UDC: 612.33+577.1 https://doi.org/10.15407/biotech18.02.035

METABOLIC CHARACTERISTICS OF GASTRIC CONTENTS UNDER CONDITIONS OF NEUROMUSCULAR DYSFUNCTION OF THE ESOPHAGOGASTRIC JUNCTION

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Received 2025/03/04
Revised 2025/03/26
Accepted 2025/04/30

Neuromuscular dysregulation at the esophagogastric junction, characteristic of achalasia cardia, leads to alterations in the metabolic composition of gastric contents, particularly in acidity, pepsin concentration, bile acids, and protective mucosal factors. Investigating these changes is essential for understanding the pathophysiological mechanisms underlying motor-secretory dysfunction and the development of esophageal and gastric disorders. The relevance of such research is underscored by the limited available data on the biochemical composition of gastric juice in the context of esophageal dysfunction, especially achalasia cardia, thereby highlighting the need for further investigations in this area.

Aim. The work was purposed to determine the biochemical characteristics of gastric contents in neuromuscular dysfunction of the esophagogastric junction.

Materials and Methods. In total of 69 patients with achalasia of the cardia and 26 control subjects were examined. The following parameters were assessed: pH, pepsin, cholic acid, NOx, calcium, glycoproteins, fucose, glycosaminoglycans, and sialic acid.

Results. Patients demonstrated increased gastric content volume (2.9 times), cholic acid (1.8 times), and sialic acid (2.4 times), as well as elevated NOx (68.2%) and calcium (31.6%) levels. Glycoproteins (85.7%), fucose (73.0%), and glycosaminoglycans (35.5%) were significantly decreased.

Conclusions. Neuromuscular dysfunction is associated with alterations in the composition of gastric juice, weakening of protective factors, and accumulation of aggressive metabolites, indicating local homeostatic disruption.

Keywords: achalasia of the cardia, gastric juice, mucosal protection, biochemical markers.

Neuromuscular dysregulation of the lower esophageal sphincter leads to alterations in the motor-secretory function of the esophagogastric junction, a hallmark feature of Achalasia cardia. This dysfunction is accompanied by delayed gastric content clearance, changes in acidity, and qualitative transformation of gastric secretions, all of which are essential contributors to disease progression. Various studies have highlighted the significance of specific biochemical parameters of gastric juice, including pH, concentrations of pepsin, and bile acids [1], as well as mucosal protective markers and molecules involved in local homeostasis, such as mucins [2]. The investigation of these changes offers insights into the mechanisms underlying altered gastric composition and reveals potential metabolic shifts associated with esophageal dysfunction [3–5].

Citation: Halinska, A. M., Severynovska, O. V., Halinskyi, O. O. (2025). Metabolic characteristics of gastric contents under conditions of neuromuscular dysfunction of the esophagogastric junction. *Biotechnologia Acta*, 18(2), 35–37. https://doi.org/10.15407/biotech18.02.035

A review of the current literature indicates that, despite several relevant studies, the biochemical alterations in gastric secretions in the context of esophageal dysfunction remain insufficiently explored, underscoring the need for further targeted research in this domain.

Aim. The work purposed to determine the physicochemical and biochemical characteristics of gastric contents in neuromuscular dysfunction of the esophagogastric junction.

Methods. Gastric juice samples from 69 patients with symptoms of impaired lower esophageal sphincter relaxation were analyzed; samples were collected during diagnostic video gastroscopy (achalasia of the cardia, ICD-10 K22.0). The examinations were conducted at the Department of Mini-Invasive Endoscopy, SI "IGNAMSU". The control group included 26 apparently healthy volunteers without gastrointestinal pathology. The following parameters were assessed: pH, concentrations of pepsin, bile acids, sialic acid, fucose, and glycosaminoglycans [6]. Calcium was determined using the "Filisit-Diagnostics" reagent kit. NOx levels were measured using nitrate reduction followed by diazotization. The study was conducted in accordance with ethical standards. Statistical analysis was performed using Microsoft Excel. Data are presented as Me (Q1; Q3); group comparisons were performed using the Mann–Whitney U test; $P < 0.05$ was considered statistically significant.

Results and Discussion. Significant changes in the physicochemical and biochemical composition of gastric contents were identified in patients with achalasia of the cardia compared to the control group. The gastric content volume in patients was 7.65 (5.08; 10.08) mL, which was 2.9 times higher than that in controls 2.60 (2.10; 4.70) mL ($P < 0.001$). The pH level in patients was elevated by 6.0% — 3.08 (2.18; 4.55) versus 2.90 (2.45; 3.58); however, this difference did not reach statistical significance ($P = 0.58$). Pepsin concentration showed a decreasing trend of 0.50 (0.08; 0.80) mg/mL in patients versus 0.92 (0.70; 1.21) mg/mL in the control group (45.8%; $P = 0.055$). Glycoprotein concentration was significantly reduced by 85.7% in patients with 0.09 (0.06; 0.16) mmol/L compared to 0.63 (0.36; 0.80) mmol/L in controls ($P = 0.001$). Cholic acid levels increased 1.8 times — 211 (140; 404) μmol/L versus 118 (113; 121) μmol/L in the control group ($P < 0.001$).

Total calcium concentration was elevated by 31.6% — 1.27 (1.08; 1.52) compared to 0.97 (0.76; 1.21) ($P = 0.045$). NOx levels were 68.2% higher in patients — 52.21 (21.69; 119.49) μmol/L compared to 31.03 (24.39; 36.63) μmol/L in controls ($P = 0.017$). The level of sialic acid in patients was 2.4 times higher — 0.18 (0.08; 0.28) mmol/L versus 0.08 (0.04; 0.08) mmol/L ($P = 0.007$). Fucose concentration was reduced by 73.0% — 0.30 (0.18; 0.58) mmol/L compared to 1.12 (0.41; 1.12) mmol/L in controls ($P = 0.001$). Glycosaminoglycans were decreased by 35.5% — 0.52 (0.30; 0.73) mmol/L versus 0.80 (0.55; 0.93) mmol/L in the control group ($P = 0.009$).

Analysis of the physicochemical and biochemical composition of gastric contents in achalasia revealed significant changes compared to the control group, as shown in Table 1.

The observed changes in the composition of gastric contents indicate a marked impairment of mucosal function, reduced protective capacity, and activation of aggressive metabolites [7]. The increase in volume, cholic acid, NOx, and sialic acid, combined with decreased levels of pepsin [8] and

Table 1. **Biochemical parameters of gastric juice**

Parameter	Control group ($n = 26$) Me (Q1;Q3)	Achalasia of the cardia ($n = 69$) Me (Q1;Q3);	*P*-value
Volume, mL	2.60 (2.10; 4.70)	7.65 (5.08;10.08)	< 0.001
pH	2.90 (2.45;3.58)	3.08 (2.18;4.55)	0.58
Pepsin, mg/mL	0.92 (0.7;1.21)	0.50 (0.08;0.80)	0.055
Glycoproteins, mmol/L	0.63 (0.36;0.80)	0.09 (0.06;0.16)	0.001
Cholic acid, μmol/L	118 (113;121)	211 (140;404)	< 0.001
Total calcium mmol/L	0.97 (0.76;1.21)	1.27 (1.08;1.52)	0.045
NOx, μmol/L	31.03 (24.39;36.63)	52.21 (21.69;119.49)	0.017
Sialic acid, mmol/L	0.08 (0.04;0.08)	0.18 (0.08;0.28)	0.007
Fucose, mmol/L	1.12 (0.41;1.12)	0.30 (0.18;0.58)	0.001
Glycosaminoglycans, mmol/L	0.80 (0.55;0.93)	0.52 (0.30;0.73)	0.009

mucus components, suggests destabilization of local homeostasis in achalasia. This area of research requires further development, as current literature lacks sufficient data specifically addressing the biochemical parameters associated with neuromuscular dysregulation of the lower esophageal sphincter.

Conclusions. In patients with achalasia of the cardia, significant alterations in the biochemical composition of gastric contents were identified, indicating impaired secretory and protective functions. An increase in gastric volume was observed along with stable pH and reduced pepsin levels, as well as decreased concentrations of glycoproteins, fucose, and glycosaminoglycans, suggesting a compromised mucosal barrier. Elevated levels of cholic acid, calcium, and NOx may reflect duodenogastric reflux and impaired motor regulation, while increased sialic acid may indicate mucus degradation. These changes may play a key role in the pathogenesis of the condition, justifying further investigation and the search for relevant biomarkers.

Authors' contribution

AMH performed biochemical analysis, primary statistical processing, and writing the abstract; OVS reviewed the manuscript and participated in data analysis; OOH designed the tables and statistical analysis.

Funding source

This research was carried out as part of the state-funded project at the SI "Institute of Gastroenterology of the NAMS of Ukraine" (2023–2024, No. 0119U102471).

Acknowledgment

The authors express their gratitude to the SI "IGNAMSU" for the opportunity to conduct the study and for scientific and methodological support. Special thanks are extended to Doctor of Medical Sciences N.V. Prolom for participation in the collection of gastric juice samples during video gastroscopy.

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