Chirurgia (2023) 118: 426-434
No. 4, July - August

http://dx.doi.org/10.21614/chirurgia.2023.v.118.i.4.p.426

# Ventral Hernia Repair and Drainage – A Prospective, Observational, and Comparative Study of Outcomes

**Ana-Maria Stan (Soare)[1], Silviu-Daniel Preda[2]*, Sandu Râmboiu[2], Dan Cârțu[2], Ștefan Pătrașcu[2], Sergiu Cazacu[3], Viorel Biciușcă[4]*, Adina Turcu Știolică[5], Octavian Andronic[6], Dan Nicolae Păduraru[6], Ion Daniel[6], George Mitroi[7], Daniela Marinescu[2], Valeriu Șurlin[2]**

[1]University of Medicine and Pharmacy of Craiova, Doctoral School, Craiova, Romania
[2]1st Department of Surgery, Clinical County Emergency Hospital of Craiova, University of Medicine and Pharmacy of Craiova, Romania
[3]Department of Gastroenterology, Clinical County Emergency Hospital of Craiova, University of Medicine and Pharmacy of Craiova, Romania
[4]Department of Internal Medicine, Filantropia Municipality Hospital of Craiova, University of Medicine and Pharmacy of Craiova, Romania
[5]Clinical Pharmacology, University of Medicine and Pharmacy of Craiova, Romania
[6]Carol Davila University of Medicine and Pharmacy Bucharest, Third General Surgery and Emergency Clinic, Bucharest Emergency University Hospital, Romania
[7]Department of Urology, Clinical County Emergency Hospital of Craiova, University of Medicine and Pharmacy of Craiova, Romania

***Corresponding author:**
Silviu-Daniel Preda, MD
University of Medicine and Pharmacy of Craiova, Department of General Surgery, Petru Rareș 2-4, Craiova Romania
E-mail: daniel.preda@umfcv.ro
Viorel Biciușcă, MD
University of Medicine and Pharmacy of Craiova,
E-mail: viorel.biciusca@umfcv.ro

Received: 14.06.2023
Accepted: 18.08.2023

## Rezumat

***Cura chirurgicală a herniilor ventrale și drenajul – un studiu prospectiv, observațional și comparativ al rezultatelor***

*Context*: În timp ce repararea herniei ventrale este o intervenție chirurgicală frecventă, posibilitatea apariției complicațiilor rămâne prezentă. Utilizarea drenajelor pentru a preveni complicațiile este un subiect de dezbatere, cu dovezi contradictorii. Acest studiu îşi propune să evalueze asocierea dintre utilizarea drenajelor şi complicațiile postoperatorii în cura chirurgicală a herniei ventrale.
*Materiale şi Metode*: Un studiu prospectiv desfăşurat într-un singur centru a inclus pacienți care au suferit o reparare a herniei ventrale în perioada 2018-2022. Datele pacienților şi tehnicile chirurgicale au fost înregistrate. S-a efectuat o analiză statistică pentru a evalua factorii de risc pentru inserția drenajului şi complicații.
*Rezultate*: Din cei 216 pacienți incluşi, 19,44% aveau diabet zaharat, iar 20% aveau neoplazii. Complicații postoperatorii (Clavien Dindo ≥ gradul IIIB) au apărut în 9,3% dintre cazuri, conducând la o mortalitate de 3,7%. Factorii decizionali pentru inserția drenajului au inclus vârsta mai înaintată, dimensiunea mai mare a herniei, rezecția intestinală cu anastomoză, prezentarea în urgență şi necesitatea adeziolizei. Nu s-au găsit diferențe între cele două

grupuri în ceea ce priveşte incidența seromului şi hematoului şi infecția plasei. Pacienții cu drenaje au avut o durată de spitalizare mai lungă şi costuri mai mari.
*Concluzie*: Decizia de a utiliza drenaje în cura herniei ventrale a fost influențată de factorii de complexitate chirurgicală mai degrabă decât de caracteristicile pacientului. Cu toate că utilizarea drenajelor nu a corelat cu morbiditatea postoperatorie, a fost asociată cu o spitalizare mai lungă şi costuri mai mari. Luarea deciziilor individualizate este crucială pentru echilibrarea complicațiilor şi utilizării resurselor în repararea herniei ventrale.

**Cuvinte cheie**: repararea herniei ventrale, drenaje, complicații, factori de risc, spitalizare, costuri

**Abstract**
*Background*: While ventral hernia repair is a frequent surgical intervention, the possibility of complications remains present. The use of drains to mitigate complications is a topic of debate, with conflicting evidence. This study aimed to evaluate the association between drain usage and postoperative complications in ventral hernia repair.
*Materials and Methods*: A single-center prospective study included patients undergoing ventral hernia repair from 2018 to 2022. Patient data and surgical techniques were recorded. Statistical analysis was performed to assess risk factors for drain insertion and complications.
*Results*: Of the 216 patients included, 19.44% had diabetes, and 20% had cancer. Postoperative complications (Clavien Dindo ≥ grade IIIB) occurred in 9.3% of cases, resulting in a 3.7% mortality. Decision factors for drain insertion included older age, larger hernia size, bowel resection with anastomosis, emergency setting and the need for adhesiolysis. No differences were found between the two groups regarding seroma and hematoma formation and mesh infection. Patients with drains had a longer hospital stay and higher costs.
*Conclusion*: The decision to use drains in ventral hernia repair was influenced by surgical complexity factors rather than patient characteristics. While drain usage did not correlate with postoperative morbidities, it was associated with longer hospitalization and higher costs. Individualized decision-making is crucial to balance complications and resource utilization in ventral hernia repair.

**Key words**: ventral hernia repair, drains, complications, risk factors, hospitalization, costs

## Introduction

Ventral hernia repair is a commonly performed surgical procedure aimed at correcting defects in the abdominal wall. It involves the closure of the hernia defect and most often, reinforcement with a mesh to provide strength and support to the weakened area. Ventral hernias can result from various causes, including previous surgical incisions, trauma, or congenital weakness in the abdominal wall. They can cause discomfort, pain, and functional limitations, and surgical repair is the mainstay of treatment in all cases (1).

Despite advancements in surgical techniques, approaches, and materials, ventral hernia repair is associated with complications. These complications include wound infections, seromas, hematomas, and mesh-related complications such as mesh infection, mesh displacement, recurrence, mesh erosion (1). Such complications not only prolong recovery, but also increase healthcare costs and may require further interventions (2). Therefore, strategies to minimize these complications and improve outcomes are of paramount importance.

One approach to mitigate some complica-

tions in ventral hernia repair is the use of drains (3). Drains are typically placed in the surgical site to prevent seroma or hematoma, reduce dead space, and facilitate wound healing. Additionally, drains may aid in the early detection of infection, enabling timely intervention, although drains can also lead to infection by themselves. However, the use of drains in ventral hernia repair remains a topic of debate, with conflicting evidence regarding their efficacy and potential risks (3–5).

Current literature trends have shown a growing interest in understanding the role of drains in ventral hernia repair (3,6–9). Several studies have investigated the association between drain usage and complications, evaluating factors such as patient characteristics, surgical techniques, and comorbidities. These studies have aimed to identify risk factors associated with drain insertion, assess the impact of drains on wound-related complications, and explore their cost-effectiveness. However, there is still a lack of consensus and definitive guidelines regarding the use of drains in ventral hernia repair.

The primary objective of this study was to evaluate the association between drain usage and postoperative complications in patients undergoing ventral hernia repair.

The secondary objectives included assessing decision factors for drain insertion, examining the impact of comorbidities on complications, and analyzing the economic implications of drain usage. By investigating these objectives, we aimed to contribute to the existing body of knowledge on the optimal management of ventral hernia repair and provide insights for clinical decision-making.

## Material and Methods

A single-center, prospective, observational, non-interventional study was performed in the First Surgical Clinic of Craiova Emergency Clinical Hospital on patients with ventral hernia repair. The study was conducted over a 5-year period, from 2018 to 2022. Inclusion criteria consisted of patients undergoing ventral hernia repair, admitted and treated in our Department, with an age of over 18 years, who have signed the informed consent.

### *Data Homogeneity*

Patients admitted were assessed for surgical candidacy. Co-morbidities were analyzed and optimized as possible, a full blood workup which included a complete blood count, glycemia, blood urea nitrogen, creatinine, urine, liver enzymes, ionogram, a coagulation panel, total proteins; an electrocardiogram (ECG) and a pulmonary X-ray was performed in all patients.

Ventral hernias were assessed clinically and classified according to the EHS classification for incisional hernias (10). The defect dimensions were measured clinically.

### *Preoperative Preparation*

Patients' preoperative diet consisted of *nil per os* 10 hours prior to surgery, mechanical bowel preparation was performed selectively. Thromboprophylaxis was conducted based on the Caprini score for Venous Thromboembolism, and patients at risk of thromboembolism received low molecular weight heparin (LMWH) (11). Antibiotic prophylaxis was systematically performed with a single intraoperative dose of a second-generation cephalosporin at the time of anesthesia induction. An additional dose of antibiotic was administered if surgical procedure was prolonged for more than 3 hours.

### *Techniques Used*

Repair technique was dictated on surgeon choice based on: setting, patient age and co-morbidities, extent of lateral dissection, extent of wound contamination.

If a mesh was used, the mesh was a polypropylene light macroporous mesh. Transversus abdominis release (TAR) was performed in cases with a defect size width of more than 10 cm and was performed bilaterally. In preperitoneal repairs, the mesh was anchored with polypropylene

2/0-transfascial sutures and the knot was buried in the subcutaneous tissue.

If closure of the anterior aponeurosis of the rectus abdominis muscle was not feasible, a substitution mesh was placed in an onlay style, with the mesh fixed to the margins of the anterior aponeurosis.

In cases of bowel resection, or in cases of a clean-contaminated field, anatomical repair was preferred over mesh repair.

### *Postoperative Care*

Nasogastric tubes (NG tubes) were placed after anesthesia induction, except in patients presenting in an acute setting and/or with a high risk of aspiration, when NG tubes were placed a priori.

In the postoperative phase, a comprehensive set of protocols were implemented. These included the encouragement of early mobilization from the bed, administration of pain control medication on a demand basis, timely removal of the urinary catheter within the first or second postoperative day, initiation of an oral liquid diet on the first postoperative day, allowance for solid food intake subsequent to the passage of flatus, vigilant monitoring of closed-circuit drains to assess drainage aspect and quantity on a daily basis, and progressive removal of drains guided by the discretion of the surgeon and the observed drainage pattern.

To alleviate pain while in an upright position, patients were instructed to employ an elastic abdominal binder. The decision to discharge patients hinged upon their restoration to a solid food diet, attainment of full mobilization, and their surgical site infection (SSI) status. Postoperatively, patients were scheduled for follow-up visits at regular intervals of 1, 3, and 6 months, with additional visits arranged based on individual requirements.

In this study we included patients with cancer. This includes patients receiving medical treatment for cancer at the moment of the repair and patients in remission for under 5 years.

### *Statistical Analysis*

Patient population was divided into two groups, one group where no drainage was added, and one group where drains were added. We examined the relationship between patient characteristics and drainage and between complications and costs in hospitalized patients among the two groups. Continuous data were expressed as mean ± standard deviation, median (interquartile range) and compared using Mann-Whitney U test or Kruskal-Wallis test. Categorical data were presented as percentage and compared by using Chi-squared or Fisher's Exact test.

A p-value less than 0.05 was considered statistically significant. Statistical analysis was performed with GraphPad Prism v.10 for Windows (GraphPad Software, San Diego, California USA, www.graphpad.com).

## Results

There were 216 patients included in the study, of whom 31.6% were males. No significant differences in terms of gender were found between patients with or without drainage, as shown in *Table 1.*

The mean age of the patients was 64.23± 13.12, ranging from 26 to 87. The patients who underwent drainage were older (66.2±12.2) compared to those who did not undergo the procedure (61.24±12.2) (p = 0.003) (*Table 1*).

No significant statistical differences were found between obese and non-obese patients and diabetic and non-diabetic patients regarding the surgeons' decision to drain (p=0.248). Similarly, diabetes (p=0.392) or cancer (p=0.734) were not observed to be deciding factors for drain insertion (*Table 1*). A total of 42 (19.4%) patients had diabetes, with half of them also having obesity.

Among the 216 patients, 44 (20.4%) were patients with neoplasia (29 patients with digestive cancers, 9 patients with pulmonary cancer and 2 patients with prostate cancer), of which 17 patients undergoing medical treatment and 27 patients were disease free.

**Table 1.** Demographic and clinical characteristics of patient groups

| | Total (n=216) | No Drain (n=95) | Drain (n=121) | p-value |
|---|---|---|---|---|
| Age | 64.23±13.12<br>66 (57-74) | 61.24±13.67<br>63 (53-70) | 66.6±12.2<br>69 (58.5-76) | 0.003 [a] |
| Gender, male, n (%) | 66 (30.6%) | 30 (31.6%) | 36 (29.8%) | 0.882 [b] |
| Obesity, yes, n (%) | 74 (34.3%) | 37 (38.9%) | 37 (30.6%) | 0.248 [b] |
| Diabetes, yes, n (%) | 42 (19.4%) | 21 (22.1%) | 21 (17.4%) | 0.392 [b] |
| Cancer, yes, n (%) | 44 (20.4%) | 18 (18.9%) | 26 (21.5%) | 0.734 [b] |
| Recurrence, yes, n (%) | 17 (7.9%) | 11 (11.6%) | 6 (5%) | 0.081[a] |
| Hospitalization days | 10.7±8.6<br>9 (7-12) | 8.7±4.9<br>7 (6-11) | 12.2±10.5<br>10 (8-13) | <0.0001 [a] |
| Emergency, yes, n (%) | 77 (35.6%) | 26 (27.4%) | 51 (42.1%) | 0.032 [b] |
| Costs, Euro | 694.3±549.1<br>605<br>(433.5-780.8) | 586.5±362.5<br>520.2<br>(395.6-724.3) | 778.9±648.7<br>647.7<br>(503.2-847.9) | <0.0001 [a] |
| Costs/day, Euro | 66.4±15.7<br>65<br>(58.2-66.6) | 65.3±14.6<br>64.8<br>(57.6-67.1) | 67.2±16.5<br>65<br>(59.3-66.6) | 0.185 [a] |

[a], Mann-Whitney U test. b, Chi-Square or Fisher's Exact Test

In the emergency setting, statistical differences were also significant between the drain and no drain groups (42.1% vs 27.4%, p=0.032). No differences were observed in regard to recurrent cases between the two groups (p=0.081) (*Table 1*).

The mean duration of hospitalization was 12.9±16.2 days, with extremes ranging from 1 to 120 days (*Table 1*). The average cost per ventral hernia repair was higher for patients with a drain (EUR 778.9±648.7) compared to those without a drain (EUR 586.5±362.5) (p<0.0001) due to a longer hospitalization period (p<0.0001) (*Fig. 1*). However, there was no significant difference in the average cost per day between the two groups of patients (p = 0.185) (*Table 1*).

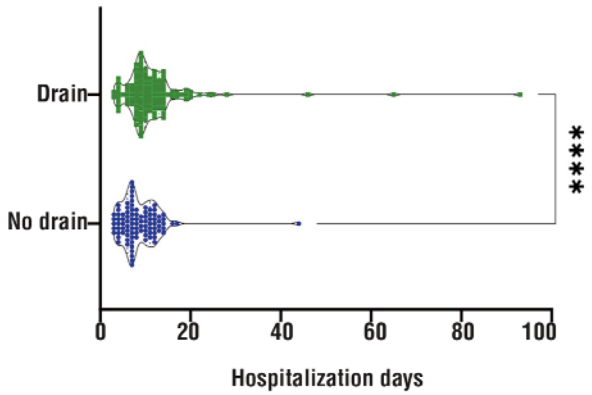


**Figure 1.** Hospitalization days among patients on drainage status. ****, p-value<0.0001.

We observed a larger hernia size in patients who received drainage (p<0.0001). Additionally, adhesiolysis was more common in patients who underwent drainage (p=0.001) (*Table 2*).

Bowel resection and anastomosis was performed in 6.9% of cases. The use of drainage was significantly higher (10.7% vs 2.1%, p=0.014) in patients undergoing bowel resection with anastomosis (*Table 2*).

Wound infection was present in 8 (3.7%) cases and mesh infection in 3 (1.4%) cases. No significance in statistical difference was observed regarding mortality between the two groups. Postoperative complications (Clavien-Dindo ≥ grade IIIb or higher) were reported in 20 (9.3%) cases, resulting in 8 (3.7%) deaths (*Table 3*).

Although not statistically significant, grade IIIb or higher Clavien-Dindo complications were more frequent in patients where drain was added (14 vs 6), seroma was more frequent in the drainage group (22.3% vs 17.9%), mesh infection occurred only in drained patients (3 patients, p=0.257) and hematoma was more frequent in the no drain group (9.5% vs 4.1%, p=0.163) (*Table 3*).

**Table 2.** Hernia characteristics according to EHS classification and repair technique employed in the study groups

| | Total (n=216) | No Drain (n=95) | Drain (n=121) | p-value |
|---|---|---|---|---|
| Size | | | | <0.0001 * |
| W1 (Small) | 31 (14.4%) | 23 (24.2%) | 8 (6.6%) | |
| W2 (Medium) | 90 (41.7%) | 41 (43.2%) | 49 (40.5%) | |
| W3 (Big) | 95 (44%) | 31 (32.6%) | 64 (52.9%) | |
| Localization | | | | 0.416 * |
| M1 or M2 (Supraumbilical) | 41 (19%) | 20 (21.1%) | 21 (17.4%) | |
| M3 (Periumbilical) | 113 (52.3%) | 49 (51.6%) | 64 (52.9%) | |
| M4 (Subumbilical) | 2 (0.9%) | - | 2 (1.7%) | |
| Multiple M (Complex) | 39 (18.1%) | 16 (16.8%) | 23 (19%) | |
| Repair | | | | 0.057 * |
| Anatomic | 49 (22.7%) | 25 (26.3%) | 24 (19.8%) | |
| Open Preperitoneal | 126 (58.3%) | 53 (55.8%) | 73 (60.3%) | |
| Onlay | 22 (10.2%) | 5 (5.3%) | 17 (14%) | |
| Open IPOM | 10 (4.6%) | 7 (7.4%) | 3 (2.5%) | |
| IPOM & Interlay | 7 (3.2%) | 5 (5.3%) | 2 (1.7%) | |
| Laparoscopic IPOM | 1 (0.5%) | - | 1 (0.8%) | |
| Laparoscopic preperitoneal | 1 (0.5%) | - | 1 (0.8%) | |
| Adhesiolysis, yes, n (%) | 123 (56.9%) | 42 (44.2%) | 81 (66.9%) | 0.001 * |
| Anastomosis, yes, n (%) | 15 (6.9%) | 2 (2.1%) | 13 (10.7%) | 0.014 * |

*, Chi-Square or Fisher's Exact Test

## Discussions

The present study aimed to investigate the use of drains in patients undergoing ventral hernia repair. The results demonstrated that the decision to use drains was not influenced by patient characteristics such as obesity, diabetes, or cancer. Diabetes and obesity are known risk factors for surgical complications (12,13). In this study, 19.44% of patients had diabetes, and half of them also had obesity. However, we did not find a significant association between diabetes or obesity and the use of drainage or the occurrence of postoperative complications. These findings suggest that proper preoperative management and perioperative care, including optimization of comorbidities, may help mitigate the potential risks associated with diabetes and obesity in ventral hernia repair. However, several factors were associated with the use of drains, including older age, larger hernia size, and the need for adhesiolysis.

In our study, we observed that the decision to use drains in ventral hernia repair was associated with operative factors. Older age, larger hernia size, the need for adhesiolysis procedures, and cases involving bowel resection and anastomosis were more frequent in patients with drain placement. These decision factors indicate the complexity of cases and the surgeon's inclination to use drainage in challenging scenarios or when placing mesh in a clean-contaminated surgical field. Specifically, emergency cases often involve complicated ventral hernias where bowel resections are common, and these cases typically necessitate drain

**Table 3.** Postoperative complications and cost analysis

| | Total (n=216) | No Drain (n=95) | Drain (n=121) | p-value |
|---|---|---|---|---|
| Complications, Clavien-Dindo ≥ grade IIIB, yes, n (%) | 20 (9.3%) | 6 (6.3%) | 14 (11.6%) | 0.505 [a] |
| Seroma, yes, n (%) | 44 (20.4%) | 17 (17.9%) | 27 (22.3%) | 0.497 [a] |
| Infection wound, yes, n (%) | 8 (3.7%) | 3 (3.2%) | 5 (4.1%) | 1.0 [a] |
| Infection mesh, yes, n (%) | 3 (1.4%) | - | 3 (2.5%) | 0.257 [a] |
| Hematoma, yes, n (%) | 14 (6.5%) | 9 (9.5%) | 5 (4.1%) | 0.163 [a] |
| Mortality, yes, n (%) | 8 (3.7%) | 2 (2.1%) | 6 (5%) | 0.471 [a] |

[a], Chi-Square or Fisher's Exact Test. b, Mann-Whitney U test.

placement due to the increased risk of complications and mesh infection associated with a contaminated field.

Marcolin et al in a systematic review and meta-analysis, found that drain placement significantly reduces seroma formation, without an increase in infectious complications (9). In our study, seroma and mesh infection were more frequent in patients who had drains inserted, although the differences were not statistically significant. This difference may be due to the duration drains are kept or issues regarding homogeneity in patient-specific characteristics (such as the number of patients with large hernias). However, hematoma was more common in patients without drains. These findings emphasize the need for individualized patient management and careful consideration of decision factors when deciding on the use of drains in ventral hernia repair.

The overall postoperative complication rate was relatively low, with complications classified as Clavien-Dindo grade IIIb or higher occurring in 9.3% of cases. However, it is important to note that these complications resulted in 3.7% mortality, underscoring the significance of even relatively rare complications in surgical outcomes.

Among the patients included in the study, 20% had a history of cancer. While this comorbidity did not appear to be a significant decision factor for drain insertion or postoperative complications, it is worth considering the potential impact of cancer and its treatment on hernia repair outcomes. Cancer-related factors, such as immunosuppression induced either by cancer or by therapy, may influence the healing process and increase the risk of complications.

The study also revealed that patients who underwent drainage had a longer hospital stay and incurred higher costs compared to those without drains. The increased duration of hospitalization in the drainage group can be attributed to the need for continued monitoring of drain output and the potential for complications associated with drain maintenance. The higher costs in the drainage group were primarily driven by the longer hospital stay, as there was no significant difference in the average cost per day between the two groups. These findings suggest that the use of drains in ventral hernia repair should be carefully considered, weighing the potential benefits of reduced complications against the associated increase in hospital stay and costs.

Comparing our results with existing literature, we found overall agreement regarding the factors influencing drain placement in ventral hernia repairs. However, it is worth noting that the evidence in this field is limited and heterogeneous. Most studies are retrospective or observational, and there is a lack of well-designed prospective randomized controlled trials specifically investigating the role of drains in ventral hernia repairs. Existing guidelines on ventral hernia repair do not address the placement of drains (14–17). Consequently, the current recommendations on drain placement remain largely based on expert opinions and clinical experience. One RCT analyzing outcomes for retromuscular repair versus onlay used drainage systematically (18).

Another RCT compared the postoperative complication rates of open mesh repair for incisional hernia with and without prophylactic wound drainage. The study included 144 patients who were randomized into two groups: one with drain placement and one without. The primary endpoint was the evaluation of residual fluid collection at 30 days postoperatively. The results showed no significant difference in fluid collection between the two groups. However, the drain group had fewer surgical complications, including a lower rate of wound dehiscence. The study concluded that prophylactic drainage does not objectively reduce the rate of postoperative fluid collections and does not support the routine use of drainage in incisional hernia repair (4).

## Conclusions

In conclusion, this study demonstrated that the decision to drain patients undergoing

ventral hernia repair was primarily influenced by surgical complexity factors rather than patient-related characteristics. Older age, larger hernia size, bowel resection and anastomosis, emergency setting and the need for adhesiolysis were associated with an increased likelihood of drain placement. While the use of drains was not influenced by patient comorbidities, it was associated with longer hospitalization and higher costs. These findings highlight the importance of individualized decision-making regarding drain placement, considering the specific characteristics of each patient and the potential trade-offs between complications and resource utilization.

Study limitations: The findings of this study may have limited generalizability due to its single-center nature, prospective design, and observational approach. To ensure the validity of the results, future studies involving multiple centers and larger sample sizes are necessary.

The inclusion of drains in this study was determined based on individual surgeon preferences, which introduces the potential for bias. To promote consistency in clinical practice and reduce variability, it would be valuable for future research to explore the implementation of standardized protocols or guidelines for drain placement.

### *Author Contributions*

A-M.S., D.M. – Conceptualization; S-D.P., S.P. – Methodology; S.C., V.B., D.N.P. – Data acquisition, ATŞ – Data analysis; SR, DC, GM - Writing - Original Draft preparation; I.D., O.A. - writing – review and editing; V.Ş. – Supervision and approval of final manuscript. Daniela Marinescu and Ana-Maria Stan have equal contributions as first author.

### *Acknowledgements*

This work was supported by the grant POCU/ 993/6/13/153178, ”Performanță în cercetare” - "Research performance" co-financed by the European Social Fund within the Sectorial Operational Program Human Capital 2014-2020.

### *Conflicts of Interest*

The authors declare they have no conflicts of interest.

### *Funding*

This article has received no external funding.

### *Ethical Statement*

Ethics of the research was obtained from the University of Medicine and Pharmacy of Craiova

## References

1. Smith J, Parmely JD. Ventral Hernia. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.
2. Plymale MA, Davenport DL, Walsh-Blackmore S, Hess J, Griffiths WS, Plymale MC, et al. Costs and Complications Associated with Infected Mesh for Ventral Hernia Repair. Surg Infect (Larchmt). 2020;21(4):344–9.
3. Plymale MA, Harris JW, Davenport DL, Smith N, Levy S, Scott Roth J. Abdominal Wall Reconstruction: The Uncertainty of the Impact of Drain Duration upon Outcomes. Am Surg. 2016;82(3):207–11.
4. Willemin M, Schaffer C, Kefleyesus A, Dayer A, Demartines N, Schäfer M, et al. Drain Versus No Drain in Open Mesh Repair for Incisional Hernia, Results of a Prospective Randomized Controlled Trial. World J Surg. 2023; 47(2):461-8.
5. Wouters D, Cavallaro G, Jensen KK, East B, Jíšová B, Jorgensen LN, et al. The European Hernia Society Prehabilitation Project: A Systematic Review of Intra-Operative Prevention Strategies for Surgical Site Occurrences in Ventral Hernia Surgery. Front Surg. 2022;9:847279.
6. Arora E, Mishra A, Mhaskar R, Mahadar R, Gandhi J, Sharma S, et al. Are drains useful in eTEP ventral hernia repairs? An AWR surgical collaborative (AWRSC) retrospective study. Surg Endosc. 2022;36(10):7295-301.
7. Kushner B, Smith E, Han B, Otegbeye E, Holden S, Blatnik J. Early drain removal does not increase the rate of surgical site infections following an open transversus abdominis release. Hernia. 2021;25(2):411-8.
8. Krpata DM, Prabhu AS, Carbonell AM, Haskins IN, Phillips S, Poulose BK, et al. Drain Placement Does Not Increase Infectious Complications After Retromuscular Ventral Hernia Repair with Synthetic Mesh: an AHSQC Analysis. J Gastrointest Surg. 2017;21(12):2083-9.
9. Marcolin P, de Figueiredo SMP, Constante MM, de Melo VMF, de Araújo SW, Mao RMD, et al. Drain placement in retromuscular ventral hernia repair: a systematic review and meta-analysis. Hernia. 2023;27(3):519-26.
10. Muysoms FE, Miserez M, Berrevoet F, Campanelli G, Champault GG, Chelala E, et al. Classification of primary and incisional abdominal wall hernias. Hernia. 2009;13(4):407-14.
11. Wilson S, Chen X, Cronin M, Dengler N, Enker P, Krauss ES, et al. Thrombosis prophylaxis in surgical patients using the Caprini Risk Score. Current Problems in Surgery. 2022;59(11):101221.

12. Wang J, Chen K, Li X, Jin X, An P, Fang Y, et al. Postoperative adverse events in patients with diabetes undergoing orthopedic and general surgery. Medicine (Baltimore). 2019;98(14):e15089.
13. Tjeertes EEKM, Hoeks SSE, Beks SSBJC, Valentijn TTM, Hoofwijk AAGM, Stolker RJRJ. Obesity – a risk factor for postoperative complications in general surgery? BMC Anesthesiol. 2015;15:112.
14. Earle D, Roth JS, Saber A, Haggerty S, Bradley 3rd JF, Fanelli R, et al. SAGES guidelines for laparoscopic ventral hernia repair. Surg Endosc. 2016;30(8):3163-83.
15. Henriksen NA, Kaufmann R, Simons MP, Berrevoet F, East B, Fischer J, et al. EHS and AHS guidelines for treatment of primary ventral hernias in rare locations or special circumstances. BJS Open. 2020;4(2):342–53.
16. Bougard H, Coolen D, de Beer R, Folscher D, Kloppers J, Koto M, et al. HIG (SA) Guidelines for the Management of Ventral Hernias. South African Journal of Surgery. 2016;54(4):S1-S29.
17. Bittner R, Bain K, Bansal VK, Berrevoet F, Bingener-Casey J, Chen D, et al. Update of Guidelines for laparoscopic treatment of ventral and incisional abdominal wall hernias (International Endohernia Society (IEHS)) - Part A. Surg Endosc. 2019;33(10):3069-139.
18. Demetrashvili Z, Pipia I, Loladze D, Metreveli T, Ekaladze E, Kenchadze G, et al. Open retromuscular mesh repair versus onlay technique of incisional hernia: A randomized controlled trial. Int J Surg. 2017;37:65-70.