

Lichtenstein Repair in Inguinal Hernia- A Retrospective Study on the Impact of In-Hospital Costs of Diabetes Mellitus

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ABSTRACT: Introduction: Inguinal hernia is one of the most common conditions in surgical departments and diabetes is known to have a significant impact on both patients' health and healthcare system. The current study aims to evaluate extensively the differences in costs for different subgroups of diabetic patients undergoing inguinal hernia repair in a tertiary care medical center in South-West Romania. Material and methods: A total number of 195 patients underwent hernia repair for primary or recurrent inguinal hernia between 2015 and 2020 and were included in the analysis. The group was divided into diabetic/non-diabetic patients and each of these subgroups was studied separately according to the presence or absence of comorbidities, sex and place of origin. Results: Statistically significant differences were found in the division of the age group, highlighting the fact that in diabetic patients the average age was around 74.76 years, unlike those without diabetes in which the average age was approximately 61.31 years. Another statistically significant difference was observed in the classification by hospitalization days of the group of patients with incarcerated inguinal hernia, in a sense that diabetic patients required a prolonged hospitalization by 1.5 days as opposed to non-diabetics. Conclusions: The costs of hospitalization for diabetic patients undergoing hernia repair surgery were marginally higher than in non-diabetic patients, but no statistical difference could be observed between any of the costs subsets in the two patients groups.

KEYWORDS: *Hernia repair; cost calculation; inguinal hernia; multimorbidity.*

Introduction

Inguinal hernia is one of the most common conditions in surgical departments, and its surgical treatment has aroused the interest of generations of surgeons, as evidenced by the large number of repair procedures developed over time [1].

Lichtenstein repair has become the preferred "tension-free" open repair for primary inguinal hernia due to its reproducibility, fast postoperative recovery, reduced postoperative pain, and low recurrence rate (ranging from 0 to 2%) [2].

Diabetes mellitus has a significant impact on both patients' health and healthcare system.

Regarding the abdominal wall defects repair, the biomechanical properties of tissues in patients with diabetes are altered, in a way that higher rigidity and less flexibility can be observed, thus making them more prone to vicious cures [3].

It has been suggested that these properties are the result of imbalances in collagen synthesis and degradation, with tissue inhibitor of metalloproteinases playing an important role [4,5].

Although an exact percentage cannot be provided, it is estimated that approximately 25% of diabetic patients undergoing surgery experience difficulties in the healing of postoperative wounds, which leads to a directly proportional increase in hospitalization and thus costs [3,6].

The current study aims to evaluate extensively the differences in costs for different subgroups of diabetic patients undergoing inguinal hernia repair in a tertiary care medical center in South-West of Romania.

Material and Methods

A total number of 195 patients were retrospectively followed between January 1st 2015 and December 31st 2020 in the 1st Surgical Department of the Emergency County Hospital of Craiova, Romania.

The specific information was collected from their clinical report files in accordance to all legal considerations. The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova (protocol no. 119 / 17.12.2018).

Inclusion criteria involved primary inguinal hernia uncomplicated and complicated with incarceration and strangulation.

Patients with intestinal lesions requiring resection were excluded because in those patients meshes were not used.

Surgical Technique

Patient was placed in dorsal decubitus, no special drape was used, and hair was trimmed

An oblique incision was performed, 2cm from the pubic bone to 2cm to anterior superior iliac spine.

After incision of subcutaneous tissue, the anterior wall of the inguinal canal was open, and the conjoint tendon and inguinal ligament were exposed.

Spermatic cord was dissected, the sac isolated from cremaster muscle and elements of the spermatic cord, and opened. Kelotomy was performed in case of strangulation.

The incarcerated content was dissected from adhesions in the hernia sac.

The content-omentum, small bowel or sigmoid-was checked for any lesion in case of strangulation.

The hernia mesh was contraindicated if a small bowel resection was performed, or if the fluid in the sac presented signs of infection.

If only omental resection was performed a Lichtenstein type repair was performed.

The repair was done in the majority of cases exactly as in the original technique, and in some cases, small variations were used.

One variation of the technique was that the posterior upper leaf of the mesh was not overlapping the inferior one, but sutured parallel to the other, while in very few cases, the split was done laterally at the level of the internal orifice.

In all cases, a polypropylene light mesh at least 7.5/11cm was used.

No drainage was deemed necessary.

Postoperative Care and Follow-Up

Patients were allowed to drink clear liquids ad libitum and eat some yogurt in the evening of the operation.

Anti-thrombotic prophylaxy was employed according to the Caprini risk stratification [7].

Patients with uncomplicated hernias, no co-morbidities and no diabetes mellitus were discharged in the 1st or maximum 2nd postoperative day.

In the rest of the cases the discharge was left at the decision of the operator.

Patients were followed in the ambulatory unit, up to one month after surgery, to remove stiches and detect early complications.

Data Collection and Statistical Analysis

The following clinico-demographic aspects were recorded: age, place of residence, the presence of comorbidities such as diabetes, obesity, hypertension, atrial fibrillation, pulmonary fibrosis, complications of hernias such as strangulation and incarceration.

The automatic calculation and standard output based on the medical records displayed by the hospital's electronic database was performed (Table 1).

Table 1. The cost parameters retrieved from the electronic database of SCJU Craiova.

1. Hospitalization costs (no of days * cost/day)
2. Food costs
3. Medication costs
3.1. costs with medication in emergency unit
3.2. costs for materials in emergency unit
3.3. costs for laboratory investigations in emergency unit
3.4. costs for radiology explorations in emergency unit
4. Costs for sanitary materials
5. Costs with laboratory analysis
6. Costs with other investigations
TOTAL COSTS

Statistical analysis was performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA), together with the XLSTAT add-on for MS Excel (Addinsoft SARL, Paris, France) and IBM SPSS Statistics 20.0 (IBM Corporation, Armonk, NY, USA) for data processing.

The data were recorded using Microsoft Excel files and then analyzed statistically to find the relationship between diabetes and patients' recorded demographic and financial parameters.

We performed a descriptive analysis of the study group (percentage of cases for categorical data, average and standard deviation for numerical data) and complex statistical tests (Chi square and Fisher exact test, Mann-Whitney test) using the statistical software mentioned above.

We used the Chi square test (χ^2) to test whether there is any relationship between the categorical variables.

If the p-value obtained from the test was <0.05 , we concluded that an influence existed between the two factors.

To test the normality of the data for the parameters involved in this study we used the Anderson-Darling test.

Because the numerical variables investigated did not have a normal distribution of data, globally or within each study group, we did not

used parametric statistical tests and had to use the non-parametric Mann-Whitney test.

If the p value obtained after performing the test was <0.05 the null hypothesis H0 was rejected and the alternative hypothesis H1 was accepted, indicated there is a difference between the values of the compared samples.

Results

The group was divided into diabetic and non-diabetic patients, with each of these subgroups being studied separately according to the presence or absence of comorbidities, sex and place of origin.

he demographic characteristics of the patient subsets are presented in Table 2.

Statistically significant differences were found in the division of the age group, highlighting the fact that in diabetic patients the average age was around 74.76 years, unlike those without diabetes in which the average age was approximately 61.31 years (p=0.0001).

The statistically significant difference appears in the spending for imaging investigations (p=0.0132) (Table 3).

Table 2. The demographic characteristics of the diabetic patients undergoing hernia repair surgery and its subgroups.

HERNIA GROUP		Diabetes (no of patients)			
Sex		Yes	No	Total	P (χ ²)
Female	Obesity	3	5	8	0.653
	Strangulated	4	13	17	
	Incarcerated	3	6	9	
	Total	4	29	33	0.626
Male	Obesity	8	9	17	0.666
	Strangulated	10	45	55	
	Incarcerated	12	17	29	
	Total	34	128	162	0.241
Place of residence					
Rural	Obesity	4	9	13	0.165
	Strangulated	8	33	41	
	Incarcerated	9	12	21	
	Total	16	78	94	0.987
Urban	Obesity	7	5	12	0.635
	Strangulated	6	25	31	
	Incarcerated	6	11	17	
	Total	22	79	101	0.402
Total	Total	38	157	195	

Table 3. Spending subset analysis in diabetic patients with inguinal hernia repair.

Hernia group	Diabetic	Non-diabetic	P Mann-Whitney
Age (years)	74.76±8.60	61.31±16.96	<0.0001
No. of hospital days	6.03±8.21	4.55±2.31	0.2035
1. Overall medical costs (Hospital days x cost/day)	1069.69±1501.55	852.99±441.15	0.6731
2. Spendings for food (daily meal x no. of hospital days)	64.45±125.47	44.95±23.17	0.6025
3. Spendings for drugs during hospitalization	105.41±118.39	92.49±119.89	0.3191
3.1. Spendings for medication in ER	2.23±10.13	2.26±11.01	0.5437
3.2. Spendings for medical consumables in ER	2.53±4.76	2.21±4.88	0.6487
3.3. Spendings for blood tests in ER	12.03±23.26	12.32±22.55	1.0000
3.4. Spendings for radiology in ER	7.03±31.24	10.52±41.69	0.3642
4. Medical consumables and disposables	78.33±79.04	70.88±79.22	0.4269
5. Blood tests	101.34±142.40	90.30±81.18	0.6221
6. Imaging investigations	5.95±14.94	1.66±8.22	0.0132
TOTAL SPENDINGS	1448.97±1875.51	1180.57±632.76	0.3906

The association of obesity partially changed the statistical situation, in a sense that blood tests spendings appeared significantly higher in

non-diabetic obese patients (p=0.0046), contrary to imaging investigation costs, which did not display any relevant differences (Table 4).

Table 4. Spending subset analysis in obese patients with diabetes mellitus undergoing inguinal hernia repair.

Obese patients	Diabetic	Non-diabetic	p Mann-Whitney
Age (years)	79.45±6.46	68.43±15.46	0.0397
No. of hospital days	5.00±1.73	5.64±2.73	0.6772
1. Overall medical costs (Hospital days x cost/day)	805.72±225.33	1078.11±590.79	0.2816
2. Spendings for food (daily meal x no. of hospital days)	42.09±13.12	54.00±25.29	0.2453
3. Spendings for drugs during hospitalization	115.14±124.23	149.72±220.48	0.8480
3.1. Spendings for medication in ER	0.09±0.30	0.00±0.00	0.2948
3.2. Spendings for medical consumables in ER	4.04±6.32	1.36±3.52	0.1765
3.3. Spendings for blood tests in ER	8.18±22.61	5.71±17.53	0.7969
3.4. Spendings for radiology in ER	18.82±57.61	3.36±12.56	0.4380
4. Medical consumables and disposables	68.85±36.65	98.62±110.20	0.8480
5. Blood tests	54.82±61.85	131.50±57.39	0.0046
6. Imaging investigations	11.48±21.80	6.57±14.50	0.7148
TOTAL SPENDINGS	1129.23±354.84	1528.96±848.07	0.2857

In patients with strangulated inguinal hernia, the mean age of occurrence for this complication among diabetic patients was 78 years, compared to the non-diabetic group where the mean age was around 63 years ($p=0.0031$).

Despite longer hospital stay in case of diabetic patients ($p=0.0168$), no significant cost variances were observed in this subset of patients (Table 5).

Table 5. Spending subset analysis in patients with diabetes mellitus and strangulated hernia undergoing surgical repair.

Strangulated group	Diabetic	Non-diabetic	P Mann-Whitney
Age (years)	78.79±9.43	63.48±18.54	0.0031
No. of hospital days	8.43±13.18	4.90±2.98	0.1338
1. Overall medical costs (Hospital days x cost/day)	1539.39±2412.29	917.17±579.40	0.1833
2. Spendings for food (daily meal x no. of hospital days)	101.43±204.42	48.05±29.25	0.2467
3. Spendings for drugs during hospitalization	145.84±149.96	122.74±146.66	0.4381
3.1. Spendings for medication in ER	6.05±16.35	5.48±17.39	0.7790
3.2. Spendings for medical consumables in ER	4.34±5.45	4.86±6.70	0.9074
3.3. Spendings for blood tests in ER	26.93±28.96	26.45±27.01	0.8256
3.4. Spendings for radiology in ER	16.93±50.78	22.22±61.53	0.2036
4. Medical consumables and disposables	80.32±96.13	77.50±101.63	0.9546
5. Blood tests	128.14±214.87	78.38±104.28	0.8704
6. Imaging investigations	4.00±10.17	1.03±6.28	0.1190
TOTAL SPENDINGS	2053.36±3013.93	1303.88±856.55	0.1742

Concerning the other complication of inguinal hernias-incarceration-the mean age for surgical procedure in diabetic patients was 82 years, compared with 69 years in non-diabetic patients ($p=0.0119$).

A statistically significant difference was also observed in the classification by hospitalization days of the group of patients with incarcerated inguinal hernia, in a sense that diabetic patients required a prolonged hospitalization by 2-3 days as opposed to non-diabetics ($p=0.0168$) (Table 6).

Table 6. Spending subset analysis in patients with diabetes mellitus and incarcerated hernia undergoing surgical repair.

INCARCERATED GROUP	Diabetic	Non-diabetic	P Mann-Whitney
Age (years)	81.80±5.39	69.00±16.15	0.0119
No. of hospital days	5.93±2.02	4.30±1.94	0.0168
1. Overall medical costs (Hospital days x cost/day)	1009.93±358.85	820.45±330.76	0.1161
2. Spendings for food (daily meal x no. of hospital days)	53.33±20.67	43.04±19.41	0.1387
3. Spendings for drugs during hospitalization	105.66±106.46	104.90±99.99	0.9167
3.1. Spendings for medication in ER	3.90±14.81	1.83±5.58	0.7598
3.2. Spendings for medical consumables in ER	3.78±5.51	1.66±2.60	0.6782
3.3. Spendings for blood tests in ER	13.13±24.56	21.48±28.51	0.4769
3.4. Spendings for radiology in ER	14.80±49.30	15.04±40.46	0.3586
4. Medical consumables and disposables	63.47±30.34	87.75±63.79	0.2890
5. Blood tests	91.13±110.56	79.87±73.51	0.9518
6. Imaging investigations	5.87±12.18	1.39±6.67	0.1527
TOTAL SPENDINGS	1365.01±440.28	1177.41±464.90	0.1649

ER: emergency room

Discussion

The current quest for cost optimization in surgery is exceeding the domain of academic research, passing well into the area of clinical necessity.

There is probably no better place to substantiate this assertion than in the case of diabetic patients, where the increasing costs of surgical procedures together with the debilitating nature of diabetes mellitus create a terrible

burden for both patients and medical system [8,9].

This study analyzed both the overall and detailed costs for surgical repair of inguinal hernia in diabetic patients admitted in a tertiary care medical center in Romania.

Although the costs of hospitalization for diabetic patients were marginally higher, no statistical difference could be observed between any of the costs subsets in the diabetic and non-diabetic patients groups.

Given the clinical characteristics of diabetic patients, such as altered immune response, poor healing etc., a more thorough analysis of the subset of patients with complicated inguinal hernia (incarcerated, strangulated) was deemed to be more relevant in the given setting.

Despite a higher financial burden in case of diabetic patients, no statistical differences were observed for patients with complicated inguinal hernia.

Interestingly, despite statistically longer hospital stay in case of diabetic patients with strangulated hernia, no major cost impact was observed.

A possible explanation may reside in the lower requirements for medication and medical care for inguinal hernia patients in the postoperative setting.

Moreover, the prolonged hospital stay in these cases was probably not a result of postoperative complications, but an effect of the extra caution that these patients usually require.

The mean hospital stay did not statistically vary in the other subgroups.

Another parameter that displayed statistically significant variations is the patients' age at presentation, which was higher in the diabetic group.

The results may initially come as a surprise, due to the general perception about the high costs associated with diabetes mellitus.

The literature shows that patients with comorbidities (like diabetes, tobacco use and obesity) undergoing hernia repair surgery are more likely to develop complications than patients without comorbidities and these patients generate higher hospital charges than those without comorbidities even when no complications occur [10].

Furthermore, if more comorbidities coexist, the clinical and financial impact for the patient will be more significant.

Interestingly, the studies also show that patients with multiple comorbidities and no complications had equivalent hospital costs compared to patients without comorbidities and with complications [11].

Other studies also found that, after controlling for surgeon-and hospital-level variation, a number of adverse postoperative outcomes and increased spending were associated with patient-level preoperative risk factors in abdominal wall surgery [12,13].

A number of these factors, such as obesity, diabetes, unhealthy alcohol use, and smoking are potentially modifiable.

Preoperatively modifying these risk factors may therefore improve patient outcomes and reduce the health care expenditures associated with these complications [14].

Regarding the effect of varying severity of diabetes mellitus on hernia repair outcomes, the studies show that insulin-dependent or complicated diabetes undergoing open hernia repair had significantly worse outcomes compared with noninsulin-dependent or uncomplicated diabetics [15].

As the total costs of hernia repair surgery are expected to increase even further, a thorough analysis of all variables involved in cost determination should be mandatory for taking the most efficient clinical and financial decisions [16].

The per capita costs are influenced not only by external factors, such as the type of approach and surgical procedure costs, but also by the clinical particularities of each patient [17].

These essential variables include the type of comorbidities, the specific treatment that should be continued during the current admission, and the perioperative therapeutic protocol used for a particular type of surgical approach or technique.

Conclusions

Despite higher overall costs for hospitalization in diabetic patients undergoing hernia repair surgery compared to non-diabetic patients, no statistical difference was noticed between the costs subsets in the two groups.

The only exception was the statistically higher costs for imaging investigations in diabetic cases.

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Conflict of interests

None to declare.

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