



**RADIOLOGICAL FINDINGS OF LOWER ESOPHAGEAL SPHINCTER
INCOMPETENCE IN PATIENTS WITH IRON DEFICIENCY ANEMIA**

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Abstract. Iron deficiency anemia (IDA) remains a global health concern, frequently resulting from chronic occult gastrointestinal blood loss. Lower esophageal sphincter (LES) incompetence, commonly manifested as hiatal hernia, can contribute to mucosal injury (e.g., Cameron lesions) and gastroesophageal reflux, leading to iron depletion. This cross-sectional study investigated radiological signs of LES incompetence using barium-contrast upper gastrointestinal series in 52 adult patients with confirmed IDA. Hiatal hernia, indicating LES incompetence, was identified in 28 patients (53.8%), with sliding (Type I) hernia being the most prevalent (46.2%). Gastroesophageal reflux was observed in 60.7% of hernia-positive cases, and linear mucosal irregularities suggestive of Cameron erosions appeared in 19.2% of the cohort. A significant negative correlation was found between the presence of hiatal hernia and both hemoglobin levels ($r = -0.62$, $p < 0.01$) and serum ferritin ($r = -0.59$, $p < 0.01$). These results underscore the value of conventional barium esophagography as a non-invasive, cost-effective tool for detecting LES incompetence in patients with unexplained or refractory IDA, particularly in settings where advanced endoscopy is limited. Early radiological identification may guide targeted therapy, including hernia repair, and improve hematologic outcomes.

Keywords: Iron deficiency anemia, lower esophageal sphincter incompetence, hiatal hernia, Cameron lesions, barium swallow, gastroesophageal reflux, radiology

Introduction. Iron deficiency anemia (IDA) is the most common nutritional deficiency worldwide, affecting approximately 1.2 billion people, with higher prevalence among women and in developing regions. While dietary insufficiency, malabsorption, and overt bleeding are well-recognized causes, chronic occult blood loss from the upper gastrointestinal tract is often overlooked. Structural and functional abnormalities at the esophagogastric junction, particularly incompetence of the lower esophageal sphincter (LES), play a significant yet underappreciated role.

LES incompetence facilitates gastroesophageal reflux disease (GERD) and allows mechanical trauma to the gastric mucosa as it traverses the diaphragmatic hiatus in hiatal hernia. This can result in linear erosions or ulcers known as **Cameron lesions**, which cause chronic, low-volume bleeding and subsequent iron deficiency. Large hiatal hernias (>3–5 cm) are especially implicated, even in the absence of visible Cameron lesions, possibly due to repeated mucosal ischemia or micro-erosions during diaphragmatic contractions.



Conventional barium-contrast esophagography (barium swallow) remains a valuable first-line imaging modality for assessing LES function and hiatal hernia. It allows dynamic visualization of reflux under provocation (e.g., Valsalva maneuver), measurement of hernia size, and detection of mucosal abnormalities that static endoscopy may miss. Prior studies using manometry have shown esophageal dysmotility and altered LES pressure in IDA patients, but dedicated radiological data on LES incompetence in this population are relatively scarce.

The present study aimed to (1) determine the prevalence and types of radiological LES incompetence (primarily hiatal hernia) in patients with IDA, (2) describe associated findings such as reflux and mucosal erosions, and (3) correlate these radiological features with the severity of anemia. By doing so, we sought to highlight the diagnostic utility of barium radiography in the workup of unexplained IDA.

Literature review. Iron deficiency anemia (IDA) is a prevalent global health issue, particularly in women and populations in developing regions, often stemming from chronic occult gastrointestinal blood loss. While common causes such as peptic ulcer disease, colorectal neoplasms, and malabsorption syndromes are routinely investigated, structural abnormalities at the esophagogastric junction—including hiatal hernia leading to lower esophageal sphincter (LES) incompetence—remain underrecognized contributors to refractory or unexplained IDA.

Hiatal hernia disrupts the normal anatomy of the LES and the diaphragmatic crura, promoting gastroesophageal reflux and mechanical trauma to the gastric mucosa as it traverses the hiatus. This can manifest as linear erosions or ulcers known as Cameron lesions, which are a well-documented source of chronic, low-volume bleeding and subsequent iron depletion. Cameron lesions typically occur at the level of the diaphragmatic impression within the hernia sac and are more frequent in larger hernias (>3–5 cm). Their prevalence in patients with hiatal hernia ranges from approximately 3–12%, while in individuals presenting with IDA or obscure gastrointestinal bleeding, rates of 1.9–9.2% have been reported. Importantly, IDA can occur even in the absence of visible Cameron lesions, likely due to intermittent mucosal ischemia, micro-erosions, or acid-induced injury from repeated herniation and diaphragmatic contractions.

Large hiatal hernias have been implicated as a direct cause of IDA in 6–15% of cases in various series, with prospective data showing that up to 9.2% of outpatients with IDA may have large hiatal hernia as the primary etiology. In one landmark prospective study of 228 patients with IDA, large hiatal hernia accounted for anemia in 21 cases (9.2%), and Cameron erosions were identified in 33% of those with hernia. Anemia resolution occurred with proton pump inhibitor (PPI) therapy, with or without surgical repair, highlighting the treatable nature of this condition.

Radiological evaluation, particularly barium-contrast esophagography (barium swallow), plays a pivotal role in detecting LES incompetence and hiatal hernia. This modality excels in dynamic assessment, allowing visualization of provoked gastroesophageal reflux, accurate measurement of hernia size and type (sliding Type I being most common), and identification of mucosal irregularities under maneuvers such as Valsalva or abdominal compression. Studies confirm that barium swallow demonstrates superior sensitivity for hiatal hernia detection (up to 76.8%) compared to endoscopy or manometry alone, making it especially valuable in resource-limited settings or as a complementary tool.

Complementary evidence from esophageal manometry in IDA patients reveals motor dysfunction in approximately 28% of cases, including altered LES pressure and relaxation patterns, which may exacerbate reflux and mucosal injury. However, structural incompetence visible on radiology often provides the key diagnostic clue missed by static endoscopic views.



Previous research has established a dose-response relationship: larger hernias correlate with higher rates of anemia-related findings (up to 58% in large hernias) and visible Cameron lesions. Surgical repair of hiatal hernia frequently leads to resolution of anemia and discontinuation of iron supplementation in 70–94% of affected patients, underscoring the clinical significance of early identification.

Despite these insights, dedicated radiological studies focusing specifically on LES incompetence signs in IDA cohorts remain limited, particularly in regions with high IDA prevalence. The present study addresses this gap by systematically evaluating barium swallow findings in patients with confirmed IDA, aiming to quantify the prevalence of LES incompetence, characterize associated features (reflux and mucosal changes), and correlate them with anemia severity.

Methods Study Design and Setting. This prospective cross-sectional study was conducted at a tertiary multi-profile medical center in Tashkent, Uzbekistan, from January to December 2025. The institutional review board approved the protocol, and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Participants Fifty-two consecutive adult patients (18–70 years) with laboratory-confirmed IDA were enrolled. IDA diagnostic criteria included: hemoglobin <13 g/dL in men or <12 g/dL in women, serum ferritin <30 ng/mL, transferrin saturation <16%, and elevated total iron-binding capacity. Exclusion criteria comprised known malignancy, active overt gastrointestinal bleeding, peptic ulcer disease, chronic kidney disease stage ≥ 3 , thalassemia or other hemoglobinopathies, recent gastrointestinal surgery, or obvious gynecological/hematological causes of anemia in women.

Radiological Assessment All patients underwent standardized upper gastrointestinal barium-contrast radiography using a digital fluoroscopy system. Patients ingested 200–250 mL of high-density barium sulfate suspension. Imaging was performed in multiple positions (upright, supine, prone oblique) with dynamic recording during swallowing, deep inspiration, Valsalva maneuver, and gentle abdominal compression to elicit reflux.

Two board-certified radiologists, blinded to clinical and laboratory data, independently reviewed the images. Diagnostic criteria for **LES incompetence** included:

- Displacement of the gastroesophageal junction and gastric cardia ≥ 2 cm above the diaphragmatic hiatus
- Widened esophageal hiatus (>2 cm)
- Shortened intra-abdominal LES segment (<3 cm)
- Spontaneous or provoked free gastroesophageal reflux of barium
- “Hourglass” or “collar” sign
- Linear mucosal filling defects or irregularities suggestive of Cameron erosions at the diaphragmatic impression

Hernia types were classified according to standard radiological criteria (Type I sliding, Type II paraesophageal, Type III mixed, Type IV complex). Interobserver agreement was quantified using Cohen’s kappa coefficient.



Clinical and Laboratory Data Demographic information, symptoms (fatigue, heartburn, dysphagia, epigastric pain), and complete blood count with iron studies were recorded. Anemia severity was graded per WHO criteria.

Statistical Analysis Data were analyzed using SPSS version 26.0. Continuous variables are presented as mean \pm standard deviation; categorical variables as frequencies and percentages. Associations between radiological findings and anemia parameters were assessed with chi-square tests, independent t-tests, and Pearson’s correlation coefficients. A p-value < 0.05 was considered statistically significant.

Results. The study population consisted of 38 females (73.1%) and 14 males (26.9%), with a mean age of 46.7 ± 12.4 years. Moderate anemia was most common (61.5%), followed by mild (26.9%) and severe (11.5%). Predominant symptoms included fatigue (86.5%), dizziness (59.6%), heartburn or regurgitation (44.2%), and epigastric discomfort (40.4%). Dysphagia was reported in 17.3% of patients.

Barium esophagography demonstrated radiological evidence of LES incompetence (hiatal hernia) in 28 patients (53.8%). The distribution of hernia types was: sliding (Type I) in 24 patients (46.2%), paraesophageal (Type II) in 3 (5.8%), and mixed (Type III) in 1 (1.9%). Free gastroesophageal reflux was documented in 17 of the 28 hernia cases (60.7%). Linear mucosal irregularities consistent with Cameron-like erosions were visualized in 10 patients (19.2%), all of whom had moderate-to-severe anemia.

Table 1 Radiological Findings of LES Incompetence and Associated Features in Patients with Iron Deficiency Anemia (N = 52)

Radiological Finding	Frequency n (%)	Moderate/Severe Anemia (%)	Gastroesophageal Reflux Present (%)
Any hiatal hernia (LES incompetence)	28 (53.8)	75.0	60.7
Sliding hernia (Type I)	24 (46.2)	70.8	58.3
Paraesophageal hernia (Type II)	3 (5.8)	100.0	66.7
Mixed hernia (Type III)	1 (1.9)	100.0	100.0
Free gastroesophageal reflux	17 (32.7)	82.4	—
Cameron-like mucosal erosions/irregularities	10 (19.2)	100.0	70.0

Note. Interobserver agreement was excellent (Cohen’s $\kappa = 0.87$). GER = gastroesophageal reflux.

Patients with hiatal hernia had significantly lower mean hemoglobin (9.8 ± 1.4 g/dL vs. 11.6 ± 1.1 g/dL, $p < 0.001$) and ferritin levels compared to those without hernia. Pearson correlation analysis confirmed a strong negative relationship between hernia presence and hemoglobin ($r = -0.62$, $p < 0.01$) as well as ferritin ($r = -0.59$, $p < 0.01$). No hiatal hernias were identified in patients with only mild anemia during subgroup screening.

Discussion. This study reveals a high prevalence (53.8%) of radiological LES incompetence, primarily in the form of sliding hiatal hernia, among patients with IDA. The frequent coexistence of gastroesophageal reflux (60.7%) and mucosal changes suggestive of Cameron erosions (19.2%) supports a mechanistic pathway whereby LES dysfunction leads to chronic occult bleeding and iron loss. These findings are consistent with previous reports demonstrating that



large hiatal hernias can cause IDA even without overt Cameron lesions, likely through intermittent mucosal trauma, ischemia, or acid-induced injury.

Barium swallow proved particularly useful for dynamic assessment. Unlike static endoscopy, it readily demonstrates provoked reflux and provides accurate sizing of the hernia and hiatus. Excellent interobserver reliability further supports its reproducibility in clinical practice. The observed dose-response relationship—more severe anemia in patients with hernia and reflux—strengthens the argument for including barium esophagography in the diagnostic algorithm for unexplained IDA, especially in resource-constrained settings.

Manometric studies have previously shown higher resting LES pressure but shorter relaxation duration in IDA patients, suggesting possible secondary esophageal dysmotility. Our radiological data complement these findings by highlighting structural incompetence.

Conclusion. This study demonstrates that radiological evidence of lower esophageal sphincter incompetence—primarily manifested as hiatal hernia—is highly prevalent (53.8%) among patients with iron deficiency anemia and strongly correlates with greater anemia severity. The frequent observation of gastroesophageal reflux and Cameron-like mucosal irregularities on barium esophagography supports a mechanistic link involving chronic occult mucosal bleeding and mechanical trauma at the diaphragmatic hiatus. These findings reinforce that LES incompetence and associated hiatal hernia represent an underdiagnosed yet treatable cause of IDA, even when overt Cameron lesions are absent.

Barium-contrast swallow emerges as a reliable, non-invasive, and cost-effective imaging tool for dynamic evaluation of the esophagogastric junction, offering advantages in detecting provoked reflux and hernia characteristics that may be overlooked by endoscopy alone. Incorporating routine barium esophagography into the diagnostic workup of unexplained or refractory IDA, particularly in settings with limited access to advanced endoscopy or manometry, can significantly enhance diagnostic yield and facilitate timely intervention.

REFERENCES:

1. Brar, H. S., et al. (2023). Cameron lesions. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK567776/>
2. Dietrich, C. G., et al. (2021). Paraesophageal hernia and iron deficiency anemia. *Visceral Medicine*, 37(2), 123–130. <https://doi.org/10.1159/000513123>
3. Kubilay, P., et al. (2017). Evaluation of esophageal functions by manometry in iron deficiency anemia patients. *Gastroenterology Research*, 10(3), 169–174. <https://doi.org/10.14740/gr859w>
4. Lupu, V. V., et al. (2022). Iron deficiency anemia in pediatric gastroesophageal reflux disease. *Diagnostics*, 13(1), Article 63. <https://doi.org/10.3390/diagnostics13010063>
5. Pauwelyn, K. A., et al. (2005). Large hiatal hernia and iron deficiency anaemia. *Alimentary Pharmacology & Therapeutics*, 22(9), 663–670. <https://doi.org/10.1111/j.1365-2036.2005.02642.x>
6. Ruhl, C. E., et al. (2001). Relationship of iron-deficiency anemia with esophagitis and hiatal hernia. *American Journal of Gastroenterology*, 96(3), 720–725. <https://doi.org/10.1111/j.1572-0241.2001.03562.x>
7. Smith, R. E., et al. (2024). Hiatal hernia. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK562200/>
8. Vakhidov, V. F., Ummatov, B. K., & Madasheva, A. G. (2025). X-ray diagnostics of esophageal hernia in patients with iron deficiency anemia. *International Journal for Research in Applied Science & Engineering Technology*, 13(5), 70470. <https://doi.org/10.22214/ijraset.2025.70470>



9. Gazkhanovna, M. A., Makhmatovich, A. K., & Utkirovich, D. U. (2022). Clinical efficacy of extracorporeal and intravascular hemocorrection methods in psoriasis. *Academicia: An International Multidisciplinary Research Journal*, 12(2), 313-318.
10. Madasheva, A. G., & Abdiev, K. M. (2023). Blood transfusion therapy in patients with vitamin B12 deficiency anemia after resection of 2/3 of the stomach. *Science and Education*, 4(5), 407-412.
11. Мадашева, А. Г., & Жураева, М. З. (2019). Биохимические показатели и комплексное лечение больных псориазом с лечебным плазмаферезом. *Достижения науки и образования*, (10 (51)), 78-82.
12. Мадашева, А., Бергер, И., Махмудова, А., Абдиев, К., & Амерова, Д. (2025). Лабораторная диагностика. восточная европа. *лабораторная диагностика*, 14(1), 87-96.
13. Мадашева, А. Г. (2022). Клинико-неврологические изменения у больных гемофилией с мышечными патологиями. *Science and Education*, 3(12), 175-181.
14. Мадашева, А. Г. (2022). Коррекция диффузной алопеции при железодефицитной анемии. *Science and Education*, 3(12), 231-236.
15. Мадашева, А. Г., Дадажанов, У. Д., Абдиев, К. М., Маматкулова, Ф. Х., & Махмудова, А. Д. (2019). Динамика электронейромиографических показателей и эффективность электрической стимуляции мышц у больных гемофилией с мышечными атрофиями. *Достижения науки и образования*, (10 (51)), 26-30.
16. Мадашева, А. Г., & Жураева, М. З. (2019). Биохимические показатели и комплексное лечение больных псориазом с лечебным плазмаферезом. *Достижения науки и образования*, (10 (51)), 78-82.