PAPER

Predictors of Long-term Outcome After Laparoscopic Esophagomyotomy and Dor Fundoplication for Achalasia

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Objective: To identify predictors of long-term outcome of laparoscopic Heller myotomy for achalasia, including predictors of heartburn and recurrent dysphagia, which occasionally develop postoperatively.

Design: Retrospective review using interviews of patients.

Setting: Academic university hospital.

Patients: One hundred sixty-five patients with achalasia who underwent a laparoscopic esophagomyotomy and Dor fundoplication.

Main Outcome Measures: Dysphagia and heartburn before and after the operation were assessed on a 4-point Likert scale, as were postoperative dilations, reoperations, and antacid use. Potential predictors were age, race, sex, body mass index, weight loss, duration of symptoms, manometry findings, esophageal diameter, previous treatment, and operative technique.

Results: Follow-up averaged 62 (range, 1-174) months. Dysphagia frequency was once a week or less in 128 patients (78%), several times per week in 25 (15%), and daily in 12 (7%). Satisfaction scores averaged 3.7 on a 4-point scale. Thirty patients (18%) required a postoperative dilation, and 6 (4%) underwent another operation. The only predictor of postoperative dysphagia was duration of symptoms longer than 10 years (odds ratio, 0.2; $P=.03$). Preoperative dilations predicted the need for postoperative dilations (odds ratio, 2.4; $P=.03$). Only 20 patients (12%) reported heartburn more than once weekly, although 75 (45%) reported taking antacids. No variable predicted postoperative heartburn or antacid use.

Conclusions: Long-term outcomes after laparoscopic esophagomyotomy were excellent across a wide spectrum of disease severity and presentations. Previous treatments, such as balloon dilation or botulinum toxin (Botox) injection, did not portend worse outcomes. When the myotomy was extended 2 cm onto the stomach and a Dor fundoplication was performed, severe heartburn was rare.

Arch Surg. 2011;146(9):1024-1028

ACHALASIA PRODUCES SEVERE dysphagia due to loss of primary esophageal peristalsis and impaired relaxation of the lower esophageal sphincter (LES). Because no therapy can restore peristalsis, treatment involves division of the LES, eliminating it as a barrier to gravity. Although botulinum toxin (Botox) injection and balloon dilation of the LES are theoretical treatment alternatives, their effects are short-lived, and dilation runs the risk of esophageal perforation.[1-5] Thus, laparoscopic Heller myotomy is widely considered the best first-line therapy for achalasia.[1,4,6-14]

See Invited Critique at end of article

Although the dysphagia almost always improves after a myotomy, it occasionally returns later. Furthermore, because gastroesophageal reflux is a risk and has been implicated as a cause of late treatment failures, a fundoplication is recommended to accompany the myotomy.[15] Prior investigations of treatment failures have studied the degree of dilatation and tortuosity of the esophageal body, the manometric behavior of the LES, previous nonoperative treatments, and technical factors of the operation itself (eg, overall myotomy length or length of the gastric extent and the type of fundoplication).[2,3,10,16-20] Nevertheless, these reports are limited by short follow-up and small cohort size.

In this study, we assessed long-term outcomes after laparoscopic Heller esophagomyotomy and Dor fundoplication using a structured patient interview. We then looked for predictors of the outcomes.

METHODS

We analyzed the course of 249 consecutive patients who underwent a laparoscopic Heller esophagomyotomy and Dor fundoplication for

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achalasia at the University of California, San Francisco, from January 1, 1994, through December 31, 2010. The study was approved by the university institutional review board, and consent was obtained. Patients who had undergone previous operations for achalasia elsewhere were excluded. In all patients, the diagnosis was confirmed by esophageal manometry. An upper gastrointestinal tract radiographic series was performed to evaluate esophageal shape and diameter, and endoscopy was used to rule out a malignant or peptic stricture of the gastroesophageal junction.

The following information was obtained for each patient: age, race, body mass index (calculated as weight in kilograms divided by height in meters squared), clinical history, duration of symptoms, distal esophageal pressure during wet swallows, LES pressure, esophageal diameter, and history of treatments for achalasia. The severity of preoperative and postoperative dysphagia, regurgitation, chest pain, and heartburn was retrospectively scored by the patients as excellent (0 indicates no dysphagia; 1, only once or twice a month), good (2, occasional dysphagia, at most once a week), fair (3, frequent dysphagia, several times per week, often requiring dietary adjustments), or poor (4, severe daily dysphagia, often preventing ingestion of solid food).

Each patient underwent laparoscopic esophagomyotomy and Dor fundoplication according to techniques previously described.[21] Operative reports were reviewed, and the length of the myotomy, length of gastric extension, and type of fundoplication were recorded. Intraoperative and postoperative complications were also recorded, including the need for postoperative dilation or revisional surgical procedures at any time within the follow-up.

The patients were interviewed by telephone or mailed questionnaire. Of the 249 patients who underwent a myotomy, follow-up was complete for 173 (69%), of whom 165 were interviewed. Eight patients who died of a cause unrelated to the operation were excluded. The severity of dysphagia, regurgitation, heartburn, and chest pain was reassessed on a 4-point Likert scale. The patients were also asked whether they had received additional treatment, such as an endoscopic dilation or another operation. Only patients who were available for follow-up were included in the analysis.

The 3 primary outcome measures were as follows: (1) dysphagia occurring more than once a week, often requiring dietary modifications (ie, a dysphagia symptom score of 3 or 4); (2) the need for postoperative dilation; and (3) the use of antacids. For each outcome measure, possible predictors were tested in regression models. For continuous variables, we first performed a quartile analysis across the range of independent values and then chose the best cutoff for the regression model accordingly. Statistical significance throughout was defined as $P<.05$.

Table 1. Characteristics of Patients Who Underwent Esophagomyotomy and Dor Fundoplication for Achalasia

Characteristic	No. (%) (N=165)
Preoperative	
Age, mean (range), y	49 (14-93)
Duration of symptoms, mean (range), mo	94 (2-696)
Race	
Nonwhite	36 (22)
White	113 (68)
Unknown	16 (10)
Sex	
Male	74 (45)
Female	91 (55)
BMI, mean (range)	26 (16-47)
Clinical history	
Food impaction requiring upper endoscopy	6 (4)
Weight loss >4.5 kg	65 (39)
Manometry	
LES pressure >25 mm Hg, %	46
LES relaxation absent, %	38
Distal esophageal amplitude, mean (SD), mm Hg	30 (33)
Esophageal diameter >6 cm, %	28
Prior treatment with balloon dilation, %	42
Prior treatment with botulinum toxin, %	19
Symptom scores, mean (SD)	
Dysphagia	3.8 (0.5)
Regurgitation	3.2 (1.3)
Heartburn	2.0 (1.7)
Chest pain	1.7 (1.7)
Operative	
Entirely laparoscopic procedure, %	97
Esophagomyotomy >6 cm in length, %	87
Gastric extension >1.5 cm in length, %	61
Dor (180°) fundoplication performed, %	97
Postoperative	
Follow-up, mean (range), mo	62 (1-174)
Symptom scores, mean (SD)	
Dysphagia	1.3 (1.3)
Regurgitation	0.7 (1.0)
Heartburn	1.0 (1.1)
Chest pain	0.6 (1.0)
Postoperative dilation required	30 (18)
Reoperation required	6 (4)
Taking antacids at follow-up	75 (45)
Satisfaction score, mean (SD)	3.7 (0.7)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); LES, lower esophageal sphincter.

RESULTS

The presenting characteristics of the 165 patients (**Table 1**) show a wide range of ages and duration of symptoms, including 1 patient who had dysphagia for more than 50 years before achalasia was diagnosed. Mean BMI was 26, and 22% were obese (BMI, >30). Despite severe dysphagia, weight loss of more than 4.5 kg was relatively uncommon (39% of patients). Only 46% had a hypertensive LES, and some degree of LES relaxation was present in 62%. All patients had aperistalsis of the body of the esophagus. Less than half (28%) presented with a dilated (>6 cm) esophagus; 9% had a sigmoid esophagus.

Overall, 19% of the 165 patients had been treated preoperatively with botulinum toxin and 42% with balloon dilation, but the number of patients who received these treatments evolved during the study period. Before 2000, 25% of the patients had been treated with botulinum toxin, but the recognition of its weak efficacy resulted in a drop to 13% afterward. Similarly, the percentage of patients who had been treated with balloon dilation fell from 50% to 30% during the study period.

Most of the patients (97%) underwent an entirely laparoscopic procedure. The extent of the myotomy onto the stomach changed during the study period. It was 1.0 cm through 2000, whereas afterwards it increased to 1.5 to 2.0 cm. Most of the patients (97%) underwent a 180° Dor fundoplication to prevent gastroesophageal reflux. No deaths occurred within 30 days of the operation. A report about complications was published elsewhere.[22]

Follow-up averaged 62 (range, 1-174) months. Seventy-six patients had more than 5 years of follow-up, and

Table 2. Predictors of Dysphagia Occurring More Than Once a Week[a] at Follow-up in Patients Who Underwent Esophagomyotomy and Dor Fundoplication for Achalasia

Variable	OR (95% CI)	*P* Value
Age per decade	1.2 (0.9-1.4)	.15
White race	1.1 (0.5-2.9)	.76
Male sex	1.6 (0.8-3.3)	.20
History of food impaction requiring endoscopy	0.7 (0.1-6.2)	.76
>4.5-kg weight loss	0.8 (0.3-1.7)	.51
BMI >30	2.1 (0.7-4.4)	.21
Duration of symptoms >10 y	0.2 (0.04-0.9)	.03
LES resting pressure >25 mm Hg	0.6 (0.2-1.4)	.21
LES relaxation present (partial or complete)	0.6 (0.2-1.5)	.27
LES length >3 cm	1.1 (0.3-3.8)	.83
Esophageal diameter >6 cm	2.3 (0.8-7.1)	.13
Sigmoid esophagus	1.4 (0.2-8.3)	.73
Preoperative dilation performed	0.9 (0.4-1.9)	.80
Preoperative botulinum toxin administered	0.8 (0.3-2.1)	.62
Myotomy length <6 cm	0.9 (0.3-3.0)	.91
Gastric extension <1.5 cm	1.3 (0.6-2.8)	.47
Follow-up >5 y	1.1 (0.5-2.4)	.72

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; LES, lower esophageal sphincter; OR, odds ratio.
[a] Indicates dysphagia symptom score of 3 or 4.

Table 3. Predictors of Postoperative Dilation in Patients Who Underwent Esophagomyotomy and Dor Fundoplication for Achalasia

Variable	OR (95% CI)	*P* Value
Age per decade	1.1 (0.8-1.3)	.69
White race	1.0 (0.4-2.6)	>.99
Male sex	1.3 (0.6-2.8)	.53
History of food impaction requiring endoscopy	1.1 (0.1-10.0)	.92
>4.5-kg weight loss	0.3 (0.1-2.2)	.22
BMI >30	0.2 (0.1-1.9)	.17
Duration of symptoms >10 y	2.4 (0.9-6.5)	.08
LES resting pressure >25 mm Hg	0.6 (0.2-1.7)	.36
LES relaxation present (partial or complete)	0.9 (0.3-2.7)	.80
LES length >3 cm	1.0 (0.3-3.7)	.96
Esophageal diameter >6 cm	1.4 (0.4-4.3)	.59
Sigmoid esophagus	NA	NA
Preoperative dilation performed	2.4 (1.1-5.4)	.03
Preoperative botulinum toxin administered	0.6 (0.2-1.9)	.38
Myotomy length <6 cm	1.2 (0.4-3.9)	.77
Gastric extension <1.5 cm	1.7 (0.8-3.8)	.18
Follow-up >5 y	1.4 (0.7-3.2)	.38

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; LES, lower esophageal sphincter; NA, not applicable; OR, odds ratio.

24 patients had more than 10 years. The myotomy provided excellent long-term relief of dysphagia (the mean symptom score dropped from 3.8 to 1.3), regurgitation (from 3.2 to 0.7), heartburn (from 2.0 to 1.0), and chest pain (from 1.7 to 0.6). Among patients requiring additional procedures, 18% underwent postoperative dilation, and 4% required reoperation. Although most patients with heartburn reported that it was infrequent, 45% were taking antacids at follow-up.

Dysphagia frequency was once a week or less in 128 patients (78%), several times per week in 25 (15%), and daily in 12 (7%). Predictors of postoperative dysphagia occurring more than once a week (ie, dysphagia score of 3 or 4) are shown in **Table 2**. The only predictor of dysphagia in the long run was a prolonged period (>10 years) of preoperative symptoms, which had a protective effect (odds ratio, 0.2; $P=.03$). Patient characteristics, preoperative manometry, esophageal dilation, prior botulinum toxin or balloon dilation treatment, and technical factors had no long-term effects. Patients whose follow-up was longer than 5 years were no more likely than those with follow-up of 5 years or less to report frequent dysphagia, suggesting that the effects of the operation were durable. Satisfaction scores were excellent, averaging 3.7 of a possible 4 points, and more than 90% of patients said they were pleased with the outcome.

Thirty patients (18%) underwent postoperative dilation. In 18 of these, the dysphagia resolved for a period, and then it returned. The dysphagia improved to once a week or less in 18 of the 30 patients (60%) after an average of 1.8 dilations. Most often, Savary dilators (not pneumatic balloons) were used for the dilation. Predictors of the need for postoperative dilation are shown in **Table 3**. Patient characteristics, manometry, preoperative botulinum toxin treatment, and technical factors had no predictive value. Only a history of preoperative dilations predicted the need for postoperative dilations (odds ratio, 2.4; $P=.03$).

Postoperatively, 45% of patients reported taking antacids. No variable predicted antacid use, and importantly, patients who had a longer (>1.5 cm) gastric myotomy were no more likely to take antacids than those with shorter ones. Only 20 patients (12%) reported heartburn more than once a week, and no variable predicted its occurrence.

COMMENT

As this and numerous earlier publications attest, laparoscopic esophagomyotomy and Dor fundoplication give excellent relief of dysphagia for patients with achalasia.[1,3,10,12,19] Complications are rare and results are durable. Because there are so few failures, little is known about why surgery sometimes fails and what, if anything, can be done to prevent it. We report 2 major findings in this regard. First, patient and disease factors known before the operation (ie, patient characteristics, degree of esophageal dilatation or tortuosity, manometry findings, and prior treatments) have little effect on the long-term outcome. Second, when dysphagia occurs after myotomy, it is more often recurrent than persistent. Thus, changes in the esophagus and/or LES that develop after the operation may be more important than preoperative variables with respect to long-term outcome.

Several investigators have sought to define predictors of outcome after a Heller myotomy. Schuchert et al[16] described 200 patients with achalasia who underwent laparoscopic esophagomyotomy and partial fundoplication with a mean follow-up of 32 months. The following 4 variables predicted postoperative dysphagia: prior endoscopic therapy, long duration of symptoms, sig-

moid esophagus, and low LES resting pressure. Most failures occurred within 18 months. Zaninotto et al[10] reported 400 laparoscopic myotomies with a mean follow-up of 30 months. High LES resting pressure predicted success, whereas chest pain and sigmoid esophagus independently predicted a higher risk of failure. Torquati et al[2] described 200 patients with a mean follow-up of 42 months. Only high LES resting pressure predicted a higher success rate. Finally, Khajanchee et al[3] reviewed 121 patients with mean follow-up of 9 months and found nothing predictive of postoperative dysphagia.

Among our patients, 22% experienced dysphagia more than once per week after laparoscopic esophagomyotomy after a mean follow-up of 62 months. Only duration of symptoms longer than 10 years was predictive of postoperative dysphagia; it had a protective effect. Because the effect was modest and is the opposite of the finding by Schuchert et al,[16] we suspect that it is probably of little or no importance. Contrary to other reports, prior treatment with botulinum toxin or balloon dilation had no effect on outcome, nor did esophageal dilatation or sigmoid esophagus.

Some of our patients were relatively dysphagia free for a period after the operation, and then the dysphagia returned. Of 30 patients with postoperative dysphagia treated with dilation, the dysphagia was recurrent in 18 (60%). Most (18 [60%]) responded to Savary dilation, and their dysphagia subsequently decreased to less than once a week. This finding suggests that incomplete myotomy is not the dominant mechanism for failure, because incomplete myotomy would result in persistent (not recurrent) dysphagia and should not resolve so easily after 1 or 2 dilations. We suspect that obstructive scar tissue or distortion of the myotomy develops in these cases. The only predictor of the need for postoperative dilation was a history of preoperative dilation. This may be the result of referral bias; patients referred from centers performing dilations for achalasia may be more likely to undergo "touch-up" with a postoperative dilation in an effort to maximize results.

Heartburn was uncommon; 20 patients (12%) had heartburn more than once a week. Mean heartburn scores dropped from 2.0 to 1.0 postoperatively. Nonetheless, on late follow-up, almost half of patients were using antacids, for obscure reasons. There were no predictors of heartburn or antacid use. It is well recognized that heartburn correlates poorly with objective measures of gastroesophageal reflux after myotomy.[3] When measured by means of 24-hour ambulatory pH monitoring, about 30% of postmyotomy patients without a fundoplication have gastroesophageal reflux; when a fundoplication is included, the rate is 9%.[1] Because symptoms are unreliable indices of reflux, some have advocated the routine prescription of acid-suppressing agents after myotomy to minimize risk of peptic stricture, Barrett esophagus, and adenocarcinoma,[3,15] but our results suggest that this is unnecessary. We had only 1 case of Barrett esophagus occur 8 years after myotomy and no cases of adenocarcinoma.

The durability of laparoscopic myotomy and fundoplication has been questioned.[15] Of our 76 patients who had more than 5 years of follow-up, there was no more dysphagia, heartburn, or need for dilations than in the overall group. In other words, late failure was not common.

The limitations of this study are its retrospective approach, lack of controls, and inability to achieve follow-up in all patients. In addition, we did not objectively measure postoperative esophageal emptying with graded barium swallows or acid reflux with ambulatory pH monitoring, as some have advocated.[3,17] Therefore, we could not test predictors against objective measures of success. Furthermore, our study may not have been adequately powered to detect weak predictors of outcome. Nevertheless, we conclude that long-term outcomes after laparoscopic esophagomyotomy were excellent across a wide spectrum of disease severity and presentations. Prior treatments, such as balloon dilation or botulinum toxin injection, did not portend worse outcomes. When the myotomy was extended further than 1.5 cm onto the stomach and a Dor fundoplication was performed, severe heartburn was rare.

Accepted for Publication: June 1, 2011.
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Author Contributions: *Study concept and design:* Carter, Roll, and Way. *Acquisition of data:* Carter, Nguyen, Roll, and Ma. *Analysis and interpretation of data:* Carter, Roll, and Way. *Drafting of the manuscript:* Carter. *Critical revision of the manuscript for important intellectual content:* Carter, Nguyen, Roll, Ma, and Way. *Statistical analysis:* Carter. *Administrative, technical, and material support:* Nguyen and Roll. *Study supervision:* Way.
Financial Disclosure: None reported.
Previous Presentation: This paper was presented at the 82nd Annual Meeting of the Pacific Coast Surgical Association; February 20, 2011; Scottsdale, Arizona, and is published after peer review and revision.
Additional Contributions: Pamela Derish, MA, provided editorial review.

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INVITED CRITIQUE

Surgery for Achalasia

Is This as Good as It Gets?

The first report on a series of patients with achalasia treated using the minimally invasive approach appeared nearly 20 years ago.[1] Although the operation described in that report underwent several modifications that made it more effective,[2,3] the principle introduced then, minimization of access trauma, remains the same and has made surgical treatment an attractive option to patients and gastroenterologists. Dr Carter and colleagues[4] now reaffirm that the operation, when performed in a center of excellence, is safe and effective and the results are durable. The information they present is more relevant today than ever, as treatments are chosen on the basis of comparative effectiveness. In that regard, the weight of the evidence today strongly favors a Heller myotomy in the management of achalasia rather than the other 3 modalities (pneumatic dilation, botulinum toxin [Botox] injection, and medical therapy).

The authors studied several factors that others reported could predict the outcome of a Heller myotomy. Finding that, among their patients, those factors did not affect outcome, they concluded that postoperative dysphagia must result from scarring and other changes in the area of operation that are beyond the control of the surgeon. I generally agree with their conclusion but feel the need to bring to the attention of the readers 2 important aspects. First, one must keep in mind that these results were obtained in patients who underwent a thorough workup and were found to have achalasia. Given the relative simplicity of the operation, there is always a temptation to apply it more liberally for patients who complain of dysphagia. In fact, a number of "myotomy failures" seen in referral centers are accounted for by patients who did not have achalasia to start with. Ablation of the lower esophageal sphincter substantially alters the physiology of the gastroesophageal junction and should only be applied judiciously to patients in whom the anatomy and physiology have been appropriately defined.

Second, I disagree with the authors' apparent willingness to accept these results as the best surgery can achieve. Although they recognize that their earlier results were improved when they extended the gastric myotomy to 1.5 cm, they dismiss evidence that shows that a 3-cm myotomy is even more effective than a 1.5-cm one,[3] and—without data to support it—state that the length of the myotomy beyond 1.5 cm does not affect the outcome. We used their current technique and had to reoperate with the same frequency they describe. That changed dramatically with the systematic use of the extended myotomy. We recommend removal of all adipose tissue at the gastroesophageal junction, identification of its exact location, and accurate measurement of the length of stomach necessary to achieve 3 cm.[2,3] The results they reported are excellent, but I submit that—like anything else we do—they can be improved.

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Financial Disclosure: None reported.

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