

Impact of Comorbidities on Outcomes and Healthcare Costs of Open Inguinal Hernia Repair in Patients with Diabetes Mellitus

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Rezumat

Impactul comorbidităților asupra rezultatelor postoperatorii și costurilor al curei chirurgicale deschise pentru hernia inghinală la pacienții cu diabet zaharat

Introducere: Managementul herniei inghinale la pacienții cu diabet zaharat (DM) și comorbidități prezintă provocări din cauza impactului potențial asupra vindecării plăgilor și riscului de infecție. Acest studiu evaluează influența comorbidităților suplimentare asupra rezultatelor după cura herniei inghinale la pacienții cu DM.

Materiale și Metode: S-a efectuat un studiu de cohortă retrospectiv la Spitalul Clinic Județean de Urgență Craiova în perioada 2015-2020. Pacienții cu DM documentat care au suferit cura herniei au fost împărțiți în două grupuri în funcție de statusul comorbidităților. Au fost colectate și analizate date despre modul de prezentare, tipul de hernie, comorbidități, spitalizare, date operatorii, rezultate post-operatorii și costuri.

Rezultate: Din cei 38 de pacienți cu DM care au suferit cura herniei, 16 au fost în Grupul A (DM fără comorbidități) și 22 în Grupul B (DM cu comorbidități). Pacienții din Grupul B au fost mai în vârstă ($p = 0,0002$) și mai predispuși să se prezinte în urgență (OR: 13,81, $p=0,0148$) cu hernii incarcerate (OR: 22,733, $p=0,0339$) sau strangulate (OR: 9,4545, $p=0,0390$). Grupul B a avut spitalizări mai lungi ($p = 0,00132$) și costuri de spitalizare mai mari ($p = 0,00262$).

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Concluzii: Pacienții cu DM și comorbidități prezintă un risc mai mare pentru hernii complexe și spitalizări prelungite. Fibroza pulmonară reprezintă o comorbiditate semnificativă care necesită strategii specifice perioperatorii. Evaluările și planurile de îngrijire preoperatorie adaptate pot optimiza rezultatele.

Cuvinte cheie: hernie inghinală, diabet zaharat, comorbidități, cura chirurgicală, rezultate chirurgicale

Abstract

Introduction: Inguinal hernia management in patients with diabetes mellitus (DM) and comorbidities presents challenges due to potential impacts on wound healing and infection risk. This study evaluates the influence of additional comorbidities on outcomes following open inguinal hernia repair in DM patients.

Materials and Methods: A retrospective cohort study was conducted at Craiova Emergency Clinical County Hospital from 2015 to 2020. Patients with documented DM undergoing hernia repair were categorized into two groups based on comorbidity status. Data on presentation mode, hernia type, comorbidities, hospitalization, operative details, postoperative outcomes, and costs were collected and analyzed statistically.

Results: Among 38 DM patients undergoing hernia repair, 16 were in Group A (DM alone) and 22 in Group B (DM with comorbidities). Group B patients were older ($p = 0.0002$) and more likely to present emergently (OR: 13.81, $p=0.0148$) with incarcerated (OR: 22.733, $p=0.0339$) or strangulated hernias (OR: 9.4545, $p=0.0390$). Group B had longer hospitalizations ($p=0.00132$) and higher hospitalization costs ($p = 0.00262$).

Conclusions: DM patients with comorbidities are at higher risk for complex hernias and prolonged hospitalizations. Pulmonary fibrosis emerges as a significant comorbidity requiring specific perioperative strategies. Tailored preoperative assessments and care plans can optimize outcomes.

Key words: inguinal hernia, diabetes mellitus, comorbidities, open repair, surgical outcomes

Introduction

Inguinal hernia is a common disease and it is estimated that 27% of men and 3% of women will develop an inguinal hernia in their life-time (1). Although the overall incidence of inguinal hernias is substantial, the management of these hernias in patients with diabetes mellitus (DM) presents unique challenges due to the potential impact of diabetes on wound healing and infection risk. The presence of additional comorbidities further complicates this scenario, necessitating a deeper understanding of their influence on surgical outcomes.

Patients with DM are known to be at

increased risk of surgical complications following various procedures, including hernia repair. A study by Hellspong et al. found that diabetes was associated with an increased risk of postoperative complications in patients undergoing groin hernia surgery (2). Impaired wound healing, higher infection rates, and delayed recovery are among the concerns when managing inguinal hernias in diabetic patients (3). In a large cohort study on patients undergoing elective surgery, Shanahan et al found higher adverse event rates for patients with preoperative hyperglycemia, thus underlying the importance of glycemic control in diabetic patients undergoing inguinal hernia repair (4).

In a study on the impact of diabetes mellitus on in-hospital costs in patients with inguinal hernia, patients with DM experienced higher costs for hospitalization in patients with DM, but without statistical significance (5).

The presence of additional comorbidities further exacerbates these challenges. The use of anticoagulant therapy (such as for patients with atrial fibrillation) is accompanied with a higher risk for postoperative bleeding (6). Several studies have found that obesity may be a protective factor for the development of inguinal hernia, but some studies have shown that obesity may put patients at a higher risk for hernia complications (7-12).

While several studies have investigated the outcomes of hernia repair in the general population, limited data exist on outcomes specifically in patients with DM and multiple comorbidities (2,13).

This study aims to bridge this gap by evaluating the impact of additional comorbidities on surgical outcomes following open inguinal hernia repair in patients with DM. Specifically, we investigate the association between comorbidities and emergency presentations, hernia complications, hospitalisation duration, postoperative outcomes and healthcare costs. Understanding these relationships is crucial for optimising patient care and resource allocation.

Recent literature has highlighted the need for personalised care strategies in high-risk surgical patients, such as those with DM and multiple comorbidities (14,15). By identifying risk factors and associated outcomes, healthcare providers can implement targeted interventions to improve patient outcomes and reduce healthcare costs.

Materials and Methods

We performed a retrospective cohort study in the first surgical ward of Craiova Emergency Clinical County Hospital. Study inclusion time was a period of 6 years, from January 1st 2015 to December 31st 2020. The study included adult patients who underwent open inguinal hernia repair with a documented diagnosis of

DM. There were no exclusion criteria. The hospital database was searched using the ICD-10 code K40 and individual patient observation charts and operative files were retrieved. Data was extracted and compiled into an Excel Spreadsheet. All patients were followed up for 6 months postoperative.

Patients were categorized into two groups based on comorbidity status: Group A that included patients with DM alone; and Group B that included patients with DM and additional comorbidities. Co-morbidities that were asserted were obesity, atrial fibrillation and pulmonary fibrosis. Patients were telephonically contacted to evaluate for postoperative pain and recurrence status. A questionnaire was developed which evaluated pain intensity on a 0-10 Likert scale (*Appendix 1*). Frequency, duration and pain characteristics (like a pressure, sting, stabbing, electrical shock, burning, cold sensation, tingling, numbness, itching), onset factors (weather-related, influence by physical activity, pain when performing everyday activities like lifting from a chair, bending, climbing stairs, driving), impact of pain on work, use of analgesics for pain control, presence of testicular pain or erectile dysfunction and recurrence status.

Demographic data, clinical characteristics, and surgical outcomes were collected from electronic medical records. The primary collected data of interest included the mode of presentation (elective vs. emergency), hernia type (incarcerated or strangulated), prevalence of comorbidities (e.g. Atrial fibrillation, obesity, pulmonary fibrosis), duration of hospitalization, operative aspects (procedure, complications), postoperative outcomes, postoperative pain and healthcare costs related to the hospital stay. The costs are expressed in Romanian New Leu (RON) which is the national currency of Romania.

Statistical Analysis

Statistical analysis was performed using the Mann-Whitney U test to compare continuous variables between the two groups. Categorical variables were analysed using Chi-square

tests. Odds ratios (ORs) were calculated to assess the association between comorbidities and surgical outcomes. A p-value of <0.05 was considered statistically significant.

Results

The search yielded 195 patients with inguinal hernia, of which 38 (19.49%) with diabetes mellitus. The study cohort comprised 38 patients with DM (16 in Group A and 22 in Group B) who underwent open inguinal hernia repair. No differences were found between the two groups regarding gender, environment, recurrence status at the moment of surgery, or bilateral localisation (*Table 1*).

The mean age of patients in Group B (DM with additional comorbidities) was significantly higher compared to Group A (DM alone) ($p = 0.0002$) (*Table 2*). The most frequent comorbidities in patients in group B were pulmonary fibrosis ($p=0.0247$), atrial fibrillation ($p=0.0764$) and obesity ($p=0.0764$) (*Table 1*).

Patients in Group B were more likely to

present in an emergency setting (OR: 13.81, 95% CI: 1.6727 - 114.1488, $p=0.0148$), or with incarcerated (OR: 22.733, 95% CI: 1.2673 - 407.8112, $p=0.0339$), or strangulated hernias (OR: 9.4545, 95% CI: 1.1196 - 79.8378, $p=0.0390$) compared to those in Group A (*Table 1*).

The survey conducted via telephone found that 3 patients in group B had deceased during the COVID-19 pandemic, which were excluded from the statistical analysis of the telephone survey. Postoperative pain was described by 7 patients (18.42%) with DM, 3 in group A and 1 in Group B, with 1 patient (2.63%) (group B) necessitating use of analgesics for pain management (*Table 1*).

Furthermore, patients in Group B experienced a significantly longer duration of hospitalisation compared to those in Group A (3.62 ± 1.05 vs 7.77 ± 10.26 , $p=0.00132$). Healthcare costs related to hospital stay were also higher in Group B ($p=0.00262$), although the overall costs did not differ significantly between the two groups (901.38 ± 239.83 vs 1847.22 ± 2344.64 , $p=0.1652$) (*Table 2*) (*Fig. 1*).

Table 1. General characteristics and statistical results

	Without additional comorbidities	With additional comorbidities	OR (95% CI)	p
No of patients	16	22		
Male sex	16	18	0.82 (0.3222-2.0774)	0.6729
Urban environment	12	10	0.61 (0.2104-1.7455)	0.3535
Recurrent	1	2	1.45 (0.1212-17.4628)	0.7676
Bilateral	3	4	0.97 (0.1901-4.9473)	0.9705
Emergency	1	19	13.81 (1.6727-114.1488)	0.0148
Incarcerated	0	15	22.7 (1.2673-407.8112)	0.0339
Strangulated	1	13	9.45 (1.1196-79.8378)	0.0390
Atrial fibrillation	0	9	13.93 (0.7560-256.7853)	0.0764
Pulmonary fibrosis	0	18	27.13 (1.5231-483.3620)	0.0247
Obesity	0	9	13.93 (0.7560-256.7853)	0.0764
Mesh repair	16	21	0.95 (0.3822-2.3840)	0.9206
Wound infection	0	1	2.2 (0.0842-57.4870)	0.6358
Hematoma	1	3	2.18 (0.2074-22.9475)	0.5158
Wound dehiscence	0	1	2.2 (0.0842-57.4870)	0.6358
Telephone survey				
Preoperative pain	8	14	1.27 (0.4316-3.7528)	0.6620
Postoperative pain	3	4	0.89 (0.2182-5.7770)	0.8898
Use of analgesics for postoperative pain	0	1	2.54 (0.0968-66.5985)	0.6358
Recurrence	0	1	2.54 (0.0968-66.5985)	0.5763

Table 2. Statistical results of age, hospital stay and costs

Costs	Without additional comorbidities (average $\pm$ standard deviation)	With additional comorbidities (average $\pm$ standard deviation)	p (Mann-Whitney)
No of patients	16	22	-
Age	68.94 $\pm$ 6.55	79 $\pm$ 7.12	0.0002
Hospitalisation	3.62 $\pm$ 1.05	7.77 $\pm$ 10.26	0.0013
1. Hospitalisation (no of days x cost/day)	656.18 $\pm$ 190.55 RON	1370.42 $\pm$ 1884.34 RON	0.0026
2. Food	34.93 $\pm$ 10.74 RON	85.91 $\pm$ 159.06 RON	0.0045
3. Medication	58.08 $\pm$ 44.99 RON	139.82 $\pm$ 138.87 RON	0.384
3.1. Medication in Emergency Unit	0 RON	3.85 $\pm$ 12.90 RON	0.205
3.2. Materials in Emergency Unit	1.68 $\pm$ 4.44 RON	3.13 $\pm$ 4.79 RON	0.404
3.3. Laboratory investigations in Emergency Unit	8.12 $\pm$ 21.50 RON	14.86 $\pm$ 23.54 RON	0.1770
3.4. Radiology in Emergency Unit	0.93 $\pm$ 3.63 RON	11.45 $\pm$ 39.81 RON	0.3472
4. Sanitary materials	77.91 $\pm$ 80.97 RON	78.62 $\pm$ 75.74 RON	0.3421
5. Laboratory analysis	54.87 $\pm$ 59.38 RON	135.13 $\pm$ 169.78 RON	0.1556
6. Other investigations	8.64 $\pm$ 19.07 RON	4 $\pm$ 10.09 RON	0.5619
Total costs	901.38 $\pm$ 239.83 RON	1847.22 $\pm$ 2344.64 RON	0.1652

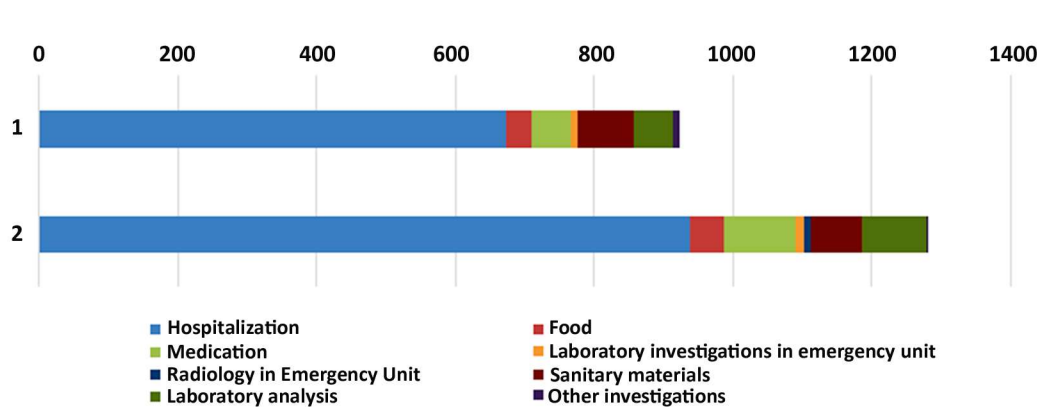
Discussions

The findings from this study shed light on the significant impact of comorbidities on surgical outcomes following open inguinal hernia repair in patients with diabetes mellitus (DM). Our analysis reveals that patients with DM and additional comorbidities were at a heightened risk of experiencing emergency presentations and hernia complications, particularly incarceration or strangulation. This finding underscores the importance of patient education and comprehensive pre-operative evaluations to identify high-risk

patients, allowing for timely interventions and potentially reducing the incidence of emergency hernia presentations (16).

The association between pulmonary fibrosis and the presence of multiple comorbidities is particularly noteworthy. Pulmonary fibrosis emerged as a significant comorbidity among patients in Group B, necessitating tailored perioperative management strategies.

Dai et al found that chronic obstructive pulmonary disease (COPD) was an independent risk factor postoperative complications (17). Similarly, Zeb et al identified atrial fibrillation as a risk factor for postoperative hematoma

**Figure 1.** Bar Chart of healthcare related costs. Group 1 – Group A; Group 2- Group B

(18). Sanders et al found that an INR greater than 3 significantly increases the risk of postoperative hematoma, and concluded that patients can safely undergo inguinal repair if INR is less than 3 (19). This highlights the importance of interdisciplinary collaboration involving pulmonologists in preoperative assessments and care planning for this vulnerable patient population (20).

Our study also demonstrated a significant correlation between comorbidities and prolonged hospitalization, which consequently led to higher healthcare costs related to hospital stays. While the overall costs did not differ significantly between the groups, the economic burden of extended hospital stays underscores the need for resource allocation strategies to optimize healthcare delivery and cost-effectiveness. This results are validated by Aydin et al who found that older age, multimorbidity, emergency operations, incarceration, longer hospital stays were significant cost-driving factors (21).

Future research should focus on prospective studies to validate these findings and explore targeted interventions to mitigate surgical risks in patients with DM and multiple comorbidities. Nevertheless, postoperative complication rates (hematoma, wound infection, wound dehiscence) or recurrence rates did not differ between the two groups. This was also the case for chronic postoperative pain occurrence rates or use of analgesics for chronic postoperative pain.

Conclusions

In conclusion, this study demonstrates that patients with DM and multiple comorbidities are more likely to present with complicated hernias requiring emergency interventions and experience prolonged hospitalisation. Pulmonary fibrosis emerges as a notable comorbidity associated with this patient population.

The presence of additional comorbidities to diabetes mellitus was not associated with an increase in adverse events, postoperative pain

rates or overall costs.

These findings underscore the importance of comprehensive preoperative assessments and individualised care planning for patients with DM undergoing hernia repair. By identifying and addressing specific risk factors, healthcare providers can optimise surgical outcomes and improve patient satisfaction.

Further research is warranted to develop targeted interventions aimed at reducing surgical complications and healthcare costs in this vulnerable patient cohort.

Study Limitations

This study is limited by its retrospective design and the relatively small sample size, which may affect the generalizability of our findings. The use of a telephone survey to assess postoperative pain may introduce recall bias, impacting the accuracy of reported outcomes. The low number of cases make subset analysis not possible and should be further validated on larger cohort studies.

Authors' Contributions

MR, SR, SP – data acquisition; ATS, DM, SL – data analysis; SDP, DC, PR – manuscript preparation and writing; VS, KS – project supervision.

Conflicts of Interest

The authors declare no conflicts of interest.

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Ethical Statement

This study was conducted following the guidelines of the Declaration of Helsinki and was approved by the ethics committee of the University of Medicine and Pharmacy of Craiova (no. 119/17.12.2018).

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Supplementary Material

Appendix 1. Questionnaire regarding quality of life and postoperative pain after Lichtenstein Repair

Patient Name:

1. Did you have postoperative pain? If YES, how strong was it on a scale of 1 to 10.
 - a. 0 - no pain
 - b. 1,2,3 - small pain
 - c. 4,5,6 - moderate pain
 - d. 7,8,9,10 - severe pain
2. Do you feel pain now?
YES/NO
3. Did you feel pain in the last week?
YES/NO
4. How often did you feel pain?
 - a. Everyday
 - b. Frequent
 - c. Occasional
5. How long did painful episodes last?
 - a. < 60 minutes
 - b. > 60 minutes
6. On a scale from 1 to 10, how strong is the pain?
 - a. 0 - no pain
 - b. 1,2,3 - small pain
 - c. 4,5,6 - moderate pain
 - d. 7,8,9,10 - severe pain
7. Pain characteristics:
 - a. Like a pressure
 - b. Like a sting
 - c. Stabbing pain
 - d. Like an electrical shock
 - e. Burning
 - f. Painful sensation of cold
 - g. Tingling sensation
 - h. Numbness
 - i. Itching sensation
8. Is the pain influenced by the weather?
YES/NO
9. Does the pain remain localized (not referred)
YES/NO
10. Is it influenced by physical activity?
YES/NO
11. Do you have pain when lifting from a chair?
YES/NO
12. Do you have pain when bending?
YES/NO
13. Do you have pain when climbing / descending stairs?
YES/NO
14. Do you have pain when driving?
YES/NO
15. Does the pain affect your work?
YES/NO
16. Do you use pain medication for this pain?
YES/NO
17. Do you have testicular pain?
YES/NO
18. Do you have erectile dysfunction?
YES/NO
19. Did you have a recurrence? YES/NO
 - a. At what time following the first surgery:
 - b. Did you consult a Surgeon?
 - c. Do you have a diagnosis of a recurrence?
 - d. Did you receive a repair for the recurrence?