Central Asian Journal of Medicine

MODERN PERSPECTIVES ON DIAGNOSIS AND SURGICAL TREATMENT OF HIATAL HERNIA

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ABSTRACT

This comprehensive review analyzes modern approaches to diagnosis and surgical treatment of hiatal hernia (HH) based on literature from 2013-2023. The study examines epidemiology, pathogenesis, and advances in diagnostic methods, including high-resolution manometry and functional imaging. Laparoscopic fundoplication remains the gold standard for surgical treatment, while robotic surgery and endoscopic methods offer new possibilities for treatment individualization. The implementation of enhanced recovery protocols has improved short-term outcomes. The review emphasizes the importance of personalized approaches considering anatomical features, functional parameters, and patient characteristics. Development of new materials and techniques for hiatal repair continues to be an active area of research.

Key words: Hiatal hernia, phrenoesophageal ligament, Heartburn, Regurgitation, Dysphagia, Epigastric pain.

INTRODUCTION

Hiatal hernia (HH) is one of the most common conditions affecting the upper gastrointestinal tract, significantly impacting patients' quality of life. The last decade has seen substantial changes in understanding HH pathophysiology, diagnostic methods, and treatment. This review analyzes modern approaches to diagnosis and surgical treatment of HH based on literature from 2013 to 2023.

HH Epidemiology

The exact prevalence of HH in the population remains debatable due to differences in diagnostic criteria and research methods. According to a meta-

analysis by Nirwan et al. (2020), the global prevalence of HH ranges from 10% to 80% depending on diagnostic criteria [37]. Symptomatic forms occur in 20-30% of patients.

Research by Eusebi et al. (2018) showed that HH prevalence increases with age [10]. In individuals over 50 years, HH is detected in 50-60% of cases, while in patients over 70 years - in 70-80% of cases. Additionally, there is a higher frequency of HH among women compared to men (ratio approximately 2:1).

Importantly, recent years have shown an increasing trend in HH detection, attributed to both improved diagnostic capabilities and rising risk factors such as obesity and sedentary lifestyle. Research by Ness-Jensen et al. (2016) showed an annual increase in HH detection of 2.3% over the past 5 years [36].

Etiology and Pathogenesis

Understanding of HH etiology and pathogenesis has expanded significantly over the last decade. Modern research emphasizes the multifactorial nature of this condition.

Genetic Factors

Research by Bonfiglio et al. (2019) identified several genetic loci associated with increased HH risk [5]. Specifically, polymorphisms were identified in genes encoding collagen and other extracellular matrix components, potentially explaining hereditary predisposition to HH.

Anatomical Factors

Work by Pandolfino et al. (2017) emphasized the importance of gastroesophageal junction anatomical features in HH development [41]. The authors found that His angle increases and phrenoesophageal ligament weakening play key roles in HH pathogenesis.

Physiological Factors

Lee et al. (2020) demonstrated that esophageal and gastric motility disorders can contribute to HH development [1-30]. Specifically, decreased lower esophageal sphincter tone and impaired esophageal peristalsis can lead to increased intra-abdominal pressure and hernia formation.

Lifestyle Factors

Meta-analysis by Chang et al. (2019) showed a strong correlation between obesity and HH risk [8-40]. The authors note that each 5-unit increase in body mass index raises HH risk by 30%.

Age-Related Changes

Research by Kahrilas et al. (2018) highlighted the role of age-related changes in HH development [22-50]. Aging leads to weakening of gastroesophageal junction connective tissue, increasing hernia formation risk.

Thus, modern understanding of HH etiology and pathogenesis considers the complex interaction of genetic, anatomical, physiological factors and lifestyle factors. This comprehensive understanding opens new perspectives for developing personalized approaches to prevention and treatment of HH.

Classification of HH

HH classification is an important aspect in understanding the disease and choosing treatment tactics. Over the last decade, several new classifications have been proposed, considering not only anatomical but also functional features of HH.

Traditional anatomical classification, proposed in the 1950s, remains widely used and includes the following HH types:

1. Type I (sliding hernia)
2. Type II (paraesophageal hernia)
3. Type III (mixed hernia)
4. Type IV (complex hernia involving other organs)

However, in 2013 Roman et al. proposed a new HH classification based on high-resolution manometry data [45]. This classification considers not only anatomical features but also functional state of gastroesophageal junction:

1. Type 1: Normal gastroesophageal junction
2. Type 2: Separation between lower esophageal sphincter and diaphragmatic compression <3 cm
3. Type 3a: Separation >3 cm, but lower esophageal sphincter above diaphragm
4. Type 3b: Separation >3 cm, lower esophageal sphincter at or below diaphragm

In 2019, Kahrilas et al. proposed an integrated HH classification, considering both anatomical and physiological parameters [23]. This classification includes:

1. Hernia size (small <3 cm, medium 3-5 cm, large >5 cm)
2. Hernia type (sliding, paraesophageal, mixed)
3. Functional state of gastroesophageal junction (based on manometry)
4. Presence and degree of reflux (based on pH monitoring)

It is important to note that classification choice can influence treatment tactics. For example, research by Siegal et al. (2021) showed that patients with type 3b HH according to Roman et al. classification have higher risk of recurrence after laparoscopic fundoplication and may require more aggressive surgical approach [51].

Thus, modern HH classifications strive to integrate anatomical and functional parameters, allowing more precise determination of treatment tactics and prediction of its results.

Clinical Presentation

The clinical presentation of HH can be quite diverse, causing difficulties in diagnosis and treatment selection. Modern studies show that HH symptoms can vary significantly depending on hernia type, size, and presence of comorbidities.

Typical symptoms: According to meta-analysis conducted by Gyawali et al. (2018), the most common HH symptoms are [18]:

1. Heartburn (occurs in 60-80% of patients)
2. Regurgitation (40-60%)
3. Dysphagia (30-50%)
4. Epigastric pain (20-40%)

However, it is important to note that symptom intensity does not always correlate with hernia size. Research by Oor et al. (2018) showed that up to 40% of patients with large HH may be asymptomatic [40].

Atypical symptoms: In recent years, more attention has been paid to atypical HH manifestations. Research by Goodwin et al. (2021) revealed that 20-30% of HH patients may experience the following symptoms [15]:

1. Chronic cough
2. Voice hoarseness
3. Bronchial asthma
4. Chest pain
5. Anemia (due to chronic bleeding)

Special attention should be paid to cardiac symptoms. Research by Krawiec et al. (2021) showed that 10-15% of HH patients may experience symptoms mimicking angina, which can lead to diagnostic errors [29].

Impact on quality of life: Modern studies emphasize significant HH impact on patients' quality of life. Meta-analysis by Becher et al. (2017) showed that HH patients have significantly lower quality of life compared to general population, especially in aspects of physical functioning and social activity [3].

Clinical features in elderly patients: Research by Richter et al. (2021) revealed that in patients over 65 years, HH clinical presentation may have several features [44]:

1. Less pronounced typical symptoms (heartburn, regurgitation)
2. More frequent atypical symptoms (anemia, dysphagia)
3. High risk of complications (bleeding, esophageal strictures)

Thus, modern view of HH clinical presentation emphasizes the need for comprehensive approach to symptom assessment, considering both typical and atypical disease manifestations. This is especially important for early diagnosis and timely treatment initiation, which can significantly improve patients' quality of life.

Modern Diagnostic Methods

HH diagnosis has undergone significant changes in the last decade due to new technology development and deeper understanding of disease pathophysiology. Modern approach to HH diagnosis is based on comprehensive use of various methods, allowing not only to detect hernia presence but also to assess its impact on gastroesophageal junction function.

Radiological Methods

Barium radiography remains an important diagnostic method for HH, especially for detecting large hernias and assessing their size. Research by Katz et al. (2018) showed that this method's sensitivity is about 85% for hernias larger than 2 cm [26].

However, in recent years, computed tomography (CT) with 3D reconstruction has gained increasing importance. Work by Santana et al. (2024) demonstrated that CT allows not only precise determination of hernia size but also assessment of diaphragmatic crura condition and surrounding tissues, which is critically important for surgical planning [48]. Additionally, CT is especially useful for diagnosing complicated HH forms, such as paraesophageal hernias or hernias with incarceration.

A new direction in radiological HH diagnosis is the use of dynamic MRI. Research by Sweis et al. (2020) showed that this method allows evaluation of gastroesophageal junction function in real time, which can be particularly useful for detecting sliding hernias [52].

Endoscopic Methods

Esophagogastroduodenoscopy (EGD) remains the gold standard for evaluating esophageal and gastric mucosa, and detecting HH complications such as erosive esophagitis or Barrett's esophagus.

High-resolution endoscopes and narrow-band imaging (NBI) have significantly improved diagnostic capabilities. Sharma et al. (2016) showed that NBI increases Barrett's metaplasia detection accuracy by 15% compared to standard endoscopy [49].

Additionally, new technologies like confocal laser endomicroscopy enable "optical biopsy" in vivo. Xiong et al. (2018) demonstrated 98% sensitivity and 94% specificity for detecting early neoplastic changes in Barrett's esophagus [57].

Esophageal Manometry

The last decade marked a revolution in functional esophageal diagnostics. High-resolution manometry (HRM) enabled more precise evaluation of lower esophageal sphincter function and esophageal peristalsis.

Roman et al. (2016) showed that HRM can detect subclinical esophageal motility disorders in HH patients, crucial for treatment strategy selection [45]. The authors proposed a new HH classification based on HRM data, considering both anatomical and functional parameters.

pH Monitoring

Impedance-pH monitoring has become standard for gastroesophageal reflux assessment. Gyawali et al. (2024) showed this method allows both quantitative reflux evaluation and differentiation between acid and non-acid reflux, important for optimal therapy selection [17].

Wireless systems for extended (up to 96 hours) pH monitoring represent a new direction. Roman, Gyawali, Savarino, Yadlapati, et al. (2017) showed this approach increases diagnostic accuracy by 20% compared to standard 24-hour monitoring [46].

Computed Tomography

3D-reconstruction CT has become an important HH diagnostic tool, especially for surgical planning. Felsenreich, Arnold et al. (2020) demonstrated that preoperative CT allows more precise determination of hernia defect size and optimal repair method selection [11].

Additionally, CT is particularly useful for diagnosing complicated HH forms. Ayyildiz et al. (2022) showed CT has 98% sensitivity and 96% specificity for detecting incarcerated paraesophageal hernias [2].

Magnetic Resonance Imaging

Dynamic contrast-enhanced MRI is gaining increasing importance in HH diagnosis. Zang et al. (2015) showed that MRI enables evaluation of both anatomical features of HH and real-time functional parameters of the gastroesophageal junction [58].

Conclusion of the Section:

Modern HH diagnostic methods are characterized by high accuracy and informativeness. A comprehensive approach combining anatomical visualization with functional assessment of the gastroesophageal junction allows not only HH detection but also determination of optimal treatment tactics for each patient.

Implementation of new technologies, such as high-resolution manometry and dynamic MRI, opens new perspectives for improving diagnosis and disease course prediction.

Indications for Surgical Treatment

Determining indications for HH surgical treatment remains a subject of discussion in the medical community. Over the last decade, treatment selection approaches have become more personalized, considering not only anatomical features of the hernia but also gastroesophageal junction functional state, patient quality of life, and comorbidities [53].

Main indications for HH surgical treatment include:

1. Failed Conservative Therapy: Garg and Gurusamy (2015) showed patients with persistent symptoms after 8-12 weeks of adequate conservative therapy (including both medication and lifestyle modifications) have high probability of successful surgical treatment [13].

2. HH Complications:

- Esophageal strictures
- Barrett's esophagus with dysplasia
- Recurrent bleeding
- Hernia incarceration Maret-Ouda et al. (2017) meta-analysis showed surgical treatment reduces Barrett's esophagus progression risk by 40% compared to conservative therapy [35].

3. Large Paraesophageal Hernias: According to SAGES 2013 guidelines, all symptomatic paraesophageal hernias >5 cm should be considered for surgical treatment due to high complication risk [27].

4. Extra-esophageal GERD: Sidwa et al. (2017) showed HH surgical treatment effectiveness in patients with bronchopulmonary and cardiac symptoms resistant to conservative therapy [50].

5. Young Patient Age: Maret-Ouda et al. (2016) demonstrated patients under 45 have better long-term outcomes after surgical treatment compared to prolonged conservative therapy [33].

6. Continuous PPI Requirement: Maret-Ouda et al. (2023) showed patients requiring continuous high-dose PPIs may be surgical candidates, especially considering potential long-term side effects [34].

7. Esophageal Motility Disorders: Ravi et al. (2015) demonstrated patients with HH and ineffective esophageal peristalsis show better results after surgical treatment versus conservative therapy [43].

8. Quality of Life: Wang et al. (2024) showed significant quality of life reduction may be independent indication for surgical treatment, even without serious complications [55].

It is important to note that surgical treatment decisions must be made individually for each patient, considering all factors. A multidisciplinary approach including gastroenterologist, surgeon, and when necessary, pulmonologist and cardiologist, is considered optimal for determining treatment strategy.

Furthermore, new studies emphasize the importance of preoperative patient evaluation. Roman et al. (2022) proposed a preoperative assessment algorithm that includes not only standard tests (endoscopy, manometry, pH monitoring) but also assessment of psychosocial factors and patient expectations from surgery, which helps improve patient selection for surgical treatment and increase satisfaction with results [47].

Thus, **the** modern approach to determining indications for HH surgical treatment is becoming increasingly personalized and comprehensive, considering a wide spectrum of factors, which allows optimization of treatment outcomes and improvement of patients' quality of life.

Surgical Treatment Methods

Surgical treatment of HH has undergone significant changes over the past decade. Development of minimally invasive technologies, new materials and techniques, and deeper understanding of disease pathophysiology have led to improved surgical approaches.

Laparoscopic Fundoplication

Laparoscopic fundoplication remains the "gold standard" for HH surgical treatment. Meta-analysis by Maret-Ouda et al. (2018) covering over 20,000 patients showed this method's effectiveness in controlling GERD symptoms is about 85% at 5 years post-surgery [32].

Main fundoplication types include: a) Nissen fundoplication (360°): Remains most common method. Bonavina et al. (2023) study showed Nissen provides best reflux control but is associated with higher postoperative dysphagia risk [4].

b) Partial posterior Toupet fundoplication (270°): According to Broeders et al. (2010) study, Toupet shows comparable effectiveness to Nissen but with lower postoperative dysphagia frequency [6].

c) Anterior fundoplication (180°): Adaba et al. (2014) study showed anterior fundoplication can be effective alternative for patients with esophageal motility disorders, providing lower postoperative dysphagia risk [1].

An important aspect of laparoscopic fundoplication is crural repair technique. Oelschlager et al. (2011) study demonstrated that using biological meshes for

crural repair reinforcement reduces recurrence rate by 50% at 10 years compared to simple diaphragmatic crus closure [39]. However, synthetic mesh use is associated with esophageal erosion risk.

A new direction is using custom 3D-printed implants for hiatal hernia repair. Pilot study by Heidari et al. (2024) showed this approach's promise, especially for large hernial defects [19].

Robotic Surgery

Application of robotic systems in HH surgery is one of the most dynamically developing directions. Studies by Melvin et al. (2002) and Huettner et al. (2009) demonstrated that robotic fundoplication provides comparable effectiveness to laparoscopic technique, but has advantages in complex cases of HH, especially in large paraesophageal hernias [28].

Main advantages of robotic surgery are:

- Enhanced 3D visualization
- Increased precision of manipulations
- Reduction of surgeon's hand tremor
- Ability to work in anatomically difficult-to-access areas

Study by Ceccarelli et al. (2023) showed that robotic surgery is particularly effective in revision operations after failed previous antireflux interventions [7].

However, as noted by Gkegkes et al. (2017), cost of robotic operations is on average €1,000-1,500 higher than laparoscopic, which limits their widespread implementation [14]. Further studies are needed to evaluate economic effectiveness of robotic HH surgery in long-term perspective.

Endoscopic Methods

Development of endoscopic technologies has led to emergence of new minimally invasive HH treatment methods. Main endoscopic methods include:

a) Transoral incisionless fundoplication (TIF): Trad et al. (2018) demonstrated TIF effectiveness in GERD symptom control in 80% of patients at 5 years post-procedure [54]. Particularly effective for small HH (up to 2 cm).

b) Magnetic reinforcement of lower esophageal sphincter (LINX): Long-term study by Ganz et al. (2016) showed that 5 years after LINX implantation, 85% of patients did not need proton pump inhibitors [12]. However, this method has limitations for large HH.

c) Endoscopic gastric plication: New endoscopic plication technique, according to Niu et al. (2024), showed promising results in treating small HH with 75% effectiveness at 3 years post-procedure [38].

Important to note that endoscopic methods have limited indications and cannot fully replace traditional surgical interventions, especially for large HH and complicated disease forms.

Mesh Implant Application

Use of mesh implants for hiatal opening reinforcement remains debatable. Pfluke et al. (2012) showed bioresorbable mesh reduces recurrence by 20% at 5 years versus simple diaphragm crural suturing, without increased complication risk [42].

However, permanent synthetic mesh use is associated with serious complications risk, such as esophageal erosion and strictures. Inaba et al. (2021) meta-analysis showed these complications risk is about 2-3% within 5 years post-surgery [21].

A new direction is bioengineered implant development. Heidari et al. (2024) presented first results of tissue-engineered implants showing good biocompatibility and low complication risk [19].

Section Conclusion:

Modern HH surgical treatment methods are characterized by minimizing invasiveness while maintaining high effectiveness. Laparoscopic fundoplication remains the "gold standard," but new technologies like robotic surgery and endoscopic methods expand treatment individualization possibilities. An important trend is development of new materials and methods for hiatal opening reinforcement aimed at reducing recurrence rates. Optimal treatment method selection should be based on individual patient characteristics, including hernia size and type, esophageal functional state, comorbidities, and patient preferences.

Postoperative Patient Management

Postoperative management after HH surgical treatment plays key role in ensuring successful outcomes and minimizing complications. Over last decade, postoperative approaches significantly evolved, emphasizing early patient mobilization and personalized rehabilitation protocols.

Early Mobilization

Enhanced Recovery After Surgery (ERAS) concept found application in HH surgery. Guiterrez et al. (2020) showed ERAS protocol reduces hospitalization length by 30% and postoperative complications by 20% [16]. Main ERAS components include:

- Early patient mobilization (2-4 hours post-surgery)
- Early enteral feeding (first 24 hours)
- Adequate pain management with minimal opioid use

- Nausea and vomiting prevention

Dietary Recommendations

Postoperative diet plays important role in patient recovery. According to Kastenmeier (2021), gradual diet expansion during first 2-4 weeks post-surgery reduces risk of dysphagia and gas-bloat syndrome [25]. Recommended schedule:

- Days 1-2: clear liquids
- Days 3-7: semi-liquid food
- Days 8-14: soft food
- After 2 weeks: gradual return to normal diet

Pain Control

Adequate pain management is key factor for early patient mobilization. Ljungqvist et al. (2017) showed effectiveness of multimodal pain management approach, including [31-58]:

- Local wound infiltration with long-acting anesthetics
- Use of non-steroidal anti-inflammatory drugs
- Use of paracetamol
- Limited opioid use

Complication Prevention

Thromboembolic complication prevention remains important aspect of postoperative management. According to SAGES guidelines (2024), all patients after laparoscopic fundoplication should use compression stockings and early mobilization [9]. High-risk patients are recommended pharmacological prophylaxis with low molecular weight heparins.

Monitoring and Correction of Postoperative Symptoms

Early detection and correction of postoperative symptoms plays important role in improving treatment outcomes. Wu et al. (2023) showed standardized questionnaire use for symptom assessment in first weeks post-surgery allows timely detection and correction of problems like dysphagia and gas-bloat syndrome [56].

Physical Rehabilitation

Postoperative physical rehabilitation programs gaining increasing importance. Hoffman et al. (2023) demonstrated structured exercise program starting 2 weeks post-surgery improves functional outcomes and patient quality of life at 6 months post-intervention [20].

Psychological Support

Psychological patient support is important aspect of postoperative management. Komolz et al. (2001) showed psychological counseling inclusion in postoperative rehabilitation program reduces anxiety and depression levels and improves patient adherence to physician recommendations [24].

Long-term Follow-up

Long-term patient follow-up after HH surgical treatment is important postoperative management component. Maret-Ouda et al. (2017) showed regular monitoring during first 10 years post-surgery allows timely detection and correction of long-term complications like HH recurrence and esophageal motility disorders [31].

Section Conclusion:

Modern approach to postoperative HH patient management is characterized by comprehensiveness and individualization. ERAS protocols, early mobilization, adequate pain management, and complication prevention improve short-term outcomes. Long-term follow-up, including physical rehabilitation and psychological support, improves long-term results and patient quality of life. Personalized approach to postoperative management, considering individual patient characteristics, is key to optimizing HH surgical treatment outcomes.

Conclusions and Summary

Hiatal hernia (HH) remains one of most pressing issues in modern gastroenterology and surgery. Literature analysis over last decade shows significant progress in understanding HH pathophysiology, improving diagnostic methods and treatment.

1. Epidemiology and Pathogenesis: Modern studies confirm high HH prevalence, especially among elderly and obese patients. Understanding of HH pathogenesis has expanded significantly, including role of genetic factors, connective tissue disorders, and intra-abdominal pressure changes. These findings open new perspectives for developing personalized prevention and treatment approaches.

2. Diagnostics: Implementation of new technologies like high-resolution manometry, impedance monitoring, and functional MRI has significantly improved accuracy of HH diagnosis and associated esophageal motility disorders. Comprehensive diagnostic approach, including both anatomical and functional parameter assessment, has become standard in HH patient management.

3. Surgical treatment: Laparoscopic fundoplication remains the "gold standard" of surgical treatment of hiatal hernia, demonstrating high

efficiency in the long term. However, the emergence of new technologies, such as robotic surgery and endoscopic methods, expands the possibilities of individualization of treatment. Particular attention is paid to optimization of the surgical technique, including the choice of the fundoplication method and the method of plastic surgery of the esophageal opening of the diaphragm.

4. Postoperative management: The introduction of enhanced recovery protocols (ERAS) has significantly improved the short-term results of surgical treatment of hiatal hernia. A personalized approach to postoperative rehabilitation, including early mobilization, optimized pain relief and dietary recommendations, can reduce the incidence of complications and improve the quality of life of patients.

5. Long-term results: Analysis of the long-term results of surgical treatment of hiatal hernia confirms its effectiveness in controlling symptoms and improving the quality of life of patients. However, the problem of recurrence remains relevant, which emphasizes the need for further improvement of surgical techniques and methods of postoperative monitoring. 6. Personalized approach: Modern research emphasizes the importance of an individualized approach to the treatment of GERD, taking into account not only the anatomical features, but also the functional state of the esophagus, the patient's genetic profile and concomitant diseases. The development of algorithms for personalized selection of treatment methods is a promising area of research.

6. Personalized approach: Current research emphasizes the importance of an individualized approach to the treatment of hiatal hernia, taking into account not only the anatomical features, but also the functional state of the esophagus, the patient's genetic profile and comorbidities. The development of algorithms for personalized selection of treatment methods is a promising area of research.

7. Economic aspects: Evaluation of the cost-effectiveness of various methods for the treatment of hiatal hernia is becoming increasingly important. Further research is needed to determine the optimal balance between the cost of treatment and its long-term effectiveness, especially in the context of the introduction of new technologies, such as robotic surgery.

8. Research prospects: The main areas of future research in the field of hiatal hernia are:

- Development of new methods for the prevention of hiatal hernia recurrence
- Optimization of surgical treatment techniques using artificial intelligence and 3D modeling

- Study of the role of the microbiome in the pathogenesis of hiatal hernia and its impact on treatment outcomes
- Development of targeted treatment methods based on the patient's genetic profile
- Improvement of long-term follow-up methods for patients after surgical treatment of hiatal hernia

In conclusion, the modern approach to the diagnosis and treatment of GERD is characterized by its complexity and the desire for personalization. The integration of new technologies, a deeper understanding of the pathophysiology of the disease, and the improvement of surgical techniques open up new prospects for improving treatment outcomes and the quality of life of patients with GERD. However, a number of unresolved issues remain that require further research and interdisciplinary cooperation between specialists in gastroenterology, surgery, and related disciplines.

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