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Intraoperative Endoscopy as a Navigational Adjunct in Laparoscopic Heller Myotomy for Achalasia: A Consecutive Case Series

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ABSTRACT

Background: Laparoscopic Heller myotomy (LHM) is a primary surgical treatment for esophageal achalasia. Achieving a complete myotomy while avoiding mucosal perforation is paramount for success, yet intraoperative challenges persist. Intraoperative endoscopy (IOE) is recommended by guidelines but remains underutilized. This study aims to illustrate the methodological application and clinical utility of a standardized IOE protocol in LHM. **Methods:** This study was a retrospective analysis of a prospectively maintained database of a consecutive series of patients who underwent LHM with routine IOE for achalasia at our institution in 2023. We present three consecutive cases. Preoperative evaluation included esophagography, upper endoscopy, and high-resolution manometry (HRM). The primary outcomes were the adequacy of myotomy, incidence of mucosal perforation, and postoperative symptomatic relief measured by the Eckardt score at three months. **Results:** Three female patients (aged 19, 30, and 65) with achalasia (Type I and II) underwent LHM with IOE. The mean preoperative Eckardt score was 9.3 ± 1.5 . IOE was successfully used in all cases to: (1) precisely identify the gastroesophageal junction (GEJ) via transillumination, (2) facilitate submucosal dissection through controlled insufflation, (3) confirm mucosal integrity with an air leak test, and (4) verify a patulous GEJ post-myotomy. No mucosal perforations occurred. At three-month follow-up, the mean Eckardt score significantly improved to 0.3 ± 0.6 ($p < 0.05$). All patients reported resolution of dysphagia and significant improvement in nutritional status. **Conclusion:** Our experience with this consecutive series supports the utility of systematic IOE during LHM. It appears to be a valuable tool for enhancing procedural safety, ensuring myotomy adequacy, and achieving optimal short-term functional outcomes. These findings reinforce existing guidelines and should encourage wider adoption of this critical surgical adjunct.

1. Introduction

Esophageal achalasia is a primary neurodegenerative motility disorder of the esophagus, defined by two cardinal pathophysiological features: the progressive loss of peristalsis in the smooth muscle of the esophageal body and impaired, often

hypertensive, relaxation of the lower esophageal sphincter (LES) upon swallowing.¹ This dysfunction arises from an inflammatory process leading to the selective destruction of inhibitory ganglion cells within the myenteric (Auerbach's) plexus, which are predominantly responsible for nitric oxide-mediated

smooth muscle relaxation.² The resulting imbalance, with unopposed cholinergic (excitatory) stimulation, transforms the distal esophagus and LES into a functional obstruction. Clinically, this manifests as a debilitating constellation of symptoms including dysphagia for solids and liquids, regurgitation of undigested food, retrosternal chest pain, and, in advanced cases, profound weight loss and malnutrition. The global incidence, while relatively low at approximately 1-2 cases per 100,000 population annually, imposes a significant and chronic burden on the patient's quality of life.³

The modern diagnostic paradigm for achalasia is anchored in objective physiological testing. While timed barium esophagography can provide classic suggestive imaging, such as a dilated esophagus tapering to a distal "bird-beak" appearance, and upper endoscopy is essential to rule out mechanical obstruction or pseudoachalasia, high-resolution manometry (HRM) remains the undisputed gold standard.⁴ HRM provides a detailed spatiotemporal assessment of esophageal motor function, allowing for a definitive diagnosis and classification of achalasia into three clinically relevant subtypes according to the Chicago Classification (currently version 4.0): Type I (classic achalasia with minimal esophageal contractility), Type II (with panesophageal pressurization), and Type III (with spastic or premature contractions). This classification is not merely academic; it carries significant prognostic weight and informs the selection of the most appropriate therapeutic strategy, with Type II patients generally showing the most favorable response to treatment.⁵

As achalasia is an incurable neurodegenerative disease, all current treatments are palliative, aimed at disrupting or weakening the non-relaxing LES to reduce the pressure gradient and facilitate esophageal emptying by gravity.⁶ Therapeutic options include endoscopic techniques, such as pneumatic dilation (PD) and per-oral endoscopic myotomy (POEM), and surgical intervention. Laparoscopic Heller Myotomy (LHM), an evolution of the open procedure first

described by Ernst Heller in 1913, has long been considered a cornerstone of treatment, offering effective and durable relief.⁷ The procedure involves a precise longitudinal incision of the circular and longitudinal muscle layers of the distal esophagus and proximal stomach, directly addressing the functional obstruction.

Despite the high success rates of LHM, reported to exceed 90% in many large series, the procedure is technically demanding and fraught with two critical challenges that dictate its outcome: the adequacy of the myotomy and the avoidance of iatrogenic mucosal perforation.⁸ An incomplete myotomy, particularly one that fails to extend sufficiently onto the gastric cardia (typically 2-3 cm) to transect the gastric sling fibers, is the leading cause of persistent or recurrent dysphagia. Conversely, a full-thickness breach of the delicate esophageal mucosa is the most feared intraoperative complication. While immediate, primary repair is often successful, a missed perforation can lead to mediastinitis, sepsis, and significant morbidity and mortality, with reported perforation rates ranging from 5% to 15% in historical series.⁹

To mitigate these risks, professional societies, including the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), have long promulgated guidelines recommending the routine use of intraoperative esophagogastroduodenoscopy (EGD), or intraoperative endoscopy (IOE), during Heller myotomy. IOE serves as a real-time navigational tool, providing invaluable feedback through multiple mechanisms: precise localization of the gastroesophageal junction (GEJ) via transillumination, facilitation of a safer dissection by creating tension in the submucosal plane, definitive confirmation of mucosal integrity via an air leak test, and functional assessment of the myotomy's adequacy. Despite these well-established advantages, large database studies reveal a surprisingly low rate of IOE utilization in clinical practice, suggesting a significant gap between best-practice guidelines and real-world application.¹⁰

The aim of this study is to reaffirm and illustrate in detail the value of a standardized protocol for routine intraoperative endoscopy during Laparoscopic Heller Myotomy. The novelty of this work lies not in proposing a new technique, but in providing a granular, methodologically transparent description of a contemporary, consecutive series of cases from a Southeast Asian cohort. We highlight the nuanced intraoperative decision-making and technical precision facilitated by IOE that contribute to optimized surgical outcomes, addressing the aforementioned gap between guidelines and practice.

2. Methods

This study was a retrospective analysis of data from a prospectively maintained surgical database at our tertiary care academic institution. We included all patients who underwent Laparoscopic Heller Myotomy with routine Intraoperative Endoscopy for a confirmed diagnosis of esophageal achalasia between January 1st, 2024, and December 31st, 2024. This represented a consecutive series of all three patients treated for this condition during the study period, thereby minimizing selection bias. All procedures were performed by the same senior surgical team.

All patients underwent a comprehensive preoperative workup. Diagnosis was established and characterized based on: (1) Clinical Assessment: A detailed history was taken, and symptom severity was quantified using the validated Eckardt score. This score assesses dysphagia, regurgitation, retrosternal chest pain, and weight loss, each on a scale of 0-3, with a total possible score of 12; (2) Timed Barium Esophagogram: This was used to assess esophageal dilation, morphology (such as a sigmoid esophagus), and emptying dynamics; (3) Upper Endoscopy (EGD): This was performed to evaluate for retained food, mucosal inflammation or malignancy, and to assess the resistance of the LES to the passage of the endoscope. Biopsies were taken as indicated; (4) High-Resolution Manometry (HRM): This was the definitive diagnostic test, used to confirm aperistalsis and impaired LES relaxation. The median integrated

relaxation pressure (IRP) was measured, and achalasia was subtyped according to the Chicago Classification v3.0 criteria.

A standardized protocol was employed for all procedures. (1) Surgical Technique: After induction of general anesthesia, the patient was placed in a modified lithotomy or split-leg position. Pneumoperitoneum was established using a Veress needle or open technique. Five laparoscopic ports were typically placed. The left lobe of the liver was retracted using a Nathanson liver retractor. The procedure commenced with the dissection of the phrenoesophageal membrane to expose the diaphragmatic hiatus and the distal esophagus. The anterior vagus nerve was identified and preserved; (2) Intraoperative Endoscopy Protocol: Concurrently, a flexible gastroscope was introduced by an endoscopist. The IOE protocol involved four key steps: (i) Localization: The endoscope was positioned in the distal esophagus, and its light source was used for transillumination. This provided the surgeon with an unambiguous, real-time identification of the precise location of the GEJ, guiding the placement and extent of the myotomy; (ii) Dissection Assistance: During the myotomy, the endoscopist provided gentle, controlled air insufflation. This created tension in the esophageal wall, causing the submucosal plane to bulge away from the mucosa. This maneuver widened the dissection plane, making the muscle fiber division safer and more precise; (iii) Integrity Check: Upon completion of the myotomy, the operative field around the esophagus was filled with sterile saline. The endoscopist then insufflated a significant volume of air into the esophagus and stomach, pressurizing the lumen. The surgeon observed for any stream of air bubbles, constituting a highly sensitive intraoperative air leak test to rule out mucosal perforation; (iv) Adequacy Assessment: Finally, the endoscope was advanced and withdrawn through the myotomized segment. The ease of passage, or "drive-through," and the endoscopic view of a now-patulous GEJ provided a functional confirmation that the obstruction had been relieved. The myotomy was extended

approximately 6-7 cm proximally onto the esophagus and 3 cm distally onto the gastric cardia. Following the myotomy, a partial fundoplication (either Dor anterior or Toupet posterior) was performed based on intraoperative findings and surgeon judgment to create an anti-reflux barrier.

Data were extracted from the electronic health record and our surgical database. The primary outcome measures were: (1) Intraoperative Outcomes: Adequacy of myotomy (confirmed by IOE), incidence of mucosal perforation, operative time, and estimated blood loss; (2) Postoperative Outcomes: Length of hospital stay, postoperative complications (classified by Clavien-Dindo), and symptomatic relief at the three-month follow-up visit. Symptomatic outcome was assessed using the Eckardt score, with clinical success defined as a postoperative score of ≤ 3 .

The study was conducted in accordance with the principles of the Declaration of Helsinki. The institutional review board provided approval for this retrospective chart review. All patients provided written informed consent prior to their surgical procedure, which included consent for the use of their anonymized clinical data for research and publication purposes.

3. Results

During the one-year study period, three consecutive female patients, with ages of 30, 19, and 65 years, underwent LHM with routine IOE for achalasia. All patients presented with significant dysphagia and regurgitation. The demographic, preoperative, intraoperative, and postoperative data are summarized in Table 1.

Table 1. Summary of Patient Demographics, Preoperative Findings, and Outcomes			
A detailed comparison of three consecutive cases undergoing Laparoscopic Heller Myotomy with Intraoperative Endoscopy.			
PARAMETER	CASE 1	CASE 2	CASE 3
Demographics			
Age (years) / Gender	30 / Female	19 / Female	65 / Female
Preoperative BMI (kg/m ²)	20.3	22.1	16.2 (Malnourished)
Preoperative Data			
Symptom Duration (months)	24	12	60
Eckardt Score (Pre-op)	9	8	11 (Severe)
Barium Esophagogram	5.5 cm diameter, "bird-beak"	4.0 cm diameter, "rat-tail"	7.5 cm diameter, sigmoid shape
HRM: Achalasia Type	Type II	Type I	Type II
HRM: IRP (mmHg)	28	22	35
Intraoperative Data			
Myotomy Length (Esoph/Gas)	6 cm / 3 cm	6 cm / 3 cm	7 cm / 3 cm
Fundoplication Type	Dor (Anterior)	Dor (Anterior)	Toupet (Posterior)
Mucosal Perforation	No	No	No
Operative Time (minutes)	135	120	160
Estimated Blood Loss (mL)	< 20	< 20	< 50
Postoperative Data			
Length of Stay (days)	4	3	7
Complications (Clavien-Dindo)	None (Grade 0)	None (Grade 0)	None (Grade 0)
Eckardt Score (3-month)	0	0	1
BMI (kg/m ²) - 3-month	22.0 (+1.7)	22.8 (+0.7)	18.0 (+1.8)
Clinical Success (Eckardt ≤ 3)	Yes	Yes	Yes

Case 1

A 30-year-old female teacher presented with a two-year history of progressive dysphagia and regurgitation, resulting in a 27 kg weight loss (preoperative BMI 20.3 kg/m²). Her preoperative Eckardt score was 9. HRM confirmed Type II achalasia. During LHM, IOE transillumination was essential for defining the GEJ on a slightly redundant esophagus. The myotomy was performed (6 cm esophageal, 3 cm gastric) with endoscopic insufflation, providing excellent visualization of the submucosal plane. The air leak test was negative. An anterior (Dor) fundoplication was performed. Her recovery was uneventful. At three months, her Eckardt score was 0, and she had gained 5 kg.

Case 2

A 19-year-old university student with well-controlled myasthenia gravis presented with a one-year history of dysphagia for solids. Her preoperative Eckardt score was 8. HRM was diagnostic for Type I (classic) achalasia. She underwent LHM with IOE using the standardized protocol. The procedure was straightforward, with IOE providing constant reassurance of mucosal integrity and confirming a patulous GEJ after myotomy. A Dor fundoplication was performed. She was discharged on postoperative day 3. At her three-month follow-up, she was asymptomatic with an Eckardt score of 0 and reported a significantly improved quality of life.

Case 3

A 65-year-old female was transferred to our center with severe malnutrition (BMI 16.2 kg/m²) secondary to a five-year history of untreated achalasia. Her preoperative Eckardt score was 11. Barium studies revealed a massively dilated, sigmoid-shaped esophagus measuring 7.5 cm in diameter. After 10 days of preoperative nutritional optimization via a nasogastric feeding tube, she underwent LHM. In this case, IOE was particularly invaluable. The tortuous, dilated anatomy made external identification of the GEJ nearly impossible. Transillumination from the

endoscope was the definitive method for localizing the correct starting point for the gastric portion of the myotomy. The myotomy was extended to 7 cm on the esophagus to accommodate the dilation. The air leak test was negative. Given the severe esophageal dilation and atony, a posterior (Toupet) fundoplication was chosen to help anchor the esophagus and provide a more robust anti-reflux barrier. Her postoperative course was smooth, and at three months, her Eckardt score had improved to 1. She was tolerating a regular diet and had gained 7 kg.

4. Discussion

This consecutive case series, though small, methodologically illustrates and reaffirms the profound value of the routine integration of intraoperative endoscopy into the practice of Laparoscopic Heller Myotomy. Our experience demonstrates that IOE is not merely a passive adjunct but an active navigational tool that appears to contribute substantively to procedural safety and functional success across a spectrum of achalasia severities.¹¹ The discussion will focus on the pathophysiological underpinnings of the myotomy and the multifaceted roles of IOE in optimizing this intervention, while also acknowledging the limitations of this study.

The therapeutic principle of a Heller myotomy is, at its core, elegantly simple: to mechanically disrupt the non-relaxing lower esophageal sphincter (LES), thereby eliminating the functional obstruction that defines achalasia. This surgical goal, however, belies a profound underlying pathophysiological complexity. Achalasia is not a simple mechanical problem but a neurodegenerative disease characterized by the inexorable loss of inhibitory ganglion cells within the myenteric plexus of the esophagus.¹² This process silences the crucial nitric oxide-mediated pathways responsible for smooth muscle relaxation, creating a state of unopposed cholinergic excitation. The result is a hypertensive, spastic, and non-relaxing sphincter that transforms the distal esophagus into a formidable barrier to the passage of food and liquid.

Consequently, a successful myotomy is an exercise in meticulous anatomical deconstruction. It must be sufficiently long to encompass the entire hypertensive segment and sufficiently deep to completely transect the spastic circular muscle fibers, releasing the esophagus from its pathological grip (Figure 1).¹³

The most critical and technically demanding zone of this procedure is the distal extent of the myotomy. To be curative, the incision must not only traverse the physiological LES but also extend a crucial 2 to 3 centimeters onto the gastric cardia. This gastric extension is non-negotiable, as it is required to divide the gastric sling and clasp fibers—muscular loops that are significant anatomical contributors to the high-pressure zone of the esophagogastric junction (GEJ). Failure to adequately address this component is the leading cause of persistent or recurrent dysphagia, turning a potentially curative operation into a failed therapy.¹⁴

It is precisely at this critical juncture that reliance on external anatomical landmarks reveals its fallibility. In a patient with early-stage disease and normal anatomy, the location of the GEJ may be reasonably inferred. However, in cases of advanced achalasia, the esophagus often becomes a dilated, tortuous, and foreshortened organ—a "sigmoid esophagus"—where the normal anatomical relationships are grossly distorted. The phrenoesophageal membrane can be thickened and scarred, and the proximal stomach can be pulled up into the hiatus, effacing the angle of His and rendering external identification of the GEJ an exercise in educated guesswork. This is where intraoperative endoscopy (IOE) transitions from an optional adjunct to an indispensable navigational tool. Through transillumination, the endoscope's light shines through the esophageal wall, providing the surgeon with an unambiguous, real-time map of the submucosal anatomy. This "glow" clearly delineates the squamocolumnar junction, the precise border between the esophagus and stomach, allowing the surgeon to perform the myotomy with absolute anatomical certainty. This ensures the crucial gastric

extension is achieved without being excessively long, which could otherwise compromise the natural anti-reflux mechanisms and create new iatrogenic pathology.¹⁵

This level of precision is not merely an academic pursuit; it has direct implications for outcomes based on the patient's specific achalasia subtype, as defined by the Chicago Classification. For patients with Type II achalasia, who are characterized by panesophageal pressurization, the esophagus retains contractile potential. Relieving the distal obstruction completely and precisely allows this preserved esophageal body pressure to effectively aid in bolus clearance, leading to the excellent outcomes typically seen in this group. An incomplete distal myotomy in these patients would leave a residual functional obstruction, representing a primary and preventable cause of treatment failure. Conversely, in patients with Type I achalasia, the esophagus is largely atonic and aperistaltic. For these individuals, esophageal emptying relies almost entirely on gravity. Therefore, a complete and verified myotomy is equally essential to create an unobstructed conduit, allowing for passive emptying and symptomatic relief. In both scenarios, the precision afforded by IOE is paramount to tailoring the operation to the patient's underlying physiology.¹⁶

Beyond its role in anatomical localization, IOE serves as a dynamic, real-time partner in ensuring the procedural safety and functional efficacy of the myotomy. The surgeon's visual assessment of separated muscle edges, while important, can be deceptive. A few remaining circular fibers can tether the mucosa, leading to incomplete relief of the obstruction. IOE provides a definitive functional endpoint for the procedure. The post-myotomy "drive-through" by the endoscopist—the ability to pass the endoscope effortlessly and without resistance from the esophagus into the stomach—offers tangible, objective confirmation of success. This simple maneuver provides immediate evidence that the high-pressure zone has been obliterated and the functional obstruction has been relieved. This intraoperative verification step may significantly reduce the

incidence of early reoperation for persistent dysphagia, a devastating outcome for the patient and a clear marker of surgical failure. It provides a level of

certainty that anatomical inspection alone cannot match.

The Surgical Imperative in Achalasia

A Visual Summary of the Heller Myotomy and the Role of Intraoperative Endoscopy (IOE)

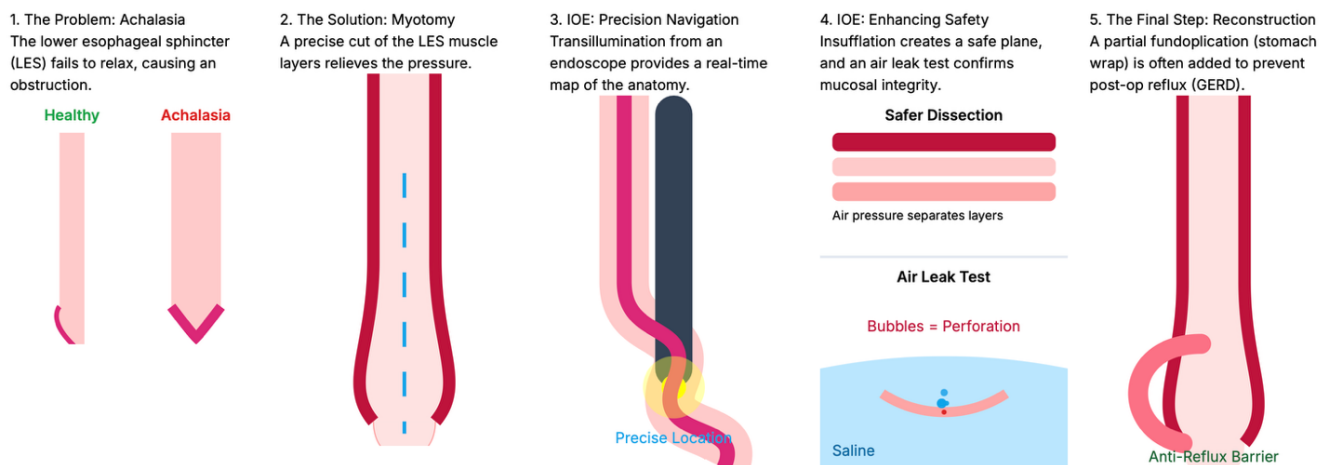


Figure 1. The surgical imperative in achalasia.

Perhaps the most profound contribution of IOE is in mitigating the most dreaded complication of LHM: iatrogenic mucosal perforation. A full-thickness breach of the delicate esophageal mucosa can lead to devastating consequences, including mediastinitis, sepsis, and even mortality. IOE enhances safety through two distinct and complementary mechanisms. First, during the dissection itself, the endoscopist can provide gentle, controlled insufflation of air. This maneuver tenses the esophageal wall, causing the gossamer-thin submucosal plane to bulge away from the overlying muscularis. This hydraulic-like effect pushes the fragile mucosa away from the surgeon's dissecting instruments—be it sharp scissors or an energy device—creating a wider, safer, and more defined surgical plane. This architectural support arguably reduces the primary risk of perforation by making the tissue layers more distinct and forgiving.

Second, upon completion of the myotomy, IOE facilitates the performance of a highly sensitive and

specific air leak test. The operative field around the exposed mucosa is filled with sterile saline, creating a water seal. The endoscopist then insufflates a significant volume of air, pressurizing the esophageal lumen. The surgeon, observing the submerged myotomy under laparoscopic magnification, watches for any stream of air bubbles. This visual cue is an unequivocal sign of perforation, allowing for immediate primary laparoscopic repair. A simple visual search for a mucosal tear by the surgeon is notoriously unreliable; it can easily miss a pinpoint thermal injury from an energy device or a small perforation on the posterior aspect of the esophagus, hidden from the direct line of sight.¹⁷ The air leak test is the definitive final inspection. This ability to detect and repair a perforation intraoperatively converts a potential catastrophe into a manageable intraoperative event, which, when repaired properly, typically has minimal long-term sequelae. The confidence provided by a negative air leak test allows

the surgeon to conclude the operation with a much higher degree of certainty regarding mucosal integrity.

Finally, the discussion of any Heller myotomy is incomplete without addressing the subsequent risk of gastroesophageal reflux disease (GERD).¹⁸ The destruction of the LES, while therapeutically necessary for achalasia, invariably compromises the primary anti-reflux barrier of the GEJ. This has led most surgeons to routinely add a partial fundoplication—most commonly a Dor (anterior) or Toupet (posterior) wrap—to create a new anti-reflux barrier. However, this step is not without its own potential morbidities. A fundoplication, if constructed too tightly or improperly, can itself become a source of iatrogenic dysphagia, trading one swallowing problem for another. It can also lead to other vexing side effects, such as gas bloat syndrome and the inability to belch or vomit.

This has led to a growing body of thought that an anti-reflux procedure may not be necessary in all patients, particularly if a minimally disruptive hiatal dissection is performed. Here again, IOE may play a pivotal, paradigm-shifting role. By allowing for precise GEJ localization, IOE facilitates a targeted myotomy that can be performed with minimal collateral dissection of the hiatus. This preserves the crucial, natural anti-reflux structures: the phrenoesophageal ligaments, which anchor the esophagus, and the integrity of the angle of His, which creates a flap-valve mechanism. The precision afforded by IOE opens the door to a more selective, evidence-based strategy for fundoplication. For instance, in a patient with Type I achalasia and a pre-existing, anatomically sound hiatus, a meticulous, IOE-guided myotomy with preservation of the hiatal attachments might be sufficient to relieve dysphagia without inducing significant GERD. In such a case, forgoing a fundoplication would spare the patient the risks associated with the wrap. This represents a tailored approach, moving away from a "one-size-fits-all" operative plan. The surgeon's decision can be adapted based on the intraoperative findings and the specific disease characteristics, such as in the case of a

massively dilated, atonic sigmoid esophagus, where a Toupet fundoplication might be chosen not only for reflux control but also to anchor the floppy esophagus and prevent volvulus. Further research, ideally in the form of randomized controlled trials, is necessary to delineate the specific subset of patients who can be safely and effectively managed without a fundoplication following an IOE-guided LHM. Such studies will be crucial in refining the surgical treatment of achalasia, optimizing outcomes by balancing the complete relief of dysphagia against the lifelong risk of GERD.^{19,20}

It is imperative to acknowledge the significant methodological limitations of this study. First, as a case series with only three patients, the results are descriptive and cannot be generalized to the broader population of patients with achalasia. The findings are susceptible to selection bias, although we attempted to mitigate this by reporting on a consecutive, unselected series. Second, the absence of a control group (such as LHM without IOE) means we cannot establish a causal relationship between IOE use and the excellent outcomes observed. The skill of the surgical team and comprehensive perioperative care are significant confounding variables. Third, the follow-up period of three months is short; longer-term data are needed to assess the durability of the symptomatic relief and to monitor for the late development of GERD. Finally, this study was conducted at a single institution, which may limit its external validity.

5. Conclusion

This consecutive case series methodologically illustrates the practical application and clinical utility of a standardized intraoperative endoscopy protocol during Laparoscopic Heller Myotomy. Our experience supports the role of IOE as a valuable navigational tool for accurately defining the surgical anatomy, facilitating a safe and complete myotomy, and confirming mucosal integrity. The excellent short-term outcomes in this diverse group of patients reinforce the principles outlined in existing SAGES guidelines.

While acknowledging the limitations of this low level of evidence, these findings should encourage the wider adoption of this critical surgical adjunct to standardize and improve the surgical treatment of achalasia. Further comparative studies are warranted to quantify its impact on outcomes and to explore its role in guiding a more selective approach to fundoplication.

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