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# The impact of overweight and obesity on the results of laparoscopic ventral hernia repair, including robot-assisted repair - a literature review

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**Abstract**

Obesity is the fifth leading cause of death worldwide. In turn, ventral hernias (including an inguinal hernias) are one of the most common cases in general surgery. Minimally invasive techniques (laparoscopic or robot-assisted procedures) are becoming more and more popular in ventral hernia treatment compared to open procedures.

The aim of this study is to analyze the impact of body mass index (BMI) value on the efficacy and safety of laparoscopic ventral hernia repairs, including inguinal hernia repairs.

Numerous studies evaluating this relationship are available. In most studies, There were also no statistically significant differences in the rate of intraoperative complications, the median operative time, the median length of hospital stay, the rate of postoperative pain, the surgical site infection, the rate of postoperative complications, the median time to recurrence, and the rate of early and late recurrences between groups with different BMI values. Moreover, studies proved that laparoscopic ventral hernia repair in obese patients is more effective compared to the open repair.

The analysis revealed that high BMI values do not have a statistically significant impact on the outcomes of laparoscopic repair, including robot-assisted laparoscopic repair, in patients with ventral hernias. However, it should be noted that the analyzed studies often have limitations. For this reason, it is essential to conduct multicenter studies and perform long-term evaluations of patients.

**Keywords: inguinal hernia repair, ventral hernia repair, obesity, BMI, laparoscopic repair, robot-assisted repair**

## INTRODUCTION

Obesity is a chronic disease involving excessive fat deposits. It can negatively impact health, predisposing to diseases (e.g., heart disease, type II diabetes). Diagnosis of overweight and obesity is based on measuring body weight and height and calculating the body mass index (BMI, expressed in units of $kg/m^2$) **[1]**. It is estimated that obesity is the fifth leading cause of death worldwide **[2]**. In the last four decades, the incidence of obesity has increased fourfold in men and twofold in women **[3]**. According to World Health Organization (WHO), in 2022, 43% of the global adult population (aged 18 years and over) were overweight (2.5 billion), and 16% were obese (890 million) **[1]**. In Europe, it is evaluated that 59% of the adult population is overweight or obese, in particular 63% among men and 54% among women. Of these, almost 23% of the European adult population is obese **[4]**.

In turn, a ventral hernias (including an inguinal hernias) are an abnormal protrusion of organs or structures through a weakness or a defect in the anterior abdominal wall **[5]**. Ventral

hernia is one of the most common cases in general surgery. In the United States, approximately 400,000 hernia repairs are performed annually. In Europe, it is estimated that there are over 300,000 such procedures **[6]**. The most prevalent type of ventral hernia is the inguinal hernia (75% of all cases) **[7]**. Ventral hernia repair techniques are mainly based on a surgical approach, which may be open, laparoscopic, endoscopic within the abdominal wall, or hybrid (combination of these methods) **[8]**. The laparoscopic ventral hernia repair necessitates smaller incisions and therefore less postoperative pain, shorter recovery times, shorter hospital stays, and lower rates of wound complications compared to the open ventral hernia repair **[9]**. Robot-assisted repair is an extension of the laparoscopic approach. It provides magnified visualization of the operative field, stability, precision, improved range of motion. These advantages of the robot-assisted repair are significant in patients with large or complex hernias that require component separation techniques. However, the robotic approach is associated with increased costs, lack of widespread accessibility and also longer operative times compared to other repair methods **[9, 10]**.

Research reveals that obesity is a significant risk factor for ventral hernias. In over 50% of obese patients with a ventral hernia are symptomatic. Overweight and obesity is also associated with an increased risk of complications after hernia repair. Attempting to lose weight before hernia repair to achieve a target BMI is not effective for every patient. Nowadays, minimally invasive techniques (laparoscopic or robot-assisted procedures) are becoming more and more popular in hernia treatment compared to open procedures **[11, 12, 13]**.

## OBJECTIVE OF THE STUDY

The aim of this study is to analyze the impact of BMI value, and thus overweight (BMI 25 - 29,9) and obesity (BMI $\geq$ 30) on the effectiveness and safety of laparoscopic ventral hernia repairs, including inguinal hernia repairs. In our study, we will focus mainly on the impact of BMI values on the rate of intraoperative complications, the median operative time, the median length of hospital stay, the rate of postoperative pain, the surgical site infection, the rate of postoperative complications, the median time to recurrence, and the rate of early and late recurrences. The study also took into account laparoscopic ventral hernia repairs performed with the robot assistance.

## MATERIALS AND METHODS

This study analyzed articles searched on the PubMed platform, and also information published on the website of WHO. We used the keywords: inguinal hernia repair, ventral hernia repair, obesity, BMI, laparoscopic repair, robot-assisted repair. The articles, which we analyzed, were divided into two groups depending on the type of minimally invasive technique. Laparoscopic repair and robot-assisted laparoscopic repair were analyzed separately. In addition, inguinal hernia was distinguished among ventral hernias.

## DESCRIPTION OF THE STATE OF KNOWLEDGE

### Robot-assisted laparoscopic inguinal hernia repair

In a multi-institutional, retrospective study, Kolachalam et al. compared the early results of robot-assisted inguinal hernia repair (n = 148) and open inguinal hernia repair for obese patients (BMI > 30). Robot-assisted procedures were more commonly associated with bilateral repairs, concomitant procedures and lower rate of postoperative complications compared with open procedures. In this study, robot-assisted repair had clinical benefits in obese patients **[14].**

Kudsi et al. conducted a study evaluating the impact of obesity on the perioperative outcomes in robot-assisted transabdominal preperitoneal inguinal hernia repair (rTAPP) for 262 non-obese patients (BMI < 30) and 131 obese patients (BMI > 30). The mean operative time for non-obese patients was shorter compared with obese patients (51 vs. 57 min). However, this difference was not statistically significant. There were also no statistically significant differences in intraoperative complications, persistent postoperative pain, wound complications, medical complications, the hospital length of stay, and recurrence between these two study groups. The rTAPP safety profile was comparable in both obese and non-obese patients **[15]**.

In another retrospective study, the effect of BMI on operative time and complications after rTAPP was analyzed for 3 groups of patients: group I with BMI < 25 (n = 102), group II with BMI 25–29.9 (n = 120), and group III with BMI > 30 (n = 82). The mean operative time was 83.5, 98.4, and 97.8 min, respectively, for bilateral procedures and 65.2, 70.9, and 85.6 min, respectively, for unilateral procedures. In both cases, the operative time was shorter for underweight/normal weight patients than for overweight or obese patients. These differences were statistically significant. However, there were no statistically significant differences in postoperative complications and inguinal hernia recurrence after rTAPP among the analyzed groups **[16]**.

**Robot-assisted laparoscopic ventral hernia repair**

The issue of effectiveness and safety of robot-assisted ventral hernia repair was addressed by Sharbaugh et al. Generally, 108 of these procedures were performed. Patients underwent various types of repair, including: primary (n = 3), transabdominal preperitoneal mesh repair (TAPP, n = 61), component separation (CS, n = 25) and intraperitoneal onlay mesh (IPOM, n = 19). The mean patient age was 52.72 ± 13.61 years. The mean BMI was 33.07 ± 7.82. There are 14 participants having a BMI > 40. The mean follow-up period was 625.6 days. Out of all the patients, 85% had an umbilical hernia. During long-term follow-up, 12.3% of the patients (n = 13) developed a hernia recurrence. The 10 of them underwent a second robot-assisted ventral hernia repair using the same technique. Primary fascial closure was successfully achieved in all patients. The researchers revealed no statistically significant differences in recurrence rate based on age, BMI, diabetes status, ASA class (American Society of Anesthesiologist class), smoking status, operative technique, or number of previous hernia repairs **[17]**.

The impact of morbid obesity (BMI > 40) on perioperative and mid-term outcomes of robot-assisted ventral hernia repair in 50 patients was also investigated by Gokcal et al. In this single-center study, the mean age of the participants was 50.14 ± 12.1 years. Besides obesity, all of them suffered from at least 1 comorbidity. 98% of the hernias were located in the abdominal midline. Intraoperative complications were not observed in any case. The mean length of hospital stay was 0.32 days (range: 0–3). After surgery, 4% of the patients required readmission to the emergency department due to: pain, syncope, urinary tract infection, pneumonia and wound concerns. 46% of the patients experienced the postoperative complications, especially: pain, nausea, pulmonary complications, surgical site infections, seroma, urinary tract infections, constipation, small bowel obstruction and hematoma. Postoperative pain had resolved by 2 months. The cases of chronic pain were not reported. The risk of pain was increased after intraperitoneal placement of the mesh. Major complications (grade III and IV) occurred only in 3 patients. These were surgical site infection, hernia recurrence (14.1 months after surgery) and $CO_2$ retention (which required CPAP). The rate of primary closure was 84%. The study found that elevated BMI was correlated with a higher rate of postoperative complications. The study results indicated that robot-assisted ventral hernia repair is effective and safe in morbid obesity. However, it should be remembered that this study also had some limitations **[18]**.

Another study evaluated the influence of BMI on perioperative complications (primary objectives) and surgical site events (secondary objectives) after robot-assisted ventrall hernia repair in 526 patients. Ultimately, the patients were divided into 2 groups based on their BMI: the patients with a BMI <35 (group A, n = 142) and patients with a BMI of 35–59.2 (group B, n = 142). The most common types of hernias were a periumbilical hernia (79.6% of patients in group A, 81% in group B), an epigastric hernia and an infraumbilical hernia. Patients underwent one of the following robot-assisted repairs: intraperitoneal onlay mesh repair (rIPOM repair), rTAPP repair or Rives-Stoppa ± transversus abdominis release repair (RS±TAR repair). The mean follow-up time of both groups was 28.5 months. The median postoperative pain score before leaving the post-anesthesia care unit was 4 in group A (range: 2-6) and 4 in group B (range: 3-5). The median hospital length of stay was 0 for group A (range: 0-20 days) and 0 for group B (range: 0-16 days). As many as 105 patients from group A and 103 patients from group B were discharged home on the day of performed procedure. There were no statistically significant differences in the rates of emergency department re-visits (13.4% vs. 9.9%), the 30-day readmission rate (5.6% vs. 1.4%) and the rates of any complication during the first 90 days (28.2% vs. 24.8%) between groups A and B. In addition, the surgical site events such as surgical site infections (SSIs), surgical site occurrences (SSOs) and surgical site occurrence requiring procedural interventions (SSOPIs) did not also differ between both groups. Limitations of the study included its retrospective and single-center nature and the lack of long-term follow-up assessment **[19]**.

Kudsi et al. compared the preoperative, intraoperative, and postoperative outcomes of patients with class II obesity (BMI 35–39.9, n = 69) and class III obesity (BMI ≥ 40, n = 69) who underwent robot-assisted ventral hernia repair. It was observed that the class II group had a lower rate of polytetrafluoroethylene (PTFE)-based mesh use compared to the class III group (17.4% vs. 39.1%). Recurrence-free time was 76.4 months and 80.4 months in the class II and III obese patients, respectively. However, there were no statistically significant differences in treatment outcomes between both groups of patients **[20]**.

**Laparoscopic inguinal hernia without robot assistance**

In a 2007 study, Raftopoulos et al. analyzed the outcomes of laparoscopic ventral hernia repair in 27 patients with a BMI greater than 35. Seven patients experienced minor or major complications. During a mean follow-up period of 14.9 months, a recurrence occurred in 5 patients. The study demonstrated that the emergency setting, the BMI value, the type and size

of the hernia, and the type of mesh did not have a statistically significant influence on the operative time, the hospital length of stay and the recurrence rate **[21]**.

In another 2-year prospective cohort study, Schjøth Iversen et al. analyzed the risk factors for inguinal v recurrence among 1,194 patients who underwent laparoscopic total extraperitoneal repair (TEP) of inguinal hernia. In both univariate and multivariate analyses, BMI > 30 was a factor significantly associated with recurrence **[22]**.

Wakasugi's study compared the efficacy of single-incision laparoscopic totally extraperitoneal inguinal hernia repair in patients with normal weight ($18.5 \leq BMI < 25$, n = 152) and overweight or obese ($BMI \geq 25$, n = 49). For unilateral hernia, the median operative time was shorter in the normal-weight group compared with the obese group (72 vs. 95 min). However, there were no significant differences in the median operative time for bilateral hernias, length of hospital stay, complication rate and recurrence rate between both groups **[23]**.

Pararas et al. investigated the influence of obesity on the efficacy and safety of laparoscopic inguinal hernia repair. They used the minimally invasive techniques such as: the TAPP (n = 28) or the totally extraperitoneal repair (TEP, n = 81). The obese group consisted of 39 patients with a mean BMI of 35.4 ± 4.9 (range: 30.1–52.7). In turn, the non-obese group included 70 patients with a mean BMI of 23.2 ± 3.3 (range: 16.2–29.7). The observation period of the patients was 30 days after hospital discharge. There were no statistically significant differences in the operative time (96.5 ± 44.1 vs. 98.7 ± 29.8 min) and complication rates (5.1% vs. 12.9%) between the obese and non-obese groups. The length of hospital stay was longer in obese patients compared to non-obese patients (1.7 ± 0.8 vs. 1.5 ± 1.9 days). And this difference was statistically significant. No chronic pain or hernia recurrence was observed in either group **[24]**.

**Laparoscopic ventral hernia without robot assistance**

The feasibility and safety of laparoscopic ventral hernia repair with Parietex Composite mesh in 79 morbidly obese patients was demonstrated in a study by Marx et al. The mean BMI of the patients was 40.83. The postoperative follow-up period was 18 months. There are no intraoperative complications. The median postoperative pain score (using a visual analog scale, VAS) was 2.86. Postoperative complications occurred in 7 patients. The mean length of hospital stay after repair was 3.2 days **[25]**.

Nardi et al. analyzed the risk factors for ventral hernia recurrence after laparoscopic repair with Parietex Composite mesh in 185 patients. The study showed that BMI ≥ 30 influences the onset of early or late recurrence. The results were statistically significant **[26]**.

Another single-center retrospective cohort study analyzed the influence of BMI on the outcomes of laparoscopic ventral hernia repair with Parietex Composite mesh. The 210 patients were divided into 2 groups: non-severely obese group (BMI < 35, n = 173) and severely obese group (BMI ≥ 35, n = 37). Mean follow-up period was 31 months. No statistically significant differences were identified in mean operative time (66 vs. 77 min), median length of postoperative hospital stay (3 vs. 4 days), mean postoperative pain score (measured by a numeric rating) and complication rate between the both groups. The ventral hernia recurrence occurred in 13% of patients in the lower BMI group (n = 23) and in 16% of patients in the higher BMI group (n = 6). However, these results were also not statistically significant **[27]**.

In another study, 163 obese patients with a mean BMI of 38 underwent laparoscopic ventral hernia repair with an expanded polytetrafluoroethylene mesh. There were no perioperative deaths. Postoperative complications occurred in 20 patients. At a mean follow-up of 25 months, 9 patients had a hernia recurrence **[28**].

The researchers analyzed the cases of 322 patients who were divided into 3 groups based on their obesity class: group I (BMI ≥ 30 and < 35, n = 231), group II (BMI ≥ 35 and < 40, n = 55), and group III (BMI ≥ 40, n = 36). All patients underwent laparoscopic inguinal hernia repair using expanded polytetrafluoroethylene (e-PTFE) mesh. In groups II and III patients had a higher rate of comorbidities (specifically hypertension and cardiovascular disease) compared to group I. There were no significant differences between the groups in terms of intraoperative complications and conversion to open surgery. The median length of hospital stay was significantly longer in group III patients (5 days) compared to groups I and II (4 days). Recurrence occurred in 7% of all patients: 11% in group II, 6% in group I, and 8% in group III. The median time to recurrence was 15 months. There were no statistically significant differences between the groups in terms of postoperative complications, surgical site infections, rate of recurrence, mean time to recurrence and chronic pain **[29]**.

Similarly, Gómez-Menchero et al. analyzed the risk factors for failure of laparoscopic ventral hernia repair with primary closure of defect using a running suture and intraperitoneal mesh placement among 58 patients. The mean follow-up was 60 months. In this study, the higher BMI was not a risk factor for bulging and recurrence **[30]**.

Kato et al. analyzed the impact of obesity on the technical difficulty of laparoscopic totally extraperitoneal (TEP) hernia repair. In the study, patients were divided into 3 groups: normal weight (BMI 18.5–24.9, n = 78), overweight (BMI 25–29.9, n = 89), obese (BMI ≥ 30, n = 23). The study found that higher BMI (and also implication of the comorbidities associated with obesity) was significantly associated with more technical difficulty during laparoscopic surgery and longer operative time. However, this correlation was only statistically significant in the first 14 patients with unilateral hernias and in the first 42 patients with bilateral hernias. The learning curve had a major impact on it **[31]**.

In a study by Liu et al., the researchers aimed to estimate the BMI threshold at which the risk of recurrence increases after laparoscopic ventral and incisional hernia repair. It included 175 patients with hernia defects ≥4 cm. The overall recurrence rate was 9.1%. Based on their results, the critical BMI threshold for hernia recurrence was estimated to be 35.3 **[32]**.

Sánchez García et al. compared the influence of BMI on the outcomes of primary ventral hernia surgery or incisional hernia surgery through the extended totally extraperitoneal pathway. The participants were divided into 2 groups: non-obese group (BMI ≤ 30, n = 38) and obese group (BMI > 30, n = 36). The median follow-up period was 16 months. The results showed that there were no statistically significant differences in complications, length of hospital stay, postoperative pain and recurrences between the two groups **[33]**.

Amatucci et al. analyzed the results of laparoscopic incisional hernia repair in a group of 15 obese patients (BMI >35). No intraoperative complications or early re-interventions were reported. The mean length of hospital stay was 2.79 days. A recurrence occurred in one patient after one year **[34]**.

In a single-center retrospective observational study, Olmi et al. compared the efficacy and safety of laparoscopic ventral hernia repair with a composite mesh before bariatric procedure (group A, mean BMI 37.8 ± 5.7, n = 30) and delayed laparoscopic repair after bariatric procedure and weight loss (group B, mean BMI 24.6 ± 4.5, n = 170). There were no statistically significant differences in the length of hospital stay (2.0 ± 2.7 days vs. 2.8 ± 1.9 days), the recurrence rate (3.3% vs. 2.3%), the bulging rate (bulging mesh implanted during the procedure predisposing to recurrence, 10% vs. 0%) and the complication level between groups A and B **[35]**.

## SUMMARY

Our analysis demonstrated that laparoscopic repair, including robot-assisted repair, can be an effective and safe treatment modality for ventral hernias, including inguinal hernias, not only in patients with normal BMI but also in overweight and obese patients. The studies suggest that the BMI value has no statistically significant impact on, among others, the rate of intraoperative complications, the median operative time, the median length of hospital stay, the rate of postoperative pain, the surgical site infection, the rate of postoperative complications, the median time to recurrence, and the rate of early and late recurrences. However, it should be noted that the analyzed studies often have limitations. For this reason, it is essential to conduct multicenter studies, studies involving larger groups of patients and perform long-term evaluations of patients.

**Disclosure**

**Author's contribution**

Conceptualization: Ostojska M and Kałuża I; Methodology: Ostojska M and Górska M; Software: Miazga M and Serkis B; Check: Golemo J, Celichowska M; Formal analysis: Dziuba G and Bentkowska Z; Investigation: Dębińska J; Resources: Kałuża I, Górska M and Miazga M; Data curation: Ostojska M and Serkis B; Writing - rough preparation: Ostojska M, Kałuża I, Górska M and Miazga M; Writing - review and editing: Serkis B, Golemo J and Celichowska M; Visualization: Dziuba G; Supervision: Bentkowska Z and Dębińska J; Project administration: Ostojska M and Dębińska J; Receiving funding: not applicable.

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