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ORIGINAL RESEARCH

Endoscopic observations around the gastroesophageal junction in patients with symptomatic gastroesophageal reflux disease

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ABSTRACT

Background: Gastroesophageal reflux disease (GERD) is a prevalent disorder influenced by the dysfunction of the gastroesophageal junction (GEJ). The gastroesophageal flap valve (GEFV), a key anatomical component, plays a significant role in reflux prevention, yet its clinical relevance remains underexplored. This study evaluates the correlation between GEFV grading, GERD symptoms, and associated endoscopic findings. **Methods:** A cross-sectional study was conducted at the Department of Endoscopy, Padmashree Diagnostic Centre, Bengaluru, India, involving 201 GERD-symptomatic patients from December 2022 to December 2024. Participants underwent upper gastrointestinal endoscopy, with GEFV grading assessed using the Hill classification. GERD symptom severity was evaluated using the GERD-Q questionnaire, and associations between GEFV grade, esophagitis, hiatus hernia (HH), and GERD-Q scores were analysed using statistical methods, including chi-square tests and ANOVA. **Results:** Among the participants, 55.2% were female, and 44.8% were male. The prevalence of non-erosive reflux disease (NERD) was 51.2%, while reflux esophagitis was observed in 7.5%. Higher GEFV grades correlated significantly with increased esophagitis ($p = 0.001$) and HH ($p < 0.001$). Hill Grade IV was strongly associated with HH (77.8%). GERD-Q scores differed significantly across diagnostic categories ($p < 0.001$), with reflux esophagitis patients exhibiting the highest scores. **Conclusion:** GEFV grading is a clinically relevant parameter in GERD assessment, demonstrating significant associations with esophagitis and HH. These findings highlight the importance of GEFV evaluation in GERD diagnosis and management, supporting its role in predicting disease severity and therapeutic response.

Keywords: Gastroesophageal reflux disease, Gastroesophageal flap valve, GERD-Q, Hiatus hernia, Endoscopy, Hill classification.

INTRODUCTION

Gastroesophageal reflux disease (GERD) is primarily a clinical diagnosis, with upper gastrointestinal endoscopy commonly used to assess esophagitis severity, associated abnormalities, and potential complications. Evaluating the gastroesophageal junction (GEJ) during upper gastrointestinal endoscopy (UGIE) provides critical insights into GERD pathophysiology (3). This study analyzed endoscopic abnormalities of the GEJ in 201 GERD-symptomatic patients who underwent evaluation between December 2022 and December 2023 at the Department of Endoscopy, Padmashree Diagnostic Centre, Bengaluru, Karnataka, India.

The Anti-Reflux Barrier and GERD Pathophysiology

The dysfunction of the anti-reflux barrier is a major factor in GERD development. The esophagogastric junction (EGJ) is a complex anatomical structure

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comprising the lower esophageal sphincter (LES), crural diaphragm (CD), His angle, and the gastroesophageal flap valve (GEFV).

The GEFV is a 180-degree musculomucosal fold located opposite the stomach's lesser curvature, visualized via retroflexed endoscopy (1). It originates from the intraluminal extension of His angle, first described by Thor et al. in 1987(2). Hill et al. later introduced a grading system in 1996 to classify GEFV morphology(1).

Factors Influencing GEFV Function

- Respiration and Meals: His angle decreases during expiration, enhancing valve contact, while gastric distension modifies the proximal fundus shape, potentially reinforcing the anti-reflux barrier (3).
- Hiatus Hernia: A Grade IV GEFV is strongly linked to hiatus hernia (1).
- Acid Reflux and Treatment Response: Studies indicate a correlation between GEFV grades and acid reflux severity, aiding in predicting response to proton pump inhibitor (PPI) therapy (4 -7)

Controversy Surrounding GEFV's Role in GERD

Although LES and CD primarily regulate EGJ pressure, the contribution of GEFV remains debated. An intact GEFV does not always preclude GERD(4). However, transoral incisionless fundoplication (TIF), a procedure reinforcing the valve, has been shown to:

- Reduce EGJ distensibility.
- Decrease refluxate volume (5). These findings suggest that while the GEFV may aid in reflux prevention, its precise role requires further investigation.

GERD Prevalence and Implications

GERD, defined by gastric reflux leading to troublesome symptoms or complications(6), affects 10–20% of individuals in Western populations(7). Dysfunction of the anti-reflux barrier at the GEJ is its primary cause, with key components including:

1. Lower Esophageal Sphincter (LES)
2. Crural Diaphragm (CD)
3. Gastroesophageal Junction Geometry (including the angle of His and GEFV)

The intraluminal extension of His angle forms the GEFV, playing a critical role in GERD pathophysiology (8-9). Studies have long recognized the significance of altered GEFV geometry in GERD development(1).

Endoscopic Grading of GEFV

Since Hill et al. introduced GEFV retroflex grading in 1996, it has been regarded as a straightforward and reproducible diagnostic tool (8). This classification aids in GERD assessment and predicting PPI response(9). Higher GEFV grades are associated with:

- Increased prevalence of reflux esophagitis.
- Barrett’s esophagus.
- Abnormal esophageal acid exposure.
- Mechanically defective sphincters (10).

Research Gaps and Study Objectives

Despite its clinical relevance, GEFV remains underexplored. Limited data exist on its role in GERD symptomatology and quality of life. Additionally, correlations between GEFV grading, hiatal defect size, and objective measures such as esophageal manometry and multi-channel intraluminal impedance pH

AIM OF THE STUDY

- To evaluate the clinical correlation between gastroesophageal flap valve (GEFV) abnormalities and GERD-related conditions.
- To assess the association between Hill Grade and the presence of esophagitis, hiatus hernia, and GERD severity.
- To analyze symptom-based classifications (Dyspepsia, NERD, and RE) in relation to endoscopic findings.
- To determine the relationship between GERD-Q scores and Hill Grade.
- To enhance the understanding of GERD pathophysiology and improve diagnostic and management strategies.

METHODS

Study Design and Participants

This cross-sectional study was conducted at Department of Endoscopy, Padmashree Diagnostic Centre, Bengaluru, Karnataka, India, to evaluate the clinical correlation between symptoms, gastroesophageal flap valve (GEFV) abnormalities, and gastroesophageal reflux disease (GERD)-related conditions.

Inclusion Criteria

- Participants aged 14 years or older
- Individuals presenting with GERD symptoms for at least three months.

Exclusion Criteria

1. Symptoms consistent with peptic ulcer-like, dysmotility-like, or nonspecific dyspepsia.
2. Use of antiplatelet agents, NSAIDs, or bisphosphonates.
3. Proton pump inhibitor (PPI) use within the past two weeks.
4. Presence of dysphagia, hematemesis, melena, ischemic heart disease, or abnormal ECG findings.

Endoscopic Evaluation

All participants underwent upper gastrointestinal endoscopy using the Olympus GIF 150 (Tokyo, Japan), performed by a single experienced gastroenterologist. The esophagus, gastroesophageal

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junction (GEJ), stomach, and duodenum were systematically examined.

- GEJ Definition: Defined based on established criteria.
- Reflux Esophagitis (RE): Categorized using the Los Angeles classification.
- Hiatus Hernia (HH): Diagnosed when the squamocolumnar junction was separated from the diaphragmatic impression by >2 cm, measured using endoscopic hashmarks at the incisors.
- Columnar-Lined Esophagus (CLE): Documented if the squamocolumnar junction extended above the gastric rugal folds.

Gastroesophageal Flap Valve Assessment

The GEFV was evaluated during retroflexion in the gastric fundus and graded using the Hill classification:

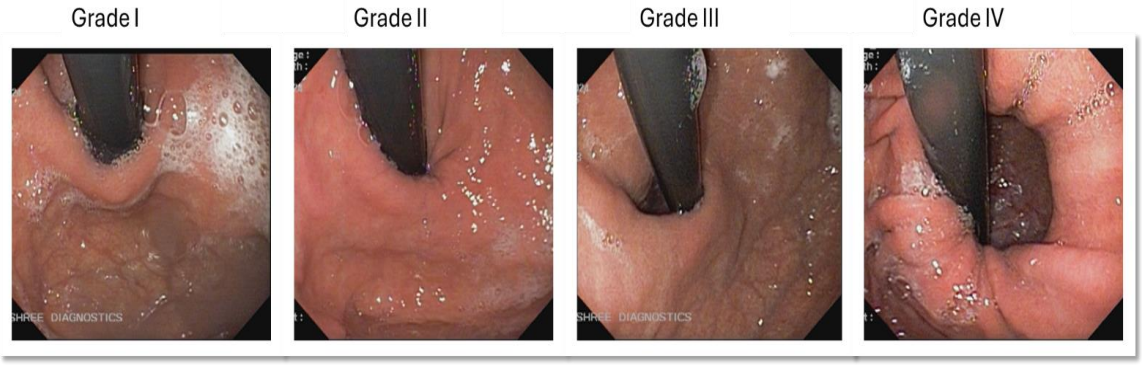

Figure: Endoscopic View of the Hill Classification for Gastroesophageal Flap Valve

Hill Grade I: A distinct tissue fold is observed along the lesser curvature adjacent to the endoscope, reflecting a well-formed valve.

Hill Grade II: The tissue fold is less pronounced, with intervals of opening and rapid closure around the endoscope, indicating a somewhat weakened valve.

Hill Grade III: The tissue fold is not evident, and the endoscope is not securely embraced by the tissue, suggesting a poorly formed valve.

Hill Grade IV: There is an absence of a fold, the esophageal lumen remains open, and the squamous epithelium is often visible from below. This usually signifies the presence of a hiatal hernia, indicating a severely incompetent valve.

Symptom Assessment

To quantify symptom severity, the GERD-Q questionnaire was administered to all participants. The GERD-Q score was calculated for each individual:

- A score of ≥8 indicated significant GERD symptoms.
- The questionnaire assessed symptom frequency (heartburn, regurgitation), sleep disturbances, and medication use.

Diagnostic Classification

Participants were categorized based on GERD-Q scores and endoscopic findings (11):

1. Dyspepsia: GERD-Q score ≤7 without esophagitis.
2. Non-Erosive Reflux Disease (NERD): GERD-Q score ≥8 without esophagitis.
3. Reflux Esophagitis (RE): GERD-Q score ≥8 with esophagitis.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics V.29 software. Statistical tests included chi-square for categorical variables, one-way ANOVA for continuous variables, and Pearson's correlation for associations. A p-value <0.05 was considered statistically significant.

RESULT

Table 1: Demographics, Endoscopic Findings, and GERD-Q Scores of Study Participants

Variable/Association	Findings
Demographics	
Female Participants	111 (55.2%)
Male Participants	90 (44.8%)
Endoscopic Findings	
No Esophagitis	186 (92.5%)
With Esophagitis	15 (7.5%)
Hill Grade Distribution	
Grade I	55 (27.4%)
Grade II	98 (48.8%)
Grade III	30 (14.9%)
Grade IV	18 (9.0%)

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Hiatus Hernia (HH) Prevalence	
No HH	155 (77.1%)
With HH	46 (22.9%)
GERD-Q Scores	
Dyspepsia	6.90 (0.88)
Non-Erosive Reflux Disease (NERD)	9.14 (0.85)
Reflux Esophagitis	10.27 (1.10)

Table 1: This table presents demographic details, key endoscopic findings, Hill Grade distribution, hiatus hernia prevalence, and GERD-Q scores, providing a comprehensive overview of participant characteristics and clinical profiles.

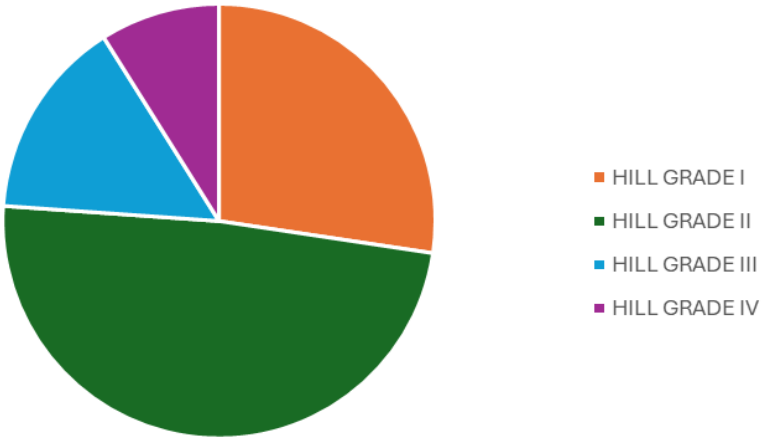

Figure 1: Pie Chart of Hill Grade Distribution

This chart illustrates the distribution of Hill grades based on endoscopic assessment of the gastroesophageal flap valve (GEFV). Hill Grade II is the most prevalent (48.8%), followed by Grade I (27.4%), Grade III (14.9%), and Grade IV (9.0%).

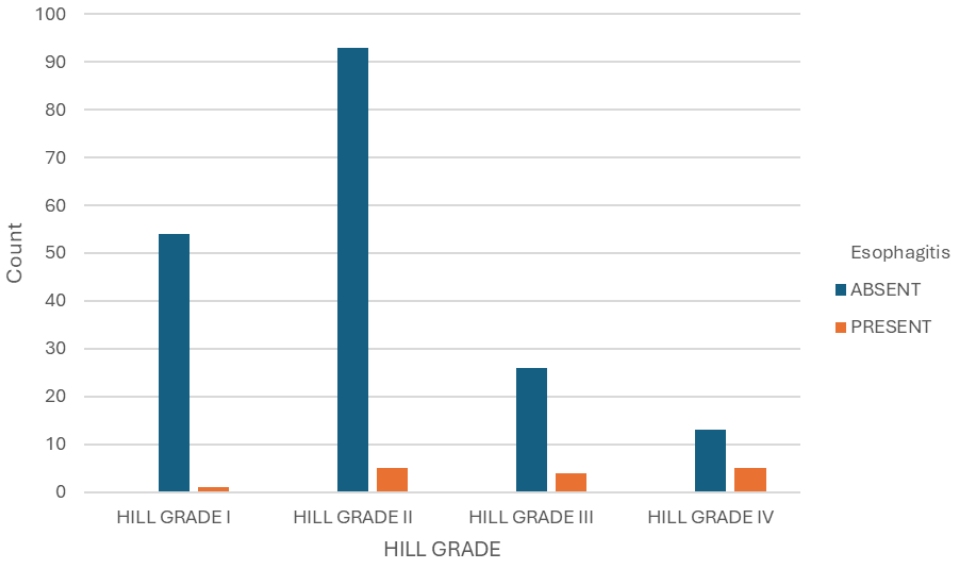

Figure 2: Clustered Bar Chart of Hill Grade by Esophagitis

This chart shows the distribution of Hill grades categorized by the presence or absence of esophagitis.

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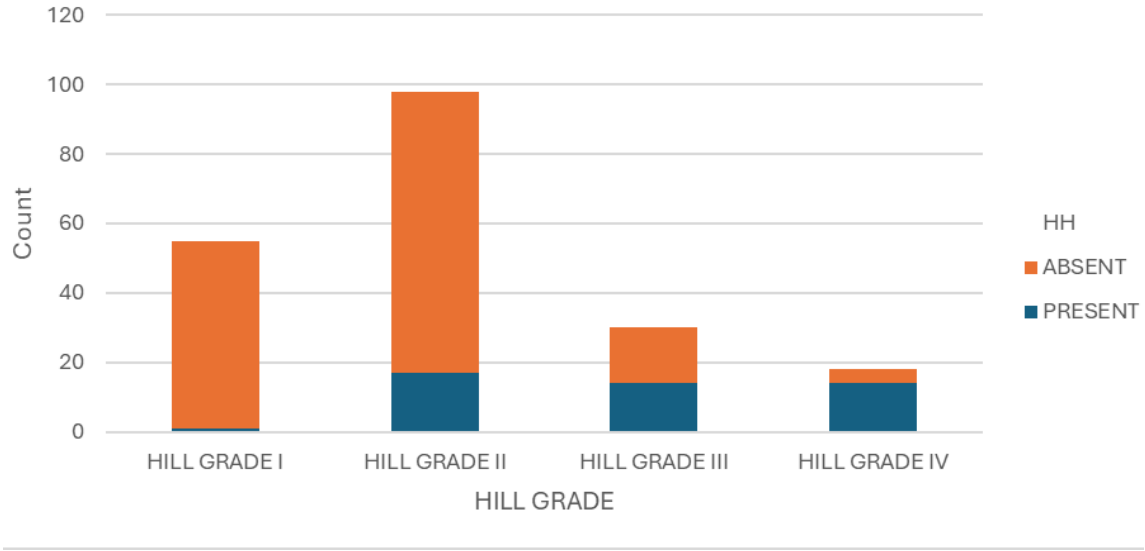

Figure 3: Stacked Bar Chart of Hill Grade by Hiatus Hernia (HH)

This chart depicts the relationship between Hill grade severity and hiatus hernia (HH).

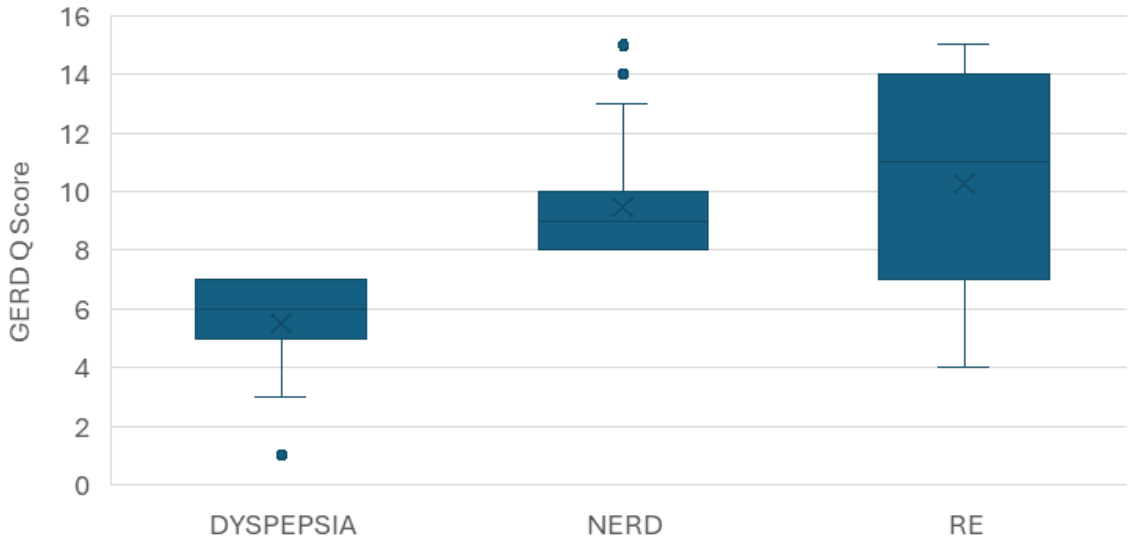

Figure 4: Box Plot of GERD-Q Score by Diagnosis

This box plot compares GERD-Q scores across Dyspepsia, NERD, and Reflux Esophagitis (RE). RE patients have the highest GERD-Q scores, while Dyspepsia and NERD show wider score distributions. The plot highlights differences in median values, variability, and outliers among these diagnostic groups.

Key Statistical Associations

Hill Grade and Esophagitis

- Chi-Square Test: Significant association, $\chi^2(3, N=201) = 15.583$, $p=0.001$.
  - Supported by the Fisher-Freeman-Halton Exact Test ($p=0.003$).
- Linear-by-Linear Association: Significant trend, $\chi^2 = 13.665$, $p<0.001$.
- Findings: Higher Hill Grades correlated with an increased likelihood of esophagitis.

Hill Grade and Hiatus Hernia

- Chi-Square Test: Strong association, $\chi^2(3, N=201) = 55.882$, $p<0.001$.
- Linear-by-Linear Association: Significant trend, $\chi^2 = 53.387$, $p<0.001$.
- Findings:
  - Hill Grade I: Only 1.8% had HH.
  - Hill Grade IV: 77.8% had HH.
- Interpretation: A clear positive correlation exists between increasing Hill Grades and the presence of hiatus hernia.

GERD-Q Scores and Diagnostic Categories

- Distribution:
  - Dyspepsia: 83 participants (41.3%)
  - NERD: 103 participants (51.2%)
  - Reflux Esophagitis (RE): 15 participants (7.5%)

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One-Way ANOVA on GERD-Q Scores by Diagnosis

- ANOVA Results: Significant difference, $F(2, 198) = 89.632$, $p<0.001$.
- Post-Hoc Analysis:
  - Dyspepsia had significantly lower GERD-Q scores than NERD and RE ($p<0.001$).
  - GERD-Q scores between NERD and RE were not significantly different ($p=0.182$).

Summary of Findings

- The majority of participants had NERD (51.2%) or dyspepsia (41.3%), while only 7.5% had reflux esophagitis.
- Hill Grade severity was significantly associated with both esophagitis and hiatus hernia.
- GERD-Q scores effectively distinguished between diagnostic categories, with dyspepsia having the lowest scores and RE the highest.

This study highlights the importance of GEFV grading in assessing GERD severity and its association with esophagitis and HH, reinforcing its clinical relevance in GERD diagnosis and management.

DISCUSSION

This study explores the clinical correlation between symptoms, gastroesophageal flap valve (GEFV) abnormalities, and GERD-related conditions. The findings offer insights into demographic variations, endoscopic characteristics, and symptom-based classifications, which have implications for understanding GERD pathophysiology and its management.

Gender Distribution and GERD Classifications

A slightly higher proportion of female participants (55.2%) was observed compared to males (44.8%). Gender-specific analysis revealed that dyspepsia was more prevalent among females (47.7%), while reflux esophagitis was more common in males (14.4%). These findings align with prior research suggesting that hormonal, anatomical, or lifestyle differences may influence GERD presentation. However, the minimal difference in GERD Q scores between genders suggests that symptom severity does not significantly vary despite classification differences.

Correlation Between Esophagitis and Hill Grade

A significant association between Hill Grade and esophagitis was observed ($p < 0.001$). Higher Hill Grades (III and IV) were linked to an increased risk of esophagitis, emphasizing the role of GEFV incompetence in esophageal inflammation. This aligns with Contractor et al. and Chang et al., who reported a positive correlation between GEFV abnormalities and esophagitis severity (11-12). Hill Grade I, which demonstrates a well-functioning valve, is associated with minimal esophageal acid exposure, explaining the lower incidence of esophagitis in this group.

Hiatus Hernia and GERD-Related Findings

Hiatal hernia (HH) was observed in 22.9% of participants and was significantly associated with higher Hill Grades and esophagitis. The presence of HH contributes to GERD by disrupting the anatomical and functional anti-reflux barriers. Consistent with Nishizawa & Suzuki (11), HH is a common finding in GERD patients, exacerbating symptoms and esophageal damage.

Association Between GEFV Abnormalities, GERD, and Endoscopic Findings

Abnormal GEFV is frequently observed in symptomatic GERD patients undergoing endoscopy. While hiatal hernias are often classified by their axial length (12), endoscopic measurement has significant interobserver variability(13). A comprehensive assessment of the gastroesophageal junction, including LES, diaphragmatic crural fibers, and GEFV, is crucial for accurate diagnosis (1).

The Hill classification is a widely used tool for evaluating GEFV integrity during gastroscopy(8). This system, which grades the GEFV from I to IV, correlates strongly with GERD prevalence, HH, and LES pressure abnormalities (14-15). Studies suggest that Hill classification predicts reflux more effectively than LES pressure alone (14), reinforcing its clinical utility.

GERD Q Scores and Symptom Severity

Esophagitis patients exhibited higher GERD Q scores ($M = 10.27$) than those without esophagitis ($M = 7.70$), indicating that esophagitis is linked to greater symptom severity. A positive correlation was observed between age and GERD Q scores ($r = 0.187$, $p = 0.008$), suggesting that GERD symptoms may worsen with age due to anatomical and functional changes.

Previous studies have associated higher Hill grades with increased GERD symptoms, reduced LES pressure, and hiatal hernia prevalence(15-16). Additionally, elevated Hill grades have been linked to poorer responses to proton pump inhibitor therapy (9). WhileHansdotter et al found no superiority of Hill grading over axial hernia length measurement, they emphasized its practicality due to technical challenges in endoscopic measurement(14).

Diagnostic Classifications

Participants were classified into dyspepsia (41.3%), non-erosive reflux disease (NERD, 51.2%), and reflux esophagitis (RE, 7.5%). NERD, the most common diagnosis, was characterized by significant symptoms (GERD $Q \geq 8$) without visible esophageal damage. The one-way ANOVA and post-hoc analyses demonstrated increasing GERD Q scores from dyspepsia to NERD to RE, supporting the progressive nature of GERD.

Studies in Asia have identified abnormal GEFV as a major risk factor for reflux esophagitis(15-17). Notably, GEFV Grades III and IV are strongly

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associated with RE, suggesting that GEFV abnormalities may be a more sensitive GERD indicator than hiatal hernia in certain populations.

The distribution of abnormal GEFV in dyspepsia and NERD patients remains understudied (15-16). Given that NERD represents the largest GERD subset, further investigation is needed to determine whether abnormal GEFV can identify NERD subtypes with increased reflux activity.Kochet al reported a positive correlation between high GEFV grades, DeMeester scores, and reflux events(4). In our study, abnormal GEFV was linked to significantly higher GERD Q scores (5.7 ± 2.4 vs. 4.9 ± 2.7, $P = 0.011$), and its prevalence increased across dyspepsia, NERD, and RE groups.

Within the dyspepsia group, 27.4% (59/215) had abnormal GEFV, suggesting increased reflux exposure despite not meeting GERD criteria. Over time, these patients may progress to GERD, particularly in the presence of risk factors such as aging, smoking, or obesity. Clinically, some dyspeptic patients develop typical reflux symptoms during follow-up, supporting the dynamic nature of GERD progression.

CONCLUSION

This study highlights a significant correlation between gastroesophageal flap valve (GEFV) abnormalities, GERD symptoms, and endoscopic findings. Higher Hill Grades were associated with increased esophagitis prevalence, higher GERD-Q scores, and a greater likelihood of hiatal hernia, reinforcing the role of GEFV integrity in GERD pathophysiology. The prevalence of NERD as the dominant GERD subtype underscores the need for refined diagnostic criteria that incorporate endoscopic and symptom-based assessments. Given the progressive nature of GERD, early identification of abnormal GEFV may aid in risk stratification and tailored management. Future research should explore longitudinal changes in GEFV function and treatment responses to optimize GERD management strategies.

LIMITATIONS

This study has several limitations. Its cross-sectional design prevents causal inferences regarding variable relationships. The relatively small number of participants in certain subgroups (e.g., Hill Grade IV) may limit generalizability. Additionally, potential confounders such as diet, lifestyle, and medication use were not controlled, which may have influenced outcomes.

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