term follow-up based on clinical, endoscopic and tomographic evaluation. Results: Anastomotic leak or stenosis was present in 27%. Pleural effusion was noticed in 11% and pneumonia in 9%. Mortality was 1.7%. Long-term follow-up (over 10 years) was possible in 42 patients. Excellent and good clinical results were obtained in 83% of the patients. Conclusion: Esophageal mucosectomy and endomuscular pull-through is a valuable procedure for the treatment of end-stage achalasia. It shows a low rate of complications and good outcomes at long-term follow-up.
The aim of the treatment for achalasia is to relieve dysphagia and avoid long-term complications of food stasis.

This study aims to describe the technique and results of esophageal mucosectomy and endomuscular pull-through for the treatment of advanced achalasia.

History and indications
Kirschner[6] in 1914 pioneered the idea of esophageal complete mucosectomy with muscular preservation through invagination. The authors were concerned at that time about mediastinal hemorrhage and pleural lesions. They tried to strip the esophagus through neck and abdomen incisions in dogs but the idea was not popular and an adequate way of reconstructing the tract with the stomach was not developed simultaneously.

Latter, others proved the possibility of the technique in humans showing acceptable results in patients with caustic stenosis, esophageal carcinoma and proximal gastric cancer[7,8].

Aquino[9] pioneered the technique in Brazil, a country with a large incidence of achalasia. The technique was employed in patients with advanced megaesophagus since transhiatal esophagectomy may be associated to complications such as accidental pleural lesion, tracheal injury and hemothorax[10-13]. Pleural and tracheal injury, as well as hemorrhage, may occur during mediastinal dissection due to severe periesophagitis leading to adhesions between the esophagus and mediastinal structures. It is also well known that stasis esophagitis observed in end-stage disease predisposes to premalignant lesions or even carcinoma[14-17]. Based on this premises, the idea of stripping the esophageal mucosa and submucosa through cervical and abdominal incisions in the absence of thoracotomy came to mind. Thus, premalignant lesions could be prevented and complications related to mediastinal esophageal dissection avoided.

We operated dogs as a preliminary study before applying the technique in clinical practice[18]. Posteriorly, human cadavers were dissected to show the feasibility of the operation. Our clinical experience started after this training and showed good outcomes[9]. Recently, a series of 115 cases was published depicting good results and less morbidity than a transmediastinal esophagectomy[19]. All patients had an end stage achalasia defined by diameter larger than 10 cm.

METHODS

Surgical technique
Surgical technique follows standardization proposed by Aquino[9].

Mucosal resection
Abdominal stage
The operation starts with a midline laparotomy from the xiphoid process to 5 cm below the umbilicus flowed by dissection of the abdominal esophagus and division of vagi nerves. Longitudinal myotomy in the anterior esophagus from the cardia to the hiatus and circumferential dissection of the mucosa/submucosa in an extension 5 to 7 cm.

Cervical stage
Left lateral cervicotomy following the anterior border of the sternocleidomastoideus from the sternum to 10 cm upwards. Dissection of the esophagus free of the posterior and prevertebral fascia and trachea. Longitudinal myotomy in the anterior esophagus from 5 cm bellow the pharynx to the sternum and circumferential dissection of the mucosa/submucosa layer.

Combined stage
After a cylindrical segment of mucosa is dissected free of the muscular in the abdomen and neck, a small mucosectomy is made in the abdomen and neck to allow the passage of a rectal tube upwards. Cervical esophageal mucosa is circumferentially transected and tied to the rectal tube attached to a long and resistant surgical thread to allow pulling the replacement viscera to the neck. The mucosa is slowly striped downwards and inverted in the abdomen. The esophagus is completely sectioned at the level of the esophagogastric junction and in the neck.

Digestive tract reconstruction
Digestive tract was reconstructed in all patients with the stomach after division of the left gastric, gastroepiploic and short vessels. Two different routes for stomach transposition were used based on accessibility to the neck. The muscular tunnel was used in 81 (70%) patients while in 34 (30%) patients the retrosternal route was the option[19]. Esophagogastrostomy was performed in the cervical level in all patients. Circular stapler end-to-side esophagogastrostomy was done in 73 (63%) patients and manual end-to-side posterior esophagogastrostomy in 42 (37%) patients[19]. A feeding jejunostomy was always added to the procedure. Drains were left in the abdomen and neck.
discarged from the ICU during the first 48 h. Oral diet was started between the 7th-10th postoperative days in 82 (72%) patients after the esophagram attested absence of leaks. Jejunostomy tube was removed after 3-4 weeks after the operation when a solid diet was possible. Oral feeding was postponed in 31 (27%) patients due to anastomotic leakage and reintroduced between days 18-29 after the esophagram attested absence of leaks.

Radiologic evaluation
Chest X-Ray was unremarkable in 92 (80%) patients. In the remaining patients, discrete to mild pleural effusion was noticed in 13 (11%) patients and pulmonary infiltrate in 10 (9%) patients. Barium esophagram was performed in 86 (76%) patients with unremarkable findings in 82 of them. Anastomotic leak was detected in 4 patients. All patients had the test repeated between 18-26th postoperative day to show absence of leak and strictures.

Complications
Mortality was 2%. Two patients died due to sepsis after graft necrosis in the 3rd postoperative day and other due to pulmonary embolism in the 5th postoperative day. A tube thoracostomy was necessary in 9 out of 13 (11%) patients with pleural effusions and moderate volume. Only observation was enough in the 4 remaining. Pneumonia was diagnosed and treated in 10 (9%) patients with satisfactory outcomes. Anastomotic leak in 31 (27%) patients was managed conservatively with resolution in all cases. In 22 cases, however, an anastomotic stenosis was present and treated satisfactorily in all patients with endoscopic dilatation.

RESULTS

Short-term results
Pathologic examination of the specimen
A complete removal of the mucosa was observed in all 115 patients. Microscopic examination showed mild to severe inflammation of the mucosa and submucosa. Leukoplakia was found in 18 (15.7%) cases. Carcinoma was not observed.

Clinical evaluation
One hundred thirteen (98%) patients out of the 115 total had an uneventful recovery and they were discharged from the ICU during the first 48 h. Oral diet was started between the 7th-10th postoperative days in 82 (72%) patients after the esophagram attested absence of leaks. Jejunostomy tube was removed after 3-4 weeks after the operation when a solid diet was possible. Oral feeding was postponed in 31 (27%) patients due to anastomotic leakage and reintroduced between days 18-29 after the esophagram attested absence of leaks.

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Table 1: Clinical evaluation

<table>
<thead>
<tr>
<th>Swallowing status</th>
<th>Regurgitation</th>
<th>Bowel movements</th>
<th>Weight variation</th>
<th>Satisfaction with the procedure</th>
<th>Return to work</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Absent</td>
<td>Unchanged</td>
<td>Gain</td>
<td>Yes</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>Occasional dysphagia</td>
<td>Ocasional</td>
<td>Diarrhea/constipation occasional</td>
<td>Unchanged</td>
<td>Yes</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Frequent dysphagia</td>
<td>Frequent</td>
<td>Diarrhea/constipation frequent</td>
<td>Loss</td>
<td>No</td>
<td>No</td>
<td>0</td>
</tr>
</tbody>
</table>

The sum of these grades was defined as a global clinical evaluation and classified as: 10 and 9 - excellent; 8 and 7 - good; 6 and 5 - regular; < 4 - bad

Short-term follow-up
Patients were kept in the intensive care unit (ICU) for 24-48 h after the operation. Early feeding through the jejunostomy was started as soon as bowel motility returned and progressed to 2,500 to 3,000 calories/day according to standard pathways by dedicated nutritionists.

Oral feeding was introduced after anastomotic integrity was confirmed through an esophagram between the 7th and 10th postoperative day. This routine was changed; however, in the event of clinical suspicious of anastomotic leak when the test was repeated or done in variable periods. Chest X-Ray was performed routinely in all patients 24 h after the operation and every 72 h during the first week or in case of necessity.

Long-term follow-up
Forty-two patients were followed for more than 10 years. Variables used to assess outcomes are depicted in Tables 1-4[9].

Table 2: Computerized tomography evaluation - retrosternal transposition of the graft

<table>
<thead>
<tr>
<th>Medestinal fluid</th>
<th>Compression of the graft</th>
<th>Medestinal esophageal muscular layer</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence</td>
<td>Absence</td>
<td>Observed</td>
<td>1</td>
</tr>
<tr>
<td>Present</td>
<td>Present</td>
<td>Not observed</td>
<td>0</td>
</tr>
</tbody>
</table>

The sum of these grades was defined as a global clinical evaluation and classified as 3 - excellent; 2 - good; 1- regular; 0 - bad

Table 3: Computerized tomography evaluation - intraesophageal transposition of the graft

<table>
<thead>
<tr>
<th>Medestinal fluid</th>
<th>Compression of the graft</th>
<th>Medestinal esophageal muscular layer</th>
<th>Displacement of the graft</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence</td>
<td>Absence</td>
<td>Observed</td>
<td>Absence</td>
<td>1</td>
</tr>
<tr>
<td>Present</td>
<td>Present</td>
<td>Not observed</td>
<td>Present</td>
<td>0</td>
</tr>
</tbody>
</table>

The sum of these grades was defined as a global clinical evaluation and classified as 4 and 3 - excellent; 2 - good; 1- regular; 0 - bad
RESULTS

Results of this evaluation are showed in the following Table 5.

DISCUSSION

Few authors described clinical experience with esophageal mucosectomy and endomuscular pull-through. Most of these authors used a phrenotomy and even resection of the diaphragmatic crus to obtain better exposure of the mediastinum and avoided the use of the technique in dilated megaesophagus[7,8]. A phrenotomy (diaphragm division) to allow a better dissection of the mediastinum hurts the principle of minimal mediastinal dissection. In our study, we avoided this step. We were able to perform a complete dissection of the mucosa. The mucosa is easily extracted from the muscular layer due to histologic features of these layers. The mucosa is a resistant epithelium but the submucosa has few collagen fibers and abundant elastic fibers allowing flexibility and tearing[7,8].

Other objective of this described technique is to resect the esophageal mucosa that frequently shows inflammatory findings due to long-term food stasis and brings a risk for malignization between 3% to 10% according to different series[14,15,19]. Cancer was not observed in the resected mucosa in our series but severe inflammation was noticed in all cases and leukoplakia in 15.7%.

 Mediastinal hemorrhage is not a common occurrence after esophagectomy without thoracotomy irrespective of the technique: transhiatal dissection, stripping or mucosectomy. However, a high level of morbimortality is expected when a hemorrhage occurs[11,13,18,20]. Large vessels such as the azygos vein or direct branches from the aorta may be injured and in case of pleural lesion may lead to hemothorax in 25% of the cases. This complication usually requires a conversion to thoracotomy.

Other complications can occur after a transhiatal esophagectomy, such as pleural effusions and hemothorax. Pleural lesion may occur from 22-83% of the cases[11,13,18,20]. The low rate of pleuropulmonary complications in our study justify the option for esophageal mucosectomy that we believe prevented this type of complication avoiding extensive mediastinal dissection.

Recently, Aquino et al.[19] compared the intra and postoperative complications associated to either esophageal mucosectomy and endomuscular pull-through or transhiatal esophagectomy in 229 megaesophagus patients. Pleural effusions (including hemothorax) were more common in patients that underwent a transhiatal esophagectomy. Other severe complication found only in the transhiatal group was massive hemothorax that occurred in 6 (5%) patients and led to 2 deaths. Three (2%) patients from the group transhiatal had a tracheal injury, one of them died. This complication did not happen in the mucosectomy patients.

Pneumonia and cardiovascular complications are common after esophagectomy in patients with achalasia due to the basal clinical status in these patients that usually have comorbidities and are undernourished. Mucosectomy once more proved to have low morbidity as noticed by a reduced rate of pulmonary and cardiovascular complications as compared to conventional transhiatal esophagectomy[19]. This advantage may be linked again to a lesser degree of mediastinal dissection.

Table 4: Upper digestive endoscopy evaluation

<table>
<thead>
<tr>
<th>Esophagastrostomy patency</th>
<th>Gastrododenal junction patency</th>
<th>Macroscopic esophageal mucosa evaluation</th>
<th>Macroscopic gastric mucosa evaluation</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenosis not present</td>
<td>-</td>
<td>Normal mucosa</td>
<td>Normal mucosa</td>
<td>3</td>
</tr>
<tr>
<td>Mild stenosis</td>
<td>-</td>
<td>Esophagitis grade A*</td>
<td>Mild gastritis</td>
<td>2</td>
</tr>
<tr>
<td>Moderate stenosis</td>
<td>Patency</td>
<td>Esophagitis grade B*</td>
<td>Moderade gastritis</td>
<td>1</td>
</tr>
<tr>
<td>Severe stenosis</td>
<td>Not patency</td>
<td>Esophagitis grade C/D*</td>
<td>Severe gastritis</td>
<td>0</td>
</tr>
</tbody>
</table>

The sum of these grades was defined as a global endoscopic evaluation and classified as 10 and 9 - excellent; 8 and 7 - good; 6 and 5 - regular; < 4 - bad. *: Los Angeles classification

Table 5: Long-term follow-up

<table>
<thead>
<tr>
<th>Evaluation method</th>
<th>Patients number</th>
<th>Evaluation results</th>
<th>Excellent</th>
<th>Good</th>
<th>Regular</th>
<th>Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>42</td>
<td></td>
<td>21 (50%)</td>
<td>14 (33%)</td>
<td>4 (9%)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>Upper endoscopy</td>
<td>42</td>
<td></td>
<td>17 (40%)</td>
<td>20 (47%)</td>
<td>3 (7%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Ct scan RTN - graft</td>
<td>16</td>
<td></td>
<td>16 (100%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ct scan I - esophageal graft</td>
<td>26</td>
<td></td>
<td>24 (92%)</td>
<td>2 (8%)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The sum of these grades was defined as a global endoscopic evaluation and classified as 10 and 9 - excellent; 8 and 7 - good; 6 and 5 - regular; < 4 - bad. *: Los Angeles classification
Esophagogastrostomy leak was found in this technique in a rate similar to other series\cite{14,21,29}. Leakage seems not be linked to the resection procedure but to other topics such as absence of serosa in the esophagus, deficient vascularization, constant movement with swallow, and low nutrition status of some patients\cite{2,13,21,24}.

The risk for bleeding in the muscular tunnel is small. All patients had hemodynamic stability after the procedure and only few required transfusion. Parrilla Paricio et al.\cite{7} showed in his series no more than 100 mL of blood collected after external drainage of the muscular tunnel in 3 patients that underwent mucosectomy due to cardia cancer. Other series; however, showed a higher level of bleeding (700-800 mL) but without hemodynamic instability nonetheless\cite{8,25}. Aquino et al.\cite{18} showed - in an experimental study in dogs - absence of active bleeding 2 h after mucosectomy. Spontaneous hemostasis occurs due to anatomic characteristics of the vessels that branches in the submucosa\cite{20}.

Early results for mucosectomy are very acceptable. Only 12% of the patients had intraoperative complications and in a significantly lower rate compared to transhiatal esophagectomy in the own author’s experience (69%). Early postoperative complications were also lower for mucosectomy compared to transhiatal esophagectomy\cite{19}.

Long-term follow-up (between 10-15 years) in 42 patients showed excellent and good results in over 80%\cite{20}. Quality of swallow was lower in a long-term follow-up to those patients with a retrosternal reconstruction of the digestive tract. The constrict space, development of local fibrosis and angulation of the stomach may lead to these results. Some authors opted to resect the manubryum and part of the clavicle in order increase this space\cite{13,29}.

Regurgitation was a symptom with significant incidence after mucosectomy (31%). Gastroduodenal junction patency was compromised in some of the patients with regurgitation. In others without demonstrable anatomic obstruction, the symptom may occur due to consequences of the vagotomy in gastric physiology.

Patients should be closely followed after the operation based on the elevated risk for metastasis, dysplasia and even carcinoma transformation in the esophageal stump\cite{27,29}. Some authors opt for chronic use of proton pump inhibitors after esophagectomy to prevent acid esophagitis in the stump\cite{27}.

Functional asocial parameters had satisfactory outcomes as shown by weight gain, quality of life, satisfaction and return to work.

In conclusion, esophageal mucosectomy and endomuscular pull-through seems to be a valuable alternative to esophagectomy in patients with end-stage achalasia.

DECLARATIONS

Authors’ contributions
Conceived and designed the study, wrote and reviewed the manuscript: J.L.B. De Aquino
Collected and tabulated data, participated in manuscript writing: M.M. Said
Participated in manuscript writing and reviewing: J.G.T. De Camargo

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None.

Conflicts of interest
There are no conflicts of interest.

Patient consent
The patient consent was obtained.

Ethics approval
This study was approval by the local Research Ethics Committee.

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Esophageal mucosectomy in advanced achalasia


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