UDC 616.329-007 43:616.26-031.26]-072.1
DOI http://doi.org/10.30978/GS-2023-2-25

ISSN 2786-5584 print
ISSN 2786-5592 online

Comparative assessment of clinical and endoscopic semiotics of hiatal hernias

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A hiatal hernia (HH) of type III combines the anatomical characteristics of HH types I and II. The manifestations of type III HHs are diverse, and they can originate from either type I or type II, but so far, there is no certainty regarding the correlation between the clinical and endoscopic manifestations of HH type III and its origin.

Objective — Based on the analysis of clinical and endoscopic manifestations of type III HH, justify the diversity of their characteristics depending on whether they originate from type I or type II HH.

Materials and methods. The study included 126 patients with HH, including 87 type III hernias and 39 type I hernias, who underwent elective laparoscopic hernioplasty. The study consisted of several steps. In the first step, an assessment of the results of endoscopic examination in patients with type III HH was conducted to determine the diversity of the obtained data and the feasibility of dividing patients into subgroups using a two-stage cluster analysis. In the second step, the subgroups obtained through cluster analysis were compared between themselves and with the patients with type I HH to determine the similarities or differences in endoscopic findings and clinical symptoms.

Results. Cluster analysis identified two clusters of indicators with a strong degree of association and differentiation. The main factor in the differentiation into clusters was the relationship between the gastroesophageal junction (GEJ) and the upper border of the HS (hernia sac) in an inversion. Based on this criterion, type III HH can be divided into two subgroups: type IIIA, where the GEJ is located proximally or at the same level as the highest point of the HS, and type IIIB, where the GEJ is located distally to the highest point of the HS. The occurrence of most endoscopic symptoms of HH in subgroup IIIA, in contrast to IIIB, did not significantly differ from type I HH, except for the shorter length of the esophagus and the greater axial length of the hernia. Additionally, patients with the IIIA HH subtype were almost indistinguishable from those with type I HH in terms of clinical characteristics, except for a higher average age and the occurrence of dyspnea. In subtype IIIB, compared to type I, symptoms related to gastroesophageal reflux were significantly less frequent, while symptoms indicative of impaired food evacuation were more frequent. The observed similarity between the endoscopic and clinical manifestations of type I and subtype IIIA HH suggests a common origin for these conditions. On the other hand, subtype IIIB, which differs in endoscopic and clinical indicators from type I and subtype IIIA HH, is evidently the result of the progression of type II HH.

Conclusions. Patients with type III HH exhibit significant diversity in clinical and endoscopic manifestations, which is attributed to the different origins of the HH (from type I or type II). An endoscopic feature indicating the hernia's origin is the position of the GEJ relative to the highest point of the HS: below it corresponds to type II HH (62.1 %), while at or above it corresponds to type I HH (37.9 %).

Keywords
hiatal hernia, diagnostic, semiotics, subtype hernia.

ARTICLE • Received 2023-05-21 • Received in revised form 2023-06-18

Hiatal hernia (HH) is characterized by the protrusion of any abdominal cavity structure, except the esophagus, into the chest cavity through an enlarged esophageal hiatus (EH) of the diaphragm [13].

Acquired HH are divided into 4 types based on their anatomical characteristics [21, 1]. In type I HH (axial or sliding), the gastroesophageal junction (GEJ) and, accordingly, the cardiac portion of the stomach move above the diaphragm by at least 2 cm [4], while the other portions of the stomach remain below it. Type I HHs are referred to as sliding hernias because one of the walls of the hernia

sac is the posterior wall of the upper part of the cardiac portion of the stomach, which is not covered by the peritoneum. Hernias of types II—IV belong to paraesophageal hernias. In type II hernias, there is a protrusion into the mediastinum of the stomach's fundus while the GEJ remains normally positioned. Type III (mixed) combines the anatomical characteristics of types I and II, meaning that above the diaphragm, not only the GEJ but also the fundus/body or the entire stomach migrates. Type IV is associated with the presence of other abdominal organs or structures within the hernia sac [10, 7, 13].

It is considered that over 95 % of diagnosed HH are classified as axial hernias, with only 5 % being paraesophageal hernias. Among paraesophageal hernias, more than 90 % are of type III [7]. However, according to data from a single population study among HH, type III hernias account for 29 %, while type I hernias make up 71 % [2].

The preoperative diagnosis of HH is quite complex, with diverse clinical manifestations. Paraclinical diagnostic methods are characterized by low sensitivity and specificity. Recently, in a meta-analysis involving 5,337 patients, it was demonstrated that the sensitivity and specificity of HH diagnosis using barium sulphate radiological examination were 0.63 and 0.85; endoscopic examination — 0.72 and 0.80; high-resolution manometry — 0.77 and 0.92, respectively [14]. Experts from a multinational European Delphi survey, consisting of 72 surgeons from 17 European countries with an average of 23 years of experience, consider fibroesophagogastroscopy to be the most informative diagnostic method for HH. They categorized it as «recommended». However, methods such as CT, contrast radiography, esophageal manometry, impedance pH testing, MRI, and esophageal planimetry were categorized as «acceptable» [5].

The diagnosis of mixed type III HH poses particular challenges as its symptoms are nonspecific. It shares common features with type I and type II hernias, but clinical and endoscopic manifestations differ [11]. Therefore, identifying the specific clinical and endoscopic characteristics unique to type III hernias can contribute to timely diagnosis and a personalized approach to treatment.

Some argue that the varied symptoms of type III HH may be linked to its origin, either from type I or type II [18]. However, there is still no definitive understanding of the connection between the clinical and endoscopic characteristics of type III HH and its origin.

Objective — of this study is to substantiate the diversity of clinical and endoscopic manifestations in type III HHs based on their origin, either from type I or type II hernias.

Materials and methods

Our experience in diagnosing HH encompasses 126 patients who underwent elective laparoscopic herniоplasty at the Bogomolets National Medical University Clinic. This includes 87 patients with type III HH from 2014 to 2021 and 39 patients with type I HH from 2019 to 2021. The hernia type was finally determined during the surgery.

The study was carried out in a structured manner, involving multiple phases. Initially, we conducted an assessment of endoscopic examination results in patients diagnosed with type III HH to ascertain the diversity of collected data and the rationale behind categorizing patients into subgroups using a two-stage cluster analysis. Subsequently, in the second phase, we juxtaposed the subgroups generated through cluster analysis, both amongst themselves and in relation to patients afflicted with type I HH, with the aim of discerning commonalities and disparities in endoscopic findings and clinical symptomatology.

The endoscopic examination was conducted using a Fujinon EG 760-R (Japan) fibrogastroduodenoscope, administered under intravenous sedation (propofol), with the patient in the left lateral position. The diameter of the endoscope was 0.92 cm.

The main landmarks during the endoscopic examination

- GEJ: the point where the upper part of the stomach's fold connects with the tubular esophagus (the location where the palisade esophageal vessels terminate).
- Squamous-columnar junction: the boundary where the squamous epithelium of the esophagus transitions into the columnar epithelium of the stomach (Z-line). It is clearly visible due to the color difference between the squamous (pale pink) and columnar (pink or red) epithelium.
- Crural impression (CI): a round or oval opening that surrounds the proximal part of the stomach. It expands and contracts in response to respiratory movements and corresponds to the location of the crus of the esophageal hiatus.

An essential characteristic of HH was the presence of gastric mucosa above the CI by more than 2 cm.

We assessed the following characteristics:

- distance from teeth to the crural impression;
- length of the esophagus, measured as the distance from teeth to the GEJ;
- axial length of the hernia, calculated as the difference between the distance from teeth to the crural impression and the length of the esophagus (i.e., the distance between GEJ and CI);

- configuration of the hernia sac (HS), characterized as either a symmetrically expanded tubular or an asymmetrically deformed cavity;
- presence of Schatzki rings;
- esophagitis;
- degree of erosive esophagitis according to the Los Angeles classification [15, 16];
- presence of Cameron ulcers as linear ulcers on the stomach or erosions on the folds of the mucous membrane in the CI area [22].
- location of the GEJ in relation to the upper border of the hernia (below, above, or at the same level) (assessed during inversion);
- presence of erosions or ulcers in the stomach and duodenum;
- anatomy of the EH — horizontal and vertical dimensions, as well as the area of the EH (assessed during inversion). The area of the EH was calculated as the area of an ellipse: (vertical dimension of EH/2) · (horizontal dimension of EH/2) · 3.14. The area of the EH was assessed during diaphragm relaxation (exhalation) since it decreases during inhalation (Fig. 1).

Statistical analysis was performed using the IBM SPSS Statistics, v. 22. Descriptive statistics were calculated, and the mean values are presented as mean and sandard deviation (M ± SD). A comparison of the means of quantitative variables was conducted using the Mann-Whitney U test. The comparison of relative values was carried out by the Pearson's chi-squared test. To assess the variance of variable values between groups, Levene's Test for Equality of Variances was applied, which is based on means. To identify groups of similar objects, a two-stage cluster analysis was performed. The null hypothesis of variable equality was rejected at $p < 0.05$.

Results

The comparison of endoscopic characteristics between patients with type I and type III HH revealed statistically significant differences in several indicators, as presented in Table 1.

In particular, with type III hernias, a shorter length of the esophagus (distance from the incisors to the GEJ) was observed, measuring 33.3 ± 2.8 cm compared to 34.6 ± 1.4 cm; a greater axial length of the hernia was observed, measuring 6.6 ± 2.6 cm compared to 5.2 ± 1.0 cm; and a larger hiatal area, measuring 7.9 ± 1.6 cm^2 as opposed to 7.3 ± 1.1 cm^2.

The analysis of the mean values of the mentioned indicators showed significantly higher data dispersion around the mean for type III hernias, which is characterized by the standard deviation. Levene's Test for Equality of Variances, based on the mean, revealed statistically significant differences in the variances of such indicators as the length of the esophagus and the axial length of the hernia between type I and type III hernias, all $p < 0.01$.

The majority of categorical parameters exhibited a nearly equal distribution in cases of type III hernias. For instance, esophagitis and reflux esophagitis were identified in approximately 59.8 % and 50.6 % of patients, respectively, whereas they were not present in approximately 40.2 % and 49.4 % of cases, respectively. In contrast, in cases of type I hernias, these conditions were diagnosed in 100 % and 82.1 % of patients, respectively.

The hernia cavity shape was also observed in two variations: as an expanded asymmetric tube in 36.8 % of cases and as a deformed sac-like cavity in 58.6 % of cases.

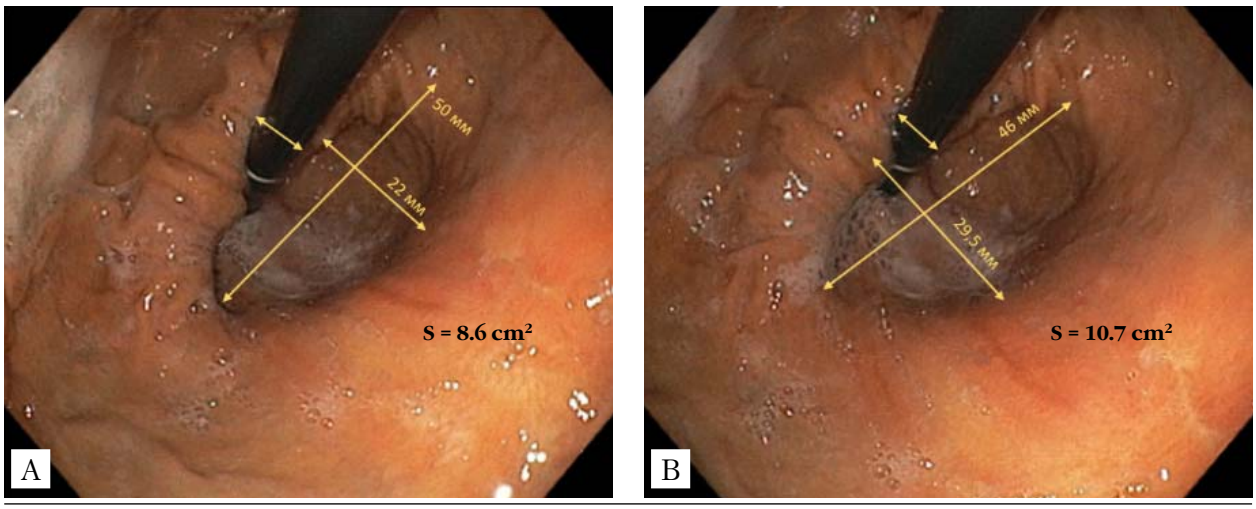

Figure 1. **Hiatal hernia examination in inversion in a patient during inhalation (A) and exhalation (B).** The hiatal hernia has an elliptical shape. The vertical and horizontal dimensions of the hernia's gates were measured relative to the endoscope's diameter (0.92 cm), and the area during inhalation was 8.6 cm^2, while during exhalation, it was 10.7 cm^2. In this case, the area of the EH during inhalation is 20.2 % smaller than during exhalation

Table 1. **A comparative assessment of endoscopic characteristics in patients with type I and type III HH**

Indicator	Type I (n = 39)	Type III (n = 87)	p
Distance from incisors to EH, cm	39.8 ± 1.4	39.9 ± 1.3	0.811
Distance from incisors to GEJ, cm	34.6 ± 1.4	33.3 ± 2.8	**0.005**
Axial length of the hernia, cm	5.2 ± 1.0	6.6 ± 2.6	**0.001**
Shape of the HS			
Expanded symmetric tubular	33 (84.6 %)	4 (4.6 %)	**0.001**
Expanded asymmetric tubular	6 (15.4 %)	32 (36.8 %)	
Deformed sac-like	0	51 (58.6 %)	
The horizontal dimension of the EH, cm	2.9 ± 0.3	3.1 ± 0.4	0.160
The vertical dimension of the EH, cm	4.9 ± 0.6	5.2 ± 0.7	0.102
The area of the EH, cm^2	7.3 ± 1.1	7.9 ± 1.6	**0.025**
Esophagitis	39 (100 %)	52 (59.8 %)	**0.0001**
Erosion esophagitis, stage according to the Los Angeles classification	32 (82.1 %)	44 (50.6 %)	**0.001**
A	0	5 (11.4 %)	**0.020**
B	6 (18.8 %)	18 (40.9 %)	
C	20 (62.5 %)	16 (36.4 %)	
D	6 (18.8 %)	5 (11.4 %)	
Schatzki ring	5 (12.8 %)	4 (4.6 %)	0.098
Location of the GEJ in relation to the upper border of the HS			
Below	0	54 (62.1 %)	**0.0001**
Above or at the same level	39 (100 %)	33 (37.9 %)	
Cameron ulcer	0	5 (5.7 %)	0.127
Erosive gastritis	9 (23.1 %)	14 (16.1 %)	0.348
Duodenal ulcer	4 (10.3 %)	3 (3.4 %)	0.123

Moderate degrees of severity of reflux esophagitis (stages A and B) together constituted 52.3 %, while more severe cases (stages C and D) accounted for 41.4 %. This is in contrast to type I hernias, where this proportion was 18.8 % / 81.2 %.

Finally, 62.1 % of cases were identified with the GEJ located distal to the upper border of the hernia sac, whereas 37.9 % of cases showed the GEJ proximal to the hernia sac or at the same level (Fig. 2).

The identified diversity in the endoscopic findings of type III HH suggests the possibility of various subtypes of such hernias.

To test this hypothesis, we conducted a two-stage cluster analysis using data from 7 variables obtained from endoscopy:

1) length of the esophagus;
2) axial length of the hernia;
3) presence of reflux esophagitis;
4) severity of reflux esophagitis;
5) variation of the hernia sac in direct view;
6) relation between the GEJ and the upper border of the hernia sac during inversion;
7) presence of Schatzki rings.

The analysis identified two clusters with a high degree of association and differentiation. This means that the endoscopy data can be divided into two groups that have significant similarity within one group and are substantially different from another. The primary grouping factor turned out to be the nature of the relationship between the GEJ and the upper border of the HS in inversion. Therefore, based on this indicator, HH can be divided

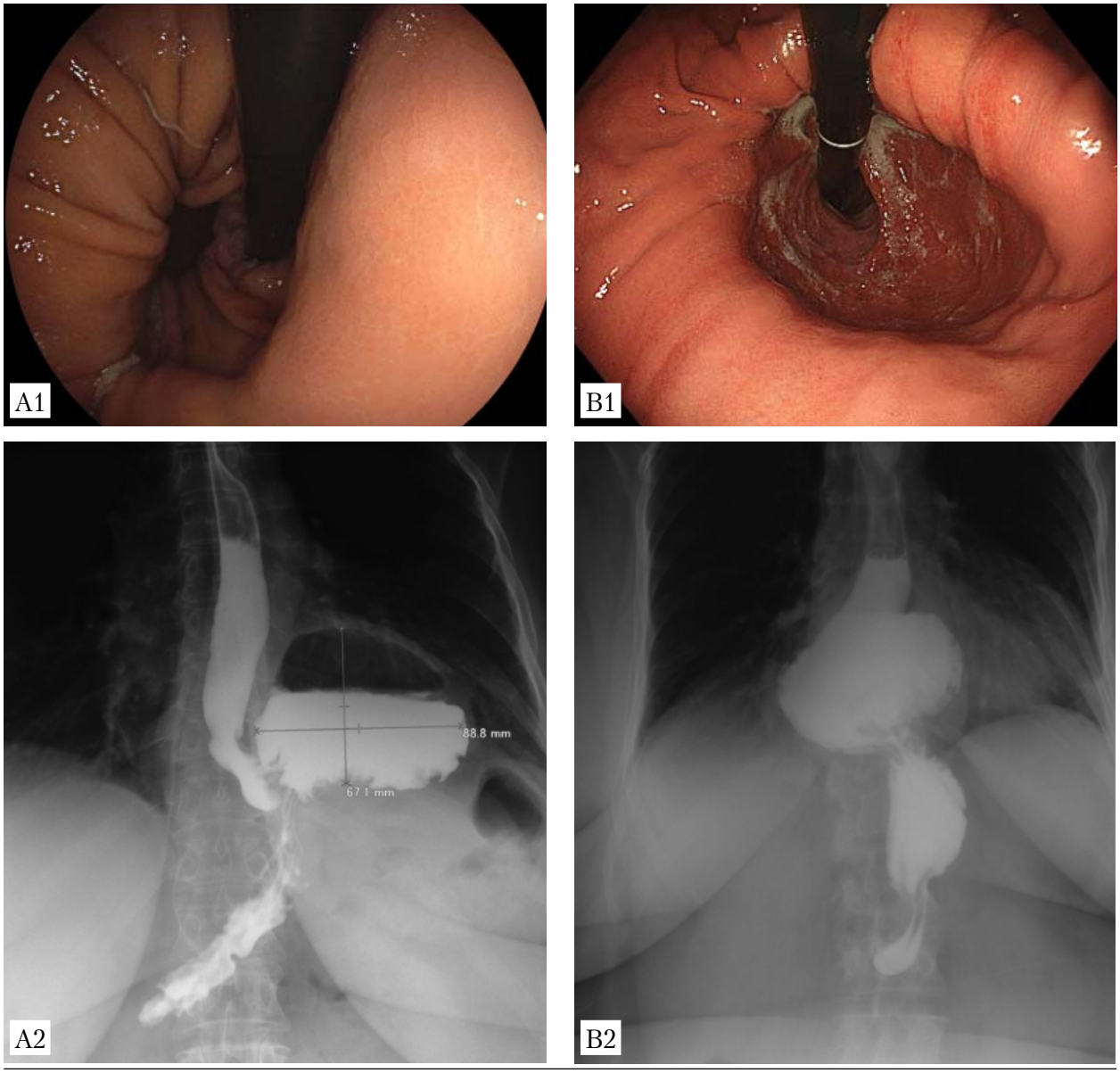

Figure 2. **Endoscopic and X-ray results for paraesophageal hernias. A1, B1 — examination of the esophageal hiatus in inversion; A2, B2 — esophagogastrography with the barium. A1, A2 — patient D: the esophageal hiatus is located distal to the upper border of the hernia sac. B1, B2 — patient C: the esophageal hiatus is located proximal to the upper border of the HS**

into two subgroups: type IIIA where the GEJ is located proximally or at the level of the upper border of the HS, and type IIIB, where the GEJ is located distally to the upper border of the HS. The comparison of endoscopic features in the formed subgroups based on the relationship between the GEJ and the upper border of the HS showed that they significantly differ in several other indicators, as indicated in Table 2.

Specifically, patients in group IIIA had, on average, a shorter esophageal length compared to patients in subgroup IIIB: 31.6 ± 3.1 cm versus 34.2 ± 2.1 cm, and a longer axial length of the hernia: 8.4 ± 2.8 cm versus 5.6 ± 1.6 cm, all $p = 0.001$. Furthermore, in patients with type IIIA HH, esophagitis was more frequently observed at 87.9 % compared to 42.6 %, and reflux esophagitis at 87.9 % compared to 27.8 %, all $p = 0.001$. In the structure of erosive esophagitis, severe stages C and D (LA) predominated at 58.6 %, while for type IIIB, they constituted 26.7 %, $p = 0.044$. In type IIIB HH, Shatzki rings were not observed, whereas in type IIIA hernias, they were present in 12.1 % of patients, $p = 0.009$.

The comparison of endoscopic phenomena in subgroups IIIA and IIIB with type I HH revealed that in subgroup IIIA, there was a significantly

Table 2. **Comparative assessment of endoscopic characteristics in patients with HH type I and subtypes IIIA and IIIB**

Indicator	Type I	Type IIIA (n = 33)	Type IIIB (n = 54)	p		
				I /IIIA	I/IIIB	IIIA/IIIB
Distance from incisors to EH, cm	39.8 ± 1.4	40.1 ± 1.3	39.8 ± 1.3	0.503	0.913	0.398
Distance from incisors to GEJ, cm	34.6 ± 1.4	31.6 ± 3.1	34.2 ± 2.1	**0.001**	0.331	**0.001**
Axial length of the hernia, cm	5.2 ± 1.0	8.4 ± 2.8	5.6 ± 1.6	**0.001**	0.254	**0.001**
Shape of the HS						
Expanded symmetric tubular	33 (84.6 %)	4 (12.1 %)	0	**0.001**	**0.001**	**0.001**
Expanded asymmetric tubular	6 (15.4 %)	26 (78.8 %)	6 (1.1 %)			
Deformed sac-like	0	3 (9.1 %)	48 (88.9 %)			
The horizontal dimension of the EH, cm	2.9 ± 0.3	3.0 ± 0.4	3.1 ± 0.4	0.679	0.076	0.202
The vertical dimension of the EH, cm	4.9 ± 0.6	5.1 ± 0.7	5.2 ± 0.8	0.208	0.103	0.867
The area of the EH, cm^2	7.3 ± 1.1	7.7 ± 1.1	8.1 ± 1.4	0.157	**0.015**	0.330
Esophagitis	39 (100 %)	29 (87.9 %)	23 (42.6 %)	**0.025**	**0.001**	**0.001**
Erosion esophagitis, stage according to the Los Angeles classification	32 (82.1 %)	29 (87.9 %)	15 (27.8 %)	**0.493**	**0.001**	**0.001**
A	0	1 (3.4 %)	4 (26.7 %)	**0.319**	**0.001**	**0.072**
B	6 (18.8 %)	11 (37.9 %)	7 (46.7 %)			
C	20 (62.5 %)	13 (44.8 %)	3 (20.0 %)			
D	6 (18.8 %)	4 (13.8 %)	1 (6.7 %)			
Schatzki ring	5 (12.8 %)	4 (12.1 %)	0	0.929	**0.007**	**0.009**
Cameron ulcer	0	2 (6.1 %)	3 (5.6 %)	0.119	0.135	0.922
Erosive gastritis	9 (23.1 %)	6 (18.2 %)	8 (14.8 %)	0.610	0.309	0.678
Duodenal ulcer	4 (10.3 %)	0	3 (5.6 %)	0.058	0.396	0.168

shorter esophageal length of 31.6 ± 3.1 cm compared to 34.6 ± 1.4 cm (p = 0.001), and a larger axial length of the hernia of 8.4 ± 2.8 cm compared to 5.2 ± 1.0 cm (p = 0.001). However, there were no differences in these indicators between patients with type I HH and subtype IIIB.

Both subgroups significantly differed from type I HH in terms of the shape of the HS during direct examination, as they didn't show cases of a HS shaped as an enlarged symmetric tube. In terms of the frequency of erosive esophagitis, the severity of its forms, and the frequency of detecting Shatzki rings, patients with type I HH and subtype IIIA were statistically similar. However, in subgroup IIIB, erosive esophagitis and its severe forms were significantly less common, and Shatzki rings were not detected.

So, patients with subtype IIIA HH (unlike subtype IIIB) exhibited endoscopic features characteristic of type I HH, along with a longer axial length of the hernia and a shorter esophageal length. It's worth noting that the area of the EH did not differ between type I HH and subtype IIIA. However, in subtype IIIB, it was significantly larger. In addition to a certain similarity in endoscopic features, patients with type IIIA HH were almost indistinguishable from patients with type I HH in terms of clinical indicators, as shown in Table 3.

In the case of HH subtype IIIA, only two indicators were found to differ from those in type I HH: a shorter duration of the disease at 49.3 ± 9.6 years compared to 56.1 ± 10.3 years (p = 0.007), and a lower frequency of dyspnea at 15.4 % compared to 39.4 % (p = 0.021).

Table 3. **Comparative assessment of clinical characteristics in patients with type I HH and subtypes IIIA and IIIB**

Indicator	Type I (n = 39)	Type IIIA (n = 33)	Type IIIB (n = 54)
Age, years	49.3 ± 9.6	56.1 ± 10.3**	52.7 ± 10.7
Male/female, %	43.6/56.4	39.4/60.6	31.5/68.5
IMT, kg/m^2	26.8 ± 2.9	27.2 ± 3.2	27.4 ± 2.2
Duration of disease, month	52.9 ± 50.7	57.0 ± 50.9	57.0 ± 50.9
Heartburn	32 (82.1 %)	28 (84.8 %)	14 (25.9 %)*#
Chest pain	25 (64.1 %)	21 (63.6 %)	13 (24.1 %)*#
Regurgitation	13 (33.3 %)	16 (48.5 %)	20 (37.0 %)
Nausea	19 (48.7 %)	10 (30.3 %)	43 (49.6 %)**#
Hoarse voice	26 (66.7 %)	20 (60.6 %)	18 (33.3 %)*###
Cough	9 (23.1 %)	11 (33.3 %)	7 (13.0 %)###
Dysphagia	7 (17.9 %)	9 (27.3 %)	18 (33.3 %)
Hiccups	3 (7.7 %)	4 (12.1 %)	16 (29.6 %)**
Odynophagia	7 (17.9 %)	5 (15.2 %)	7 (13.0 %)
Vomiting	3 (7.7 %)	5 (15.2 %)	13 (24.1 %)***
Postprandial fullness	6 (15.4 %)	8 (24.2 %)	31 (57.4 %)*##
Weight loss	7 (17.9 %)	11 (33.3 %)	11 (20.4 %)
Arrhythmia	5 (12.8 %)	9 (27.3 %)	26 (48.1 %)*
Dyspnea	6 (15.4 %)	13 (39.4 %)***	23 (42.3 %)**

Note. The difference from the type I is statistically significant: * $p \le 0.001$; ** $p \le 0.01$; *** $p \le 0.05$.
The difference from the type IIIA is statistically significant: # $p \le 0.001$; ## $p \le 0.01$; ### $p \le 0.05$.

At the same time, patients with HH subtype IIIB significantly differed from patients with HH type I in nearly all clinical indicators: they less frequently experienced heartburn — 25.9 % compared to 82.1 % ($p = 0.001$), chest pain — 24.1 % compared to 64.1 % ($p = 0.001$), hoarseness of voice — 33.3 % compared to 66.7 % ($p = 0.001$). These symptoms are characteristic of gastroesophageal reflux and gastroesophageal reflux disease (GERD). Instead, symptoms more characteristic of impaired food evacuation were more frequently reported. Specifically, patients more often complained of postprandial fullness — 57.4 % compared to 15.4 % ($p = 0.001$), vomiting — 24.1 % compared to 7.7 % ($p = 0.039$), and hiccups — 29.6 % compared to 7.7 % ($p = 0.010$). They more frequently reported shortness of breath — 42.3 % compared to 15.4 % ($p = 0.005$) and heart rhythm disturbances — 48.1 % compared to 12.8 % ($p = 0.001$).

It should be noted that in terms of clinical symptoms, patients with HH subtype IIIB also differed from those with subtype IIIA, almost as much as they did from patients with type I HH.

Discussion

It is generally accepted that HH type III (mixed type) combines the anatomical characteristics of type I and type II hernias, meaning that above the diaphragm, it can involve not only the GEJ (as in the first type) but also the fundus/body or the entire stomach (as in the second type). A type III hernia should therefore acquire other shared features of type I and type II hernias.

On the other hand, it is known that axial sliding hiatal hernias in most cases manifest with symptoms of gastroesophageal reflux and GERD [9], while type II paraesophageal hernias typically

have an asymptomatic course [8, 20, 6]. Endoscopically, type I HHs are characterized by esophageal shortening, an increased distance between the GEJ and the EH, esophagitis, GERD, cardia herniation, and other signs, while in type II HH, the length of the esophagus remains unchanged, there are usually no endoscopic reflux symptoms, and only the herniated protrusion of the gastric fundus is visualized in retroflexion. So, how do these different clinical and endoscopic manifestations of type I and type II hernias combine to form type III hernias?

Of course, a type III hernia does not develop suddenly and instantaneously but forms gradually over time. It is important to understand which specific type of hernia (type I or type II) precedes the development of a type III hernia.

P. J. Kahrilas, et al. [9] write that with the progressive enlargement of the hernia through the diaphragmatic hiatus, the diaphragmatic-esophageal ligament stretches, displacing the GEJ above the diaphragm and adding a sliding component to the type II hernia. They mean that a type III hernia is a transformation of a type II hernia. R.V. Petrov, et al. [19] also believe that type III paraesophageal hernia arises from a type II hernia due to the continuous stretching of the diaphragmatic-esophageal ligament, the gradual enlargement of the EH, and the formation of a HS from the peritoneum. The GEJ, in addition to a part or the whole fundus and body, migrates upward, either partially or entirely, after the stomach, within the hernia sac.

A. O. Nykonenko, et al. [17] outline a characteristic feature of type III hernia, in their view, in which the GEJ is displaced along the longitudinal axis, as in type I hernia, while the most proximal part of the stomach, which protrudes into the mediastinum, is located above the GEJ. This formulation also implies that a type II hernia preceded the development of a type III hernia.

Unlike the viewpoint mentioned before, S. Paul and R. Bueno emphasize that a type III HH can originate from either a type I HH or a type II HH. In the presence of a type I HH, over time, the diaphragmatic-esophageal ligament may weaken, leading to the development of a type II defect.

Conversely, the presence of a type II defect can, over time, weaken the diaphragmatic-esophageal ligament, leading to the development of a type I defect. In this case, the symptoms of type III HH manifest as a combination of symptoms from both type I and type II hernias. Typically, the symptoms of the larger defect predominate. The incidence of the progression from a type I or type II HH to a type III hernia is unknown [18].

If we assume that hernias of type I and type II, which differ in clinical and endoscopic manifestations, are precursors of type III hernia, then in such patients, significant variability in these manifestations can be expected.

The study comprised 126 patients with HH, including 87 with type III hernia and 39 with type I hernia, who underwent elective laparoscopic hernia surgery.

The study had several steps. In the first step, an assessment of the results of endoscopic examination in patients with type III HH was conducted to determine the diversity of the obtained data and the feasibility of dividing patients into subgroups using a two-stage cluster analysis. In the second step, the subgroups obtained through cluster analysis were compared with each other and with patients with type I HH to determine the similarities or differences in endoscopic examination data and clinical symptoms.

To the best of our knowledge, this is the first study in which the diversity of clinical and endoscopic manifestations of type III HH has been assessed and the rationale for its differentiation into subgroups based on its origin, either type I or type II, has been established.

In type III HH, the endoscopic indicators were significantly more diverse than in type I HH, which could indicate the likelihood of different subtypes of type III hernia. A two-stage cluster analysis was conducted using data from 7 variables: the length of the esophagus, the axial length of hernia, the presence and severity of reflux esophagitis, the form of the HS in a direct view, the relationship between the GEJ and the upper border of the HS in an inversion view, and the presence of Schatzki rings. This analysis identified two clusters (groups) with a good degree of association and differentiation.

The primary factor in group formation was the relationship between the GEJ and the upper border of the HS in an inversion view. Therefore, based on this indicator, type III HH can be categorized into two subgroups: type IIIA, where the GEJ is positioned proximally or at the level of the upper border of the HS, and type IIIB, where the GEJ is located distally to the upper border of the HS.

The differentiation of patients with type III HH into two subgroups based on this endoscopic feature can be explained by the various origins of the hernia. If a type III hernia preceded a type I hernia, the GEJ is expected to be positioned higher or at the level of the upper border of the HS (Fig. 3). Conversely, if a type II hernia precedes it, the GEJ is expected to be positioned lower than the upper border of the HS (Fig. 4).

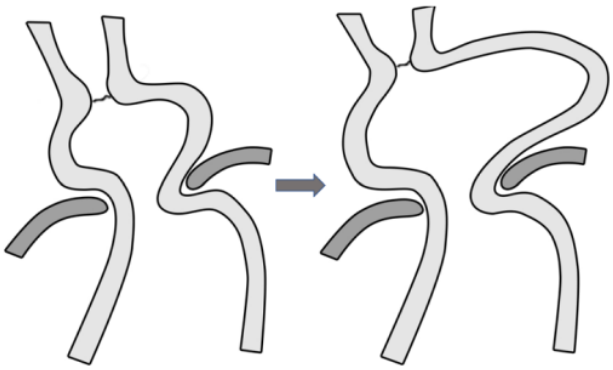

Figure 3. **The transformation from type I to type III hiatal hernia**

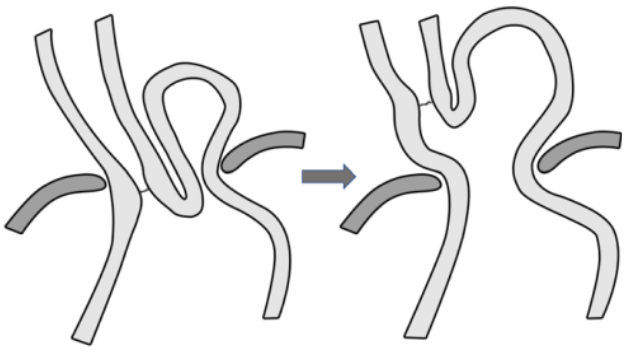

Figure 4. **The transformation from type II to type III hiatal hernia**

Based on this criterion, we formed two subgroups: subgroup IIIA (where, theoretically, the development of type III hernia was preceded by type I hernia) and subgroup IIIB (where, theoretically, the development of type III hernia was preceded by type II hernia).

Comparing the clinical symptoms of patients with type I hernia to those assigned to a specific subtype of type III hernia showed no significant difference in the frequency of symptoms between type I hernia and subtype IIIA. On the other hand, patients with type III B hernias significantly differed from patients with type I hernias in most clinical characteristics: they less frequently experienced symptoms associated with gastroesophageal reflux and GERD (heartburn, chest pain, hoarseness of voice), which is probably related to the partial preservation of anti-reflux mechanisms, and more frequently reported symptoms characteristic of impaired food evacuation (postprandial fullness, vomiting, hiccups).

They also more frequently reported dyspnea and heart rhythm disturbances. In terms of clinical symptoms, patients with HH subtype IIIB also differed from those with HH subtype IIIA, much like they differed from patients with HH type I.

The formed subgroups also significantly differed in terms of endoscopic indicators.

Patients in subgroup IIIA had, on average, a shorter length of the esophagus, a longer axial length of the hernia, and more frequently presented with esophagitis and reflux esophagitis. They also had more frequent occurrences of Schatzki rings, which were absent in subtype IIIB. In the structure of erosive esophagitis, severe stages C and D (LA) predominated, accounting for 58.6 % compared to 26.7 % in type IIIB, $p = 0.044$.

In the case of type IIIB hernias, Schatzki rings were not observed, whereas in type IIIA hernias, they were present in 12.1 % of patients, $p = 0.009$. Therefore, in patients with type IIIA HH (compared to type IIIB), there is a predominance of endoscopic signs characteristic of type I HH.

Therefore, patients with type III HH exhibit significant diversity in clinical and endoscopic manifestations, which is determined by the different origin of the hernia (from type I or type II).

An endoscopic characteristic indicating the origin of the hernia is the location of the GEJ relative to the highest point of the HS: below it, from type II HH (62.1 %), at or above it, from type I HH (37.9 %).

Limitations of the study. The data obtained by us can be extrapolated to the entire population of patients with HH types I—III with certain caution.

Firstly, this is due to the relatively small number of patients included in the study.

Secondly, the study does not encompass all variations of HH progression in the population. Specifically, it did not include patients with asymptomatic or mildly symptomatic HH and those with HH type II.

Thirdly, the study was retrospective, while precise data regarding the transformation of HH types can be obtained through prospective observation of patients with type I and II HH.

Declaration of interests

The authors declare that they have no conflicts of interest.

Ethics approval

The protocol was presented by the ethical commission of Bogomolets National Medical University.

Authors contributions

T. A. Tarasov: concept and design of the study, collection, analysis, and interpretation of data, drafting and revision of the manuscript; L. Y. Markulan: collection, analysis, and interpretation of data.

References

1. Barrett NR. Hiatus hernia: a review of some controversial points. Br J Surg. 1954 Nov;42(173):231-43. doi: 10.1002/bjs.18004217303. PMID: 13219304.
2. Bild DE, Bluemke DA, Burke GL, Detrano R, Diez Roux AV, Folsom AR, Greenland P, Jacob DR Jr, Kronmal R, Liu K, Nelson JC, O'Leary D, Saad MF, Shea S, Szklo M, Tracy RP. Multi-Ethnic Study of Atherosclerosis: objectives and design. Am J Epidemiol. 2002 Nov 1;156(9):871-81. doi: 10.1093/aje/kwf113. PMID: 12397006.
3. Dreifuss NH, Schlottmann F, Molena D. Management of paraesophageal hernia review of clinical studies: timing to surgery, mesh use, fundoplication, gastropexy and other controversies. Dis Esophagus. 2020 Aug 3;33(8):doaa045. doi: 10.1093/dote/doaa045.
4. Edmundowicz SA, Clouse RE. Shortening of the esophagus in response to swallowing. Am J Physiol. 1991 Mar;260(3 Pt 1):G512-6. doi: 10.1152/ajpgi.1991.260.3.G512. PMID: 2003613.
5. Gerdes S, Schoppmann SF, Bonavina L, Boyle N, Müller-Stich BP, Gutschow CA; Hiatus Hernia Delphi Collaborative Group. Management of paraesophageal hiatus hernia: recommendations following a European expert Delphi consensus. Surg Endosc. 2023 Jun;37(6):4555-4565. doi: 10.1007/s00464-023-09933-8.
6. Hashemi M, Sillin LF, Peters JH. Current concepts in the management of paraesophageal hiatal hernia. J Clin Gastroenterol. 1999 Jul;29(1):8-13. doi: 10.1097/00004836-199907000-00005. PMID: 10405224.
7. Hutter MM, Rattner DW Paraesophageal and other complex diaphragmatic hernias. In: Yeo CJ (ed) Shackelford's surgery of the alimentary tract. Saunders Elsevier, Philadelphia, 2007, pp 549-562.
8. Jung JJ, Naimark DM, Behman R, Grantcharov TP. Approach to asymptomatic paraesophageal hernia: watchful waiting or elective laparoscopic hernia repair? Surg Endosc. 2018 Feb;32(2):864-871. doi: 10.1007/s00464-017-5755-y. Epub 2017 Aug 4. PMID: 28779249.
9. Kahrilas PJ, Kim HC, Pandolfino JE. Approaches to the diagnosis and grading of hiatal hernia. Best Pract Res Clin Gastroenterol 2008;22:601-16. 10.1016/j.bpg.2007.12.007.
10. Kavic SM, Segan RD, George IM, Turner PL, Roth JS, Park A. Classification of hiatal hernias using dynamic three-dimensional reconstruction. Surg Innov. 2006 Mar;13(1):49-52. doi: 10.1177/155335060601300108. PMID: 16708155.
11. Kim P, Turcotte J, Park A. Hiatal hernia classification-Way past its shelf life. Surgery. 2021 Aug;170(2):642-643. doi: 10.1016/j.surg.2021.02.062. Epub 2021 Apr 15.PMID: 33867168.
12. Kohn G. P., Prince R. R., DeMeester S. R., et al., Guidelines for the management of hiatal hernia, Surg. Endosc. 27 2013 4409-4428, https://doi.org/10.1007/ s00464-013-3173-3.
13. Landreneau RJ, Del Pino M, Santos R. Management of paraesophageal hernias. Surg Clin North Am. 2005 Jun;85(3):411-32. doi: 10.1016/j.suc.2005.01.006. PMID: 15927641.
14. Li L, Gao H, Zhang C, Tu J, Geng X, Wang J, Zhou X, Pan W, Jing J.. The diagnostic value of X-ray, endoscopy, and high-resolution manometry for hiatal hernia: a systematic review and meta-analysis. Journal of Gastroenterology and Hepatology. 2019, 2020 Jan;35(1):13-18. doi: 10.1111/jgh.14758. Epub 2019 Jul 28. doi:10.1111/jgh.14758.
15. Lundell LR, Dent J, Bennett JR, Blum AL, Armstrong D, Galmiche JP, Johnson F, Hongo M, Richter JE, Spechler SJ, Tytgat GN, Wallin L. Endoscopic assessment of oesophagitis: clinical and functional correlates and further validation of the Los Angeles classification. Gut. 1999 Aug;45(2):172-80. doi: 10.1136/gut.45.2.172. PMID: 10403727; PMCID: PMC1727604.
16. Nayar DS, Vaezi MF. Classifications of esophagitis: who needs them? Gastrointest Endosc. 2004 Aug;60(2):253-7. doi: 10.1016/s0016-5107(04)01555-x. PMID: 15278054.
17. Nykonenko A. O., Haidarzhi Ye. I., Letkeman T. V. Hiatal hernia types and their radiological diagnostics in patients with gastroesophageal reflux disease Zaporizhzhya Medical Journal. 2022:24(2, 131);168-175. doi: 10.14739/2310-1210.2022.2.241656.
18. Paul S, Bueno R. Hiatal Hernia in Encyclopedia of Gastroenterology 2004, Pages 382-386. doi: 10.1016/B0-12-386860-2/00371-3.
19. Petrov RV, Su S, Bakhos CT, Abbas AE. Surgical Anatomy of Paraesophageal Hernias. Thorac Surg Clin. 2019 Nov;29(4):359-368. doi: 10.1016/j.thorsurg.2019.07.008.
20. Schieman C, Grondin SC. Paraesophageal hernia: clinical presentation, evaluation, and management controversies. Thorac Surg Clin. 2009 Nov;19(4):473-84. doi: 10.1016/j.thorsurg.2009.08.006. PMID: 20112630.
21. Skinner DB, Belsey RH. Surgical management of esophageal reflux and hiatus hernia. Long-term results with 1,030 patients. J Thorac Cardiovasc Surg. 1967 Jan;53(1):33-54. PMID: 5333620.
22. Weston AP. Hiatal hernia with cameron ulcers and erosions. Gastrointest Endosc Clin N Am. 1996 Oct;6(4):671-9. PMID: 8899401.

Порівняльна оцінка клінічної та ендоскопічної семіотики гриж стравохідного отвору діафрагми

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Грижа стравохідного отвору діафрагми (ГСОД) III типу поєднує анатомічні характеристики гриж I і II типів. Прояви III типу грижі гетерогенні і можуть відзеркалювати її походження — з типу I чи II, але дотепер немає визначеності щодо зв'язку клінічних і ендоскопічних проявів ГСОД типу III з її походженням.

Мета — на підставі аналізу клінічних і ендоскопічних проявів грижі стравохідного отвору діафрагми типу III обгрунтувати гетерогенність їхніх характеристик різним походженням: від типу грижі I чи II.

Матеріали та методи. У дослідження увійшло 126 хворих з ГСОД, у тому числі 87 III типу та 39—I типу, яким виконано планову лапароскопічну герніопластику. Робота мала декілька кроків. На першому кроці проведена оцінка результатів ендоскопічного дослідження у хворих із ГСОД III типу для визначення гетерогенності отриманих даних та доцільності поділення пацієнтів на підгрупи за допомогою двоетапного кластерного аналізу. На другому кроці отримані в результаті кластерного аналізу підгрупи співставлялися між собою та хворими з ГСОД I типу для визначення спільності або відмінності даних ендоскопічного дослідження і клінічної симптоматики.

Результати. Кластерний аналіз визначив два кластери показників з хорошою мірою їх зв'язаності та поділу. Основним фактором поділу на кластери виявився характер відношення стравохідно-шлункове з'єднання (СШЗ) та верхньої межі грижової порожнини при огляді в інверсії. За цим показником ГСОД типу III можна поділити на дві субгрупи: тип IIIA — СШЗ розташоване проксимальніше або на її рівні найвищої точки грижової порожнини та тип IIIB — СШЗ розташоване дистальніше найвищої точки грижової порожнини. Частота більшості ендоскопічних симптомів грижі в субгрупі IIIA на відміну від субгрупи IIIB, статистично значущо не відрізнялася від грижі типу I за винятком меншої довжини стравоходу та більшої осьової довжини грижі. Крім того, хворі з субтипом грижі IIIA майже не відрізнялися від хворих типу I за клінічними показниками за винятком більшого середнього віку та частоти віддишки. При субтипі IIIB порівняно з грижею типу I статистично значущо рідше спостерігалися симптоми, пов'язані з гастроезофагеальним рефлюксом, натомість частіше відмічалися симптоми, характерні для порушення евакуації їжі. Виявлена схожість ендоскопічних і клінічних проявів грижі типу I і субтипу IIIA свідчить про їх спільне походження. Натомість субтип IIIB, який відрізняється за ендоскопічними і клінічними показниками від грижи типу I і субтипу IIIB вочевидь є результатом прогресування грижі типу II.

Висновки. Хворі з ГСОД типу III мають суттєву гетерогенність клінічних і ендоскопічних проявів, що обумовлено різним походженням грижі (з типу I або з типу II). Ендоскопічною ознакою, що вказує на походження грижі, є розташування шлунково-стравохідного з'єднання відносно найвищої точки грижової порожнини: нижче неї — з грижі II типу (62,1 %), на рівні або вище — з грижі I типу (37,9 %).

Ключові слова: грижа стравохідного отвору діафрагми, діагностика, семіотика, підтипи грижі.

FOR CITATION

Tarasov TA, Markulan LY. Comparative assessment of clinical and endoscopic semiotics of hiatal hernias. General Surgery (Ukraine). 2023;2;25-35. http://doi.org/10.30978/GS-2023-2-25.