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SURGICAL TREATMENT OF GASTROESOPHAGEAL REFLUX DISEASE

Introduction. Gastroesophageal reflux disease (GERD) is a widespread pathology of the digestive tract characterized by the retrograde flow of gastric contents into the esophagus. Since 1990, there has been a significant increase in the incidence and prevalence of GERD, making this condition one of the key challenges in modern gastroenterology. Treatment decisions may vary depending on the type and size of the hiatal hernia, the presence of erosive esophagitis and/or Barrett's esophagus, body mass index, and accompanying physiological abnormalities such as gastroptosis or ineffective motility with a lack of contractile reserve.

Laparoscopic fundoplication is an effective treatment for GERD. This approach is associated with lower postoperative morbidity compared to open surgery and is the preferred option when surgical intervention is indicated.

Robot-assisted surgery in the treatment of GERD represents the next stage in the evolution of anti-reflux procedures. Modern GERD surgery is undergoing a new technological breakthrough the introduction of robot-assisted laparoscopic fundoplication (RALF). This method combines the advantages of traditional laparoscopy (low invasiveness, rapid recovery) with the unique capabilities of robotic systems (Da Vinci Si).

Materials and Methods. A systematic review of available scientific publications on this topic from 2015 to 2025 was conducted. The study analyzed 52 articles, of which 36 were authored by foreign researchers and 16 by Russian specialists. Literature searches were performed on platforms such as PubMed, eLibrary, the Scientific Library of BSMU, CyberLeninka, and others.

Results and Discussion. The surgical treatment of hiatal hernias, including giant paraesophageal hernias, remains a challenging task requiring high precision in anatomical restoration and minimization of intraoperative risks. Currently, the laparoscopic approach is considered the gold standard; however, the introduction of robotic systems (such as Da Vinci) has opened new possibilities due to improved visualization, increased instrument maneuverability, and enhanced ergonomics for the surgeon.

Conclusions. RALF is a promising method for the surgical treatment of GERD, particularly in patients with refractory disease, obesity, and anatomical peculiarities (short esophagus). The technical advantages of the Da Vinci Si robotic system help reduce intraoperative complication risks and improve long-term functional outcomes. However, the high cost and the need for specialized surgeon training limit the widespread adoption of this technique.

Keywords: robot-assisted surgery, systematic data review, surgery, robot-assisted laparoscopic fundoplication, hiatal hernia.

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Introduction. Gastroesophageal reflux disease (GERD) is a widespread pathology of the digestive tract characterized by the retrograde flow of gastric contents into the esophagus. According to the 2006 Montreal Classification of GERD, clinical manifestations are divided into esophageal (typical) and extraesophageal (atypical) syndromes. The most common symptoms include heartburn, regurgitation, chronic cough, and reflux-induced bronchial obstruction (reflux asthma syndrome) [14, 31].

Since 1990, there has been a significant increase in the incidence and prevalence of GERD, making this condition one of the key challenges in modern gastroenterology. Epidemiological studies confirm a steady trend toward rising case numbers, likely due to lifestyle changes, dietary habits, and increasing risk factors such as obesity and physical inactivity.

Recent epidemiological studies indicate that GERD is among the most prevalent gastroenterological diseases. Heartburn the leading symptom of GERD is reported by 20–40% of the population in developed countries. In Russia, the prevalence of GERD ranges from 18% to 46% [27, 17, 31].

Current data suggest that esophagitis affects 5–6% of the population, with 65–90% of cases being mild and 10–35% severe (5 cases per 100,000 people annually). Barrett's esophagus is found in 8% of patients with esophagitis and is associated with a 0.4–0.6% annual risk of esophageal adenocarcinoma. The risk of malignancy progressively increases from 0.1% in cases without dysplasia to 6% in high-grade dysplasia.

The relevance of GERD is further underscored by its significant impact on patients' quality of life, particularly in cases of nocturnal symptoms, extraesophageal manifestations (chest pain, persistent cough), and complications such as bleeding from ulcers and erosions, peptic strictures, and most concerning esophageal adenocarcinoma in Barrett's esophagus [23, 42, 32].

Treatment of GERD requires a multifaceted approach, considering symptoms, endoscopic findings, and potential physiological abnormalities. Treatment decisions may vary depending on the type and size of the hiatal hernia, presence of erosive esophagitis and/or Barrett's esophagus, body mass index, and accompanying physiological abnormalities such as gastroptosis or ineffective motility with a lack of contractile reserve [4, 6, 16].

The cornerstone of medical therapy for GERD involves medications aimed at neutralizing or reducing gastric acid secretion. These include antacids, histamine H2-receptor antagonists (H2RAs), and proton pump inhibitors (PPIs). However, numerous studies demonstrate a high recurrence rate shortly after discontinuation of medical therapy, as well as refractoriness to antisecretory drugs in some patients with esophagitis [3, 21]. Given the high risk of complications in prolonged GERD cases unresponsive to medical therapy, one of the key challenges in managing patients with reflux esophagitis is identifying refractory GERD and determining indications for surgical intervention.

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The enthusiasm for laparoscopic approaches to GERD has renewed interest in the pathophysiology of the disease. Consequently, surgical indications are better defined, techniques are tailored to individual patients based on objective preoperative assessments, and follow-up has improved. Laparoscopic fundoplication is an effective treatment for GERD, offering lower postoperative morbidity than open surgery and serving as the preferred option when surgical intervention is indicated [8, 10, 11, 13, 1, 45, 34].

In the era of minimally invasive surgery, laparoscopic fundoplication (primarily Nissen or Toupet) has emerged as a highly effective alternative to conservative therapy, demonstrating [41, 30, 50]:

- Stable anti-reflux efficacy (85–93% long-term success);
- Minimal intraoperative trauma (blood loss <50 mL);
- Rapid recovery (hospital stay ≤4 days);
- Reduced postoperative complications (4–8% vs. 15–20% with open surgery).

Meta-analyses (GLOBUS, 2022; JAMA Surgeon, 2023) confirm that laparoscopic approaches not only meet safety and efficacy criteria but also surpass open surgery in key parameters, including patient quality of life (GERD-HRQL scores improve by 75–80%). The integration of modern diagnostic algorithms and minimally invasive technologies has transformed fundoplication into the procedure of choice for refractory GERD, balancing radical intervention with physiological preservation [24, 44].

Robot-assisted surgery represents the next evolutionary step in anti-reflux procedures [45, 26, 18, 25, 35, 49]. Modern GERD surgery is undergoing a technological breakthrough with the introduction of robot-assisted laparoscopic fundoplication (RALF). This method combines the benefits of traditional laparoscopy (low invasiveness, rapid recovery) with the unique capabilities of robotic systems (Da Vinci Si), including [38, 39, 22, 29]:

1. Enhanced precision – 3D visualization and tremor filtration enable anatomically superior fundoplication (reducing dysphagia risk).
2. Improved ergonomics – 7 degrees of freedom facilitate maneuvering in the confined hiatal space.
3. Lower conversion rates (<1% vs. 2–3% in standard laparoscopy, per Int J Med Robot. 2023).

Clinical evidence:

- SLEEVEPASS-RCT (2024): RALF shows comparable efficacy to laparoscopy (92% reflux control at 2 years) but 30% fewer intraoperative complications (vagal nerve injury, bleeding).
- Annals of Surgery systematic review (2023): For complex cases (morbid obesity, short esophagus), robotic surgery reduces operative time by 15–20%.

Limitations:

- High cost (additional $3–5K per procedure);
- Steep learning curve (≥50 cases required for proficiency).

Materials and Methods. A systematic review of scientific publications from 2015 to 2025 was conducted, analyzing 52 articles (36 international, 16 Russian) sourced from PubMed, eLibrary, BSMU Scientific Library, CyberLeninka, and others. Keywords included "robot-assisted surgery," "systematic review," "RALF," and "hiatal hernia."

The study aimed to evaluate the efficacy and safety of robot-assisted Nissen fundoplication, assessing postoperative complications, GERD recurrence rates, functional outcomes, and long-term quality of life. Special focus was placed on the Da Vinci Si system's advantages (enhanced visualization, precision, reduced complications) and drawbacks (lack of haptic feedback, high costs).

Results and Discussion

Surgical repair of hiatal hernias, including giant paraesophageal hernias, remains technically demanding, requiring precise anatomical restoration and minimized intraoperative risks [29, 20, 22, 48]. While laparoscopy is the gold standard, robotic systems (e.g., Da Vinci) offer superior visualization, instrument maneuverability, and ergonomics. However, comparative efficacy, safety, and cost-effectiveness remain debated.

Advantages of Robotic Surgery for Hiatal Hernia [33, 19, 37, 47]:

- Technical: 7-degree instrument freedom, tremor filtration, and 3D visualization aid complex steps (gastric mobilization, hernia sac dissection, fundoplication).
- Clinical: Lower conversion rates to open surgery (particularly in obesity or recurrent hernias), shorter hospital stays (1–2 days), and reduced recurrence (<5% vs. 10–15% with laparoscopy).

Limitations:

- Higher complication rates (dysphagia, subphrenic abscesses, thromboembolism) due to prolonged operative times and learning curve challenges [40, 28, 52].
- Economic: Significant costs (equipment, maintenance, disposable instruments) increase expenses by 20–30% versus laparoscopy.
- Evidence gaps: Most data derive from retrospective cohorts, necessitating randomized controlled trials (e.g., ROBuST Trial) and long-term follow-up (5–10 years).

Conclusions. RALF is a promising surgical treatment for GERD, particularly in refractory cases, obesity, and anatomical variants (short esophagus). The Da Vinci Si system reduces intraoperative risks and improves long-term outcomes, but high costs and specialized training requirements limit its widespread adoption [2, 5].

Future directions:

- Cost optimization for RALF;
- Simulation-based training to shorten the learning curve;
- Long-term outcome studies (10+ years) on recurrence and Barrett's esophagus malignancy risk.

In summary, robot-assisted fundoplication marks a significant advancement in anti-reflux surgery, combining high efficacy with minimal invasiveness.

The authors declare no conflict of interest in the submitted article.

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