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ORIGINAL ARTICLE

CONTENTS

Gasless laparoscopy in the treatment of hiatal hernia

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ABSTRACT

Aim: To report the experience in the use of gasless laparoscopy in the treatment of patients with hiatal hernia that was accumulated in a specialized thoracic center.

Materials and Methods: Operations were performed via three to six centimeter midline access in the epigastrium with a camera installed in the left hypochondrium. A laparolift provided with the traction on the edge of the midline wound. Hiatus was repaired with diaphragmatic pillars suturing without mesh emplacement. Patients with gastroesophageal reflux disease underwent fundoplication. Operations were estimated concerning their duration, and complications and hernia recurrence development.

Results: The analysis covers the results of treatment of 159 patients with primary and seven recurrent hiatal hernia, 112 women and 54 men with median age of 61 years, who underwent gasless laparoscopy from October 2019 to July 2025 in the single thoracic centre. Among all instances, 57 (34.34%) met the criteria for large hiatal hernia. The duration of operations with posterior esophageal cruroplasty and antireflux procedure, excluding cases of recurrent hernias, conversions, and intraoperative complications, was 227±59 minutes, and 313±69 minutes ($p<0.001$) for recurrent hiatal hernia. Intraoperative complications occurred in nine cases, postoperative morbidity in 22. Recurrent hiatal hernia emerged in seven patients; their occurrence is considering predictable in five.

Conclusions: Gasless laparoscopy allows combining the advantages of minimally invasive and open surgery in the hiatal hernia treatment. Our findings suggest that the method may be beneficial in large paraesophageal hernias, and in patients with severe comorbidities.

KEYWORDS: hiatal hernia, fundoplication, gastroesophageal reflux disease, minimally invasive surgery, gasless laparoscopy, cruroplasty

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INTRODUCTION

Laparoscopic repair with antireflux surgery is the accepted standard in the surgical treatment of hiatal hernia (HH) [1, 2]. Existing controversies relate mainly to specific technical aspects of the procedure under different clinical conditions, including reinforcement of the diaphragmatic crura with mesh or biologic grafts, the need for fundoplication in paraesophageal HH without gastroesophageal reflux disease (GERD), and some aspects of redo surgery in recurrent HH [3-5]. Conventional laparoscopy (CLS) remains the principal minimally invasive approach for HH repair. Meanwhile, publications on gasless laparoscopy (GLLS) in cholecystectomy and gynecological surgery have demonstrated clinical effectiveness and economic advantages of this technique [6, 7].

AIM

The purpose of this study is to report the experience in the use of GLLS in the treatment of patients with HH, that has been accumulated in a specialized thoracic center.

MATERIALS AND METHODS

The analysis included 166 patients with primary and recurrent HH who underwent surgical treatment using GLLS between October 2019 and July 2025. Hernias were classified into types I-IV according to Skinner and Belsey (1967) [8] based on the results of computed tomography (CT) or barium contrast radiography. Regardless of type, large HH were defined by one of the following criteria [9]: I) more than 30% of the stomach displaced

into the thoracic cavity in CT or radiographic image; II) intraoperatively measured transverse diameter of the esophageal hiatus was greater than 5 cm; III) hiatal area exceeded 10 cm^2.

All procedures were performed under multicomponent general anesthesia with mechanical ventilation through a 3-6 cm upper midline epigastric access. The operative space was supplied by the traction on the left edge of the wound with a laparolift system. The visualization was provided by a camera had been installed in the left hypochondrium.

Regardless of HH type, surgical principles consistent with modern hiatal surgery [10, 11] were followed: complete mobilization of the cardia and lower esophagus including abdominal and supradiaphragmatic segments, mobilization of the gastric fundus with division of the upper short gastric vessels, preservation of the main gastric arterial and vagal trunks, excision of the hernial sac, removal of displaced retroperitoneal fat, careful dissection and suturing of the diaphragmatic crura without tension and under direct visualization predominantly behind the esophagus.

Mesh reinforcement was not used because the diaphragmatic pillars remained mobile and suitable for reconstruction. In most cases, the anterior esophageal wall was fixed to the margin of the hiatal opening. HH type I, as well as HH type III associated with GERD, required fundoplication with subsequent fixation of the wrap to the right diaphragmatic crus. In cases without fundoplication, left-sided fundophrenicopexy was performed.

Patients were stratified according to age, sex, obesity at body mass index (BMI) >35, HH type, and hernia size. HH-related complications and comorbidities were also taken into account. Surgical outcomes were assessed based on duration of procedures, perioperative complications, and HH recurrences. The adequacy of hiatal repair was evaluated radiologically by barium contrast imaging 14-21 days after surgery.

HH recurrence was defined as displacement of the fundoplication wrap or esophagogastric junction more than 2 cm above the diaphragm [12]. Reappearances were identified during routine follow-up within 6-12 months, after referral due to clinical symptoms, or incidentally by CT examinations performed for other reasons.

Statistical analysis included calculation of mean values, standard deviation, median values, and Student's t-test. The study was approved by the Bioethics Commission of the National Pirogov Memorial Medical University, Vinnytsya, Ukraine.

ETHICS

This work complies with the principles of the Declaration of Helsinki.

AI STATEMENT

The author states that no AI tools were used in writing this article.

RESULTS

GLLS were used for 159 primary and 7 recurrent HH repair in 112 women and 54 men with a mean age of 57.5±11.3 years. Among primary HH, type I was identified in 81 of 159 (51.0%), type II in five (3.1%), type III in 67 (42.1%), and type IV in six (3.8%) cases. Large HH occured in 57 patients (34.34%). Since 2022, the proportion of HH type III and IV increased from 25.8% (8 of 31) in 2019-2021 to 44.9% (22 of 49) in 2022-2023 and 54.4% (43 of 79) in 2024-2025. Overall, 93 of 166 patients (56.0%) were older than 60 years, with a median age of 61 years. Among these patients, 71 belonged to the 60-69-year age group, 20 to the 70-79-year group, and two patients were older than 80 years. In patients older than 60 years, type III HH predominated (59 of 93 cases, 63.4%).

Regarding recurrent HH, six of seven cases developed after conventional laparoscopic procedures performed at other institutions. In one patient, hernia reappeared after inadequate primary repair at our center.

Among HH-related complications, GERD-associated conditions prevailed, including esophagitis in 114 and anemia in 29 cases. Eight patients experienced strangulation without necrosis of incarcerated organs.

Concomitant diseases (Table 1) were identified in 146 patients, with a total of 422 comorbidities corresponding to 2.9 diagnoses per patient.

Hiatal repair was performed using interrupted sutures placed behind the esophagus in 161 cases and anteriorly in five ones. Antireflux procedures were conducted in 133 of 166 patients (80.1%), predominantly Nissen fundoplication (129 patients). The Toupet and Dor techniques were used twice each. In 33 elderly patients with type III HH without GERD, fundoplication was omitted and left-sided fundophrenicopexy was performed instead.

In all recurrent HH, posterior esophageal cruroplasty was used for hiatal reconstruction. Existing fundoplication wraps were preserved during redo operations. One patient underwent Dor fundoplication, whereas in another case where the wrap had not been formed previously, Nissen procedure was performed.

The mean operative duration for posterior esophageal cruroplasty with antireflux surgery was 227±59 min (median 222 min), excluding recurrent HH, conversions, and intraoperative complications,. According to HH type, operative duration was 219±59 min for type I, 215±60 min for type II ($p>0.5$), 236±59 min for type III ($p>0.1$), and 283±67 min for type IV HH ($p<0.05$). In

Table 1. Concomitant diseases in 146 patients (422 comorbidities)

Diagnosis	n (%)
Arterial hypertension	127 (87.0%)
Myocardiosclerosis	118 (80.8%)
Acquired valve pathology	26 (17.8%)
Arrhythmias	18 (12.3%)
Angina pectoris	7 (4.8%)
Circulatory failure	43 (29.5%)
Pathology of the veins of the lower extremities	11 (7.5%)
Grade II-III obesity	18 (12.3%)
Peritoneal adhesions	15 (10.3%)
Kidney diseases (single kidney (2), chronic kidney disease (2), cysts (5), urolithiasis (1))	10 (6.8%)
Goiter	6 (4.1%)
Chronic arthritis	6 (4.1%)
Chronic hepatitis	6 (4.1%)
COPD	2 (1.4%)
Diabetes	4 (2.7%)
Calculous cholecystitis	4 (2.7%)
Esophageal achalasia	1 (0.7%)
Total diagnoses, n	422

Source: compiled by the authors of this study

Table 2. Intraoperative complications and methods of correction (n=166)

Complication	n (%)	Method of correction	Conversion to open surgery, n
Bleeding from gastric vessels	4 (2.4%)	Local hemostasis	1
Splenic bleeding	2 (1.2%)	Local hemostasis	0
Pneumothorax	2 (1.2%)	Pleural drainage	0
Esophageal perforation	1 (0.6%)	Suturing under endoscopic control	0
Total	9 (5.4%)		1

Source: compiled by the authors of this study

Table 3. Factors associated with recurrent HH after surgery (n=7)

Factor category	Specific factor	n (%)
Technical factor	Inadequate closure of the hiatal defect due to insufficient preparation of the left diaphragmatic pillar	1 (14.3%)#
Tactical factor	Isolated anterior cruroplasty	2 (28.6%)
Anatomical factor	Hyperkyphosis	2 (28.6%)
Unidentified factor	Not found	2 (28.6%)
Total		7 (100%)

– patient underwent redo surgery
Source: compiled by the authors of this study

18 obese patients (BMI >35) surgeries lasted 297±60 min compared to 213±54 min in other cases (p<0.001).

Redo operations for recurrent HH required prolonged and meticulous dissection (313±69 min, p<0.001) due to the presence of dense adhesions in the upper abdomen and mediastinum.

Intraoperative complications were observed in nine patients (5.4%). Bleeding from gastric vessels occurred in four cases, and splenic bleeding was noted in two. Pneumothorax developed in two patients due to pleural opening during dissection of intrathoracic adhesions in recurrent HH. Esophageal perforation occurred in one patient. All complications were managed intraoperatively without adverse effects on final outcomes (Table 2).

Conversion to open surgery was necessary in three patients due to difficulties associated with fixation of

hernial contents in the mediastinum during reoperation in two cases and bleeding in one case.

Postoperative morbidity developed in 22 patients (9.6%), with a total of 26 complications classified as Clavien-Dindo grades I-IIIA. Among them surgical site infection prevailed (19 occurrences). Other complications included: exudative pleurisy (3 instances), two deep vein thrombosis of the lower extremities with an event of non-massive pulmonary embolism, and an acute perforated gastric ulcer. There were no fatal consequences.

During follow-up, persistent abdominal distension lasting more than six months after surgery was observed in 15 patients and was managed conservatively using prokinetics and simethicone. No clinically significant long-term postoperative dysphagia requiring reintervention was observed. Recurrent HH developed in seven patients within 6-48 months after surgery owing to the factors summarized in Table 3. One patient underwent redo surgery, while the others remained asymptomatic and did not require intervention.

DISCUSSION

The use of GLLS for HH repair has not yet been investigated sufficiently. Most studies comparing laparoscopy with and without pneumoperitoneum have focused on cholecystectomy and gynecological procedures. A systematic review demonstrated non-inferiority of GLLS regarding safety and efficiency [6]. The technique has also been considered useful for expanding minimally invasive surgery in low- and middle-income countries [7, 12]. Although the Ukrainian healthcare system remains technologically equipped, current wartime and postwar conditions necessitate rational use of resources. Nevertheless, most leading authors in lift-assisted laparoscopy originate from high-income countries [13], suggesting that interest in this technique is associated not only with economic considerations but also with clinical advantages. Thus, GLLS is able to reduce the negative effects of prolonged pneumoperitoneum on hemodynamics, visceral perfusion, and respiratory function [14-19], which is particularly important in high-risk patients. In the present study, most patients were older than 60 years and cardiovascular diseases predominated among comorbidities; however, no deterioration of concomitant conditions was observed perioperatively.

Another potentially important aspect of GLLS concerns the management of large hiatal hernias, which correlate with elevated perioperative morbidity [20] and high recurrence risk after conventional laparoscopic repair [21, 22]. Caused by pneumoperitoneum excessive tension during hiatal closure is considered one of the HH recurrence predictors [23, 24]. Meanwhile, abdominal wall lifting does not cause additional lateral traction on the diaphragmatic crura.

In the present series, predisposing factors for recurrence were found in five of seven patients. One recurrence was related to technical error during primary repair. The patient underwent repeat surgery with good result. Two recurrences occurred after isolated anterior cruroplasty, which had been provided in critically ill patients because of hemodynamic instability and strangulated HH. We also experienced hernia reappearence in two patients with severe hyperkyphosis, which has been recognized as a risk factor for failure of HH repair [25]. Further studies involving larger patient populations and longer follow-up are required to clarify whether GLLS provides advantages over conventional laparoscopy in reducing recurrence rates.

The limitations of GLLS include reduced operative space and altered visualization geometry [6]. Additional technical difficulties include the close proximity of instruments to the camera and the absence of the "carboxydissection" effect. These disadvantages become especially pronounced in obese patients. In the present study, obesity was associated not only with prolonged operative duration but also with increased intraoperative morbidity, since all severe bleeding episodes and the single esophageal perforation occurred in patients with BMI >35. In extended and technically demanding procedures, surgeon fatigue additionally contributes to complications; therefore, surgeon rotation might be reasonable in selected cases.

Furthermore, high risk of surgical site infection related to prolonged wound retraction is regarded among GLLS challenges [6]. In the present study, surgical site infections represented the most common postoperative complication.

CONCLUSIONS

GLLS combines several advantages of minimally invasive and open surgery in the treatment of HH. The technique appears particularly promising in patients with large paraesophageal hernias and severe comorbidities, where avoidance of prolonged pneumoperitoneum and reduction of tension during hiatal repair might be beneficial. At the same time, obesity and technically demanding redo procedures remain important risk factors for operative difficulties and complications. Further prospective studies with longer follow-up are necessary to determine the long-term clinical benefits and recurrence outcomes of GLLS compared to conventional laparoscopic repair.

REFERENCES

1. Daly S, Kumar SS, Collings AT et al. SAGES guidelines for the surgical treatment of hiatal hernias. Surg Endosc. 2024;38(9):4765-4775. doi: 10.1007/s00464-024-11092-3. DOI
2. Nickel F, Müller PC, Cizmic A et al. Evidence mapping on how to perform an optimal surgical repair of large hiatal hernias. Langenbecks Arch Surg. 2023;409(1):15. doi: 10.1007/s00423-023-03190-y. DOI
3. Hanna NM, Kumar SS, Collings AT et al. Management of symptomatic, asymptomatic, and recurrent hiatal hernia: a systematic review and meta-analysis. Surg Endosc. 2024;38(6):2917-2938. doi: 10.1007/s00464-024-10816-9. DOI
4. Goglia M, Reitano E, Gallo GA et al. Management of recurrent hiatal hernia: a systematic review and meta-analysis comparing mesh versus no mesh reinforcement. Hernia. 2025;29(1):103-115. doi: 10.1007/s10029-025-03376-x. DOI
5. Weiss B, Emile S, Horesh N et al. Evaluating surgical outcomes of hiatal hernia repair techniques with and without fundoplication: a network meta-analysis. Surg Endosc. 2025;39(4):6200-6212. doi: 10.1007/s00464-025-11793-3. DOI
6. Shoman H, Sandler S, Peters A et al. Safety and efficiency of gasless laparoscopy: a systematic review protocol. Syst Rev. 2020;9(1):98. doi: 10.1186/s13643-020-01365-y. DOI
7. Aruparayil N, Bolton W, Mishra A et al. Clinical effectiveness of gasless laparoscopic surgery for abdominal conditions: systematic review and meta-analysis. Surg Endosc. 2021;35(12):6427–6437. doi: 10.1007/s00464-021-08677-7. DOI
8. Fuchs KH, Kafetzis I, Hann A, Meining A. Hiatal Hernias Revisited—A Systematic Review of Definitions, Classifications, and Applications. Life. 2024;14(9):1145. doi: 10.3390/life14091145. DOI
9. Rajkomar K, Wong CS, Gall L et al. Laparoscopic large hiatus hernia repair with mesh reinforcement versus suture cruroplasty alone: a systematic review and meta-analysis. Hernia. 2023;27(4):849-860. doi: 10.1007/s10029-023-02783. DOI
10. Westcott LZ, Ward MA. Techniques for closing the hiatus: mesh, pledgets and suture techniques. Ann Laparosc Endosc Surg. 2020;5(2):16.
11. Asti E, Lovece A, Bonavina L et al. Laparoscopic management of large hiatus hernia: five-year cohort study and comparison of mesh-augmented versus standard crura repair. Surg Endosc. 2016;30(12):5404-5409. doi: 10.1007/s00464-016-4897-7. DOI
12. Dawkins B, Aruparayil N, Ensor T et al. Cost-effectiveness of gasless laparoscopy as a means to increase provision of minimally invasive surgery for abdominal conditions in rural North-East India. PLOS One. 2022;17(8):e0271559. doi: 10.1371/journal.pone.0271559. DOI
13. Pérez-Reátegui J, Arge-Gamarra BJ, Díaz-Ruiz R, Hernández-Vásquez A. Global scientific production on gasless laparoscopy: a bibliometric analysis. Front Surg. 2024;11(1):1416681. doi: 10.3389/fsurg.2024.1416681. DOI
14. Egawa H, Morita M, Yamaguchi S et al. Comparison Between Intraperitoneal CO2 Insufflation and Abdominal Wall Lift on QT Dispersion and Rate-corrected QT Dispersion During Laparoscopic Cholecystectomy. Surg Laparosc Endosc Percutan Tech. 2006;16(2):78-81. doi: 10.1097/00129689-200604000-00004. DOI
15. Alijani A, Hanna G, Cuschieri A. Abdominal Wall Lift Versus Positive-Pressure Capnoperitoneum for Laparoscopic Cholecystectomy: Randomized Controlled Trial. Ann Surg. 2004;239(3):388-394. doi: 10.1097/01.sla.0000114226.31773.e3. DOI
16. Galizia G, Prizio G, Lieto E et al. Hemodynamic and pulmonary changes during open, carbon dioxide pneumoperitoneum, and abdominal wall-lifting cholecystectomy. Surg Endosc. 2001;15(5):477–483. doi: 10.1007/s004640000343. DOI
17. Koivusalo AM, Kellokumpu I, Ristkari S, Lindgren L. Splanchnic and Renal Deterioration During and After Laparoscopic Cholecystectomy: A Comparison of the Carbon Dioxide Pneumoperitoneum and the Abdominal Wall Lift Method. Anesth Analg. 1997;85(4):886-891. doi: 10.1097/00000539-199710000-00032. DOI
18. Koivusalo AM, Kellokumpu I, Scheinin M et al. Randomized comparison of the neuroendocrine response to laparoscopic cholecystectomy using either conventional or abdominal wall lift techniques. Br J Surg. 1996;83(11):1532–1536. doi: 10.1002/bjs.1800831112. DOI
19. Ninomiya K, Kitano S, Yoshida T et al. Comparison of pneumoperitoneum and abdominal wall lifting as to hemodynamics and surgical stress response during laparoscopic cholecystectomy. Surg Endosc. 1998:12(2):124–128. doi: 10.1007/s004649900611. DOI
20. Latorre-Rodríguez AR, Rajan A, Mittal SK. Perioperative morbidity after primary hiatal hernia repair increases as hernia size increases. Dis Esophagus. 2025;38(1):doae117. doi: 10.1093/dote/doae117. DOI
21. Zhao M, Liu X, Li H, Zhang W, Wang Z. The management of recurrent hiatal hernia: a single-center retrospective study. BMC Surg. 2025;25(1):365. doi: 10.1186/s12893-025-03129-8. DOI
22. Armijo PR, Pokala B, Misfeldt M et al. Predictors of Hiatal Hernia Recurrence After Laparoscopic Anti-reflux Surgery with Hiatal Hernia Repair: a Prospective Database Analysis. J Gastrointest Surg. 2019;23(4):696–701. doi: 10.1007/s11605-018-04073-0. DOI
23. Oelschlager BK, Pellegrini CA, Hunter J et al. Biologic prosthesis reduces recurrence after laparoscopic paraesophageal hernia repair: a multicenter, prospective, randomized trial. Ann Surg. 2006;244(4):481-490. doi: 10.1097/01.sla.0000237759.42831.03. DOI
24. Oelschlager BK, Pellegrini CA, Hunter J et al. Biologic Prosthesis to Prevent Recurrence after Laparoscopic Paraesophageal Hernia Repair: Long-term Follow-up from a Multicenter, Prospective, Randomized Trial. J Am Coll Surg. 2011;213(4):461-468. doi: 10.1016/j.jamcollsurg.2011.05.017. DOI
25. Perisetla N, Doyle WN, Ladehoff L et al. Effects of Spinal Deformities on Hiatal Hernia Occurrence and Recurrence. J Gastrointest Surg. 2023;27(12):2718-2723. doi: 10.1007/s11605-023-05877-5. DOI

CONFLICT OF INTEREST
The Authors declare no conflict of interest

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