A short 4-cm oesophageal myotomy relieves the obstructive symptoms of achalasia

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Abstract

Objective: Controversy still persists regarding the ideal length of myotomy to treat oesophageal achalasia. This investigation reports the effects of a short myotomy with an added partial fundoplication for reflux prevention. Methods: From 1997 to 2007, 22 patients (13 men, 9 women, median age: 41 years) with achalasia underwent a 6-cm short myotomy (four oesophagus and two stomach) with a Belsey partial fundoplication by left thoracotomy. Assessments include clinical and radiological evaluation, radionuclide transit studies, manometry, 24-h pH and endoscopy. Results: No morbidity and no mortality occurred. Median follow-up is 54 months (range: 4—139 months). Dysphagia present in all 22 patients left an episodic slow emptying sensation in three patients after operation (p < 0.001). Fresh food regurgitation decreased significantly after the myotomy (17 pre-, four post-regurgitation, p < 0.001). Heartburn present in four patients before the operation was recorded in nine patients postoperatively (p = 0.179). Radiologically, barium stasis decreased significantly from 85% to 30% (p = 0.007). No diverticular formation was seen in the myotomy zone. On the oesophageal scintigram, stasis at 2 min decreased from a median of 60% before the operation to 16% (p < 0.001). The lower oesophageal sphincter (LOS) gradient decreased from 30 to 9.7 mmHg (p < 0.001). LOS relaxation improved from 40% pre- to 93% postoperatively (p = 0.003). Endoscopies and biopsies documented increased mucosal damage after the operation (one preoperative, 13 postoperative; p < 0.001). Conclusions: When treating achalasia, the myotomy, despite being shortened in length, reduces the LOS gradient, relieves obstructive symptoms and improves oesophageal emptying. The LOS relaxation is improved. Complete coverage of the myotomised zone by the fundus prevents diverticular formation. Oesophageal mucosal damage from reflux is significant despite the partial fundoplication.

Keywords: Oesophagus; Achalasia; Myotomy; Fundoplication; Anti-reflux procedure; Gastro-oesophageal reflux

1. Introduction

Achalasia is a primary oesophageal motility disorder characterised by a hypertensive non-relaxing lower oesophageal sphincter (LOS) and aperistalsis of the oesophageal body. These functional abnormalities are attributed to the denervation of the oesophageal muscles [1,2].

A modified Heller’s myotomy is considered at present the most efficient long-term solution. It is often proposed as the first line of treatment [3,4]. Palliation of dysphagia remains the first goal of therapy as the motor dysfunction persists after the operation. The main goal of the oesophagogastroduodenal myotomy is to reduce the abnormal sphincter function by division of sling-and-clasp fibres. However, if left open, pathological reflux will result. The addition of a fundoplication remains necessary to prevent such damage [5].

In 1982, a long myotomy with a total fundoplication to relieve symptoms was documented. The initial follow-up was 19 months [6]. When the oesophagus was re-assessed after more than 10 years, Topart et al. [7] have reported that a total fundoplication, over time, creates too much resistance to allow proper oesophageal emptying. Diverticulum formation appears through the myotomised area over time, and its size is proportional to the length of the myotomy. The fallout of this ‘diverticulisation’ results in liquid and food retention, thus exacerbating patients’ symptoms. This leads to a high re-operation rate (29%) either to take down the Nissen fundoplication or to perform an oesophagectomy [8].

In 2002, we have reported the long-term results of long myotomy and partial fundoplication [8]. It appears that a partial fundoplication creates less obstructive symptoms and
allows better oesophageal emptying. However, with a long-term outcome, diverticulisation of the myotomised oesophagus still appears in two-thirds of the patients. This is further supported by our recent comparison of the long-term results of total and partial fundoplication with a long myotomy [9].

Since then, our group has opted for a short distal oesophageal myotomy totally covered by a partial fundoplication. This attitude was dictated by the need to obtain a surgical solution providing the best functional long-term outcome, allowing relief of symptoms and avoiding the long-term complications of a long myotomy.

This article aims at reporting the functional results of a short oesophagogastric myotomy and partial fundoplication in achalasia patients.

2. Materials and methods

2.1. Patient population

The Institutional Review Board (IRB) of our hospital approved the design of this study, and because of its retrospective nature, the need for patient consent was waived.

Between July 1997 and February 2007, 22 patients (13 males, 9 females) with a median age of 41 years (range: 19–77 years), had a manometric diagnosis of oesophageal achalasia. They underwent a short modified Heller’s myotomy and a Belsey Mark IV partial fundoplication. Four patients had a pneumatic dilatation as a primary approach prior to their operation. Pre- and postoperative assessment included symptoms, radiological observation and oesophageal emptying scintigrams. Manometric evaluation, 24-h pH monitoring and endoscopy with biopsies were obtained.

2.2. Symptom assessment

All patients were assessed for their symptoms either at the outpatient’s clinic or the oesophageal function laboratory. The presence or absence of four symptom categories was recorded without any attempt at quantifying their severity: (1) dysphagia or slow emptying; (2) odynophagia and chest pain independent from swallowing; (3) heartburn with sour-tasting regurgitation or regurgitation of fresh food; and (4) oropharyngeal symptoms including aspiration. Height and weight were recorded.

2.3. Radiology

A standard barium oesophagogram was obtained under fluoroscopic control. Four to six frames per second were recorded. The presence of abnormal contractions, atony, largest transverse lumen diameter, barium stasis, abnormal out-pouching of the mucosa in the myotomised zone and visual gastro-oesophageal reflux were assessed.

2.4. Oesophageal emptying scintigram

The oesophageal emptying capacity was assessed after a 4–6-h fast. The patient stands upright in front of a large-field-of-view scintillation camera interfaced to a computer and equipped with a low-energy, all-purpose, parallel-hole collimator. After ingestion of a 10-ml bolus of water labelled with 1.0 mCi of sulphur colloid Tc-99m, computerised data are acquired at 0.5-s intervals for 2 min over the whole oesophageal region. The time for oesophageal clearance of 25%, 50%, 75% and 90% of the ingested radioactive water, and the oesophageal stasis at 2 min were recorded. Oesophageal stasis at 2 min was considered the end result of the oesophageal emptying capacity.

2.5. Manometry

Fasting patients were assessed using a four-lumen, polyvinyl motility catheter (Mui Scientific, Mississauga, ON, Canada). Each lumen had an internal diameter of 0.8 mm with the orifices opening at 5-cm intervals and radially oriented at 90°. The recording tube was introduced through the nose and connected to external transducers (Hewlett Packard, 1290C, Corvallis, OR, USA) placed at the head level. Pressures were pre-amplified and recorded on a four-channel physiograph (Gould, TA-11, Valley View, OH, USA). Constant low-volume perfusion (0.3 ml min⁻¹ for each channel) was obtained by a pneumohydraulic perfusion system (Mui Scientific, PIP-3) using 776 mmHg (15 psi) of pressure for both the oesophageal body and sphincters. Transducers were calibrated before and after each study, using atmospheric pressure as the zero baseline. Ten wet swallows of 2 ml of water were given to the patient, while pressures were recorded in each of the four specific oesophageal areas: the upper oesophageal sphincter (UOS), the proximal and distal half of the oesophageal body and the LOS area. UOS and LOS recordings were performed using a stationary pull-through technique.

Manometric recordings were compared to those of a normal patient population (n = 20, mean age 50.5 years, male:female = 9:11) who underwent a full oesophageal investigation for unrelated symptoms (atypical epigastric or chest pain). These patients had no evidence of oesophageal disease or upper gastrointestinal (GI) pathology following their evaluations.

2.6. 24-h pH recording

An ambulatory pH recorder (Sandhill, RDL, Littleton, CO, USA) was used to assess the reflux events in the oesophagus. After calibration, the antimony electrode was placed 5 cm above the gastro-oesophageal junction previously identified and localised by manometry. A pH < 4 was interpreted as acid reflux. Results were computed over a 24-h period. The total number of reflux episodes, episodes of reflux with a duration greater than 5 min, total time of acid exposure in minutes and total percentage of acid exposure over time were the retained parameters.

2.7. Endoscopy

Endoscopic examinations were performed using a video-monitoring system (Olympus, GIF-130, Olympus Canada, Toronto, ON, Canada). Mucosal lesions were recorded using the Armstrong’s MUSE system where metaplasia, ulcer, stricture and erosion were quantified [10]. Liquid or food
Retention and the presence or absence of diverticulum formation in the myotomised area were recorded.

2.8. Operation

All the patients were operated through a left posterolateral thoracotomy above the eighth rib. The lower oesophagus was mobilised and both vagi were protected. Anterior and lateral Hiatal attachments were taken down. The cardia and the whole gastric fundus were mobilised into the distal chest. A 50 Maloney bougie was positioned into the stomach and used as an oesophageal stent during the completion of the myotomy across the oesophagogastric junction. The muscle was incised over the last 4 cm of the oesophagus and extended 2 cm on the gastric wall musculature. The myotomised muscle is freed from the mucosa over 50% of the circumference. At the distal limit of the myotomy, lateral muscle transection of the elevated muscle allowed eversion of a muscle flap to avoid re-closure of the myotomy. The everted muscularis served as an anchor point for a partial Belsey Mark IV type fundoplication. Two levels of 2/0 silk sutures were applied 2 cm apart to suture the partial fundoplication to the transected and everted muscularis. The apex of the fundoplication was tied to the transected muscle of the proximal limits of the myotomy. No freed mucosa was left uncovered. Once completed, the fundoplication was reduced under the diaphragm and the most proximal row of sutures was transfixed through the diaphragm to be tied above the diaphragm in the chest. The immobilised posterior hiatus was left untouched behind the oesophagus (Fig. 1).

2.9. Statistical analysis

In order to provide reliable pair-wise comparison, only patients with available functional assessment before and after the operation were included in the statistical analysis. The comparison between the control group information and the preoperative manometric information was analysed with the non-parametric Mann—Whitney test. Values are expressed as median and range or mean and standard deviation, as appropriate. Related dichotomous variables were analysed by the McNemar test (two-tailed test). The Wilcoxon test was used for comparing between paired continuous variables (preoperative and postoperative data). A p-value less than 0.05 is considered statistically significant.

3. Results

There was no morbidity and no mortality. Two mucosal punctures were identified in the myotomised zone and repaired primarily before complete coverage by the fundoplication. The median hospital stay was 7 days (range: 6—12 days). The mean height of the patients was 170 cm (range: 152—182 cm) and their weight was 68.1 kg (range: 47—95 kg) at operation. The median follow-up was 54 months (range: 4—139 months).

3.1. Symptoms

The pre- and postoperative symptoms are detailed in Table 1. Dysphagia was present in all patients, and it had been present for 24 months (range: 6—564 months). Fresh food regurgitation affected 77% of the group. Both symptoms were reduced significantly. Improvement persisted over time after the operation without frank dysphagia. Three patients mentioned episodes of slow emptying after the operation. Pain on swallowing and episodes of chest pain disappeared.
Four patients complained of heartburn before the operation and this number increased to nine after surgery ($p = 0.17$).

Body weight increased significantly after the myotomy (preoperative: 68 kg (range: 47—95 kg), postoperative: 71.1 kg (range: 55—108 kg), $p = 0.001$).

3.2. Radiology

The radiologic evaluation is summarised in Table 2. Stasis could be seen in 17 of 20 patients before the operation. This was reduced to six patients after the repair ($p = 0.007$). The oesophageal preoperative diameter of 4 cm (range: 2—7 cm) decreased to 3.1 cm (range: 2—4 cm) after the operation ($p = 0.001$). No diverticular formation could be observed in the myotomised zone. Tertiary contractions became more evident after the reduction of the oesophageal diameter.

3.3. Radionuclide emptying

The information on oesophageal emptying capacity in 18 patients is summarised in Fig. 2. A significant improvement is observed after the operation. Stasis at 2 min was 60% (range: 15—90%) before myotomy, and it decreased to level of 16% (range: 3—31%) after the myotomy ($p < 0.001$).

3.4. Manometry

Table 3 first compares the motor function of the achalasia patients with that of the control group. High resting pressures with weak contractions and absent peristalsis are recorded in the achalasia group. An elevated LOS resting and gradient pressure with poor relaxation is observed.

The effects of the operation on preoperative function were recorded in 17 patients. Resting pressures are decreased in both the proximal and distal halves of the oesophagus. A return of peristalsis is recorded in 40% of swallows in the proximal oesophagus. The distal oesophagus remains aperistaltic. At LOS level, resting and closing pressures and the measured gradient between stomach and oesophagus are all significantly reduced. A return of the relaxation phase in the high-pressure zone is observed.

3.5. 24-h pH monitoring

The 24-h oesophageal pH recording when available was obtained in 15 patients before the myotomy and in 10 patients after. Eight patients were eligible for a pair-wise
comparison before and after the operation. The recorded parameters are summarised in Table 4. No significant change is observed in those eight patients, but increased reflux episodes and more minutes of acid exposure were recorded after the operation.

### 3.6. Endoscopy and pathology

Seventeen of the 22 patients were assessed pre- and postoperatively by endoscopy and biopsies. Their findings are summarised in Table 5. Food and saliva retention that was observed in 13 of 17 patients before the operation was not seen after surgery \( (p < 0.001) \). No diverticular formation was observed. Mucosal erosions appeared on the oesophageal mucosa in six of 17 patients, and a junctional ulcer was seen in one patient after the operation.

Pathologic documentation of reflux damage was present postoperatively in 13 patients. This was described most often as inflammation characterised by inflammatory infiltrate in the squamous epithelium. One patient had documented intestinal metaplasia at the mucosal junction after the myotomy. In two patients, biopsies documented the margins of ulceration. No dysplasia was observed over time.

### 4. Discussion

Oesophageal myotomy for achalasia decreases the LOS resting pressure without completely abolishing it. Over time, the physiological effects of the myotomy on the sphincter remain stable \([6,11]\). For the 22 patients in this cohort, we have used a short distal oesophageal myotomy extending 2 cm on the gastric musculature. Lateral transsection of the muscle towards the anterior and posterior smaller curvature removed the clasp-and-sling-fibre effect. Even if made short, the myotomy reduces the LOS dysfunction but retains the oesophageal musculature. Better emptying is obtained, and resting pressure is reduced. In the proximal half of the oesophagus, peristalsis partly returns after this myotomy just as was observed with longer myotomies. This return of propulsion persists over time \([6,11]\). In the smooth muscle oesophagus however, the contractions remain aperistaltic and powerless after the myotomy.

The oesophageal myotomy length has been reported to extend as much as 12 cm on the proximal oesophagus \([9]\). It has also been suggested that it could be made as short as 3 cm \([11,12]\). Fig. 3 summarises the different length of oesopha-gogastric myotomies that were used and proposed in the surgical literature. When Ellis investigated the effects of extending the myotomy longer on the oesophagus, he reported that a longer myotomy resulted in reflux for one-third of the operations. A shorter myotomy had the same effects on the LOS pressure gradient but resulted in less reflux \([13,14]\). Based on these observations, he limited the myotomy to the distal oesophagus, leaving a small subhiatal portion of the LOS intact to prevent reflux \([12,14,15]\). Subsequently, Chen reported that a longer myotomy extending onto the stomach results in a reduced LOS gradient and better emptying. Distal oesophageal contractions are made weaker and remain aperistaltic \([8]\). With an evolution of 7—19 years, long myotomy results in 67% of the patients developing a mucosal diverticulum through the
mytomised area. Eventually, these diverticula lead to food retention and recurrent symptoms. Removing the lower sphincter effects without altering the oesophageal musculature has not been assessed. Our small group of patients reveals that if a myotomy is made short in order to remove solely the obstructive effects of the LOS, it produces the same functional results on the oesophageal body function than a longer extensive myotomy. The ‘diverticulisation’ of the mytomised area is prevented by the fundoplication covering the myotomy.

Distal extension of the myotomy on the stomach wall has varied significantly over the years. Ellis kept it to a minimum to preserve part of the sphincter, hoping that this would be a sufficient protection against reflux [15]. A number of authors have reported a gastric extension of the myotomy from 1 to 4 cm [11,12,16]. Di Martino et al. have reported that extending the myotomy 2–3 cm on to the stomach is more effective in ablating the LOS and to relieve dysphagia [17]. Oelschlager extended the myotomy 3 cm on the stomach wall [18]. They added a 270° Toupet fundoplication for reflux prevention. Comparing this 3-cm myotomy to a 1.5-cm extension on the stomach, they report more efficient lowering of the LOS resting pressure than the shorter one. They also observed that the shorter extension on the stomach results in more dysphagia episodes. The same group subsequently provided further evidence that the 3-cm extension of the myotomy on the gastric wall relieved dysphagia better than a shorter one [19]. Their explanation for this success is a more complete division of the sling-fibre component of the LOS. Our observation also suggests that despite a myotomy made short on the oesophagus and extending to divide the cardia musculature, adequate ablation of the abnormal LOS function results. The sphincter gradient is reduced to one-fourth of its initial value. Oesophageal emptying and symptoms are improved.

When the hyper-functioning LOS responsible for the functional oesophageal obstruction is sacrificed, pathologic gastro-oesophageal reflux will result with a high probability. Adding an anti-reflux repair to prevent mucosal damage has to take into consideration oesophageal mucosal protection on the one hand and the emptying capacity of an aperistaltic and powerless oesophageal body on the other hand. Richard et al., in their prospective and randomised observation, reported a reduction from 47% to 9% of the pathologic reflux if a Dor fundoplication is added after the myotomy [5]. Rice et al. reported on their experience of 149 patients (88 patients with fundoplication and 61 without any anti-reflux protection). Better protection was afforded by the partial fundoplication [20]. The Dor partial fundoplication however still allows pathologic reflux with a 32–54% abnormal DeMeester’s score, influenced by the gastric extent of the myotomy [18,19]. As Csendes pointed out with Dor fundoplication, there is a progressive clinical deterioration of initially good results if a very long follow-up is performed (23 years after surgery), mainly due to an increase in pathologic acid reflux disease and the development of short- or long-segment Barrett oesophagus in approximately 20% of the patients. In our hands, a partial Belsey-type fundoplication is not sufficiently competent to prevent occurrence of reflux [24]. It results in increased mucosal damage in the distal oesophagus in up to two-thirds of our 22 patients.

A total fundoplication is a better anti-reflux protection when treating gastro-oesophageal reflux disease. However, in an oesophagus made powerless by a long myotomy, such an anti-reflux protection has been reported to result in functional obstruction [7]. Six years after a long myotomy, the use of a partial Belsey fundoplication has been reported to cause less obstruction, less dilatation and less retention [8]. A longer follow-up may well show different results. The ideal reflux protection, if selective removal of the LOS is obtained in achalasia patients, remains to be described.

To date, there is no discussion that laparoscopic myotomy is the preferred approach when treating dysphagia in achalasia patients [23]. However, we have always emphasised that for the surgeon the best and safest (patient-wise) approach remains the one that he is more familiar with. Success in the control of dysphagia depends on how the operation is completed when it is done at the first attempt. To our knowledge, there has been no level-1 evidence that one approach over the other is better with regard to the length of the myotomy, its extension on the stomach and the anti-reflux repair. The indications to treat achalasia patients have not changed and the surgical approach to do it remain optional. It has been suggested that laparoscopic approach offers similar symptomatic outcomes to that of the open Heller myotomy, but with superior quality-of-life outcome domains of physical functioning and bodily pain [25]. These data are likely to deserve further investigations.

This retrospective observation has several limitations. Although it represents an evolution in thinking after treating patients with achalasia initially by a long myotomy and a total fundoplication and then by a myotomy with a partial fundoplication, it now presents a small cohort of patients with a much shorter myotomy and a partial fundoplication covering the whole area that has been myotomised. Only a prospective and randomised study comparing this solution with the more current approaches will clarify the question.

In summary, this small patient cohort with achalasia treated by a short myotomy fully covered by a partial fundoplication reveals that good dysphagia relief is afforded by the operation. Complete coverage of the myotomised area by the partial fundoplication prevents the appearance of a diverticulum through the myotomised zone. As performed here, a Belsey partial fundoplication does not protect against pathological gastro-oesophageal reflux. Although unwarranted with a long myotomy, a total fundoplication completely covering a myotomised LES area with the rest of oesophageal musculature intact has not been investigated. Complete palliation of dysphagia and full protection against postoperative reflux remain the main goals when treating achalasia patients.

References

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