De Aquino *et al. Mini-invasive Surg* 2017;1:167-72
DOI: 10.20517/2574-1225.2017.29

Mini-invasive Surgery
www.misjournal.net

Topic: Achalasia Management: the South American viewpoint | Open Access

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

Jose Luis Braga De Aquino, Marcelo Manzano Said, José Gonzaga Teixeira De Camargo

Department of Surgery, Medical School, Catholic University at Campinas, Campinas, SP 13015-192, Brazil.

Correspondence to: Dr. Jose Luis Braga De Aquino, Department of Surgery, Medical School, Catholic University at Campinas, Boaventurado Amaral, 1190, ap. 12-CEP, Campinas, SP 13015-192, Brazil. E-mail: jlaquino@sigmanet.com.br

How to cite this article: De Aquino JLB, Said MM, De Camargo JGT. Non-conventional surgical approach to achalasia: mucosectomy and endomuscular pull-through. *Mini-invasive Surg* 2017;1:167-72.

Article history:
Received: 27 Jul 2017
First Decision: 10 Aug 2017
Revised: 1 Oct 2017
Accepted: 14 Oct 2017
Published: 28 Dec 2017

Key words:
Achalasia,
esophagectomy,
megaesophagus,
mucosectomy

ABSTRACT

Aim: Transhiatal esophagectomy is a therapeuthic 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 stomachthourgh 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 efusion 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.

INTRODUCTION

Idiopathic and chagasic achalasia have different etiology but, apart from this fact, both diseases share the same clinical, radiologic, endoscopic and manometric presentations. Thus, any therapeutic modality may be applied equality irrespective of etiology.

Different approaches have been proposed to treat this disease, such as endoscopic dilatation, esophageal caliber-reducing operations, operations on the diaphragm or esophageal extrinsic innervation, cardiectomy, cardioplasties, transthoracic and transhiatal esophagectomy. Neither treatment; however, seems to be ideal since they do not act directly on the physiopathology of the disease[1-5].

Quick Response Code:

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 striping 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.

Table 1: Clinical evaluation

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

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

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

Medestinal fluid	Compression of the graft	Medestinal esophageal muscular layer	Grade
Absence	Absence	Observed	1
Present	Present	Not observed	0

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

Medestinal fluid	Compression of the graft	Medestinal esophageal muscular layer	Displacement of the graft	Grade
Absence	Absence	Observed	Absence	1
Present	Present	Not observed	Present	0

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

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].

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.

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.

Table 4: Upper digestive endoscopy evaluation

Esophagastrostomy patency	Gastrododenal junction patency	Macroscopic esophageal mucosa evaluation	Macroscopic gastric mucosa evaluation	Grade
Stenosis not present	-	Normal mucosa	Normal muscosa	3
Mild stenosis	-	Esophagitis grade A*	Mild gastritis	2
Moderade stenosis	Patency	Esophagitis grade B*	Moderade gastritis	1
Severe stenosis	Not patency	Esophagitis grade C/D*	Severe gastritis	0

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

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

Long-term 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[11,12,20,21]. 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.

Esophagogastrostomy leak was found in this technique in a rate similar to other series[14,21,23]. 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[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.*[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[8,25]. Aquino *et al.*[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[26].

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[19].

Long-term follow-up (between 10-15 years) in 42 patients showed excellent and good results in over 80%[30]. 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[13,21].

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 metaplasia, dysplasia and even carcinoma transformation in the esophageal stump[27-29]. Some authors opt for chronic use of proton pump inhibitors after esophagectomy to prevent acid esophagitis in the stump[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 review: J.G.T. De Camargo

Financial support and sponsorship

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.

REFERENCES

1. Rezende JM. História da cirurgia da acalásia do esôfago e do megaesôfago chagásico. Avaliable from: http://www.jmrezende.com.br/acalasia1.htm. [Last accessed on 20 Nov 2017]
2. Aquino JLB, Said MM, Pereira EVA, Kelmann BV, Oliveira MB. Tratamento cirúrgico do megaesôfago recidivado. *Rev Col Brás Cir* 2007;34:310-13.
3. Aquino JLB, Said MM, Leandro-Merhi VA, Ramos JP, Ichinohe LH, Machado DGG. Avaliação da esofagocardioplastia no tratamento cirúrgico do megaesôfago não avançado recidivado. *ABCD Arq Bras Cir Dig* 2012;25:20-4.
4. Aquino JL, Said MM, Pereira DA, Leandro-Merhi VA, Nascimento PC, Reis VV. Early and late assessment of esophagocardioplasty in the surgical treatment of advanced recurrent megaesophagus. *Arq Gastroenterol* 2016;53:235-9.
5. Herbella FA, Aquino JL, Stefani-Nakano S, Artifon EL, Sakai P, Crema E, Andreollo NA, Lopes LR, de Castro Pochini C, Corsi PR, Gagliardi D, Del Grande JC. Treatment of achalasia: lessons learned with Chagas' disease. *Dis Esophagus* 2008;21:461-7.
6. Kirschner M. Operacionesenlacavidad torácica. Intervenciones enel carcinoma del esófago. In: Tratado de técnica operatoria general y especial - Parte 2. Barcelona: Editorial Labor; 1944. p. 985-1020.
7. Parrilla Paricio P, Aguayo Albasini JL, Ponce Marco JL. "Stripping" esofágico submucoso como técnica de esofagectomíasin toracotomia. Estudoclínico y experimental. *Cir Esp* 1984;38:546-52.

8. Saidi F, Abbassi A, Shadmehr MB, Khoshnevis-Asl G. Endothoracicendoesophageal pull-through operation. A new approach to cancers of the esophagus and proximal stomach. *J Thorac Cardiovasc Surg* 1991;102:43-9; discussion 49-50.
9. Aquino JLB. Tratamento do megaesofago pela mucosectomia com conservação da túnica muscular esofágica por via cervico abdominal. Tese (Doutorado). Faculdade de Ciências Médicas da Universidade Catolica de Campinas, 1996. (in Portuguese)
10. Ferreira EA. Subtotal esophagoplasty by combined cervico-abdominal route: its possible use in megaesophagus. *Rev Paul Med* 1973;82:133-4. (in Portuguese)
11. Ferreira EAB. Esofagectomia subtotal e esofagogastroplastiatransmedi astinal posterior sem toracotomia no tratamento do megaesofago. Tese (livre-docência) - Faculdade de Medicina, Universidade de São Paulo, 1975. (in Portuguese)
12. Orringer MB, Stirling MC. Esophageal resection for achalasia: indications and results. *Ann Thorac Surg* 1989;47:340-5.
13. Orringer MB, Marshall B, Stirling MC. Transhiatal esophagectomy for benign and malignant disease. *J Thorac Cardiovasc Surg* 1993;105:265-76; discussion 276-7.
14. Aquino JLB, Said, MM, Merhi LVA, Ischione L, Ramos JPZ, Guimarães DM. Analise das complicações da esofagectomia transmediastinal no tratamento cirúrgico do megaesôfago recidivado. *ABCD Arq Bras Cir Dig* 2011;24:20-4.
15. Camara-Lopes LH. Carcinoma of the esophagus as a complication of megaesophagus: an analysis of seven cases. *Am J Dig Dis* 1961;6:742-56.
16. Goodman P, Scott LD, Verani RR, Berggreen CC. Esophageal adenocarcinoma in a patient with surgically treated achalasia. *Dig Dis Sci* 1990;35:1549-52.
17. Oberg S, Johansson J, Wenner J, Walther B. Metaplastic columnar mucosa in the cervical esophagus after esophagectomy. *Ann Surg* 2002;235:338-45.
18. Aquino JLB, Moraes SP, Martinez SE, Said MM, Reis Neto JA. Esofagectomia submucosa. *Acta Cir Bras* 1989;4:64.
19. Aquino JLB, Said MM, Pereira DAR, Machado FR, Ramos JPZ, Brandi Filho LA, Leandro Merhi VA. Analise comparativa da mucosectomia esofágica e da esofagectomia transmediastinal no tratamento do megaesôfago avançado: Estudo comparativo em 229 pacientes. Anais do XXXII Congresso Brasileiro de Cirurgia, 2017. (in Portuguese)
20. Ferreira-Santos R. Aperistalsis of the esophagus and colon (megaesophagus and megacolon) etiologically related to Chagas' disease. *Am J Dig Dis* 1961;6:700-26.
21. Orringer MB, Marshall B, Chang AC, Lee J, Pickens A, Lau CL. Two thousand transhiatal esophagectomies: changing trends, lessons learned. *Ann Sur*g 2007;246:363-72; discussion 372-4.
22. Pinotti HW. Subtotal esophagectomy by transmediastinal tunnel without thoracotomy AMB. *Rev Assoc Med Bras* 1977;23:395-8. (in Portuguese)
23. Cecconello I, Polara W, Zilberstein B, Sallum RA, Pinotti HW. Esofagectomia transmediastinal no megaesofago. *Rev Col Bras Cir* 1988;15:76-9.
24. Aquino JLB .Sutura manual e mecânica da anastomose esofagojejunal. Analise clinica em 38 gastrectomias totais. Tese (Mestrado). Faculdade de Ciências Médicas. UniversidadeEstadual de Campinas,1990. (in Portuguese)
25. Saidi F. Endoesophagealpull through. A technique for the treatment of cancers of the cardia and lower esophagus. Ann Surg 1988;207:446-54.
26. Potter SE, Holyoke EA. Observations on the intrinsic blood supply of the esophagus. *AMA Arch Surg* 1950;61:944-8.
27. Pochini Cde C, Gagliardi D, Saad Júnior R, de Almeida RF, Corsi PR. Esophagectomy with gastroplasty in advanced megaesophagus: late results of omeprazole use. *Rev Col Bras Cir* 2015;42:299-304.
28. da Rocha JR, Ribeiro U, Cecconello I, Sallum RA, Takeda F, Nasi A, Szachnowicz S. Gastric secretory and hormonal patterns in end-stage chagasic achalasia. *Dis Esophagus* 2009;22:606-10.
29. da Rocha JR, Ribeiro U Jr, Sallum RA, Szachnowicz S, Cecconello I. Barrett's esophagus (BE) and carcinoma in the esophageal stump (ES) after esophagectomy with gastric pull-up in achalasia patients: a study based on 10 years follow-up. *Ann Surg Oncol* 2008;15:2903-9.
30. Aquino JLB, Said MM, Pereira DAR, Machado FR, Ramos JPZ, Brandi Filho LA, Leandro Merhi VA. Avaliação comparativa dos resultados tardios do tratamento cirúrgico do megaesôfago avançado pela mucosectomia esofágica versus esofagectomia transmediastinal: Estudo retrospectivo em 79 pacientes com 15 anos de pós operatório. Anais do XXXII CongressoBrasileiro de Cirurgia, 2017. (in Portuguese)