PhD THESIS

ASPECTS OF SURGICAL MANAGEMENT OF HIATAL HERNIAS

- ABSTRACT -

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1. Introduction

Hiatus hernia is an underdiagnosed disease, with an underappreciated importance in regards to the impact on quality of life, with an undervalued incidence and prevalence, with a poorly understood ethiopathogeny.

Even after more than two decades since the first minimally invasive laparoscopic procedure, a lot of unknowns persist regarding the optimal management of this disease, especially in regards to the indication of surgery, the surgical approach of choice, optimal hiatoplasty and fundoplication methods, even postoperative follow-up and treatment of early and late complications [1].

2. CURRENT STATE OF KNOWLEDGE

2.1. Definition

Hiatal hernia is a disease characterized by the protrusion of any abdominal structure (other than the esophagus), into the thoracic cavity, through an enlarged esophageal hiatus [2].

Key words: hernia, hiatal, paraesophagean, parahiatal, management, laparoscopic, concomitant, planning, preoperative
2.2. **Ethopathogeny**

Three theories regarding the ethiopathogenesis exist in the literature: increased intra-abdominal pressure pushes the eso-gastric junction in the thorax; shortening of the esophagus due to fibrosis or excessive vagal nerve stimulation pulls the esophago-gastric junction in the thorax; enlarging of the esophageal hiatus secondary to modifications of the muscular tissue or connective tissue, either congenital or age-dependent, facilitate the migration of the eso-gastric junction in the thorax [3].

2.3. **Risk factors**

Old age, male gender and obesity are key risk factors for the development of a hiatal hernia [4]. There is a 4-5 times higher risk of developing a hiatal hernia in people with a body mass index (BMI) greater than 30 [5]. Diseases of the skeletal system increase the risk of developing this condition by changes in anatomy caused by kyphosis or degenerative diseases of the spinal disc [6,7].

2.4. **Classification**

Several classifications have been proposed over time, the most widely used classification dividing hiatal hernia into 4 types today; sliding (type I), pure paraesophageal (type II), mixed (type III) and complex (type IV).

2.5. **Symptoms**

Most hiatal hernias are asymptomatic and accidentally discovered [5,8].

The most common form of presentation cited in the literature is gastroesophageal reflux disease [9]. The most common symptom is heartburn, but extra-esophageal symptoms such as chronic cough and asthma may also occur [8,10]. The appearance of dysphagia, odynophagia, weight loss of anemia or upper gastrointestinal bleeding are alarming signs [11].
2.6. **Imaging**

Imaging investigations used for the diagnosis and evaluation of hiatal hernias are: pulmonary radiography (a retrocardiac air-fluid level is pathognomonic for large hiatal hernias), upper digestive endoscopy (evaluates the mucosa of the esophagus, stomach, duodenum; may determine the size and type of hiatal hernia), barium meal (diagnoses hiatal hernia, reducibility of the hernia sac, short esophagus, esophageal motility disorders, stenosis and peptic strictures), computed tomography (useful in emergencies when gastric volvulus is suspected, may visualize hernia and herniated organs) and esophageal manometry (can calculate the size of the hernia).

2.7. **Preoperative planning**

In laparoscopic surgery, abdominal cavity access is achieved through the use of trocars. The positioning of these trocars is an essential step for achieving a safe and ergonomic laparoscopic intervention.

Although the principles of trocar positioning are already established, the strategy may vary depending on a variety of factors, such as anatomical considerations, pathological features, technical limitations, or aesthetic reasons.

In today’s practice, because no virtual planning method is adopted on a large scale, the role of the surgeon is to also establish a certain intraoperative strategy, which relies on his experience [12].

2.8. **Objectives of surgery**

The objectives of the surgical procedure are: reducing of herniated content, sac excision, intrathoracic esophagus dissection, calibration of the esophageal hiatus, and prevention of gastroesophageal reflux.

For the calibration of the esophageal hiatus, a mesh is passed through the retroesophageal window, thus encircling the esophagus at the level of the esophago-gastric junction. Through lateral traction of the mesh, the posterior portion of the hiatus is visualised [13]. The crus are sutured with non-absorbable sutures, without tension, recalibrating the esophageal hiatus [14]. If the diaphragmatic crus are frail
and the hiatus is over 5 cm, the suture may be reinforced with a prosthetic mesh, fixed with suture or stapling [15,16]. In cases in which the hiatal defect is very large and the approximation of the crus by suture is not achievable, a prosthetic mesh can be used as a substitution.

### 2.9. Gastro-esophageal reflux prevention

After hiatoplasty is performed, the gastro-esophageal reflux disease follows is addressed by adding a fundoplication. The rationale for adding a fundoplication is to treat coexisting GERD or to prevent de novo GERD from occurring postoperatively [17]. The hiatal hernia management guideline elaborated by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) in 2013, vaguely affirms that fundoplication is important in hiatus hernia repair and the recommendation is attributed a low degree of evidence [2]. Morris-Stiff, in a prospective study on 23 patients, concluded that routine addition of a fundoplication is not mandatory [18]. The most used fundoplications are the Nissen fundoplication, respectively the Toupet fundoplication [19].

### 2.10. Concomitant surgery

Concomitant surgery refers to performing two or more surgeries on a patient under a single anesthesia. Laparoscopic approach is not the routine approach for all surgical procedures, but given that the minimally invasive approach for both hiatal hernia and repair and cholecystectomy are considered the standard of care, concomitant surgery has its charm.

The idea of being able to combine multiple minimally invasive procedures and perform them under one anesthesia is very appealing, as in open surgery, but with the added benefits of minimally invasiveness: shortened hospitalization, less analgesics used, faster recovery and increase in patient satisfaction.

However, prolongation of operative time, risk of intraoperative complications and postoperative morbidity should be considered for both interventions [20].
2.11. Particular situations – parahiatal hernia
Parahiatal hernias are a type of diaphragmatic hernias in which herniation occurs through a diaphragmatic defect, adjacent to the esophageal hiatus, which is usually anatomically intact. These hernias are very rare, only a few cases being reported in the literature.

Because of the relationship with the hiatus, similar symptoms, imaging and treatment, many authors include this type of hernia in hiatal hernias [21]. From an ethiopathogenic standpoint, they can be classified as primary or secondary parahiatal hernias [22].

2.12. Postoperative complications
The incidents of complications needing reintervention the first 30 postoperative days ranges from 1.6% to 4.9% [23]. Most of these reinterventions are for postoperative fistulas, perioperative recurrence, visceral injury, bleeding, too tight a fundoplication or intestinal obstruction [23].

Recurrence has a reported incidence between 15% and 42% [24]. Due to this high rate, the use of prosthetic mesh in the hiatus to reduce the recurrence rate has become an attractive alternative for surgeons [25].

Although the cited recurrence is lower in cases with mesh reinforcement than in cases of suture hiatoplasty, these cases are accompanied by the risk of mesh erosion and migration. Serious complications have been reported, with erosion and migration of the mesh into the esophageal or gastric wall [25].

3. PERSONAL CONTRIBUTION

3.1. WORKING HYPOTHESIS AND GENERAL OBJECTIVES
The aim of this paper is to analyze the characteristics of patients with hiatal hernia that require surgical correction, in terms of demographics, history, symptoms, paraclinical investigations performed and to analyze the procedures used for
surgical correction and the results obtained; and comparing these data with existing data in the literature.

3.2. MATERIAL AND METHODS

3.2.1. General data on the study performed

We conducted a prospective, observational, cohort, multicenter study in the following clinics: First Clinic of Surgery of the Craiova County Emergency Hospital, First Clinic of Surgery in Cluj-Napoca, Surgery Clinic of the Clinical Hospital "Colțea", and Third Clinic of Surgery of the University General Hospital of Thessaloniki, Greece.

The study was conducted over a period of four years, between January 1, 2017 and January 1, 2021, in which patients with hiatal hernia surgery were included in the respective clinics.

A patient data entry and follow-up form (Anexa 1) was prepared and disseminated along with the information and acceptance forms for patient participation in the study.

3.2.2. Preoperative planning

In patients where a preoperative computed tomography scan was available, a preoperative planning of the surgery was conducted, with the calculation of the place of insertion of the trocars for an optimal positioning of the laparoscopic trocars.

IMTECH, an open-source program, was used for preoperative planning. IMTECH generates a three-dimensional volumetric reconstruction of the patient's anatomy from the DICOM files generated during the CT acquisition. The three-dimensional representation can be adjusted to highlight different anatomical structures such as air, bone, large vessels, skin, adipose tissue, etc.

The laparoscopic planning module allows the insertion and manipulation of the forceps and the camera in the 3D representation of the patient, allowing the
representation of the tip of the instrument on the 2D axes of the multiplanar reconstruction (MPR).

The simulation program allows the calculation of the optimal distance between trocars based on the following determinants: azimuth angle, manipulation angle and elevation angle.

The results were compared with a control group of patients who underwent laparoscopic surgery for hiatal hernia. Only large hiatal hernias were included in the control group. Patient observation charts, surgical protocols, and surgery recordings were analyzed, and key data was recorded.

The surgery was performed by the same surgical team in all cases.

We compared the duration of the surgery and the specific duration of the essential surgical tasks: dissection (dissection of the hernia sac and hiatus, mobilization of the greater curvature of the stomach), hiatoplasty and creation of fundoplication. The surgeon's fatigue was also assessed using a questionnaire based on a Likert scale (Anexa 2).

3.2.3. Concomitant surgery

We extrapolated the data of patients who underwent concomitant laparoscopic surgery for both hiatal hernia repair and cholecystectomy in the aforementioned clinics.

3.2.4. Patient follow-up; immediate and late complications

Patient follow-up was conducted postoperatively for a period of 2 years. Postoperatively, two weeks after discharge, patients underwent barium meal, and six weeks postoperatively, underwent upper gastrointestinal endoscopy. The presence and severity of heartburn quantified by the Visick score were recorded: [26]. The Bazaz score was used to evaluate dysphagia [27].
3.3. RESULTS AND DISCUSSIONS

We identified 77 patients with hiatal hernia who underwent surgical repair in the aforementioned centers.

Physical activity increases intra-abdominal pressure and has been reported in our study as intense or moderate in 38.9% of cases. Regarding the frequency of bowel movement, more than half of the patients in our study reported the emission of a stool every 2 days or more than 2 days. Thus, they can contribute to the increase of the size of a pre-existing hiatal hernia but can also be ethiopathogenic factors.

3.3.1. Personal physiological history

Multiple pregnancies may play an ethiopathogenic role in the development of a hiatal hernia due to increased intra-abdominal pressure during pregnancy. In our study, the average was 1.8 ± 0.8 births, a higher rate than the average of the European Union which in 2019 was 1.53 births / woman [28] or the United States of America which was 1.63 in 2020 [29]. At the regional level, the average number of births in our study remains high compared to the 2019 fertility rate of 1.35 births / woman in Greece and 1.76 births / woman in Romania [30,31].

3.3.2. Personal pathological history

Personal pathological history can reveal ethiopathogenic factors for the development of a hiatal hernia by increasing intra-abdominal pressure, or ligament weakening due to altered composition, but may also reveal complications of reflux disease or hernia; and last but not least, they are important for the assessment of the operative risk and the optimal management of the condition, the purpose of which must be to minimize any additional risk.

Obesity, a risk factor for the development of hiatal hernia, and for the progression of hernia size due to increased intra-abdominal pressure, but also a co-morbidity due to decreased respiratory compliance, its relationship with asthma (present in our group at 3.9% from patients) but also by belonging to the metabolic syndrome, was the most common co-morbidity in our study, present in 71.4% of patients [32–34].
The presence of obesity also has implications for the surgeon by increasing the difficulty of creating pneumoperitoneum, requires optimal positioning of the trocars both as a coordinate and as a transparietal path, and often increases the difficulty of surgery by increasing ligament adiposity and the eso-gastric "fat pad", which can cause problems both in terms of orientation and identification of planes but also by reducing the workspace. The presence of obesity in a majority of patients increases the difficulty of this type of surgery.

Kyphosis, a condition present in 10.3% of patients in our group, plays a role in the pathophysiology of the development of paraesophageal hernias and the presence of severe kyphosis increases the technical difficulty for performing surgical correction [35].

The presence of other hernias was found, such as inguinal hernia (present in 10.3% of patients), umbilical hernia (present in 6.4% of patients), incisional hernia (present in 5.1%). The presence of multiple hernia defects confirms the presence of a systemic alteration of the connective tissue (herniosis), but also increases the difficulty of surgery due to the risk of postoperative adhesions and the need to address them intraoperative, when possible [36].

The rather high prevalence of some diseases, in whose etiopathogenesis there are alterations of the connective tissue, leads us to the conclusion that many patients with hiatal hernia suffer from systemic alterations of the connective tissue. In the absence of other data, we can only conclude that the etiopathogenesis of hiatal hernia is multifactorial.

3.3.3. Symptoms
The most prevalent symptoms in our study were pain (present in 92.2% of patients), heartburn (present in 77.9% of patients), regurgitations (present in 66.2% of patients) and dysphagia (present in 49.3% of patients). Thus, the presence of symptoms reveals a severe impairment on the quality of life of these patients.

3.3.4. Surgery
The laparoscopic approach was performed in 93.5% of cases. However, in 1 case (1.29%) conversion to laparotomy was necessary, and the classic approach was used in 4 patients (5.19%).

The ASA score of the patients in our study reveals 29.8% with ASA score 3 and 7.7% with ASA score 4, being a good indicator for the complexity of the case, as patients with systemic conditions require both additional evaluation, close supervision, and the need to reduce the risk of co-morbidities by specific treatment.

Type I hiatal hernias accounted for 14.29% of patients, a much lower percentage than 58.45% reported by Kockerling in the analysis of the Herniamed registry [19]. Regarding paraesophageal hernias, type III represented 75.3% of the patients in our study, followed by type IV in 6.4% of cases, type II in 2.6% of cases and parahiatal hernia in 1.3% of cases. In another assessment of the 2017 registry, Kockerling reports a prevalence of axial hiatal hernias of 67.3%, 8.6% for type II, 9.2% for type III and 14.9% for type IV [37]. Thus, there is a big difference between the prevalence of the type of hernia in our group and the one reported in the literature.

If we compare the type of hernia (axial or paraesophageal) with the ASA score, we notice that patients with hiatal hernia type I have a lower ASA score than patients with hiatal hernias type II, III or IV. Similar data has been published in the literature [37]. Thus, patients with paraesophageal hernias have a higher risk of perioperative morbidity and mortality.

Complicated hernias were found in 24.6% of cases, of which 23.38% were incarcerated and gastric volvulus in 1.3% of cases. When dealing with a hiatal hernia, there is a high risk of a hernia complication, which increases the difficulty of surgery.

For the management of hiatal hernias, the most debated technical aspects are cruroplasty and fundoplication, as they have the greatest potential to influence the results.
In our study, all patients benefited from the association of a fundoplication. The reasons for adding a fundoplication were as follows: there were no completely asymptomatic patients; may prevent *de novo* GERD due to extensive dissection; the anti-reflux valve, by increasing the size at the level of the eso-gastric junction, can act as a barrier to prevent a recurrence.

In our study, Nissen fundoplication was performed in 82.8% of patients, Toupet fundoplication was performed in 14.47% of patients and Dor fundoplication is 2.63% of patients.

Patient follow-up reveals good control of heartburn 24 months after surgery for patients with Nissen fundoplication. Thus, at 24 months after surgery, 1.59% had mild heartburn (Visick 2) and 1.59% had moderate heartburn (Visick score 3). There were no patients with heartburn which affected the quality of life (Visick score 4). In the case of Toupet fundoplication, at 24 months follow-up, mild heartburn was present in 18.18% of patients and moderate heartburn in 18.18% of patients. Two years after surgery, Toupet fundoplication is associated with a higher prevalence of heartburn than Nissen fundoplication (*p* = .0001).

One month postoperatively, the incidence of dysphagia was 17.1% (15.78% for Nissen fundoplication and 1.31% for Toupet fundoplication). Although the incidence is high, dysphagia is described by patients as mild. Although postoperative dysphagia was higher in Nissen fundoplication, no threshold of statistical significance was reached. Postoperative dysphagia was present in 2.63% of patients at 24 months postoperatively and was described as moderate according to the Bazaz score.

In our study mesh reinforcement was performed in 16.88% of cases. One patient developed a recurrence at 6 months postoperatively. There were no complications related to the prosthetic mesh, and the case of recurrence occurred in a patient with suture hiatoplasty without mesh reinforce.

Given the lack of data in the literature to draw a definitive conclusion on the use of mesh in hiatal hernia surgery, both in terms of recurrence and in terms of
complications, we cannot formulate a clear recommendation for cruroplasty with mesh. and we advise against routine use of mesh and only in selected cases.

3.3.5. Preoperative planning

Although laparoscopic surgery has become the standard of care in surgery for complex cases of hiatal hernia; BMI variability, anatomical, topometric, and pathological changes require individualized placement of surgical ports.

To solve this problem, the laparoscopy module of the iMTECH program was created, allowing for preoperative planning, for improved ergonomics in demanding laparoscopic surgery (knot tying, suturing).

In our study, the optimization of geometric and kinematic requirements was directed by the operator. In addition, the program can follow the trajectory of the instruments in the limited space of the subphrenic region to check the limitation of the movements imposed by the nearby solid anatomical structures.

3.3.6. Concomitant surgery

Performing both hiatal hernia repair and cholecystectomy by laparoscopic approach is feasible and safe, and by performing both interventions under a single general anesthesia, the need for a second hospitalization is minimized and the patient does not require multiple medical leave [38].

The combined procedure does not require the insertion of trocars in addition to those required for the approach to the hiatal hernia, as the positioning of the trocars is similar to the French cholecystectomy technique.

The insertion of the trocars must be planned preoperatively, taking into account the ergonomics and triangulation of the instruments for laparoscopic suturing and knot tying. In patients with morbid obesity, it should be noted that the umbilicus is not a reliable landmark. The position of the landmark should be 15 centimeters from the xyphoid, on the xypho-umbilical midline [39].
Performing both surgeries provides the obvious benefit of a single anesthesia and a single surgical time for two pathologies and is safe and feasible in the hands of an experienced team in laparoscopic surgery [20].

Although there is evidence in the literature on the safety of prosthetic mesh in clean-contaminated cases [40–45], we believe that the current level of evidence is not high enough, and we recommend the use of mesh in carefully selected cases when cholecystectomy is performed.

3.3.7. Parahiatal hernia

For the case of parahiatal hernia, due to its rarity, we considered it necessary to conduct a literature review.

The PubMed database was searched using the keywords 'parahiatal' and 'hernia', and 28 articles were identified; additionally, 1 article from other sources. After excluding articles that did not contain information about parahiatal hernias, and excluding articles without abstract or extenso, 26 articles remained. Then, after evaluating the articles, we excluded the following: 9 articles with secondary parahiatal hernias, 2 articles with parahiatal hernias in children, 2 articles written in Japanese, 1 article with incidental parahiatal hernias in corpses, and 2 articles that did not contain parahiatal hernias. After excluding the aforementioned articles, 8 articles remained.

Data collected from the articles were compiled into a table, and the result is a study of 14 patients (including the patient in our study) with primary parahiatal hernias.

The gender distribution reveals an equal distribution, 1:1 (7 female:7 male). In most cases (12 out of 14 cases; 85.71%), the diagnosis was made intraoperatively.

Complications were found in 6 of 14 patients (42.85%) as follows: perforated gastric necrosis (16.66%); gastric incarceration (33.33%) and mesentero-axial gastric volvulus (50%).

The treatment consisted of closure of the defect through suture in 6 cases (46.15%), mesh reinforcing in 6 cases (46.15%) and mesh repair in 1 case (7.69%).
Intraoperative incidents reported were gastric tear (1 case) and left pleural perforation (1 case).

Postoperatively, patients were discharged on average at 8.3 days ± 12.76 days, with a minimum of 2 days, a maximum of 42 days, a median of 4 days and a mode of 5 days.

Due to the identical clinical presentation with hiatal hernias and subtle differences in imaging, we did not identify cases of primary parahiatal hernia diagnosed preoperatively, other than ours.

If the diagnosis is not established preoperatively, then it is established intraoperatively, and a surgeon who regularly addresses hiatal hernias should consider the possibility of encountering this condition.

The symptoms which can occur are varied, making clinical suspicion almost impossible [21,46,47].

The surgical attitude is represented by primary closure of the defect through suture. The closure of the defect must be done without tension in the suture [48]. In terms of mesh reinforcement, it was added in 7 out of 14 cases analyzed. Some authors have reported the presence of a fibrous ring around the defect which makes closure only by suturing difficult, so mesh reinforcement can be added or in extreme cases, mesh repair [21,49,50].

We consider it necessary to routinely dissect the esophageal hiatus in these situations, as closing the defect can put pressure on the hiatus, thus increasing the risk of hiatal hernia. If the hiatus is enlarged, hiatoplasty becomes mandatory. Hiatoplasty was performed in half of the cases analyzed.

Fundoplication should not be performed routinely, but only in the presence of GERD or a hiatal hernia [49]. We chose to perform a floppy Nissen fundoplication because the patient had specific symptoms and an axial hiatal hernia was evident intraoperatively.
3.4. CONCLUSIONS

Certain living conditions and personal physiological and pathological history, that have the effect of increasing intra-abdominal pressure, such as moderate or intense physical activity; stool emission every 2 days or more than 2 days; multiple pregnancies; obesity; were present in high percentages in patients in our group, and may be ethiopathogenic factors for the development of a hiatal hernia.

Diseases whose etiopathogenesis involve connective tissue alterations were also highly prevalent in our study and indicate a possible systemic connective tissue alteration in these patients.

The laparoscopic approach is safe and effective for most cases of hiatal hernia and should only be discontinued in the presence of contraindications or intraoperative complications. Laparoscopic surgery can be performed safely even in the presence of severe systemic co-morbidities (ASA 3) or severe life-threatening systemic disorders (ASA 4).

The prevalence of the type of hernias in our group was vastly different from that reported in the literature, with large hernias occupying the first place in terms of frequency. The high maximum age proves the feasibility of performing this surgery in elderly patients. These are important because the ASA score is higher in patients with paraesophageal hernias than in patients with hiatal sliding hernias. Also, the esophageal hiatus is larger in patients with paraesophageal hernias, which increases the difficulty of surgery.

A significant percentage (24.6%) of patients have complicated hernias at the time of surgery.

Two years after surgery, the Toupet fundoplication is associated with a higher prevalence of heartburn than the Nissen fundoplication.

Two years after surgery, Nissen's fundoplication was associated with a postoperative dysphagia rate of 2.63%. The intensity of dysphagia was described as moderate according to the Bazaz score.
In our study, 16.8% of patients received mesh reinforce. No mesh complications were encountered at the 2-year follow-up.

IMTECH software is an intuitive and useful tool for simulating the position of trocars for efficient coverage, superior maneuverability and good exposure for surgeons. These are essential to reduce the fatigue of the surgical team, reduce the duration of surgery and the overall success of the operation.

Treatment of hiatal hernia and cholelithiasis is a safe and feasible option for patients undergoing surgery for both conditions. Caution is required when deciding to use mesh in clean-contaminated cases. The concomitant procedure should be performed by a surgical team with experience in laparoscopic surgery and a surgeon who regularly performs these procedures.

Parahiatal hernias are rare entities with a low incidence, with symptoms and imaging similar to paraesophageal hernias. It is most often diagnosed intraoperatively and treatment consists of suturing the defect. In the presence of tension in the suture line, mesh reinforcement can be added. Calibration of the esophageal hiatus is mandatory, especially in cases where the closure of the defect exerts tension on the hiatus, in the presence of an associated hiatal hernia or in the presence of a GERD.

Bibliography


