UNIVERSITY OF MEDICINE AND PHARMACY "CAROL DAVILA", BUCHAREST
DOCTORAL SCHOOL
FIELD OF MEDICINE

MINIMALLY INVASIVE EXTRAPERITONEAL APPROACH FOR ABDOMINAL INCISIONAL HERNIA REPAIR

SUMMARY OF THE DOCTORAL THESIS

PhD Supervisor:

PROF. UNIV. DR. PĂTRAȘCU TRAIAN

PhD Candidate:

SUHACIU DIANA TEODORA

2026

Table of Contents

Chapter 1. Introduction

Incisional hernias represent one of the most frequent and complex complications of abdominal surgery, having a significant impact on patients' quality of life, functional status, and healthcare-related costs. The importance of this pathology derives both from its high prevalence following abdominal surgical procedures and from the reconstructive difficulties, as well as the significant rate of recurrences and postoperative complications. Their incidence after laparotomy is reported in the literature to range between 10% and 20%; however, it may increase significantly in the presence of risk factors such as obesity, diabetes mellitus, surgical site infection, repeated surgical interventions, or oncological pathology(1).

From a pathophysiological point of view, the occurrence of incisional hernias is the consequence of impaired normal fascial healing, determined by the complex interaction between biological, mechanical, and technical factors(2). The resulting defect leads to loss of abdominal wall continuity, protrusion of abdominal contents, and impairment of the functionality of the abdominal myofascial system.

Over the last decades, ventral hernia surgery has undergone rapid development through the introduction of minimally invasive techniques and modern concepts of functional abdominal wall reconstruction. The evolution of extraperitoneal retromuscular approaches has significantly changed the current therapeutic strategy, orienting reconstruction toward the anatomical and biomechanical restoration of the abdominal myofascial system. Extraperitoneal retromuscular approaches such as eTEP-RS and eTEP-TAR allow anatomical restoration of the abdominal wall, mesh placement in a biomechanically favorable plane, and reduction of direct contact between the mesh and the intra-abdominal viscera(3).

The introduction of robotic surgery represented a new step in the evolution of minimally invasive abdominal wall reconstruction, offering important technical advantages such as three-dimensional visualization, articulated instruments, and superior ergonomics, thus facilitating complex dissections and intracorporeal suturing(4).

In this context, the evaluation of the outcomes of minimally invasive extraperitoneal approaches used in the treatment of abdominal incisional hernias represents a subject of major interest in modern abdominal wall surgery.

Chapter 2. Anatomy of the Abdominal Wall

The abdominal wall represents a complex anatomical and functional structure composed of multiple muscular, fascial, and aponeurotic layers that contribute to the maintenance of intra-abdominal pressure, trunk stability, and protection of intra-abdominal organs. From a surgical perspective, detailed knowledge of abdominal wall anatomy is essential for performing modern reconstructive procedures. Structures such as the linea alba, rectus sheath, semilunar line, transversalis fascia, and retromuscular spaces play a fundamental role in incisional hernia surgery.

Structurally, the abdominal wall consists of the following layers: skin, subcutaneous tissue including the superficial fascia (Camper's and Scarpa's fascia), the myofascial system, transversalis fascia, preperitoneal adipose tissue, and parietal peritoneum. The myofascial system is composed of five pairs of muscles grouped into the median and anterolateral compartments.

The linea alba, extending from the xiphoid process to the pubic symphysis, is a fibrous midline structure formed mainly by collagen and elastin fibers. It represents the convergence area of the aponeuroses of the external oblique, internal oblique, and transversus abdominis muscles. The rectus abdominis muscle, the principal component of the median muscular compartment, is enclosed within the rectus sheath, which consists of anterior and posterior layers. In the upper two-thirds of the abdominal wall, the anterior layer is formed by the aponeurosis of the external oblique muscle and the anterior leaf of the internal oblique aponeurosis, while the posterior layer is formed by the posterior leaf of the internal oblique aponeurosis together with the transversus abdominis aponeurosis. The inferior margin of the posterior sheath is known as the arcuate line (Douglas' line), located inferior to the umbilicus.

The external oblique muscle is the largest and most superficial muscle of the anterolateral abdominal wall, with fibers oriented inferomedially. The internal oblique muscle lies deep to the external oblique and superficial to the transversus abdominis, with fibers running superomedially. The transversus abdominis is the deepest of the three flat muscles and extends around most of the abdominal circumference. Its anterior muscular border is known as the semilunar line (Spigelian line).

The transversalis fascia is a thin connective tissue layer located between the transversus abdominis muscle and the parietal peritoneum. Posteriorly, it continues with the thoracolumbar fascia; inferiorly, with the pelvic and iliac fascia; and superiorly, with the diaphragmatic fascia. The arterial supply of the abdominal wall derives from branches of the subclavian artery, thoracic and abdominal aorta, external iliac artery, and femoral artery. Venous drainage is divided into superficial and deep systems, while motor innervation is provided by the anterior branches of the T7–T12 thoracic spinal nerves and the first lumbar nerve (L1).

Modern abdominal wall reconstruction techniques are based on the use of the natural anatomical planes of the abdominal wall. The retromuscular approach allows mesh placement between the rectus abdominis muscle and the posterior rectus sheath, providing optimal tissue integration and reducing complications associated with intraperitoneal mesh positioning. The Transversus Abdominis Release (TAR) technique, described by Novitsky, represents an important evolution of posterior component separation, enabling the creation of an extended retromuscular space and tension-free reconstruction of complex abdominal wall defects.

2.1 Retromuscular Endoscopic Surgical Anatomy

The minimally invasive retromuscular approach involves the development of the space located anterior to the posterior rectus sheath. Therefore, detailed knowledge of the anatomical elements encountered during this procedure is essential for safe surgical performance. Surgical access is frequently achieved using the Hasson technique, which involves skin incision below the costal margin, dissection of the subcutaneous tissue, incision of the anterior rectus sheath, and blunt dissection through the muscle fibers until the posterior sheath is identified. A trocar is then inserted, followed by carbon dioxide insufflation. The introduction of a 30° endoscope allows blunt dissection and development of the retromuscular space in a caudal direction.

After entering the retromuscular space, several anatomical landmarks can be identified, including the rectus abdominis muscle anteriorly, the posterior rectus sheath, the lateral neurovascular bundles, the junction between the linea alba and the posterior rectus sheath, fine connective fibers with a “spider-web” appearance (“angel hair”), the inferior epigastric vessels and their branches, and the neurovascular bundles located at the semilunar line. At the peri-umbilical level, vascular perforators can be identified lateral to the neuromuscular bundles of the lower six intercostal nerves, which course between the internal oblique and transversus abdominis muscles before penetrating the posterior sheath to innervate the rectus abdominis muscle.

Dissection of the retromuscular space continues caudally to the level of the arcuate line, which represents the inferior limit of the posterior rectus sheath. From this level, access is gained into the prevesical preperitoneal space. The dissection proceeds by lowering the umbilical ligaments and urachus toward the pubic symphysis, sometimes extending into the subpubic region, allowing visualization of the pectineus muscle and structures of the inguinal region. The preperitoneal space is bounded posteriorly by the peritoneum and anteriorly by the transversalis fascia and contains adipose tissue. Topographically, it is divided into the Bogros space, located lateral to the inferior epigastric vessels, and the Retzius space, situated medially between the two lateral umbilical ligaments.

An important anatomical structure encountered during retropubic dissection is the corona mortis, representing a vascular anastomosis between the inferior epigastric and obturator vessels. Dissection of the inguinal region also allows identification of structures such as the urinary bladder, vas deferens, spermatic vessels (or the round ligament in women), external iliac vessels, and branches of the lateral femoral cutaneous or genitofemoral nerves.

Following complete dissection of the right retrorectal space, the surgeon crosses the linea alba to access the contralateral retrorectal space. Identification of the inferior epigastric vessels is essential before inserting additional trocars. The dissection then continues superiorly toward the xiphoid process. The linea alba represents a fundamental landmark in abdominal wall reconstruction because restoration of this structure re-establishes the functional continuity of the abdominal musculature and contributes to trunk stability.

Chapter 3. Clinical and Epidemiological Aspects of Incisional Hernias

Incisional hernias occur in patients with a history of laparotomy and are associated with multiple risk factors. Among the most important predisposing factors are obesity, advanced age, diabetes mellitus, smoking, surgical site infection, and repeated surgical interventions.

The pathogenesis of incisional hernias involves impairment of collagen synthesis and remodeling, with alteration of the ratio between type I and type III collagen, leading to decreased mechanical strength of the fascial scar(7).

From a clinical perspective, patients may present with parietal swelling, abdominal discomfort, pain, or limitation of physical activities. In severe cases, complications such as incarceration or strangulation of the hernia contents may occur.

The diagnosis of incisional hernias is established through clinical examination and imaging methods, with computed tomography playing an essential role in assessing defect dimensions, hernia contents, and planning the reconstructive strategy.

The European Hernia Society (EHS) classification currently represents the standard used for characterizing abdominal wall defects, including localization, size, and number of recurrences(8).

E H S **Incisional Hernia Classification**			
Midline	subxiphoidal	M1	
	epigastric	M2	
	umbilical	M3	
	infraumbilical	M4	
	suprapubic	M5	
Lateral	subcostal	L1	
	flank	L2	
	iliac	L3	
	lumbar	L4	
Recurrent incisional hernia?	Yes O	No O	
length:	cm	**width**:	cm
Width **cm**	**W1** <4cm O	**W2** ≥4-10cm O	**W3** ≥10cm O

Table 3.1. EHS Classification of Incisional Hernias(8)

Midline Hernias

The boundaries of the midline are:

- cranially – the xiphoid process
- caudally – the pubic symphysis
- laterally – the lateral borders of the rectus sheath

Depending on their location, midline hernias are divided into five zones:

- **M1** – subxiphoidal (from the xiphoid process to 3 cm inferiorly)
- **M2** – epigastric
- **M3** – umbilical
- **M4** – infraumbilical
- **M5** – suprapubic

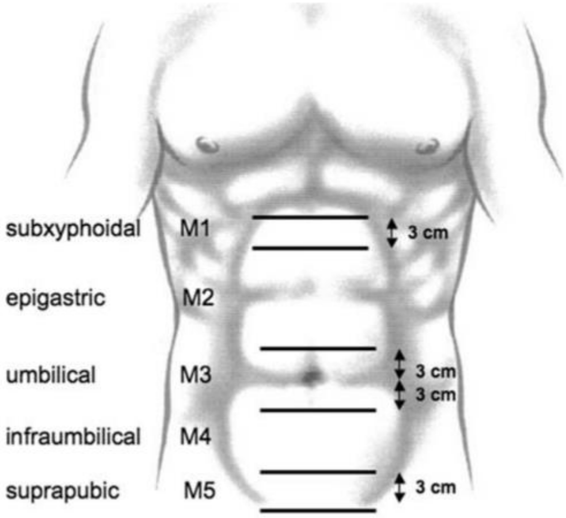


Figure 3.2. Localization of midline incisional hernias according to the EHS classification(8)

Lateral Hernias

The boundaries of lateral hernias are:

- cranially – the costal margin
- caudally – the inguinal region

- medially – the lateral border of the rectus sheath
- laterally – the lumbar region

The lateral hernia zones are:

- **L1** – subcostal
- **L2** – flank
- **L3** – iliac
- **L4** – lumbar

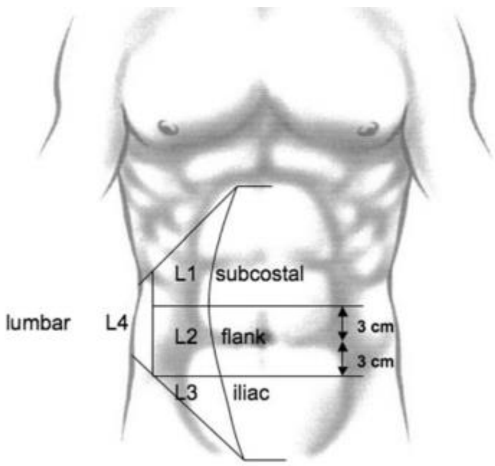


Figure 3.3. Localization of lateral incisional hernias

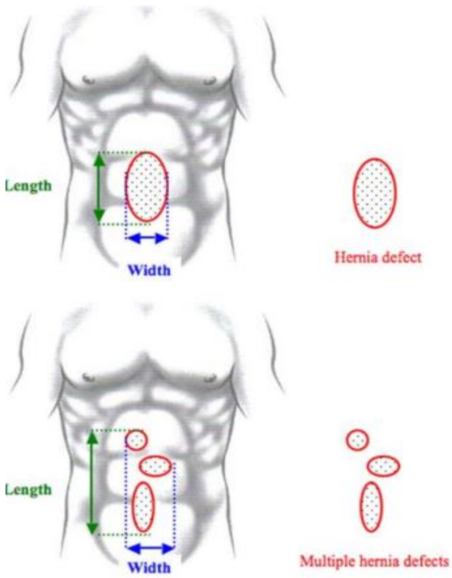
Size of the Hernia Defect

The size of the incisional hernia is assessed using two measurements:

- defect width – the greatest horizontal distance between the lateral margins
- defect length – the greatest vertical distance between the cranial and caudal margins

In cases of multiple defects, the width is measured between the most laterally separated margins of the defects(8).

Figure 3.4. Definition of the length and width of the hernia defect in incisional hernias(8)



Chapter 4. Surgical Treatment of Incisional Hernias

The modern surgical treatment of incisional hernias aims to achieve both functional and anatomical restoration of the abdominal wall by obtaining a tension-free reconstruction reinforced with prosthetic materials.

The Rives–Stoppa technique represented the foundation for the development of modern retromuscular reconstructions. Placement of the mesh in the retromuscular plane provides important biomechanical advantages and reduces the risk of complications related to intraperitoneal mesh contact(9).

The development of laparoscopic and subsequently robotic techniques enabled the transfer of the retromuscular concept to minimally invasive surgery.

The eTEP-RS technique allows extraperitoneal retromuscular reconstruction through dissection of the space between the rectus abdominis muscle and the posterior layer of its sheath(10).

In cases of complex defects or when tension-free fascial closure cannot be achieved, the technique may be complemented by posterior component separation using the TAR technique(11).

Robotic surgery facilitates these procedures through superior ergonomics, three-dimensional visualization, and articulated instruments, which allow delicate dissections and precise intracorporeal suturing.

4.1 Indications and Advantages of the TAR Technique in Complex Incisional Hernias

Abdominal wall reconstruction in complex incisional hernias represents a major surgical challenge, especially in cases involving large abdominal wall defects or loss of domain. In these situations, conventional fascial repair techniques may be insufficient to achieve tension-free reconstruction of the midline.

The Transversus Abdominis Release (TAR) technique, described by Yuri Novitsky, represents a modern method of posterior component separation that allows significant mobilization of the musculoaponeurotic structures and the creation of a large retromuscular space for prosthetic mesh placement(9).

By incising the transversus abdominis muscle and developing the retroperitoneal plane, the TAR technique enables medialization of the muscular components of the abdominal wall, thereby reducing tension on the fascial suture and facilitating restoration of the linea alba.

Indications for the TAR Technique

The TAR technique is mainly indicated in the treatment of complex incisional hernias in the following situations(3):

- large incisional hernias (defects > 8–10 cm)
- recurrent incisional hernias
- hernias associated with rectus abdominis diastasis
- multiple abdominal wall defects
- hernias associated with loss of domain
- abdominal wall defects located near the semilunar line
- situations in which primary closure of the linea alba would produce excessive tension

In addition, the TAR technique is useful in patients requiring complex abdominal wall reconstruction, including those with multiple previous surgical interventions or extensive postoperative scarring.

Chapter 5. Personal Contributions

5.1 Aim and Objectives of the Study

The aim of the present study was to evaluate the outcomes of minimally invasive extraperitoneal surgery in the treatment of abdominal incisional hernias, with emphasis on laparoscopic and robotic retromuscular techniques, from the perspective of feasibility, safety, reconstructive efficiency, and their impact on perioperative and postoperative outcomes.

The study aimed to analyze the feasibility, safety, and effectiveness of minimally invasive eTEP-RS and eTEP-TAR reconstructions, as well as to evaluate the associated perioperative and postoperative results. The research objectives included the analysis of patients' demographic and clinical characteristics, evaluation of abdominal wall defects according to the EHS classification, analysis of the prosthetic materials used, and comparison of laparoscopic and robotic approaches.

In addition, intraoperative and postoperative complications, operative time, length of hospital stay, postoperative analgesic consumption, and the learning curve associated with minimally invasive techniques were analyzed.

5.2 Materials and Methods

The study was conducted on a group of patients diagnosed with abdominal incisional hernia and treated using a minimally invasive approach between July 2020 and September 2024. The research was retrospective and included patients operated on using laparoscopic and robotic retromuscular techniques.

Demographic characteristics, comorbidities, localization and dimensions of hernia defects, characteristics of the prosthetic materials used, types of reconstructive procedures, operative time, length of hospitalization, and associated complications were analyzed. Abdominal wall defects were classified according to the EHS classification, and the statistical evaluation included descriptive analyses, Pearson correlation tests, linear regressions, and regression models used to identify factors involved in the variability of operative time and length of hospitalization.

5.3 Results

Characteristics of the Study Group

The study included 196 patients diagnosed with abdominal incisional hernia and treated surgically using minimally invasive approaches. Patients were divided into two groups according to the surgical technique used:

- Group A – robotic surgery: 42 patients
- Group B – laparoscopic surgery: 154 patients

The study was observational, prospective, and non-randomized, and the included patients represented a representative sample of individuals diagnosed and treated for abdominal incisional hernias in a private medical center.

Analysis of the laparoscopic group demonstrated a predominance of patients in the sixth and seventh decades of life, with most cases concentrated between 50 and 70 years of age. The most frequent comorbidities identified were dyslipidemia, arterial hypertension, and diabetes mellitus, suggesting a complex metabolic and cardiovascular profile of the analyzed population. Regarding the distribution of hernia defects, midline localizations predominated, especially umbilical and epigastric defects.

Duration of Surgery and Anesthesia

The mean operative time in the entire cohort was 217 ± 93 minutes:

- 269 ± 91 minutes for robotic procedures
- 203 ± 89 minutes for laparoscopic procedures

The mean duration of anesthesia was 270 ± 102 minutes, being longer in robotic surgery (334 ± 99 minutes) compared to the laparoscopic approach (252 ± 95 minutes).

Dimensions of the Abdominal Wall Defect

The dimensions of the abdominal wall defect represented an essential factor in choosing the surgical technique and assessing procedural complexity. In our study, the mean defect length was 14 cm, and the mean defect area was 116 cm^2, with maximum values reaching 600 cm^2, reflecting the inclusion of a wide spectrum of incisional hernias, including large abdominal wall defects.

Characteristics of the Prosthetic Materials

The average dimensions of the meshes used were:

- length: 29 ± 8 cm
- width: 22.5 ± 7.3 cm

The mean mesh area was 699 ± 386 cm^2. The average ratio between mesh area and defect area was approximately 11, suggesting adequate prosthetic coverage of the abdominal wall defect. The most frequently used prosthetic material was polypropylene mesh (Parietene).

Postoperative Management

During the postoperative period:

- 4% of patients benefited from epidural analgesia
- the average number of NSAID doses administered during hospitalization was 2.93 doses
- the average number of morphine-equivalent doses administered was 1.38 doses

Postoperative antibiotic therapy was required in 14% of patients, while 86% received antibiotic prophylaxis consisting of a single intraoperative dose.

Length of Hospital Stay

The mean length of hospitalization in the analyzed cohort was 1.82 days, reflecting the advantages of minimally invasive surgery in the treatment of incisional hernias. The high frequency of the TAR technique suggests the increased complexity of the abdominal wall defects included in the study and the need for advanced tension-free reconstructions. Bilateral posterior component separation was required in an important number of cases, reflecting the presence of extensive abdominal wall defects and significant loss of domain.

Correlations Between Mesh Size and Defect Size

Pearson correlation analysis demonstrated statistically significant positive associations between the dimensions of the abdominal wall defect and the dimensions of the prosthetic meshes used for abdominal wall reconstruction. All identified correlations were statistically significant (**$p < 0.001$**), suggesting a direct relationship between defect complexity and the reconstructive strategy adopted.

The strongest association observed was between defect area and mesh area (r = 0.784), indicating that mesh dimensions were proportionally adapted to the extent of the abdominal wall defect. This strong correlation reflects adherence to modern principles of incisional hernia surgery, which recommend the use of sufficiently large meshes to ensure adequate overlap and reduce the risk of postoperative recurrence.

Complications and Postoperative Evolution

Intraoperative complications were rare and mainly included bowel injuries and retromuscular hematomas. Postoperative complications included ileus, retromuscular hematomas, and internal hernias secondary to posterior layer dehiscence. Most complications were manageable and did not compromise the integrity of the abdominal wall reconstruction.

Chronic Pain and Hernia Recurrence

Chronic postoperative pain was evaluated at a minimum of three months after surgery, according to HerniaSurge recommendations. The incidence of symptomatic chronic pain was low, with most patients demonstrating favorable functional outcomes.

Regarding hernia recurrence, analysis of the results demonstrated a low recurrence rate during the follow-up period. The mean postoperative follow-up duration was approximately 14 months for the laparoscopic group and 8 months for the robotic group. The obtained results suggest that minimally invasive retromuscular reconstructions allow favorable functional and anatomical outcomes in the medium term.

Chapter 7. Analysis of Factors Influencing Operative Time

Operative time was defined as the interval between the insertion of the first trocar and the placement of the final skin suture.

The dependent variable, represented by operative time (expressed in minutes), showed a continuous distribution; therefore, the statistical analysis was performed using univariate and multivariate linear regression models. The independent variables included demographic parameters, associated comorbidities, characteristics of the abdominal wall defect, and intraoperative variables.

The univariate analysis demonstrated a statistically significant difference between the two surgical approaches evaluated. Operative time was significantly longer in robotic surgery compared to the laparoscopic approach. The estimated beta coefficient for laparoscopic surgery was –66 minutes (95% CI: –97 to –35; $p < 0.001$), indicating that laparoscopic procedures were, on average, approximately 66 minutes shorter than robotic procedures.

From a statistical perspective, the coefficient of determination ($R^2 = 0.085$) suggests that the type of surgical approach explains only approximately 8.5% of the variability in operative time. This relatively low value indicates that operative duration is influenced by multiple additional factors beyond the surgical technique itself.

From a clinical perspective, the increased duration of robotic procedures may be explained by the technical particularities of the robotic platform, including the time required for system docking, instrument positioning, and the complexity of maneuvers performed within the retromuscular space. In addition, patient selection for the robotic approach may have included more complex abdominal wall defects, further contributing to prolonged operative time. Overall, although the difference between the two techniques was statistically significant, the contribution of surgical approach type to operative time variability remained limited, emphasizing the multifactorial nature of this parameter ($R^2 = 0.085$; $p < 0.001$).

Influence of Body Mass Index and Obesity

Linear regression analysis did not demonstrate a statistically significant association between body mass index (BMI) and operative time ($p = 0.45$). The regression coefficient was $\beta = 1.0$ minute/BMI unit (95% CI: –1.7 to 3.8), suggesting only a minimal increase in operative duration with increasing BMI values, without statistical significance. The confidence interval, which included zero, confirmed the absence of a robust relationship between these variables.

The coefficient of determination (**$R^2 = 0.003$**) indicated that BMI explained only a negligible proportion of the variability in operative time.

Influence of Abdominal Wall Defect Characteristics

Hernia Defect Area

Linear regression analysis demonstrated a strong positive and statistically significant association between hernia defect area and operative time ($p < 0.001$). The regression coefficient was $\beta = 0.62$ minutes/cm² (95% CI: 0.52 to 0.71), indicating that each increase of 1 cm² in defect area was associated with an average increase of approximately 0.62 minutes in operative time. The confidence interval, which did not include zero, confirmed the robustness of this relationship.

Prosthetic Mesh Area

Linear regression analysis also demonstrated a strong positive and statistically significant association between mesh area and operative time ($p < 0.001$). The regression coefficient was $\beta = 0.15$ minutes/cm² (95% CI: 0.12 to 0.18), indicating that an increase of 1 cm² in mesh area was associated with an average increase of approximately 0.15 minutes in operative duration. The narrow and exclusively positive confidence interval confirmed the robustness of this relationship.

The coefficient of determination ($R^2 = 0.383$; adjusted $R^2 = 0.380$) demonstrated that mesh area explained approximately 38% of the variability in operative time, making it one of the most important predictors analyzed.

Influence of Intraoperative Complications

Linear regression analysis demonstrated a statistically significant association between the occurrence of intraoperative complications and operative time ($p = 0.008$). Patients who developed intraoperative complications had an average operative duration approximately 84 minutes longer compared to those without complications ($\beta = +84$ minutes; 95% CI: 22 to 146). The confidence interval, which did not include zero, confirmed the statistical significance of this association.

The coefficient of determination ($R^2 = 0.036$; adjusted $R^2 = 0.031$) indicated that intraoperative complications explained approximately 3.6% of the variability in operative time, suggesting a modest but statistically relevant influence.

Multivariate Model

The results of the analysis highlighted the multifactorial nature of operative time, which was mainly influenced by:

- the type of surgical procedure;
- the size of the abdominal wall defect;
- the size of the prosthetic mesh;
- the occurrence of intraoperative complications;
- the presence of certain comorbidities (particularly renal disease).

Among these factors, defect area and type of surgical approach emerged as the principal independent determinants of operative duration, with both statistically significant impact and major clinical relevance.

Chapter 8. Analysis of Factors Influencing Length of Hospital Stay

Postoperative length of hospital stay was analyzed using a negative binomial regression model, considering that the dependent variable (number of hospitalization days) was discrete and presented an asymmetric distribution, with predominance of low values (1–2 days).

Multiple demographic, clinical, and intraoperative variables were evaluated in order to identify factors associated with postoperative hospitalization duration. The analysis did not demonstrate a statistically significant association between the type of surgical intervention and postoperative length of stay. From a clinical perspective, these results suggest that although the minimally invasive approach may influence hospitalization duration, the differences between laparoscopic and robotic techniques are currently limited, probably due to the implementation of similar perioperative protocols and enhanced recovery pathways.

Influence of Age

Negative binomial regression analysis demonstrated a positive and statistically significant association between patient age and postoperative length of hospitalization ($p = 0.018$). The Incidence Rate Ratio (IRR) coefficient was 1.01 (95% CI: 1.005–1.02), indicating that each one-year increase in age was associated with an approximately 1% increase in hospitalization rate, respectively in the probability of prolonged hospitalization. Although the effect magnitude was modest, the confidence interval, which did not include the value 1, confirmed the statistical significance of this relationship.

Influence of ASA Score

Negative binomial regression analysis demonstrated a significant influence of ASA score on postoperative hospitalization duration. Compared to patients classified as ASA I, patients with ASA II did not show statistically significant differences (IRR = 1.12; 95% CI: 0.84–1.50; $p = 0.454$). In contrast, patients with ASA III had a significantly higher probability of prolonged hospitalization (IRR = 1.43; 95% CI: 1.01–2.05; $p = 0.046$), indicating an approximately 43% increase in hospitalization rate compared to ASA I patients.

Influence of Hernia Defect Characteristics

The analysis demonstrated a statistically significant association between hernia defect area and postoperative hospitalization duration. An increase of 10 cm^2 in defect area was associated with an approximately 3% increase in the probability of an additional hospitalization day ($p < 0.001$). The Nagelkerke R^2 value of 0.277 indicated that this predictor explained approximately 30% of the variability in hospitalization duration.

Influence of Prosthetic Mesh Size

Negative binomial regression analysis demonstrated a positive and statistically significant association between mesh area and postoperative hospitalization duration ($p < 0.001$). The Incidence Rate Ratio (IRR) coefficient was 1.03 for each increase of 10 cm^2 in mesh area (95% CI: 1.02–1.03), indicating that larger mesh dimensions were associated with an approximately 3% increase in hospitalization rate and therefore with a higher probability of prolonged hospitalization. The narrow confidence interval, situated entirely above the value 1, confirmed the robustness of this relationship. An increase of 10 cm^2 in mesh area was associated with an approximately 1% increase in the probability of an additional hospitalization day ($p < 0.001$).

Influence of Surgical Procedure Duration

Negative binomial regression analysis demonstrated a positive and statistically significant association between total procedure duration (including anesthesia and operative time) and postoperative hospitalization duration ($p < 0.001$). The Incidence Rate Ratio (IRR) coefficient was 1.02 for every 10-minute increase in procedure duration (95% CI: 1.01–1.03), indicating that prolonged procedures were associated with an approximately 2% increase in hospitalization rate and in the probability of longer hospitalization. The confidence interval, entirely above the value 1, confirmed the robustness of this association.

The pseudo-R^2 value (Nagelkerke $R^2 = 0.208$) indicated that procedure duration explained approximately 21% of the variability in hospitalization duration, making it one of the important predictors of this outcome.

Analysis of Clavien–Dindo Complications

Negative binomial regression analysis demonstrated a positive and statistically significant association between postoperative complications classified according to the

Clavien–Dindo system and hospitalization duration ($p < 0.001$). Patients who developed postoperative complications had an approximately 83% higher probability of prolonged hospitalization compared to patients without complications (IRR = 1.83; 95% CI: 1.29–2.53). The confidence interval, situated entirely above the value 1, confirmed the robustness of this association.

The pseudo-R^2 value (Nagelkerke $R^2 = 0.106$) indicated that postoperative complications explained approximately 10% of the variability in hospitalization duration. From a clinical perspective, these results emphasize the major impact of postoperative complications on patient recovery, representing an important determinant of prolonged hospitalization.

Conclusions of the Hospitalization Duration Analysis

Postoperative hospitalization duration was determined by a limited number of independent factors, mainly:

- procedure complexity (reflected by mesh area);
- patient biological status (age);
- occurrence of postoperative complications.

For the laparoscopic approach, the Pearson correlation coefficient was $r = -0.20$, indicating a weak negative correlation between the number of procedures performed and operative time. The value $p = 0.01$ confirmed that this association was statistically significant, suggesting a real relationship between increasing surgical experience and reduction of operative duration.

In robotic surgery, the Pearson correlation coefficient was $r = -0.05$, indicating the absence of a relevant correlation between surgical experience and operative time. The value $p = 0.75$ confirmed the lack of statistical significance, suggesting that no relationship between increasing experience and reduction of operative time could be demonstrated in the analyzed cohort.

Chapter 8. Chronic Postoperative Pain

Chronic postoperative pain represents an important variable in the evaluation of functional outcomes following the surgical treatment of incisional hernias. Conventionally, it is defined as persistent or recurrent pain lasting for at least three months after surgery.

In incisional hernia repair, the use of alloplastic prosthetic materials may contribute to the persistence of a local inflammatory response caused by mesh integration, periprosthetic fibrosis, and biomechanical changes of the reconstructed abdominal wall. For this reason, some authors consider that the assessment of chronic pain exclusively at three months postoperatively may either overestimate or incompletely reflect the true evolution of painful symptoms.

In the present study, the minimum interval used for the evaluation of chronic pain was three months postoperatively.

In this analysis, chronic pain was considered clinically relevant when it persisted beyond three months after surgery and had a disturbing character, influencing patient comfort or daily activities. This definition allows differentiation between minimal, occasional, or exertion-related pain and pain with real functional impact, which has clinical significance in the evaluation of postoperative outcomes.

Therefore, the assessment of chronic pain after surgical treatment of incisional hernias should go beyond simple quantification using the VAS scale and should include its impact on quality of life, mobility, physical activity, and socio-professional reintegration. This perspective is essential in evaluating the functional outcomes of abdominal wall reconstruction.

Chapter 9. Hernia Recurrence

Recurrence represents one of the most important indicators for evaluating the effectiveness of surgical treatment in incisional hernias, having direct implications on both the patient's quality of life and the need for complex reoperations. In modern abdominal wall surgery, the primary objective of reconstruction is not limited to simple closure of the abdominal wall defect, but rather the restoration of stable and durable biomechanical functionality with reduction of the risk of defect recurrence.

In minimally invasive laparoscopic and robotic approaches, recurrence reduction is closely related to the advantages of retromuscular reconstruction and extraperitoneal mesh placement. These techniques allow achievement of wide mesh overlap, restoration of the midline, and uniform distribution of tension across the abdominal wall, all of which are considered essential elements for long-term biomechanical stability.

In the cohort analyzed in the present study, the mean postoperative follow-up period was approximately 14 months for the laparoscopic group and 5 months for the robotic group. This difference can be explained by the more recent introduction of the robotic approach into the practice of the analyzed center and by the shorter follow-up period available for these patients. Therefore, direct comparison of recurrence rates between the two groups should be interpreted with caution, since hernia recurrence is an event that may occur long after surgery.

Thus, recurrence prevention in incisional hernia surgery should be regarded as the result of a complex reconstructive strategy that includes appropriate selection of the surgical technique, biomechanical restoration of the abdominal wall, use of a suitable prosthetic mesh, and control of patient-related risk factors.

In this context, both laparoscopic and robotic approaches represent modern and effective options for the treatment of complex incisional hernias, with promising results regarding reconstruction stability and reduction of postoperative recurrence.

Bibliography

1. Muysoms FE, Antoniou SA, Bury K, Campanelli G, Conze J, Cuccurullo D, et al. European Hernia Society guidelines on the closure of abdominal wall incisions. Hernia [Internet]. 2015 Feb 25;19(1):1–24. Available from: http://link.springer.com/10.1007/s10029-014-1342-5

2. MT H, CW S, LA G, SH G, KR F, CC V. Risk factors for the development of incisional hernia after abdominal surgery. J Am Coll Surg. 2010;210(5):784–790.

3. Novitsky YW, Elliott HL, Orenstein SB, Rosen MJ. Transversus abdominis muscle release: A novel approach to posterior component separation during complex abdominal wall reconstruction. Am J Surg [Internet]. 2012 [cited 2026 Mar 15];204(5):709–16. Available from: https://pubmed.ncbi.nlm.nih.gov/22607741/

4. Novitsky YW, Orenstein SB, Elliott HL, Kasten KR, Delaney CP, Rosen MJ. Robotic transversus abdominis release: early outcomes. Surg Endosc. 2016;30(11):5309–5317.

5. Zăhoi DE, Pusztai AM, Daescu E. Anatomia clinică a omului. Vol. III: Anatomia clinică a abdomenului. Editura Victor Babeș; 2023.

6. Baig S, Priya P. Extended totally extraperitoneal repair (eTEP) for ventral hernias: Short-term results from a single centre. J Minim Access Surg [Internet]. 2019 [cited 2021 Apr 11];15(3):198. Available from: /pmc/articles/PMC6561058/

7. U K, H Z, ZY S, V S, RS B, B K. Altered collagen synthesis in fascia transversalis of patients with inguinal hernia. Hernia. 1999;3(4):181–7.

8. Muysoms FE, Miserez M, Berrevoet F, Campanelli G, Champault GG, Chelala E, et al. Classification of primary and incisional abdominal wall hernias. Hernia [Internet]. 2009 Jun 3 [cited 2024 Apr 13];13(4):407–14. Available from: https://link.springer.com/article/10.1007/s10029-009-0518-x

9. Alfredo M. Carbonell. Hernia Surgery. In: Novitsky YW, editor. Hernia Surgery. Cham: Springer; 2016. p. 131–41.

10. Radu VG, Lica M. The endoscopic retromuscular repair of ventral hernia: the eTEP technique and early results. Hernia [Internet]. 2019 Oct 1 [cited 2021 May 12];23(5):945–55. Available from: https://link.springer.com/article/10.1007/s10029-019-01931-x

11. Belyansky I, Zahiri HR, Park A. Laparoscopic Transversus Abdominis Release, a Novel Minimally Invasive Approach to Complex Abdominal Wall Reconstruction. Surg Innov. 2016 Apr 1;23(2):134–41.

12. Novitsky YW, Fayezizadeh M, Majumder A, Neupane R, Elliott HL, Orenstein SB. Outcomes of Posterior Component Separation With Transversus Abdominis Muscle Release and Synthetic Mesh Sublay Reinforcement. Ann Surg [Internet]. 2016 Aug 1 [cited 2026 Mar 15];264(2):226–32. Available from: https://pubmed.ncbi.nlm.nih.gov/26910200/