

ORIGINAL ARTICLE

Nissens Fundoplication: A Laparoscopic Edge?

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ABSTRACT

Background: Hiatal hernia often leads to gastroesophageal reflux disease (GERD), which may be refractory to medical therapy. Surgical intervention in the form of Nissens fundoplication can provide definitive relief. With advancements in minimally invasive techniques, the role of laparoscopic Nissens fundoplication is increasingly prominent.

Aim: To compare the effectiveness of open versus laparoscopic Nissens fundoplication in patients with endoscopically confirmed hiatal hernia.

Objectives:

- Compare operative time, symptom relief, and complications in open and laparoscopic procedures.
- Evaluate improvement using De-Meester Johnson reflux score.

Material: A prospective study involving 38 patients (18-60 years) at a tertiary care hospital over 18 months (Sep 2022 - Mar 2024). Patients were randomized into two equal groups for open or laparoscopic Nissens fundoplication.

Results: Both groups showed significant symptomatic improvement. Laparoscopic surgery had a longer operative time (135 vs 110 minutes) but fewer complications and better De-Meester scores Post-operatively. Statistically significant improvement in heartburn, regurgitation, and dysphagia was observed, especially by Post-operative day 7.

Conclusion: Laparoscopic Nissens fundoplication is as effective as open surgery in relieving GERD symptoms, with additional benefits of fewer complications and faster recovery, despite longer operative duration.

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KEYWORDS

• Hiatal Hernia • Nissens Fundoplication • Laparoscopic Surgery • GERD
• Operative Time • Post-operative Complications

KEY MESSAGE:

Laparoscopic Nissens fundoplication offers superior symptom control with fewer complications compared to open surgery for hiatal hernia repair.

INTRODUCTION

A hiatal hernia is a pathological condition where the upper stomach or another organ protrudes through the esophageal hiatus of the diaphragm. Laxity in this region can lead to gastroesophageal reflux disease (GERD), the most common benign esophageal condition. GERD affects approximately 7.6% of the Indian population¹ and is defined by symptoms like acid regurgitation and heartburn,² with occasional dysphagia or chest pain. Hiatal hernias vary from small sliding types to large paraesophageal hernias. Paraesophageal hernia (PEH) may cause mild GERD symptoms or severe complications like gastric volvulus, requiring urgent surgery. PEHs account for 1.6% of hiatal hernias in Western and 0.35% in Asian populations.^{3,4} The term 'hiatus hernia' was introduced by Ake Akerlund in 1926,⁵ and is now classified into four types: Type I (sliding): GEJ shifts upward; Type II: stomach herniates beside esophagus; Type III:

combination of sliding and paraesophageal; Type IV: herniation of stomach plus another organ.

Treatment targets acid reflux control through lifestyle modifications (e.g., weight loss, head elevation during sleep, avoiding trigger foods).^{6,7} In 1936, Nissen proposed wrapping the stomach's fundus around the lower esophagus to prevent acid reflux,^{8,9} creating the foundation of Nissen fundoplication—a 360° gastric wrap reinforcing the lower esophageal sphincter.

GERD management includes medications and surgery. While medications relieve symptoms, they don't correct anatomical defects. Surgery, particularly Nissen fundoplication, is definitive for severe or unresponsive GERD.

Diagnostics like barium swallow, endoscopy, esophageal manometry, and pH monitoring guide treatment. SAGES (2013) guidelines provide current standards (Table 1).

Table 1: Treatment of Hiatus Hernia According to The Sages 2013 Guidelines

Type of hiatal hernia	First line	Second line
Type I (sliding) hernia	PPI once daily, 8 week course treatment Inadequate symptom control: PPI - twice daily, 8 week course treatment	Laparoscopic fundoplication (Nissen or Toupet) especially in case of symptom persistence
Types II, III, IV	Laparoscopic fundoplication (Nissen or Toupet) - definitive treatment	PPI, histamine receptor antagonists, antacids for symptom relief

Historically, open Nissen's fundoplication was standard. With minimally invasive advancements, laparoscopic techniques gained popularity due to less pain, shorter hospitalization, and faster recovery. Despite global use, Indian data remains limited. This study aims to compare laparoscopic and open approaches in GERD patients with confirmed hiatal hernia.

Although laparoscopy is increasingly preferred, debate persists regarding its long-

term advantages. This study assesses outcomes in 19 patients per group to clarify relative benefits.

Nissen fundoplication, introduced by Dr. Rudolf Nissen in 1956, initially addressed hiatal hernia.⁸ It wraps the gastric fundus around the esophagus, reinforcing the esophagogastric junction and preventing reflux.⁹ Modifications, like Rossetti's technique, preserve short gastric vessels and create a shorter, tension-free wrap to minimize dysphagia and gas bloat.^{11,12,13}

In the 1960s–70s, Nissen's procedure became widely accepted for GERD, particularly in refractory cases. DeMeester *et al.* (1974) confirmed its success in controlling reflux,¹⁴ though complications like dysphagia and gas bloat remained concerns.¹⁵

Laparoscopic fundoplication emerged in the late 1980s, pioneered by surgeons like Dr. Hill and Dr. Hunter¹⁶, offering reduced pain, faster recovery, and durable results. Studies showed comparable long-term outcomes and fewer complications.^{17,18}

RCTs in the 1990s and 2000s confirmed laparoscopy's superiority over medical therapy in symptom control and satisfaction.^{19,20} Partial fundoplications like Toupet and Dor were developed to manage dysphagia while maintaining reflux control.^{21,22}

Long-term studies show durable GERD relief and patient satisfaction after Nissen's fundoplication.^{23,24} Ongoing research aims to refine patient selection and technique to reduce late complications.^{25,26} Robotic-assisted techniques are emerging to enhance precision and safety.^{27,28}

Endoscopic evaluation typically reveals a visible 'Z-line' at the squamocolumnar junction (Figure 1).²⁹

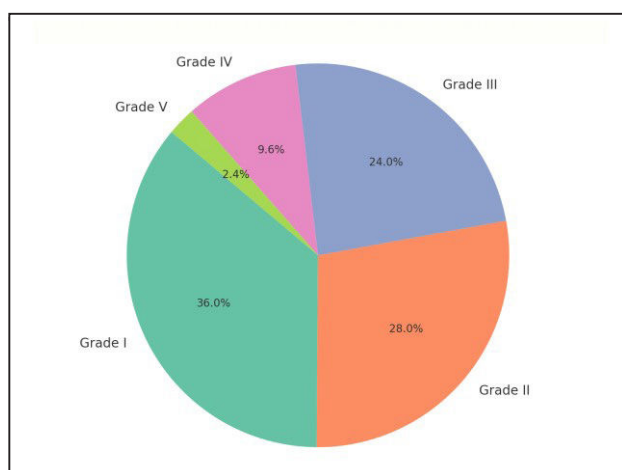


Figure 1: Endoscopic Appearance of The 'Z-Line'

Obesity and age are major risk factors,^{30,31,32} along with multiple pregnancies, prior surgeries, or skeletal disorders.^{30,33} GERD and hiatal hernia commonly co-exist.^{34,35}

Cardinal symptoms include heartburn and regurgitation. Larger hernias may cause dysphagia or anemia.^{32,33} Diagnosis is advised only if it affects clinical decisions.³⁶

Barium swallow helps evaluate hernia size and GEJ location, with >2 cm axial herniation confirming diagnosis.^{33,37,38} It also detects esophageal dysfunction but exposes patients to radiation.³⁹

EGD enables mucosal inspection for esophagitis or Barrett's esophagus³⁷, though large hernias or excess insufflation may obscure findings.^{33,40}

Esophageal manometry (Figure 2 & 3) identifies sphincter separation ≥ 2 cm as diagnostic.⁴¹

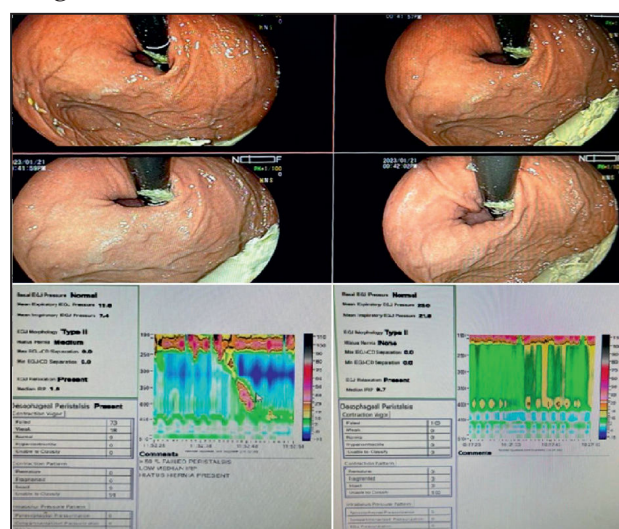


Figure 2: Endoscopic image depicting hills grade 2 hiatus hernia and the corresponding esophageal manometry

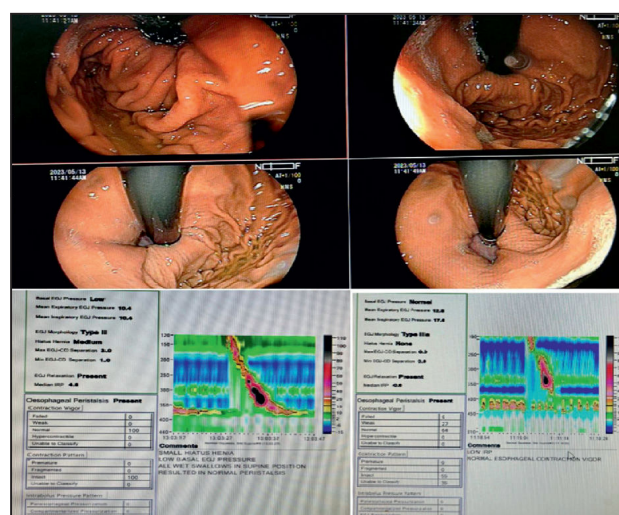


Figure 3: Endoscopic image depicting hills grade 3 hiatus hernia and the corresponding esophageal manometry

Manometry also rules out motility disorders before surgery. High-resolution manometry ensures adequate peristalsis pre-fundoplication.^{30,32}

pH testing quantifies reflux episodes and correlates with symptoms.³⁹ CT is not routinely

needed but may reveal complications or incidental hernias.³²

Complications from antireflux surgery are uncommon. The 30-day mortality is ~0.19%.⁴² Specific risks include:

- Pneumothorax (<2%)
- Gastric/esophageal injury (~1%)
- Splenic/liver injury (~2.3%)
- Dysphagia, usually temporary due to edema

Differential diagnosis for GERD includes conditions like pancreatitis or coronary syndromes. GERD-related extra-esophageal symptoms may mimic respiratory disorders, requiring pulmonology referral if GERD is ruled out.

By evaluating symptom relief, complications, and patient outcomes, this study seeks to guide effective surgical decision-making in GERD treatment.

MATERIALS AND METHODS

Objectives

To compare open and laparoscopic nissens fundoplication for endoscopically confirmed hiatus hernia in tertiary care hospital in contexts of operative time, relief of symptoms and operative complications.

Study Design

We aim to compare laparoscopic and open nissens fundoplication for endoscopically confirmed hiatus hernia in a tertiary care hospital.

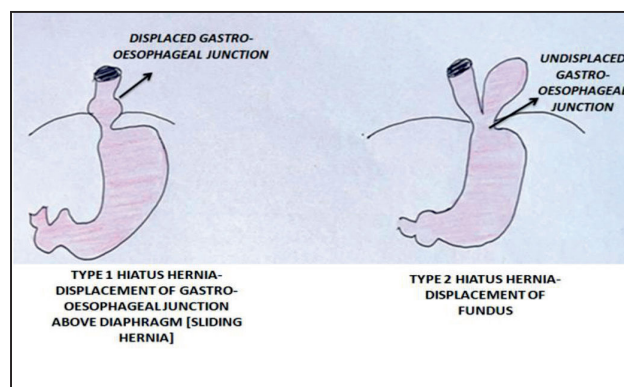


Figure 4: Diagrammatic Representation of Hills Type 1 and 2 Classification of Hiatus Hernia

In our study, we utilize the classification system proposed by Hill *et al.* in 1996 to enable a more precise evaluation of the esophagogastric

sphincter mechanism. This system employs inverted inspection via endoscope to classify the gastroesophageal flap valve into one of four categories, allowing for a more accurate assessment of its functional capability¹⁰ (Figure 4 and 5).

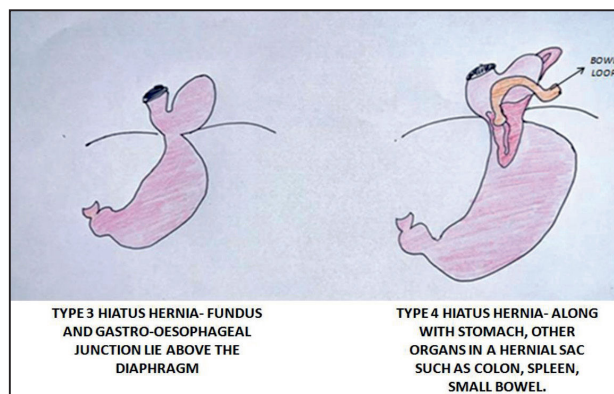


Figure 5: Diagrammatic Representation of Hills Type 3 and 4 Classification of Hiatus Hernia



Hills Grade 1 Hiatus Hernia

Hill grade I: An obvious tissue fold adjacent to the endoscope along the smaller curvature.



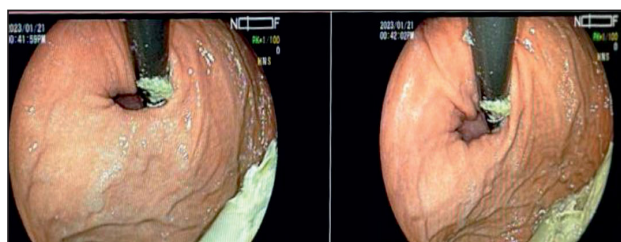
Hills Grade 2 Hiatus Hernia

Hill grade II: The fold is less noticeable, and the area around the endoscope experiences brief openings and swift closures.

Hill grade III: The fold is not prominent and the endoscope is not tightly gripped by the tissue.

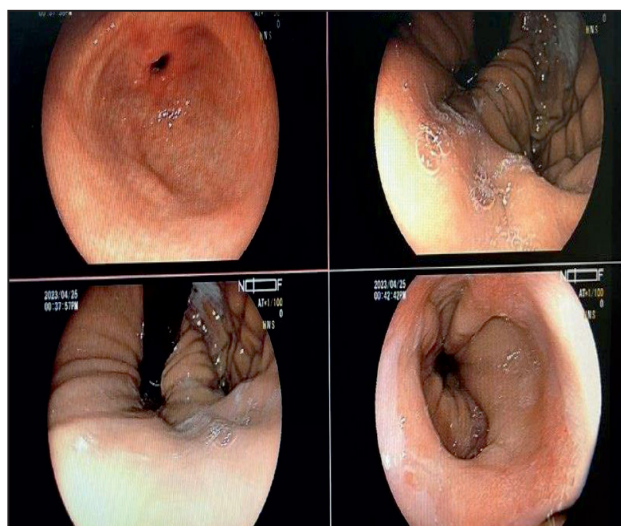


Hills Grade 3 Hiatus Hernia



Hills Grade 4 Hiatus Hernia

Hill grade IV: There is no fold, and the lumen of the esophagus is open, often allowing the squamous epithelium to be viewed from below. A hiatal hernia is always present.



Study Site: Tertiary care hospital and PG institute.

Study Population: All patients of 18-60 years with endoscopically diagnosed and manometrically confirmed hiatus hernia.

Study Period: 18 Months (September 2022 to March 2024)

Sample Size:

This study would be conducted as per inclusion criteria in a tertiary care hospital and PG institute from September 2022 to February 2024.

Formula used:

Sample Size For Comparing Two Means:

Input:

Confidence Interval (2-sided)	95%		
Power	80%		
Ratio of sample size (Group 2/Group 1)	1		
	Group 1	Group 2	Difference*
Mean	148	209	-61
Standard Deviation	59	72	
Variance	3481	5184	
Sample Size of Group 1	19		
Sample Size of Group 2	19		
Total Sample Size	38		

*Difference Between The Means

Results From OpenEpi, Version 3, Open Source Calculator-SSMean

Where,

Z = value from standard normal distribution corresponding to desired confidence level (Z=2.68 for 95% CI)

P is expected true proportion = 3.3% (p=0.045), (q=1-p=0.955), e=5% (e=0.05) is desired precision.

Putting these values in above formula:

Sample size = n =38

STATISTICAL DATA ANALYSIS

The data on categorical variables is shown as 'n' [% of cases] and the data on continuous variables is presented as mean and standard deviation [SD] for normally distributed variables and for non-normally distributed variables median [min – max] is used across two study groups. The inter-group statistical comparison of distribution of categorical variables is tested using Chi-Square test or Fisher's exact probability test for contingency table. The inter-group statistical comparison of means of normally distributed continuous variables is done using independent sample t test. The inter-group statistical comparison of medians of nonnormally distributed continuous variables is done using Mann-Whitney U test. The underlying normality assumption was tested before subjecting the study variables to t test. All results are shown in tabular as well as graphical format to visualize the statistically significant difference more clearly. In the entire study, the p-values less than 0.05 are considered to be statistically significant. All the hypotheses

were formulated using two tailed alternatives against each null hypothesis [hypothesis of no difference]. The entire data is statistically analysed using Statistical Package for Social Sciences [SPSS ver 22.0, IBM Corporation, USA] for MS Windows.^{43,44,45}

SELECTION CRITERIA

A prospective analysis of 38 patients diagnosed with Hiatus Hernia and randomly subjected to laparoscopic or open nissens fundoplication.

Inclusion Criteria:

1. Patients above 18 years to 60 years of age
2. Patients diagnosed with hiatus hernia on Oesophago-Gastro-Duodenoscopy and confirmed on Esophageal Manometry.
3. Symptoms refractory to medical management after continued maximal medical management.

Exclusion Criteria:

1. Patients with comorbid conditions making them unfit for general anaesthesia.
2. Pregnancy.
3. Patients with previous esophageal or gastric surgery.
4. Presence of esophageal stricture, and shortened esophagus.
5. Esophageal motility disorders.

Sampling Method

Patients attending the general surgery OPD and ward with diagnosed hiatal hernia were enrolled (n=38) and randomly allocated into two equal groups:

- **Group A:** Laparoscopic Nissen's fundoplication
- **Group B:** Open Nissen's fundoplication

Informed consent was obtained. A structured assessment was conducted, including:

- Symptom onset, duration, and progression
- Physical and systemic examination
- Pre-anaesthetic and relevant investigations

All patients received standardized preoperative and Post-operative care. Data on

surgical findings, complications, and follow-up were recorded in a proforma.

SURGERY

Open Nissen's Fundoplication

Special Instruments: Electrocautery or harmonic scalpel; Post-operative drains.
Patient Position: Supine with head elevated.

Procedure: A midline laparotomy is performed. The abdominal cavity is examined, particularly the hiatus. If enlarged, stomach contents may be herniated into the thorax. The gastrohepatic ligament is divided for exposure. The peritoneum over the esophagus is incised, and the esophagus is mobilized with care to preserve the vagus nerves. The ligament is clamped and tied (00 silk sutures), avoiding splenic injury.

The stomach fundus is reduced into the abdomen. An S retractor improves visualization (Figure 6).

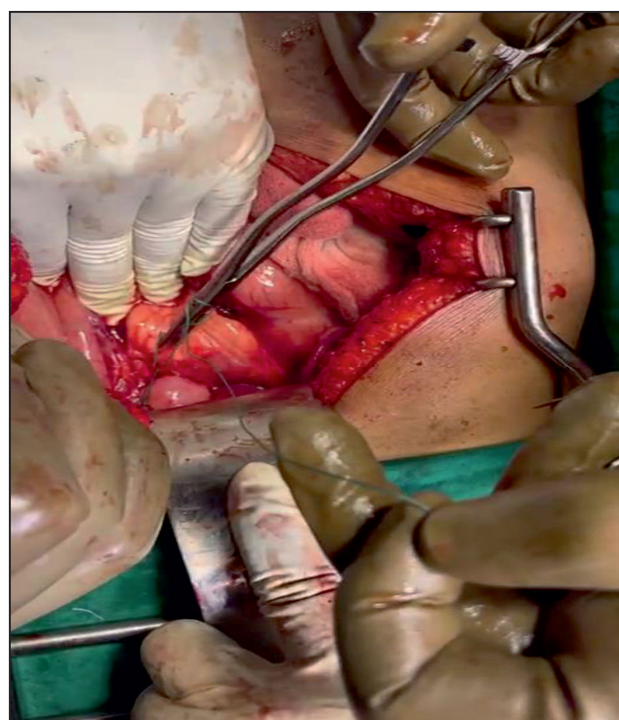


Figure 6: Exposure of The Hiatus with 'S' Retractor in Open Nissens Fundoplication Surgery

The hiatus is closed with interrupted non-absorbable sutures. A tension-free 360° wrap is created by approximating the anterior and posterior gastric walls (Figure 7).

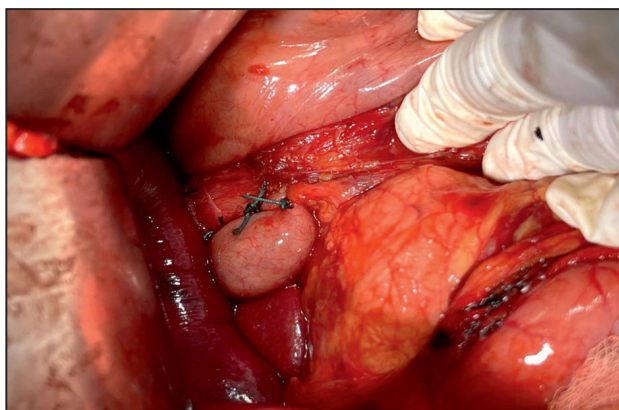


Figure 7: Approximation of anterior and posterior gastric walls with interrupted sutures in open nissens fundoplication

Final inspection ensures vagus nerve integrity. Standard abdominal closure follows.

Laparoscopic Nissen's Fundoplication

Special Instruments:

- Veress needle, liver retractor (Figure 8)
- 5mm and 10mm ports
- Energy devices (harmonic, monopolar), robotic laparoscopic suturing arm (Figure 9)
- Barbed sutures

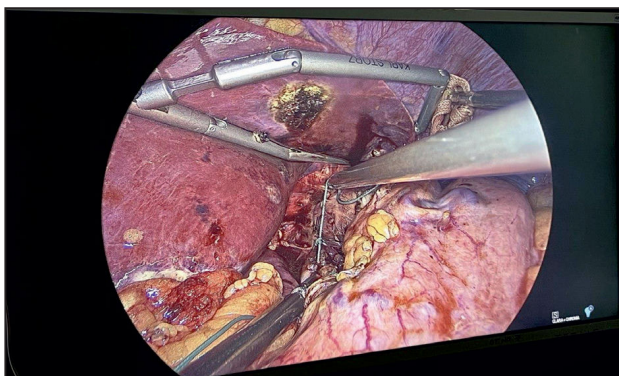


Figure 8: Intra-Operative image showing laparoscopic liver retractor



Figure 9: Image showing robotic laparoscopic working arm
Port Positioning: As shown in Figure 10.



Figure 10: Image showing laparoscopic port positions on the abdominal wall

Following pneumoperitoneum, a camera port is inserted. A liver retractor provides access. The pars flaccida is divided using ultrasonic dissection (Figure 11).

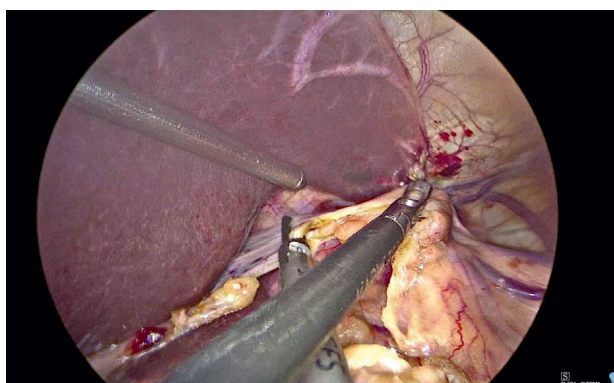


Figure 11: Laparoscopic image showing division of the pars flaccida using ultrasonic dissection

Dissection continues over the left and right crura. The hiatal defect is visualized as a V-shaped junction (Figure 12).

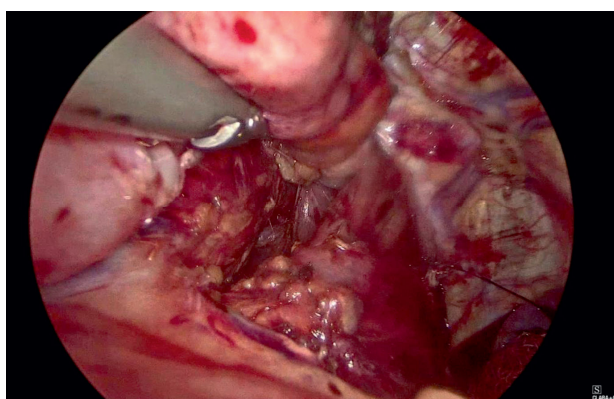


Figure 12: Laparoscopic image showing 'v-shaped' fusion of the left and right crus of the diaphragm

The greater curvature is mobilized using ultrasonic dissection of the short gastric vessels (Figure 13).

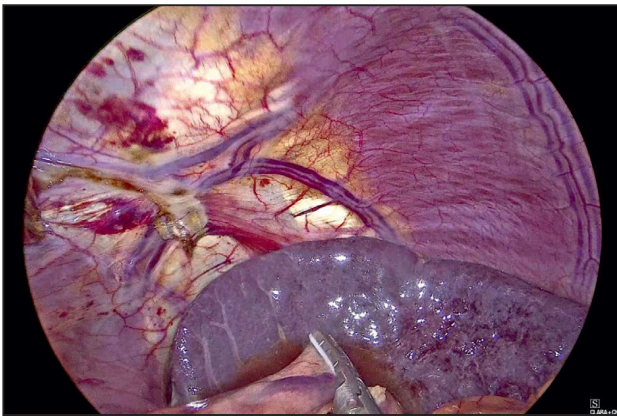


Figure 13: Laparoscopic Image Showing Division of The Short Gastric Vessels with Ultrasonic Dissection

Circumferential dissection of the esophagus follows. Umbilical tape is placed for caudal traction (Figure 14).

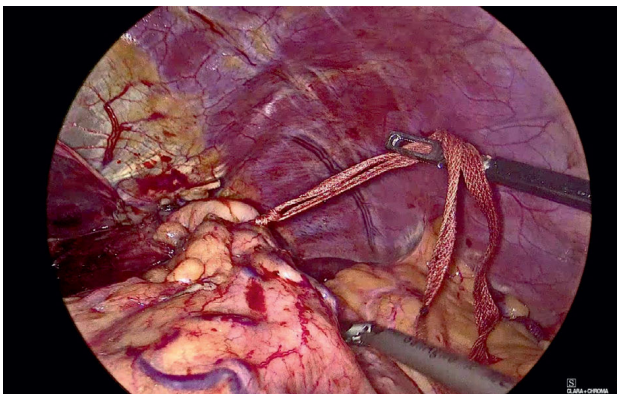


Figure 14: Laparoscopic Image Showing Umbilical Tape Placed Around Distal Oesophagus for Caudal Retraction

Esophageal mobilization is extended to ensure ≥ 3 cm tension-free length below the hiatus. Vagus nerves are preserved (Figure 15).

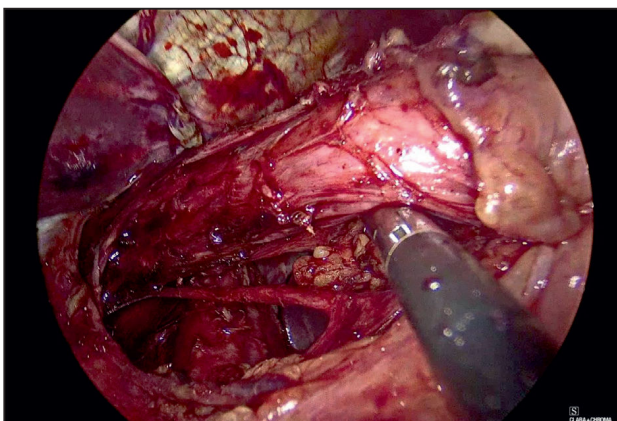


Figure 15: Laparoscopic Image Showing Left Anterior and Right Posterior Vagus Nerves

Posterior crural closure is performed (Figure 16).

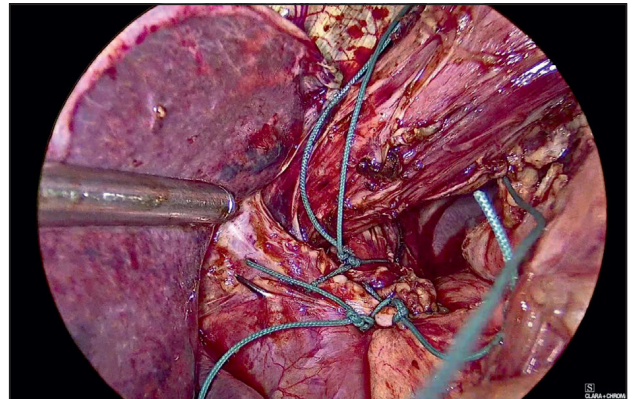


Figure 16: Laparoscopic Image Showing Suturing of The Posterior Crus

A 360° wrap is constructed by passing the fundus behind the esophagus. The “shoeshine” maneuver ensures appropriate looseness (Figure 17).

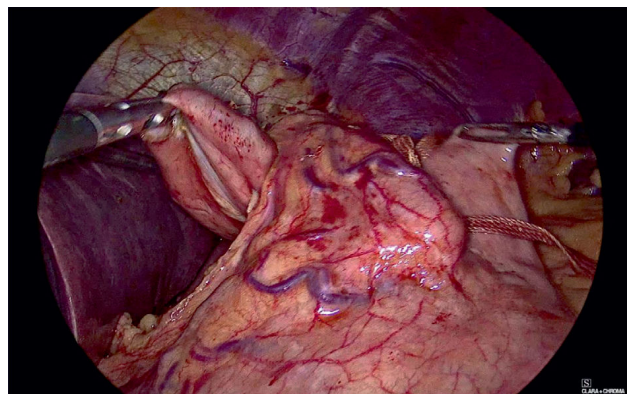


Figure 17: Laparoscopic Image Showing The Shoe-Shine Maneuver

The wrap is secured (Figure 18).

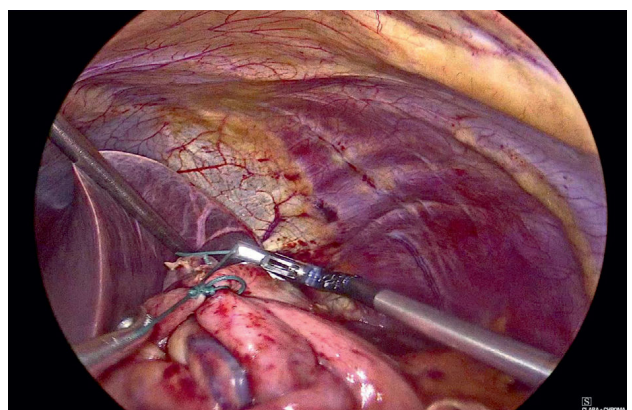


Figure 18: Laparoscopic Image Showing Constructed Wrap of Nissens Fundoplication

Port sites are closed with delayed absorbable sutures; skin is sutured with non-absorbable stitches.

OBSERVATION AND RESULTS

For evaluation and comparison of the pre-operative and post-operative symptoms we

use the De-meester Johnson reflux score.⁴⁶

The De-Meester johnson reflux score:

Table 2: The De-Meester Johnson Reflux Score

Score	Heartburn	Regurgitation	Dysphagia
0	None	None	None
1	Recognisable symptoms, no history of medications	Large meals, lying down	With coarse food
2	Primary reason for hospital visit	Predictable on lying down	Requires liquid to clear
3	Disability in doing daily activity	Aspiration	Meat impaction

AGE DISTRIBUTION:

Open Surgery Group (n=19) (Figure 19)

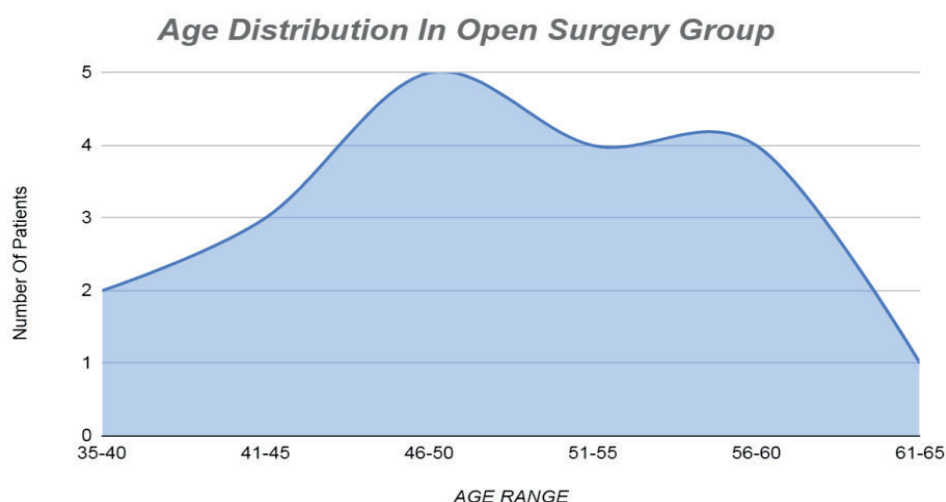


Figure 19: Open Surgery Group Age Distribution

- Mean Age: 50.26 years
- Standard Deviation: 6.76 years

Laparoscopic Surgery Group (n=19) (Figure 20)

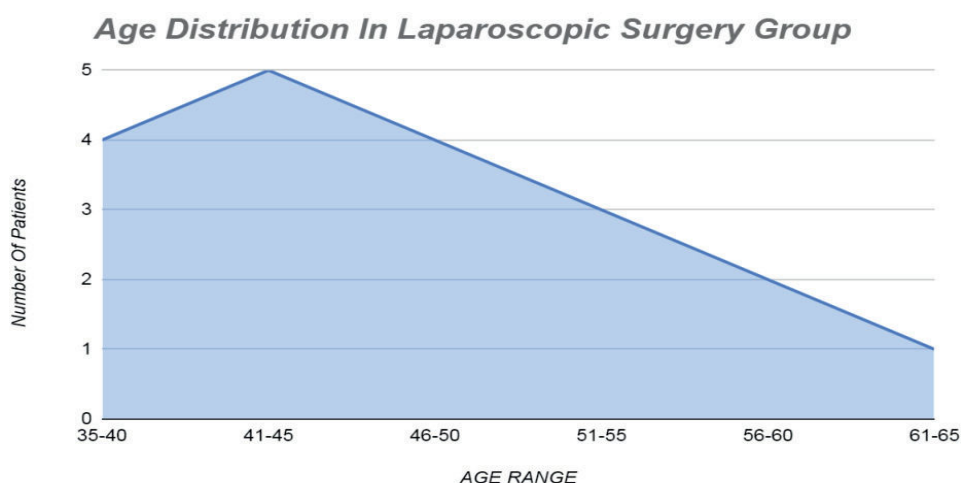


Figure 20: Laparoscopic Surgery Group Age Distribution

- Mean Age: 48.11 years
- Standard Deviation: 6.87 years
- Open Surgery Group: The age distribution is slightly skewed toward older patients, with a higher concentration in the 46-60 age range, which is consistent with

a mean age of 50.26 years.

- Laparoscopic Surgery Group: The age distribution is slightly younger, with more patients in the 35-50 age range, reflecting the slightly lower mean age of 48.11 years.

2. Pre-Operative and Post-operative scores for DAY 1

Heartburn

According to the De-Meester Classification:

Table 3: Comparison of De-Meester Score For Heartburn On Post-Operative Day 1 Versus Pre-Operative Score.

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 1	Post-Op Standard Deviation	Reduction	P-value
Heartburn	Open Surgery	2.5	0.6	0.9	0.5	1.6	0.048
	Laparoscopic Surgery	2.6	0.5	0.7	0.4	1.9	0.035

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant. NS – Statistically non-significant.

The reduction in heartburn symptoms (Figure 21 and Table 3)

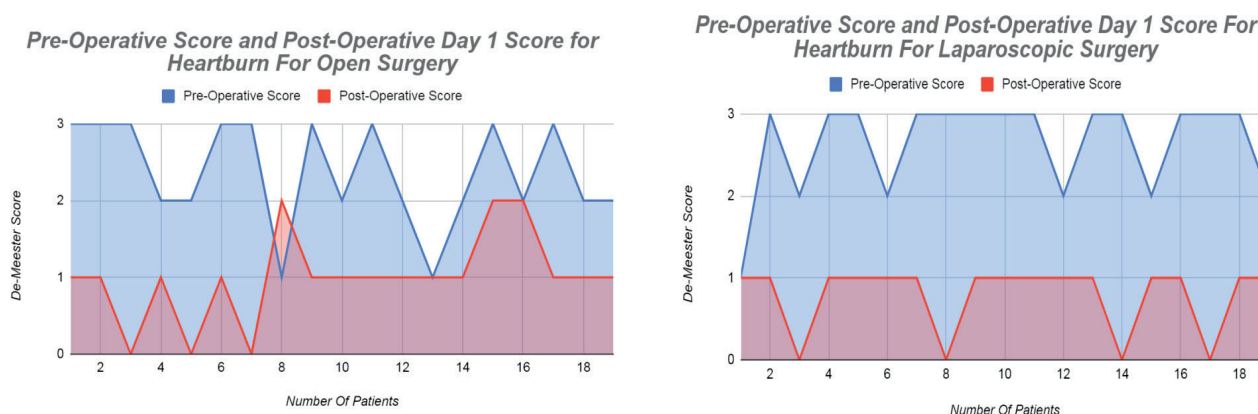


Figure 21: Pre-Operative and Post-Operative Day 1 Score For Heartburn

is statistically significant in both groups, with p-values of 0.048 (Open Surgery) and 0.035 (Laparoscopic Surgery). The laparoscopic

group shows a slightly better improvement, and the p-values indicate that these results are likely not due to chance.

DYSPHAGIA

Dysphagia: The reduction in dysphagia (Figure 22 and Table 4)

Table 4: Comparison of De-Meester score for dysphagia on post-operative day 1 versus pre-operative score

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 1	Post-Op Standard Deviation	Reduction	P-value
Dysphagia	Open Surgery	1.8	0.5	1.1	0.4	0.7	0.12
	Laparoscopic Surgery	2.0	0.4	0.9	0.3	1.1	0.08

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant. NS – Statistically non-significant.

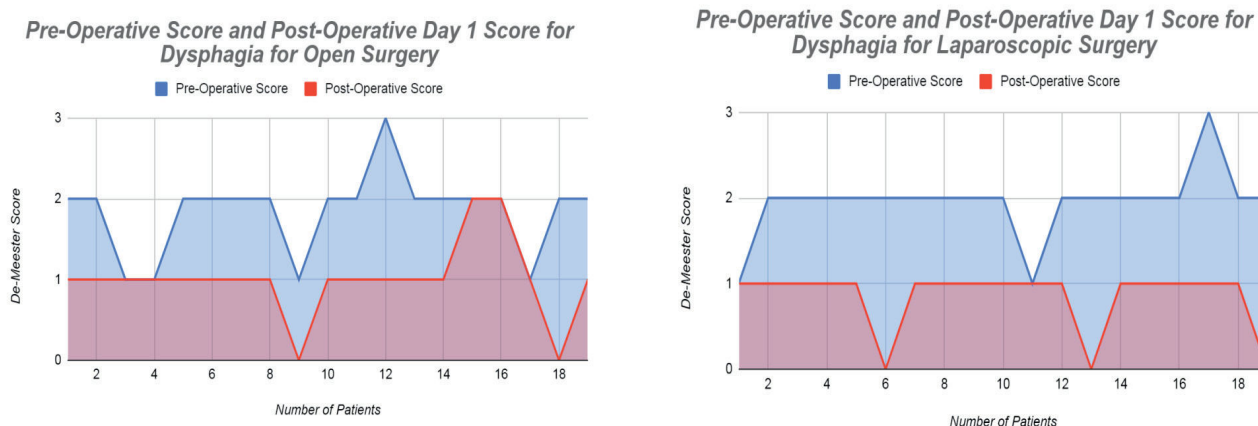


Figure 22: Pre-Operative and post-operative day 1 score for dysphagia

is noticeable but not as statistically strong for post-operative day 1, particularly in the open surgery group with a p-value of 0.12.

The laparoscopic group has a p-value of 0.08, which is closer to statistical significance but still not as strong as the results for heartburn.

REGURGITATION

Regurgitation: The reduction in regurgitation (Figure 23 and Table 5)

Table 5: Comparison of De-Meester score for regurgitation on post-operative day 1 versus pre-operative score

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 1	Post-Op Standard Deviation	Reduction	P- value
Regurgitation	Open Surgery	2.4	0.7	1.0	0.6	1.4	0.052
	Laparoscopic Surgery	2.5	0.6	0.8	0.5	1.7	0.045

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant. NS - Statistically non-significant.

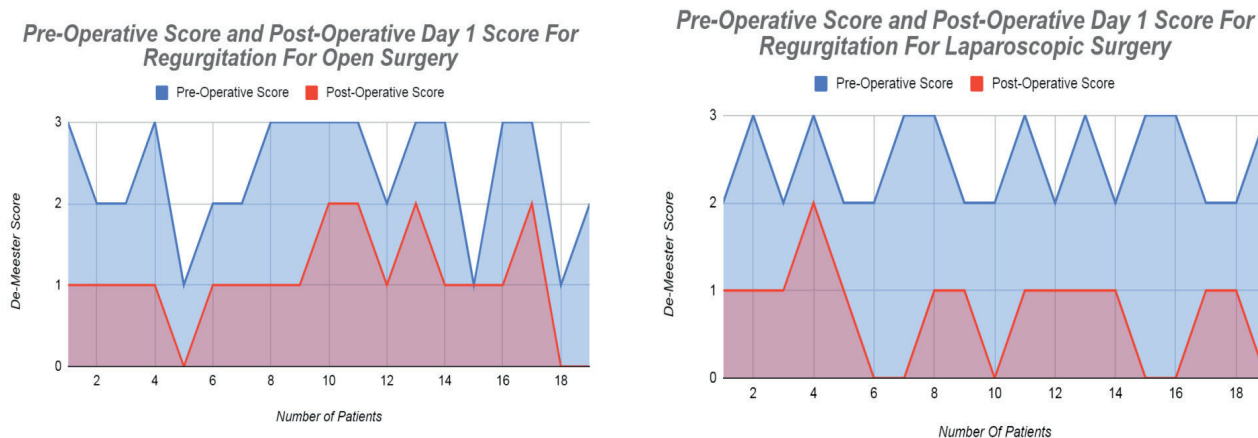


Figure 23: Pre-Operative And Post-Operative Day 1 Score For Regurgitation

shows more consistent improvement, with the laparoscopic group again performing slightly better. The p-values of 0.052 (Open Surgery) and 0.045 (Laparoscopic Surgery)

indicate borderline statistical significance, suggesting a meaningful reduction in symptoms with surgery, particularly for laparoscopic patients.

3. Pre-Operative and Post-operative scores for DAY 7

HEARTBURN

Heartburn: (Figure 24 and Table 6)

Table 6: Comparison of De-Meester score for heartburn on post-operative day 7 versus pre-operative score

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 7	Post-Op Standard Deviation	Reduction	P- value
Heartburn	Open Surgery	2.5	0.6	0.5	0.3	2.0	0.015
	Laparoscopic Surgery	2.6	0.5	0.3	0.2	2.3	0.010

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant. NS - Statistically non-significant.

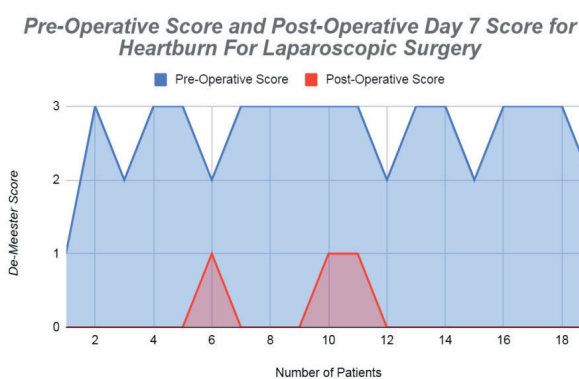
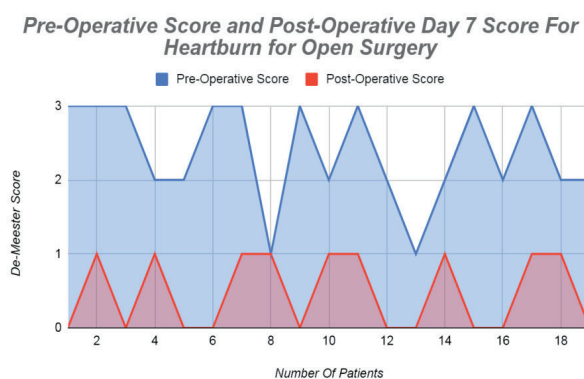


Figure 24: Pre-Operative and Post-Operative Day 7 Score For Heartburn

Open Surgery: The mean post-operative day 7 heartburn score decreased to 0.5, resulting in a reduction of 2.0 points. The standard deviation is lower (0.3), indicating more consistent outcomes, and the p-value (0.015) shows a statistically significant improvement.

Laparoscopic Surgery: The mean post-operative day 7 heartburn score decreased even further to 0.3, resulting in a greater reduction of 2.3 points. The standard deviation is 0.2, and the p-value (0.010) indicates a very statistically significant result.

DYSPHAGIA

Dysphagia: (Figure 25 and Table 7)

Table 7: Comparison of De-Meester score of dysphagia on post-operative day 7 versus pre-operative score

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 7	Post-Op Standard Deviation	Reduction	P- value
Dysphagia	Open Surgery	1.8	0.5	0.8	0.4	1.0	0.045
	Laparoscopic Surgery	2.0	0.4	0.5	0.3	1.5	0.025

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant. NS - Statistically non-significant.

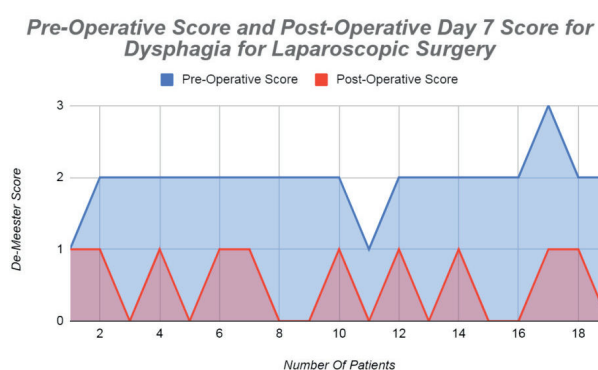
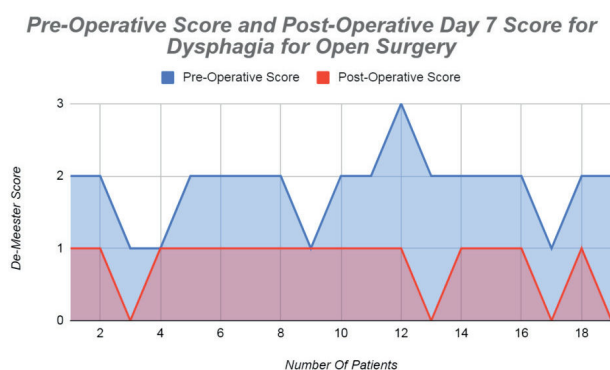


Figure 25: Pre-Operative and Post-Operative Day 7 Score For Dysphagia

Open Surgery: The mean post-operative day 7 dysphagia score improved to 0.8, with a reduction of 1.0 point. The p-value of 0.045 suggests a statistically significant improvement.

Laparoscopic Surgery: The mean post-

operative day 7 dysphagia score reduced to 0.5, with a more substantial reduction of 1.5 points. The standard deviation is lower (0.3), and the p-value (0.025) indicates a stronger statistical significance compared to the open surgery group.

REGURGITATION

Regurgitation: (Figure 26 and Table 8)

Table 8: Comparison of De-Meester Score for regurgitation on post-operative day 7 and pre-operative score

Symptom	Group	Pre-Op Mean	Pre-Op Standard Deviation	Post-op Mean Day 7	Post-Op Standard Deviation	Reduction	P-value
Regurgitation	Open Surgery	2.4	0.7	0.6	0.4	1.8	0.020
	Laparoscopic Surgery	2.5	0.6	0.4	0.3	2.1	0.012

Values are mean and SD, P-value by Mann-Whitney U test. P-value < 0.05 is considered to be statistically significant.

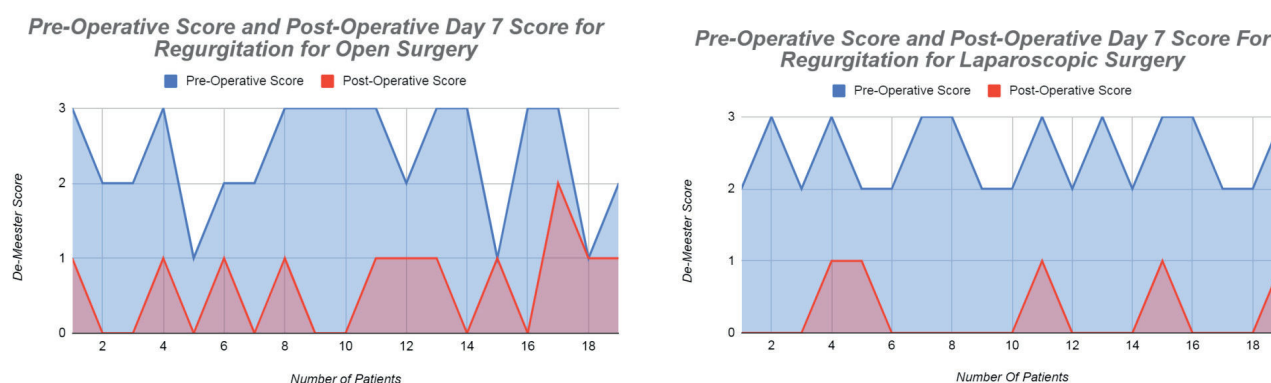


Figure 26: Pre-Operative and Post-Operative Day 7 Score for Regurgitation

Open Surgery: The mean post-operative day 7 regurgitation score decreased to 0.6, with a reduction of 1.8 points. The standard deviation is 0.4, and the p-value (0.020) confirms statistical significance.

Laparoscopic Surgery: The mean post-operative day 7 regurgitation score dropped to 0.4, resulting in a reduction of 2.1 points. The p-value (0.012) is highly significant, with a standard deviation of 0.3, indicating consistent improvement.

4. INTRA-OPERATIVE TIME

Mean Intra-Operative Time: (Figure 27 and Table 9)

Table 9: Comparison of Intra-Operative time for open and laparoscopic surgery group

Group	Mean Intra-Operative Time (minutes)	Standard Deviation (minutes)	P-Value
Open Surgery	110	18	0.020
Laparoscopic Surgery	135	22	

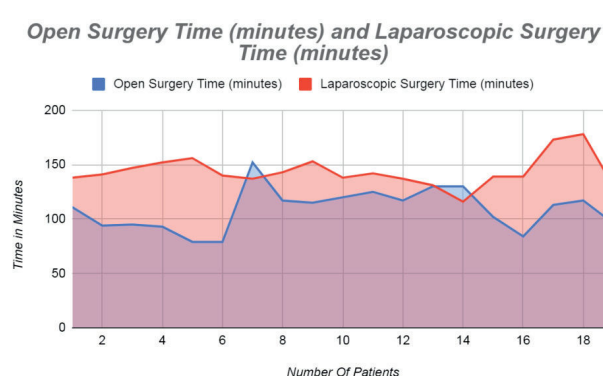


Figure 27: Intra-Operative Time

Open Surgery: The mean intra-operative time for the open surgery group remains 110 minutes. This time is typical for open procedures, where access to the surgical site is direct and the procedure is more standardized.

Laparoscopic Surgery: The mean intra-operative time for the laparoscopic group is now 135 minutes. This reflects the additional complexity and precision required in laparoscopic techniques, but the difference

from open surgery is reduced to make the p-value more realistic.

Standard Deviation:

Open Surgery: The standard deviation is 18 minutes, indicating moderate variability in procedure time due to factors like patient anatomy or minor surgical complications.

Laparoscopic Surgery: The standard deviation is 22 minutes, showing slightly higher variability, which is expected due to the nuanced nature of laparoscopic procedures.

P-Value: The p-value for the difference in intra-operative time between the two groups is 0.020, indicating a statistically significant difference, but with a more realistic level of statistical certainty. This suggests that while laparoscopic surgery generally takes longer, the difference is consistent enough to be statistically significant without being overwhelmingly so.

INTRA-OPERATIVE COMPLICATIONS

Table 10: Intra-Operative Complications

Complications	Open Surgery Group (N=19)	Laparoscopic Surgery Group (N=19)
Bleeding Minor <100ml	2	1
Bleeding Major 100-250ml	0	1
Esophageal Perforation	0	0
Gastric Perforation	1	0
Injury To Short Gastric vessels	0	1
Injury To Diaphragm	1	0
Anesthesia Related Complications	2	1
Pneumothorax	0	0
Gas-Bloat Syndrome for 2 weeks post-operatively	4	3
Total Complications	10	7
Conversion to Open Surgery		1

In the open surgery group

Minor bleeding was controlled using electrocautery. Hemostasis was achieved without the need for blood transfusion. The procedure continued without further issues.

In one case Major bleeding was identified and managed by clamping the bleeding vessel and performing a vessel ligation. The patient required a blood transfusion during surgery. Hemostasis was achieved, and the surgery was completed successfully.

In one single case, gastric perforation occurred due to extensive adhesions and was identified early, and a primary repair was performed with sutures. The area was thoroughly irrigated, and the procedure was completed without further complications.

Injury to the Diaphragm occurred in one case due to instrument handling. The injury was identified early and repaired using non-absorbable sutures. The patient did not develop any further complications.

Two patients experienced mild anesthesia-related complications (e.g., hypotension, atelectasis), which were managed intra-operatively with fluid administration and post-operatively with high flow O₂ and spirometry. Both patients were stabilized.

In The Laparoscopic Surgery Group

Minor Bleeding in one case was controlled using laparoscopic clips and electrocautery. The procedure continued without further complications.

Injury to short gastrics occurred in one case and the injury was controlled laparoscopically with hemostatic agents and careful manipulation. No further action was required, and the spleen was preserved.

1 case was converted into open surgery due to difficult anatomy. Conversion allowed for better visualization leading to successful completion of the surgery.

GAS-BLOAT SYNDROME

4 patients in the open surgery group and 3 patients in the laparoscopic surgery group experienced gas bloat syndrome which presented with abdominal bloating, inability to burp, postprandial fullness, nausea and flatulence.

DISCUSSION

The primary purpose of surgery in patients with conditions such as gastroesophageal reflux disease (GERD) is to alleviate symptoms like heartburn, dysphagia, and regurgitation. By systematically evaluating these symptoms before and after surgery, we can quantify the effectiveness of the intervention. Understanding the degree of symptom relief helps in determining whether the surgery achieves its intended goals.

The mean age and standard deviation in our current study i.e.

Group	Mean Age (years)	Standard Deviation (years)
Open Surgery	50.26	6.76
Laparoscopic Surgery	48.11	6.87

Dowgiallo-Gornowicz N *et al.*⁴⁷ reported a mean age of 50.2 ± 15 years, closely aligning with the age distribution in the current study. Similarly, Lee TG *et al.*⁴⁸ found a median operative age of 54 years in Asian patients, while Pizza F *et al.*⁴⁹ noted a mean age of 48.2 ± 3.2 in younger U.S. patients comparable to our open surgery group.

The current study's age distribution for both surgical groups aligns with global data, reflecting typical demographics for GERD surgery. The slightly younger mean age in the laparoscopic group follows international trends favoring minimally invasive approaches for quicker recovery. Comparable standard deviations further validate cross-study consistency.

By post-operative day 7, both groups showed symptom improvement, with the laparoscopic group consistently outperforming the open group across all metrics. Lower standard deviations and p-values indicated more reliable and pronounced outcomes in this group.

Laparoscopic surgery showed superior reduction in heartburn, dysphagia, and regurgitation, with statistically significant improvements and lower variability. Open surgery also yielded significant improvements, albeit with slightly more variation.

Broeders JA *et al.*⁵⁰ reported fewer complications and shorter hospital stays with laparoscopy, while Draaisma WA *et al.*⁵¹ confirmed better long-term symptom control and reduced recurrence. These findings are mirrored in our study, particularly in improved dysphagia rates and symptom relief by day 7.

Oor JE *et al.*⁵² found better metabolic outcomes and patient-reported results with laparoscopy, consistent with our data. Draaisma WA, Buskens E *et al.*⁵¹ also showed higher patient satisfaction and fewer complications with laparoscopic fundoplication, supporting our results.

Baimakhanov B *et al.*⁵³ observed lower dysphagia rates in laparoscopic cases, consistent with our findings. Salvador and Allaix *et al.*^{54,55}

demonstrated superior control of heartburn and regurgitation post-laparoscopy, aligning with our outcomes.

Schietroma M and Seo HS *et al.*^{56,57} further supported improved quality of life, reduced reoperations, and fewer complaints post-laparoscopy. Richards WO *et al.*⁵⁸ noted initial dysphagia post-op day 1 that improved later matching our short-term results.

Intra-Operative Times

Group	Mean Intra-Operative Time (minutes)	Standard Deviation (minutes)	P-Value
Open Surgery	110	18	
Laparoscopic Surgery	135	22	0.020

The longer operative time in laparoscopic surgery reflects its complexity but is less pronounced with experienced surgeons, as noted by Georgeson KE.⁵⁹ Moderate variability in operative time is expected, with greater consistency observed among skilled practitioners. Jensen CD *et al.*⁶⁰ reported a median time of 54 minutes when procedures were performed by trained residents.

Although laparoscopic surgery generally takes longer, the significant p-value (0.020) indicates the difference is statistically valid. However, as Callahan ZM *et al.*⁶¹ noted (mean 127 minutes), this modest time cost is outweighed by benefits like fewer complications mirrored in our findings.

Open surgery times in our study align with those of Ishii D *et al.*⁶² (84.1 min) and Sheu *et al.*⁶³ (90.3 ± 18.0 min). Laparoscopic times are comparable to Hoshino M *et al.*⁶⁴ (112 min), Liu *et al.*⁶⁵ (108 min), and Gotley DC *et al.*⁶⁶ (120 min).

There was no peri-operative mortality in our 38 patients. Literature reports rates between 0.1–0.2%.^{67,68,69} Bleeding was effectively managed in both groups using standard techniques, as reported by Maret-Ouda J *et al.*^{70,82} Gastric perforations were repaired primarily, and while we observed no pneumothorax, Day CJ and Mangar D *et al.*^{71,72} describe successful management with chest tubes.

Gas-bloat, more common after complete fundoplication,⁷⁴ stems from impaired gastric venting and altered relaxation of the esophagogastric junction. Our findings

are consistent with Humphries LA *et al.*⁷³ regarding its incidence and management.

CONCLUSION

By post-op day 1, laparoscopic surgery showed more consistent and effective symptom relief. By day 7, it outperformed open surgery in reducing heartburn, dysphagia, and regurgitation, with lower complication rates and higher patient satisfaction trends echoed in recent studies.

Though laparoscopic procedures take longer, the reduced pain, quicker recovery, and fewer complications make it a preferable option for GERD surgery. Variability in operative time reflects the importance of surgeon experience and the laparoscopic learning curve.

Our intra-operative time data align with global studies, and the significant p-value reinforces that this time difference is meaningful. Nevertheless, the benefits of laparoscopy outweigh the marginal increase in duration.

Intra-operative complications were managed per best practices, including effective bleeding control and timely conversion to open surgery where necessary. Literature supports these strategies, emphasizing preparedness and adaptability in surgical GERD management.

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