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Intensive Care Unit Admission Predictors of Geriatric Patients Who Underwent Hemiarthroplasty due to Hip Fracture

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ABSTRACT

Objective: In this study, we aimed to investigate the clinical features of geriatric hip fracture cases that underwent hemiarthroplasty surgery and to reveal the predictors of hospitalization in ICU accordingly.

Methods: In this study, 158 geriatric patients who underwent hemiarthroplasty surgery for femoral neck fracture between January 2017 and December 2019 were retrospectively analyzed. The patients were divided into two groups as patients who were admitted to the ICU (ICU) and patients who were not admitted to the ICU (non-ICU). The clinical characteristics of the patients were compared between the two groups, and predictors of ICU admission were determined by a multivariate regression model.

Results: The mean age of the patients was 82.16±7.5 years, the mean duration of ICU hospitalization was 1.98±1.4 days, and the mortality rate was 9.5%. One hundred nineteen of the patients (75.31%) were admitted to the ICU after the surgery. According to the results of the univariate regression analysis, advanced age, presence of comorbidities (coronary artery disease, cerebrovascular disease), number of comorbidities, ASA score, Charlson age-corrected comorbidity index, transfusion of erythrocyte suspension, and cement application were significant risk factors for admission to ICU (p<0.02 for each). According to multivariate regression analysis, ASA score (OR=2.77, p=0.04) and cement application (OR=5.97, p<0.001) were determined as independent risk factors for hospitalization in ICU.

Conclusion: Factors that are predictors of the need for ICU after hemiarthroplasty surgery (ASA score and cement application) should be considered in geriatric patients. More comprehensive research is required to show the potential effects of these predictors better.

Keywords: Geriatrics, hemiarthroplasty, intensive care unit, predictor

Introduction and Purpose

Hip fracture (HF) is a significant health problem that mainly affects the elderly and may cause functional impairment, complications, and even death at high rates (1). The world population is aging rapidly. Thus, the annual HF incidence is increasing hastily due to the global rise in the elderly population (2). The number of HF's seen is estimated to reach 6.26 million annually in the world in 2050 (2).

HF in the elderly causes high mortality and morbidity due to limited physiological reserve, multiple comorbid conditions, trauma complications, and major surgical complications (1,2). Approximately 75% of patients with HF are geriatric patients over the age of 70 and 95% have at least one major preoperative comorbidity (1). Femoral neck fractures constitute approximately half of the HF's (3). Hemiarthroplasty (HA) is a preferred surgical method for femoral neck fractures of elderly patients (3). It has been reported in the literature that cemented HA is preferred to total hip arthroplasty, particularly in elderly patients, and provides less blood loss and shorter duration of the operation. (3,4). However, high mortality rates have been reported as a consequence of cardiopulmonary risks in elderly patients due to the use of cement (4,5).

In clinical studies, many factors, such as age, gender, ASA score, comorbid diseases, fracture type, time passed from fracture to operation, and albumin levels were associated with several postoperative complications and mortality (4-6). Regarding the intraoperative process, it has been demonstrated that factors, such as the longer duration of operation, the application of cement, the anesthesia method applied, the presence of hypothermia, excessive blood loss, and the emerging surgical complications increase the risk of postoperative complications and intensive care unit (ICU) admissions (3,6,7). Besides, surgical complications and pulmonary thromboembolism are commonly seen in these patients also in the postoperative period (3-7). Due to these reasons, patients with high health risks after HF surgery may be admitted to the ICU planned or unexpectedly, depending on their perioperative clinical status.

In the literature, the problem of which patients will need postoperative ICU after HA, which is major surgery, is a controversial issue among anesthesiologists and surgeons. No standard protocol has been defined to be used as a guide for the admission of these patients to ICU. The decision to admit a patient to the ICU is complex and is primarily the responsibility of the anesthesiologist. On the other hand, it is critical to carefully and accurately identify patients who need postoperative intensive care, especially during the COVID-19 pandemic, for more efficient use of the limited number of ICU beds.

Studies in the literature generally focused on postoperative mortality and complications after HF. To our knowledge, there are few studies describing risk factors or predictors of ICU hospitalization after HF. Therefore, it may be helpful for both anesthetists and surgeons to predict which patients may need ICU after HF, which is a surgery with a high complication rate.

This study aims to investigate the clinical characteristics of geriatric patients who underwent hemiarthroplasty for HF, then admitted to ICU after surgery, and to reveal the predictors of ICU hospitalization in this regard.

Materials and Methods

Ethical declaration

The ethics committee approval for this study was obtained from the Local Clinical Research Ethics Committee, in accordance with the Helsinki Declaration criteria (date: 2019, no: 137).

Study design and the medium of the research

This study was conducted by retrospectively examining the hospital files of geriatric patients who underwent HA for femoral neck fractures in our hospital between January 2017 and December 2019.

Inclusion criteria in this study were as follows: (1) Cemented or cementless HA must be performed in the patient. (2) The age of the patient had to be over 65. (3) The information and records in the patient's hospital file had to be complete.

The exclusion criteria in this study were as follows: (1) If the age of the patient was 65 years old or younger. (2) If the patient died during the operation. (3) If the surgery performed in the patient was a revision surgery. (4) If the patient was a multiple trauma patient. (5) If the patient's file records were not complete or accurate (Figure 1).

Study data

All patients evaluated in the study consisted of patients with isolated HF's that developed after simple trauma due to falls.

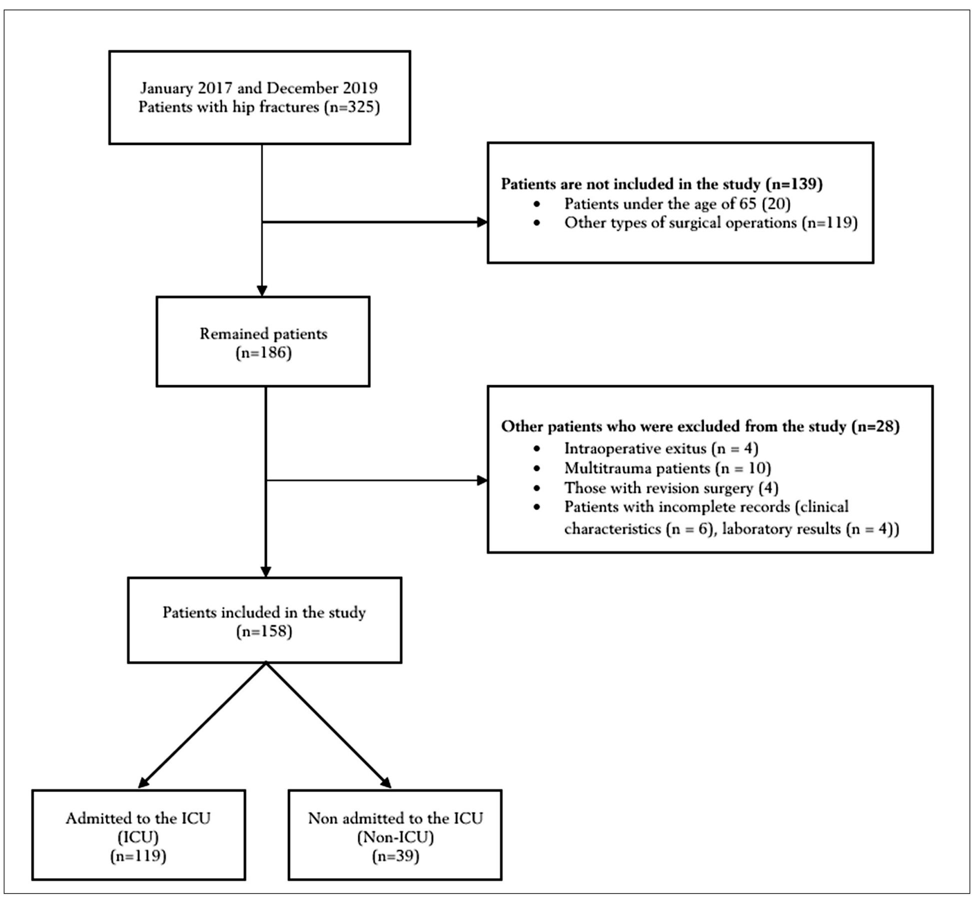

Figure 1. Retrospective study patient inclusion procedure (study flow chart).

Data were obtained from patient files, anesthesia follow-up forms, and the hospital information management system. The patients were divided into two groups as admitted to ICU (ICU) and not admitted to ICU (Non-ICU). In cases of recurrent ICU admissions, the first admission of the patient was evaluated.

The demographic characteristics, comorbidities, ASA (American Society of Anesthesiologists) scores, and preoperative laboratory parameters (Haemoglobin, Glucose, Sodium, Urea, Creatinine, Albumin) of the patients were evaluated. The surgical data evaluated were: fixation type (with or without cement application), anesthesia method (regional anesthesia (RA) or general anesthesia (GA)), time passed from fracture to surgery, duration of operation, need for intraoperative blood transfusion, and need for positive inotrope infusion. The total duration of the operation for each surgery was calculated by the sum of the duration of the anesthesia procedure and the duration of the surgical procedure.

All patients were routinely consulted for medical departments (cardiology, respiratory disease or internal medicine) in the preoperative period. The presence of comorbidities in the patients was confirmed by examining the consultation records obtained in the preoperative period. The comorbidity status was divided into four categories: "no additional illness", "1 additional illness", "2 additional illnesses", "3 or more additional illnesses". The Charlson age-corrected comorbidity index (CACI) of the patients was calculated on the website "http://www.pmidcalc.org/?sid=7722560&newtest=Y" and the obtained results were recorded (9). Patients with no comorbidities or mild comorbidities were grouped as "ASA I/II" and patients with more severe additional diseases or organ failure were grouped as "ASA III" or "ASA IV".

The decision to admit the patient to ICU was made by the anesthesiologist according to the patient's perioperative clinical status. Besides, the duration of hospitalization in ICU and mortality of the patients in ICU were recorded.

Statistical analysis

All statistical analyses were performed using SPSS v.20.0 (IBM Corp., Armonk, NY, USA) software. Frequency, mean, standard deviation, percentage (%), median, and interquartile range (25-75 p) values were determined with the analysis of the data. Normality was assessed using the Kolmogorov-Smirnov test. The statistical difference between the two groups was evaluated using the Mann-Whitney U test and the chi-square test. As a result of these calculations, parameters differed significantly ($p<0.25$) between the two groups were evaluated using univariate logistic regression analysis. Multivariate logistic regression analysis was performed over the parameters in which the p-value remained below 0.02 ($p<0.02$) in the univariate logistic regression analysis. Thus patient's admission predictors to ICU were determined utilizing these statistical methods.

Results

Data of 158 patients who met the inclusion criteria out of 325 patients who were confirmed to undergo elective HF surgery in our center during the specified study period were analyzed. In this study, 63 of the patients (39.9%) were male, 95 (60.1%) were female, and the mean age of the patients was 82.16±7.5 (min=65, max=103) years. The mean length of ICU stay was 1.98 ± 1.4 (min=1, max=7) days, and 9.5% of the patients died after surgery. 75.31% (119) of the patients were accepted to ICU postoperatively. The demographic characteristics of the patients, information on anesthesia and surgery processes, comorbidities, and preoperative laboratory parameters are given in detail in Table 1.

Demographic data

When the demographic data of the patients were evaluated, it was observed that the mean age was significantly higher in the ICU group compared to the non-ICU group (82.87±8.2 vs. 80.3±4.4) ($p=0.008$), but there was no significant difference between the male and female ratios in these two groups ($p=0.559$) (Table 1).

Preoperative variables

The waiting duration of the patients before surgery was similar between the two groups. When the comorbidities were evaluated, it was found that coronary artery disease (CAD) and cerebrovascular disease (CVD) were more common in the ICU group ($p=0.010$ and $p=<0.001$, respectively). While 44 patients had three or more comorbid diseases, 15 patients had no comorbidities. Additionally, the CACI score and the number of comorbidities differed significantly between the groups (both $p<0.001$). It was determined that the number of patients with an ASA score of 3/4 was significantly higher in the ICU group ($p<0.001$).

Preoperative laboratory parameters

Among the preoperative laboratory parameters, urea and creatinine levels were significantly higher in the ICU group ($p=0.002$ and $p=0.022$, respectively). No statistically significant association was found between other laboratory parameters and admission to ICU ($p>0.05$ for all values) (Table 1).

Intraoperative period

In the evaluation of the intraoperative period, the duration of the operation and anesthesia method applied were similar between the groups. The number of patients who received erythrocyte suspension (ES) transfusion and the total number of transfused ES units were significantly higher in the ICU group ($p=0.004$ and $p=0.006$). It was observed that the number of patients that cement applied and the number of patients who needed positive inotrope infusion was higher in the ICU group ($p<0.001$ and $p=0.029$, respectively).

Predictors of the ICU Admission

All variables in Table 1 were evaluated to determine the predictors of ICU admission, and only those with a significant difference at $p<0.05$ value between groups were included in univariate regression analysis. As a result of this analysis, age, presence of arrhythmia, presence of CAD, presence of CVH, number of additional diseases, ASA score, CACI score, ES transfusion status, and cement application status were significant risk factors for ICU admission (Table 2). It was found that high urea levels, high creatinine levels, low albumin levels, and the presence of chronic lung disease did not show a significant correlation with

Table 1. Clinical characteristics of the patients: Demographic distribution, preoperative and intraoperative characteristics, laboratory values, and surgical data

	ICU admission (ICU) (n=119)	Non-ICU admission (Non-ICU) (n=39)	p
Age (years)	83 (78-89)	80 (76-83)	**0.008†**
Sex (male), n (%)	49 (77.8)	14 (22.2)	0,559*
Time before surgery (days)	2 (1-3)	2 (1-4)	0.113†
Comorbidities, n (%)			
Hypertension	74 (62.2)	22 (56.4)	0.522*
Diabetes mellitus	33 (27.7)	12 (30.8)	0.715*
Congestive heart failure	19 (16)	5 (12.8)	0.635*
Coronary artery disease	37 (31.1)	4 (10.3)	**0.010***
Chronic renal failure	9 (7.6)	1 (2.6)	0.266†
Cerebrovascular disease	34 (28.6)	3 (7.7)	**<0.001***
Chronic lung disease	20 (16.8)	2 (5.1)	0.068*
Comorbidity number	2 (1-3)	1 (0-2)	
No	5	10	
1	41	16	**<0.001**
2	32	10	
3 and above	41	3	
ASA, II/III/IV, n	4/84/31	19/15/5	**<0.001†**
CACI score	5(4-6)	4(4-5)	**<0.001†**
Anesthesia method (RA/GA), n (%)	107 (74.8)/12 (80)	36 (25.2)/3 (20)	0.658*
Operation time (min)	125 (100-145)	140 (92-168)	0.467†
Cemented /cementless, n (%)	104/15 (87.4/12.6)	16/23 (41.0/59.0)	**<0.001***
Need for blood transfusion, n (%)	80 (67.2)	16 (41)	**0.004***
Total ES units, mean±S.D.	1.36±1.31	0.74±1.01	**0.006**
Need for inotropics, n (%)	19 (16.0)	1 (2.6)	**0.029***
Mortality, n (%)	14 (11.8)	1 (2.6)	0.119†
Biochemical measurements			
Haemoglobin (g/dl)	11.3 (10-12.7)	12 (10,9-13,7)	0.133†
Glucose (mmol/l)	141,0 (108,0-180.0)	136.0 (119.0-178.0)	0.950†
Sodyum (mmol/L)	138 (136-140)	139 (136-141)	0.653†
Urea (mmol/l)	44.9 (34.4-60.1)	42.8 (24.0-46.2)	**0.002†**
Creatinine (μmol/l)	0.93 (0.79-1.20)	0.81 (0.73-1.02)	**0.022†**
Albumin (g/dL)	3.51 (3.10-3.81)	3.6 (3.2-4.1)	0.099†

ES: Erythrocyte suspension; ASA: American Society of Anesthesiologists; CACI: Charlson Age-added Comorbidity Index
GA: general anesthesia, RA: regional anesthesia
Median (25-75 p.), *p<0.005, IQR: interquartile range
*Chi-square Test †Fisher Exact Test
† Mann-Whitney's U test

the probability of ICU admission (Table 2). Multivariate logistic regression analysis was performed over parameters with a p-value below 0.02 ($p<0.02$) found in univariate regression analysis. The statistically significant independent risk factors for admission to ICU were ASA and cement application according to multivariate analysis (logistic regression model) (Table 2).

Discussion

In this retrospective study investigating the predictors of ICU admission in geriatric patients who underwent hemiarthroplasty for HF, high ASA score, and cement application status were found to be independent risk factors. In addition, increased age, presence of accompanying comorbidities (arrhythmia, CAD, CVH), CACI score, and ES transfusion status were observed to be risk factors for ICU admission.

Geriatric patients who underwent hip replacement surgery are mostly admitted to the ICU after the operation in clinical practice (7-11). However, there is often a dispute about which patients will be followed up in the ICU postoperatively. There are no clear and objective criteria to decide on the admission of these high-risk patients to the ICU. In addition to the clinical characteristics of the patient, factors, such as the type and duration of the surgery, anesthesia method applied, hospital's ICU capacity, the preference of the surgeon and anesthesiologist, also play a role in this decision.

Advanced age (>75) and associated comorbidities increase the risk of complications, morbidity, and need for ICU after hip surgery (9-12). Camurcu et al. reported in their study that having three or more comorbidities in geriatric patients is a major predictor of mortality seen within one year after HF (4). Nordio et al. reported that negative results after HA are more commonly seen in male

Table 2. Predictors of ICU admission, univariate and multivariate logistic regression analysis

	Univariate Logistic Regression			Multivariate Logistic Regression		
	OR	95% CI	p	OR	95% CI	p
Age	1.123	1.03-1.21	**0.003**			
Arrhythmia	5.42	1.22-23.99	**0.026**			
Coronary artery disease	3.94	1.30-11.91	**0.015**			
Cerebrovascular disease	4.80	1.38-16.63	**0.013**			
Comorbidity number	2.45	1.57-3.81	**<0.001**			
ASA	7.04	3.13-15.83	**<0.001**	2.77	1.04-7.34	**0.040**
CACI	2.23	1.48-3.36	**<0.001**			
Urea	0.59	1.01-1.06	0.324			
Creatinine	2.38	0.80-7.05	0.118			
Erythrocyte suspension	1.62	1.12-2.33	**0.009**			
Cement application	9.96	4.31-23.01	**<0.001**	5.97	2.21-16.07	**<0.001**

ASA: American Society of Anesthesiologists; CACI: Charlson Age-added Comorbidity Index

patients and patients over 85 years of age (13). Similar to our study, Zeyneloğlu et al. reported that patients admitted to ICU after HF had a higher mean age compared to the patient group who did not need ICU, CAD and arrhythmia were more commonly seen comorbidities in these patients, and there was no difference between genders (10). In the same study, advanced age and digoxin use were found to be statistically significant predictors for ICU admission (10). The advanced age, which was reported as an independent risk factor by other studies, was not determined as a significant predictor in our study, although the mean age was higher in the ICU group.

As the number and severity of chronic medical conditions of the patient in the preoperative period increase, the risk of the development of unwanted consequences in the postoperative period also grows (7,14). In our study, it was demonstrated that as the number of comorbidities increased, the rate of postoperative ICU admission rose significantly. A high ASA physical status classification score, which is a reflection of the severity of preoperative comorbidities, is one of the most reliable prognostic indices for perioperative mortality and is also utilized to predict the occurrence of postoperative complications (7,15). A high ASA score was determined in our study as an independent predictor for ICU admission. This result we reached is supported by many other studies (5,11,15).

Another method in which the physical status and age of the patient are evaluated together and used to predict postoperative mortality is the CACI scoring system (9). In a recent study comparing several indexes used to predict the need for ICU after major surgery, the CACI scoring system was determined to be the most powerful prediction tool (16). Although a high CACI score was observed to be a significant risk factor for ICU admission in our research, it could not be identified as an independent predictor in the multivariate analysis. Although ASA scoring was developed to predict perioperative mortality, it appears to be a significant parameter as a predictor of admission to ICU according to our results.

In our study, when the preoperative laboratory parameters were evaluated, it was observed that serum urea and creatinine levels were higher in patients hospitalized in ICU, and there was no significant difference between ICU and non-ICU groups in other laboratory parameters. In addition, none of these parameters were found to be a significant independent predictor in multiple regression analysis. In several studies, it has been reported that low hemoglobin levels (17-19) and hypoalbuminemia (10,18,21) are predictors for admission to ICU. Besides, high serum urea and creatinine levels, which were found to suggest a negative outcome in our study, were also determined to be significantly higher in patients admitted to ICU again in the same studies (10,20,21). We consider, according to the results we reported that when predicting the clinical outcome of patients with high preoperative urea/creatinine values, care should be taken in terms of the risk of postoperative ICU admission.

Although waiting duration before surgery is known as a significant risk factor for various complications in HF patients (8), it was not found as a significant risk factor for ICU admission in our study. Similarly, the duration of operation did not differ significantly between the groups. Although regional anesthesia is mostly preferred as the anesthesia method applied, it has been found that the anesthesia method has no effect on the risk of postoperative ICU admission. Differently, Akbaş et al. reported that patients over 80 years of age who had HF's and who underwent general anesthesia during the operation were accepted to ICU more frequently and that the mortality rate was higher in these patients (22). In the same study, it was concluded that regional anesthesia was safer for this patient group (22). However, there are studies reporting that the anesthesia method applied has no effect on the risk of ICU admission (5,11).

According to our analysis, the most prominent risk factor for ICU admission after HA surgery was the cement application. In our study, the majority of the patients (87%) who were admitted to the ICU were patients who underwent cement application during the HA surgery. Cement implantation syndrome associated with acrylic bone cement (polymethylmethacrylate) is a severe adverse reaction that may even lead to cardiovascular collapse (4). It has been demonstrated that cemented HA causes more hemodynamic changes and longer duration of surgery (4,17). In addition, complications of pulmonary embolism, air embolism, or fat embolism can be seen in these patients (4,17). On the contrary, Tero et al. reported that the mortality rate after cemented HA was similar to cementless HA and that 90-day complications were higher after cementless HA (3).

Several studies have demonstrated that intraoperative blood loss and blood product transfusion status in patients undergoing major surgery is associated with postoperative complications and the need for ICU (11,22,23). It has been reported that blood loss is higher in elderly patients, patients receiving general anesthesia, intertrochanteric fractures, and total hip replacement surgeries (1,22,23). In our study, the amount of intraoperative blood transfusion and the need for positive inotrope infusion were significantly higher in the ICU group, but these were not determined as predictors in the multiple regression analysis. Similarly, Uygar et al. reported that the need for intraoperative blood transfusion and the need for positive inotrope infusion in geriatric HF patients over the age of 80 years were higher in ICU patients with a mortal clinical course (11).

This study has some limitations. First, our results might be affected by local factors as it is a single-center study. Because patient admission to ICU may vary depending on the type of ICU, its capacity, characteristics of the patient population, and the condition of the communication between the anesthesiologist and the surgeon. The second limitation of our study is that we could not reach some data, such as intraoperative blood loss, with full accuracy because our study was a retrospective study. However, the most crucial strength of our study is the number of patients we were able to evaluate. The underlying reason for this is the frequent admission of geriatric HF patients to our center as it is a tertiary referral hospital.

Conclusion

The findings obtained in this study showed that ASA score and cement application status were strong predictors in foretelling the need for ICU in the postoperative period in patients who will undergo hemiarthroplasty surgery due to femoral neck fracture. Larger clinical studies are needed to prove the effectiveness of these factors in predicting the need for ICU.

AUTHOR CONTRIBUTIONS:

Concept: OHM, OK, AY, AA, HO; **Design:** OHM, OK, AY, AA, HO; **Supervision:** OHM, OK; **Fundings:** OHM, OK, AY; **Materials:** OHM, OK, AY; **Data Collection and/or Processing:** OHM, OK, AY, AA, HO; **Analysis and/or Interpretation**: OHM, OK, AY, AA; **Literature Search:** OHM, AY, AA; **Writing Manuscript**: OHM; **Critical Review:** OHM, OK, AY, AA, HO

Ethics Committee Approval: Approval was obtained from the Malatya Clinical Research Ethics Committee (2019 / 137).

Informed Consent: Informed consent was obtained from all participants.

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Conflict of Interest: Authors have no conflicts of interest to declare.

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