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Original scientific paper

Comorbidities, Preoperative Preparation Duration and Treatment Outcomes in Hip Fracture Patients: A Retrospective Study

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Abstract

Introduction. Hip fractures in the elderly pose a major public health challenge, particularly due to the frequent presence of comorbidities which can prolong the preoperative preparation and increase intraoperative and postoperative risks.

Aim. This study aimed to assess whether the comorbidity burden changes preoperative preparation duration and evaluate its mediating effect through additional diagnostic tests and anesthesiological risk assessment.

Methods. A retrospective observational study was conducted on 71 patients with hip fractures admitted to the University Hospital Sveti Duh over one year. Demographic data, ASA classification, comorbidity types, and the number of additional diagnostic procedures were analysed. Statistical methods included the Mann-Whitney U test, multiple linear regression, and Sobel's test to evaluate mediation effects.

Results. Urological, neurological, and endocrine comorbidities significantly prolonged preoperative preparation ($p<0.05$). The number of additional diagnostic tests was the strongest predictor of preparation duration ($p<0.001$) and mediated the relationship between comorbidity burden and preoperative delay. Higher ASA classification scores were linked to longer preoperative preparation times and more required tests.

Conclusion. Comorbidities in hip fracture patients have prolonged the preoperative planning, with spe-

cific conditions leading to prolonged hospital stays and increased diagnostic demands. Optimising chronic disease management before trauma occurrence may help reduce preoperative delays and improve surgical outcomes.

Introduction

Elderly individuals accounted for 39.6% of all hospitalised patients in Croatia in 2022, reflecting a slight increase from 38.8% the year before. The average hospital stay decreased slightly from 9.49 to 9.36 days. In geriatric patients, hip fractures were among the most common diagnoses, and in those over 85, they were the leading cause of hospitalisation, highlighting the significant impact of falls and musculoskeletal injuries in this age group (1, 2).

Hip fractures account for approximately 30% of all bone fractures in individuals over 50 years of age, with a prevalence three times higher in women. The fracture risk in this population is notably elevated, 5.6% in men and 20% in women, primarily due to osteoporosis (3-5). Over the next decade, hip fracture incidence is projected to increase by 12% in women and 6.4% in men (4-6). By 2050, this trauma is expected to reach epidemic proportions, with an estimated 6 million hip fractures occurring annually in geriatric patients (4, 6).

Hip fractures pose a major public health concern due to their high incidence, associated morbidity and mortality (7). The global rise in hip fractures is largely driven by population aging and increased life expectancy (8). Projections indicate a continuing increase in fracture numbers, placing substantial strain on healthcare systems worldwide (9-11). Osteoporotic fractures, including hip fractures, contribute to over 10 million cases annually, imposing significant burdens on patients, families, and healthcare infrastructures (7, 9).

Similar to other traumatic injuries, femoral fractures in the hip region are unpredictable and place a significant burden on the bed capacity of healthcare facilities due to the need for hospitalisation and intensive treatment. Cost-benefit analyses indicate that these fractures involve substantial financial expenditure (12, 13). Nearly two-thirds of hip-region femoral fractures are both functionally and biomechanically unstable, necessitating hospital admission, surgical intervention, and a prolonged period of rehabilitation (14). These injuries are among the most frequently surgically treated traumatic conditions (15). Full recovery is achieved in only about 25% of cases, while nearly 50% of patients require long-term systemic support. Additionally, around 40% continue to need physical therapy, and approximately 25% remain at risk of sustaining a fracture in the contralateral hip (6, 13).

A crucial aspect of effective management is the patient's preoperative preparation, which involves comprehensive diagnostic assessments, preventive strategies, and the thorough preparation of both the patient and the surgical field to ensure optimal surgical conditions.

The timing of surgical intervention in hip fractures remains a subject of ongoing debate. In elderly patients with multiple comorbidities, a multidisciplinary evaluation is essential to identify potential contraindications related to cardiovascular, respiratory, or neurological function. Nonetheless, early surgical intervention is key to reducing the duration of bed rest and minimizing the risk of complications. Balancing these considerations makes the interval between hospital admission and surgery a critical factor, with important implications for clinical outcomes and healthcare system efficiency (14, 16).

Given the high prevalence of comorbidities in geriatric patients, surgical treatment must be precise to optimize recovery and maintain the quality of life (15, 17, 18). Following trauma, initial hip fracture diagnosis is performed using primary radiological assessments, followed by preoperative evaluation. Standardized laboratory tests and diagnostic procedures are required before anesthesiological clearance for surgery. However, most patients have one or more chronic or acute conditions, which frequently delay surgical approval. Additional specialist evaluations and diagnostic tests further extend the time to treatment (13, 19). Prolonged preoperative preparation has negative consequences, including an increased risk of complications related to extended bed rest, such as respiratory infections, urinary tract infections, pain management difficulties leading to distress syndrome, psychomotor disorders, and nosocomial infections. The surge in preoperative examina-

tions also places a considerable burden on diagnostic resources and healthcare personnel, prolonging hospital stays, increasing bed occupancy, and leading to substantial financial costs (16, 20).

The healthcare implications of hip fractures are profound, involving extended hospitalization, increased rehabilitation needs, and higher healthcare costs (21). Beyond the economic impact, hip fractures significantly affect patients' quality of life, often resulting in reduced mobility, loss of independence, and psychological distress (20, 22, 23). Understanding the influence of comorbidities on preoperative preparation duration and treatment outcomes remains essential for improving patient care (23).

Aim

This study aimed to examine the number of comorbidities, the initial anaesthesiological risk assessment, and the need for additional diagnostic procedures with the duration of preoperative hospitalisation in patients undergoing surgical treatment for femoral fractures in the hip region. Furthermore, it investigated how these factors are related to delays in surgical interventions and overall length of hospital stay, to identify opportunities to optimise preoperative management and enhance patient outcomes.

Methods

Study design

This retrospective observational research study included all patients admitted to the Traumatology Department through the emergency surgical outpatient clinic of the Emergency Department of the University Hospital Sveti Duh over one year (from January 1st, 2015 to January 1st, 2016), in whom surgical treatment of a radiologically verified femoral fracture in the hip area was indicated. The study was approved by the Ethics Committee of the University Hospital Sveti Duh (approval number 01-3225). Data were collected from the hospital information system database, and all participant identities remained anonymous and protected.

Respondents

Data were analysed regarding participants' sex and age, the type and number of comorbidities, American Society of Anesthesiologists (ASA) classification (24) at the initial anaesthesiological assessment, the number of prescribed and performed additional examinations and tests, and the number of days required for preoperative preparation for the planned surgical procedure. The collected data on comorbidities were categorised into seven groups. The cardiac comorbidities group included: hypertension, arrhythmias and conduction disorders, history of myocardial infarction, and conditions following coronary artery bypass grafting and stent placement. The neurological comorbidities group comprised Parkinson's disease, post-stroke with consequent paresis, and various peripheral neuropathies. In the group of urological comorbidities, the following were observed: acute and chronic urinary tract infections, incontinence, and prostate hypertrophy.

Pulmonary comorbidities included acute and chronic respiratory infections, asthma, chronic bronchitis, and COPD. In the group of psychiatric comorbidities, the following were found: Alzheimer's disease, various degrees of dementia, and psycho-organic syndromes. The group of "other" comorbidities included malignant diseases, metastatic fractures, circulatory insufficiency, venous ulcer disease, and autoimmune disorders. A total of 71 patients participated in our one-year study, including 57 women (80.3%) and 14 men (19.7%), which is consistent with epidemiological findings from other studies (25). The average age of the patients was 82, with the youngest being 59 and the oldest 93.

Of the patients included in the study, only 4.2% had no comorbidities, while the remaining exhibited between one and five comorbid conditions. The most frequently observed was two comorbidities, present in 35.3% of patients, followed by three in 31.0%, one in 22.5%, four in 4.2%, and five comorbidities in 2.8% of cases.

Statistics

The statistical significance level was set at 5% ($p < 0.05$), and two-tailed statistical tests were applied to all analyses. The normality of the distribution of continuous variables was tested using the Kolmogorov-Smirnov test for the entire patient set and subsamples larger than 30 patients, and the Shapiro-Wilks test for even smaller samples. Due to deviations from a normal distribution, the median and interquartile range were used to measure central tendency and dispersion. The Mann-Whitney test was employed to compare patients with and without a particular type of comorbidity. In the case of statistically significant differences, the AUC (area under the curve) was calculated as a standardised measure of effect size. The point-biserial coefficient was used for dichotomous variables, such as gender, and continuous variables. The simultaneous contribution of demographic and clinical characteristics to predicting the duration of preoperative preparation was examined using multiple linear regression analysis. All analyses were performed using the IBM SPSS statistical package. The hypothesis that the number of additional examinations is a mediator of the relationship between the number of comorbidities and the duration of preoperative preparation was tested using the Sobel test implemented in the PROCESS macro, version 2.16.3 (26).

Results

The study included 71 patients hospitalised at the Traumatology Department through the emergency surgical outpatient clinic of the Center for Emergency Medicine – Central Emergency Department of the University Hospital Sveti Duh over one year, who required surgical treatment of a radiologically verified femoral fracture in the hip area.

The most common comorbidities were cardiac (71.8%), followed by urological (40.8%), endocrinological (32.4%), neurological (28.2%), psychiatric (18.3%), and "other" conditions (12.7%). Respiratory comorbidities were the least frequent, occurring in 8.5% of patients. The number of prescribed and additional examinations and tests ranged from none to 16, while the duration of preoperative preparation varied from two to 11 days (Table 1).

Table 1. **Patient demographic and clinical data**

Sex	**n**	**(%)**
men	14	(19.7)
women	57	(80.3)
Total	71	(100.0)
Age (years), median (IQR)	*82*	*(79-85)*
Comorbidities		
cardiac	51	(71.8)
urological	29	(40.8)
endocrinological	23	(32.4)
neurological	20	(28.2)
psychiatric	13	(18.3)
respiratory	6	(8.5)
Other	9	(12.7)
Number of comorbidities, median (IQR)	2	(1-3)
Number of comorbidities, n (%)		
0	3	(4,2)
1	16	(22.5)
2	25	(35.3)
3	22	(31.0)
4	3	(4.2)
5	2	(2.8)
ASA classification at initial exam		
2	19	(26.8)
3	48	(67.6)
3-4	4	(5.6)
Number of additional tests, median (IQR)	2	(1-4)
Preoperative duration (days), median (IQR)	4	(3-6)

IQR = interquartile range, ASA = American Society of Anesthesiologists

The data concerning each type of comorbidity and the total length of preoperative preparation were also analysed. The length of preoperative preparation was compared in patients with and without the four most common comorbidities (Table 2).

There was no statistically significant difference in the length of preoperative preparation between patients with and without cardiac comorbidities. On the other hand, the length of preoperative preparation was longer in patients with urological comorbidities (Mann-Whitney U = 406.0; $p = 0.016$; AUC = 0.33). In the presence of endocrinological comorbidities, the length of preoperative preparation was longer than in their absence (Mann-Whitney U = 169.0; $p < 0.001$; AUC = 0.15. Neurological comorbidities also prolonged the preoperative preparation (Mann-Whitney U = 253.5; p = 0.001; AUC = 0.25).

Furthermore, the level of ASA classification at the initial anaesthesiology examination was divided into two categories. The first group consisted of patients whose ASA-sum was 2, while the second group consisted of patients whose ASA-sum was 3 or 3-4. At the univariate level, it was determined that the number of days spent on preoperative preparation has a statistically highly significant correlation with the number of prescribed and additionally performed examinations and tests, whereby the number of days of preparation increased with the number of additional tests. A greater number of days of preoperative preparation was associated with a greater number of comorbidities and a higher level of ASA classification at the initial anaesthesiology examination. A greater number of comorbidities was also associated with advanced patient age and a higher level of ASA classification at the initial anaesthesiology examination (Table 3).

Multiple linear regression analysis showed that the demographic and clinical predictor variables examined explained a proportion of the variation in the length of preoperative preparation, which amounted to 82.2% (R^2 = 0.822; F (5.65) = 60.11; p<0.001). The analysis showed that the number of prescribed and additionally performed examinations and tests was the only statistically significant predictor of the length of preoperative preparation.

Table 2. **Median duration of preoperative care and significance of the presence of specific comorbidities**

	Not-present		Comorbidity present		
Comorbidity type	**Median**	**(IQR)**	**Median**	**(IQR)**	***p***
Cardiac	4.0	(2.3-6.8)	4,0	(3.0-6.0)	0.871
Urological	4.0	(2.0-6.0)	5,0	(4.0-7.5)	0.016
Endocrinological	4.0	(2.0-5.0)	7,0	(6.0-10.0)	< 0.001
Neurological	4.0	(2.0-6.0)	5,5	(4.3-9.0)	0.001

IQR = interquartile range; *p* = statistical significance level; Mann-Whitney U test results

Table 3. **Relation of the duration of preoperative preparation and demographic and clinical predictor variables**

	1	2	3	4	5	6
1 Preoperative preparation (days)	-	-0.13	0.16	0.68***	0.53***	0.90***
2 Sex (female)		-	0.09	-0.08	-0.14	-0.03
3 Age			-	0.25*	0.11	0.13
4 Number of comorbidities				-	0.65***	0.75***
5 ASA classification at initial anesthesiological exam 3 or 3-4					-	0.51***
6 Number of additional tests						-

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 4. **Regression Analysis of the duration of Preoperative Preparation Based on Demographic and Clinical Characteristics**

	B	SE B	β	t	*p*
Age	0.03	0.02	0.06	1.12	0.266
Number of comorbidities	-0.20	0.23	-0.08	-0.88	0.383
ASA classification at initial anesthesiological exam 3 or 3-4	0.63	0.41	0.11	1.53	0.130
Number of additional tests	0.780	0.07	0.89	11.28	< 0.001

B = non standardised (raw) regression coefficient; SE B = standard error of regression coefficient; β = standardised regression coefficient

Furthermore, even after adjusting for other predictors in the regression model, more prescribed and performed examinations and tests remained significantly associated with a prolonged preoperative preparation period (Table 4).

Although the number of comorbidities was statistically significantly associated with the length of preoperative preparation at the univariate level (Table 3), this relationship was not statistically significant when other variables were considered in the multivariate prediction. At the univariate level, the number of comorbidities was highly correlated with the number of additional examinations (r = 0.75), so the possibility that the number of comorbidities affects the length of preoperative preparation due to the number of additional examinations was considered. In other words, the mediation hypothesis was tested where the number of comorbidities influences the length of preoperative preparation through the number of additional examinations.

In the first step, the relationship between the number of additional examinations and the number of comorbidities was examined using multiple linear regression, controlling for gender, age, and level of anaesthesia risk, and it was found that the number of comorbidities statistically significantly contributed to the prediction of the number of additional examinations (B=2.04; SE B=0.31; t=6.65; $p<0.001$). In the second step, the indirect effect of the number of comorbidities on the length of preoperative preparation was analysed using the Sobel test, while controlling for other variables included in the analysis. The analysis revealed that this indirect effect is statistically significant (z=5.71; SE z=0.28; $p<0.001$), thus confirming the mediation hypothesis.

In other words, it was determined that the number of additional examinations is a mediator, or an intervening variable, in the relationship between the number of comorbidities and the duration of preoperative preparation. A higher number of comorbidities leads to additional examinations, which in turn prolong the duration of preoperative preparation.

Discussion

Hip fractures in elderly patients represent a significant global health concern, particularly due to the high prevalence of comorbidities that complicate preoperative preparation, surgical procedures, and postoperative recovery (19, 27). The presence of multiple chronic conditions prolongs the time required for preoperative optimisation and increases the risk of complications, leading to worse treatment outcomes and higher healthcare costs (10, 28-31). Optimising the management of comorbidities before the occurrence of trauma could help reduce the duration of preoperative preparation and potentially improve the surgical outcomes for hip fracture treatment in elderly patients (32, 33).

Analysis of the collected data showed that cardiac comorbidities were the most common, affecting 71.8% of patients, a finding consistent with other studies (34, 35). Urological comorbidities were also common, present in 40.8% of patients, followed by endocrinological (32.4%), neurological (28.2%), psychiatric (18.3%), and "other" comorbidities (12.7%). Respiratory comorbidities were the least frequent, affecting 8.5% of patients. These findings align with those observed in similar studies (36). The high percentage of cardiac comorbidities was to be expected, most likely due to the advanced age of the participants.

Data analysis was focused on the relationship between the occurrence of each type of comorbidity and the total length of preoperative preparation. The preoperative preparation duration was compared between patients with and without the four most common comorbidities. The analysis revealed no statistically significant difference in the length of preoperative preparation for patients with cardiac comorbidities compared to those without such conditions. However, urological comorbidities ($p=0.016$) and neurological comorbidities ($p=0.001$) were significantly connected to the length of preoperative preparation. Endocrinological comorbidities had the most pronounced statistically significant relation to the length of preoperative preparation ($p<0.001$).

The number of prescribed and additional examinations and tests ranged from none (0) to 16. The duration of preoperative preparation varied from two to 11 days, with a typical range of three to six days. In

our study, the duration of preoperative preparation is similar to the average duration of preoperative preparation in published studies (37-41).

Through multiple linear regression analysis, it was determined that a statistically significant proportion of the variation in the length of preoperative preparation could be explained based on the investigated clinical predictor variables ($p<0.001$) and that the number of prescribed and additionally performed examinations and tests is the only statistically significant predictor of the length of preoperative preparation. After controlling for other predictor variables in the regression model, more prescribed and additionally performed examinations and tests were associated with a longer preoperative preparation time.

This study has several limitations. The retrospective, single-center observational design and the moderate sample size may introduce potential biases. These biases could be mitigated by extending the study period to account for seasonal variations, which may influence the incidence of hip fractures. Furthermore, changing the design and adding more locations could improve results of the study.

Conclusion

This study demonstrates that comorbidities in patients with hip fractures pose a significant challenge in the implementation of preoperative preparation, thereby affecting the overall surgical treatment process. The length of preoperative preparation was found to increase statistically significantly in patients with a higher ASA classification at the initial anaesthesiology examination, in those with endocrinological, urological, and neurological comorbidities, and in patients prescribed additional tests due to uncontrolled comorbidities and a high ASA classification.

Author contributions

Conceptualization and methodology (TM, SK, ADŽ); Data curation and formal analysis (TM, NG); investigation and project administration (TM, ADŽ, NG); and Writing – original draft and review & editing (TM, SK, NG). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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