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Original Research

Outcomes and cost-effectiveness of different anesthesia techniques in elderly patients with hip fracture

Cheaper and less lethal anesthetic technique

Gülnihal Gökalp[1], Oğuzhan Gökalp[2], Habip Atalay[3]
[1] Department of Anesthesiology and Reanimation, Uşak Training and Research Hospital, Uşak
[2] Department of Orthopaedics and Traumatology, Faculty of Medicine, Uşak University, Uşak
[3] Department of Anesthesiology and Reanimation, Faculty of Medicine, Pamukkale University, Denizli, Turkey

Abstract

Aim: This study aimed to determine the optimal type of anesthesia for elderly patients to reduce the need for intensive care, mortality, and costs of operations for hip fractures.

Material and Methods: In this retrospective and cross-sectional study, the records of 204 patients aged 60 years and older who were operated on for hip fracture with neuraxial (107 patients) or general anesthesia (97 patients) at Pamukkale University Hospital. The duration of intensive care stay, duration of hospital stay, mortality, and cost were considered primary endpoints.

Results: All evaluation parameters were evenly distributed between both groups. Among the analyzed parameters, the duration of surgery and the rate of patients requiring >1 unit of blood transfusion were found to be significantly lower in neuraxial anesthesia patients, compared to general anesthesia patients (p=0,001). Intensive care need, duration of intensive care stay and duration of hospital stay, three-month mortality, and cost were found to be significantly lower in the neuraxial anesthesia group, compared to the general anesthesia group (for all p=0.001). Based on logistic regression analysis, age (age 80-89, OR= 2.782, 95% CI= 1.156-6.694; age 90 +, OR= 8.779, CI= 2.056-37.486), general anesthesia (OR = 8.069, 95% CI= 2.778-23.436) and need of intensive care (OR= 5.155, 95% CI= 2.233-11.903) were independent risk factors affecting mortality.

Discussion: The results of our study show that the use of neuraxial anesthesia in geriatric hip fracture surgery has significant advantages, including lower costs and mortality rates compared to general anesthesia.

Keywords

Hip Fractures, Anesthesia Conduction, Anesthesia, Mortality, Cost-Effectiveness

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Corresponding Author: Oğuzhan Gökalp, Department of Orthopaedics and Traumatology, Faculty of Medicine, Uşak University, Uşak, Turkey.
E-mail: oguzhangokalp@gmail.com P: +90 505 950 32 31
Corresponding Author ORCID ID: https://orcid.org/0000-0003-4062-8559
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Introduction

Hip fracture is a frequent problem in the elderly population. The predicted number of hip fractures by 2050 is 6.3 million [1]. Approximately 8.4% of patients die within 30 days after hip fracture surgery and 15-30% in the following year [2]. The effect of anesthesia techniques used in elderly patients on outcomes has not yet clarified in the literature. Available scientific evidence that will enable the selection of the most appropriate anesthesia technique in femur fracture surgery to be used is still limited [2].

The costs related to intensive care services are approximately 22% of all hospital expenditures, while intensive care beds constitute only 10% of all hospital beds [3]. Thus, intensive care expenses have an important role in the total cost of surgery-related hospitalizations such as hip fracture treatments. Although the use of neuraxial anesthesia in hip fracture surgery, is shown to result in a reduction in intensive care stay and related costs, the multifactorial reasons for this advantage are not yet all elucidated.

Our primary aim in this study is to compare the impact of anesthesia techniques in hip fracture surgery on postoperative intensive care admission, mortality and cost. Our hypothesis is that local anesthesia is superior to general anesthesia in terms of specified criteria in elderly hip fracture patients. We also wanted to determine the independent effects of variables of the patient and treatment process on mortality.

Material and Methods

This study was approved by the Ethics Committee of Pamukkale University Faculty of Medicine upon the application of the senior author (No: 60116787/64).

In this retrospective cross-sectional study, hospital information management system records and anesthesia intensive care files of 287 patients aged 60 years and older who were operated on with neuraxial or general anesthesia due to hip fracture at Pamukkale University Medical Faculty Hospital were retrospectively analyzed. The choice of anesthetic technique in our study, i.e. general or neuraxial, depended on factors related to both patient consent and the consultation of the anesthesiologist. Both procedures were explained to the patients in detail with advantages and disadvantages, and patient consent was obtained.

Patients were placed in either general anesthesia (GA) or neuraxial anesthesia (NA) group, which included either spinal or epidural anesthesia patients. Patients who met the exclusion criteria were excluded from the study (Figure-1).

Information such as demographic data, history of smoking, ASA risk assessment, Charlson Comorbidity Index (CCI) [4], preoperative laboratory parameters, type of surgery, type of fracture, preoperative intensive care need, duration of operation, use of cement, and amount of intraoperative blood transfusion were obtained from the hospital records. Length of stay in the intensive care unit, duration of hospital stay, mortality, and cost were considered primary endpoints. Mortality rates were assessed at 7 days, 1 month, and 3 months.

Preoperative laboratory parameters were taken from the last lab reports before surgery. Costs were calculated according to the average US dollar rates at the hospitalization date of patients. The cost calculation was made according to the duration of intensive care and hospital stay. Implant costs were subtracted from the total cost because of the variability in the type and cost of implants.

For the statistical analysis of data, the Statistical Package for the Social Sciences (SPSS) 18.0 software was used. The results were assessed with a 95% confidence interval at P <0.05 significance level.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Out of the 204 patients who met the study criteria, 107 received GA, and 97 NA. The selection of patients is shown in the flow diagram (Figure 1). There were no statistically significant differences between the GA and NA groups, regarding the distribution of age, sex, history of smoking, ASA, CCI, and preoperative laboratory parameters.

The duration of surgery and the rate of patients who needed more than one unit of blood transfusion were found to be statistically significantly lower in the NA patients. Transfer to the intensive care, duration of intensive care, hospital stay, one-month and three-month mortality, and cost (USD) were found to be significantly lower in the NA group (Table 1). Since the ICU length of stay variable was skewed to the right, the analysis was conducted by excluding outliers. Among 107 patients who received GA, 70 were predicted to be transferred to the intensive care unit, and 53 of them ultimately were transferred (53/70, 76%); while of the 97 patients who received NA, 53 were predicted to be transferred to the intensive care, but only 18 were eventually transferred (18/53, 34%) (p<0.05).

The evaluation of all cases showed that, in cases who were transferred to the intensive care unit, some parameters such as ASA III score (I- II or III, 67.6% vs 33.8%), CCI >3 score (<3 or >3, 59.2% vs 26.3%), and need for more than 1 unit of blood transfusion (63.4% vs 27.1%) were found to be statistically significantly higher, preoperative albumin rates were significantly lower and duration of surgery was longer

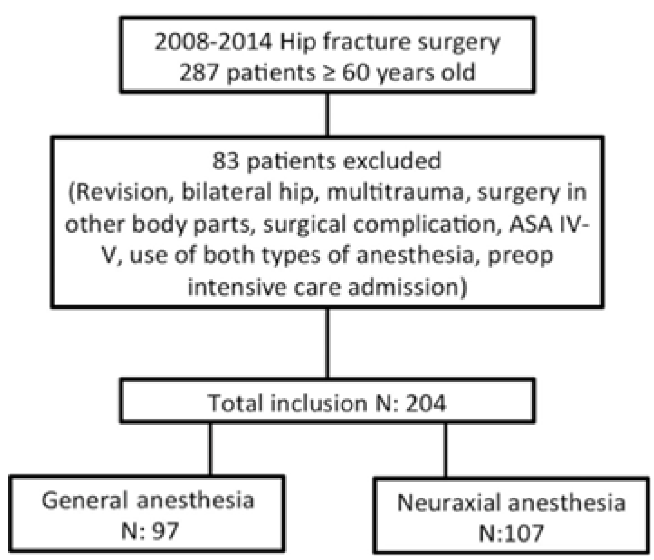

Figure 1. Flow diagram of inclusion and exclusion of patients. ASA, American Society of Anesthesiologists

compared to patients who did not go to the intensive care unit (P <0.05).

The evaluation of risk factors affecting mortality showed that some variables, which were considered significant in the

Table 1. Distribution of parameters according to the type of anesthesia.

		GA (N:107)			NA (N:97)		P
Type of Fracture	Intracapsular	53 (49.5%)			51 (52.6%)		0.664[1]
	Extracapsular	54 (50.5%)			46 (47.4%)		
Type of Surgery	Open	88 (82.2%)			74 (76.3%)		0.294[1]
	Closed	19 (17.8%)			23 (23.7%)		
Use of Cement	Yes	57 (53.3%)			45 (46.4%)		0.326[1]
	No	50 (46.7%)			52 (53.6%)		
Blood Transfusion	≤1 Unit	46 (43.0%)			77 (79.4%)		0.001[1]
	>1 Unit	61 (57.0%)			20 (20.6%)		
Entrance to ICU	Yes	53 (49.5%)			18 (18.6%)		0.001[1]
	No	54 (50.5%)			79 (81.4%)		
Mortality	7 Days	2 (1.9%)			0 (0.0%)		0.499[1]
	30 Days	9 (8.4%)			2 (2.1%)		0.045[1]
	3 Months	36 (33.6%)			5 (5.2%)		0.001[1]
	Mean (SD)	Median	Q1/Q3	Mean (SD)	Median	Q1-Q3	P
Duration of Surgery (min)	99.1 (20.7)	100	90/110	85.1 (21.1)	85	80/95	0.001[2]
Duration of ICU (hours)	36.8 (21.3)	28	22.3/48.0	25.8 (13.4)	22	18.5/27.5	0.005[2]
Duration of Hospital Stay (days)	14.2 (6.3)	13	10.17	8.6 (2.6)	9	7.10	0.001[2]
Cost (USD)	4277.6 (2796.6)	3200	2900/4200	2829.2 (460.5)	2725	2500/3000	0.001[2]

GA, general anesthesia; NA, neuraxial anesthesia; ICU, Intensive Care Unit; USD: United States Dollar. [1.] Chi-square Test; [2.] Mann-Whitney U Test

Table 2. Mortality rates according to variables.

		1-month mortality (11/204, 5.4%)			P	3-month mortality (41/204, 20.0%)			P
Age	60-79	7/95 (7.4%)			0.410[1]	12/95 (12.6%)			0.012[1]
	80-89	4/95 (4.2%)				23/95 (24.2%)			
	90 and above	0/95				6/14 (42.9%)			
ASA	I or II	2/111 (1.8%)			0.013[1]	16/111 (14.4%)			0.027[1]
	III	9/93 (9.7%)				25/93 (26.9%)			
CCI	<3	3/127 (2.4%)			0.014[1]	18/127 (14.1%)			0.007[1]
	≥3	8/77 (10.4%)				23/77 (29.8%)			
Type of Fracture	Intracapsular	6/104 (5.8%)			0.808[1]	22/104 (21.1%)			0.701[1]
	Extracapsular	5/100 (5.0%)				19/100 (19.0%)			
Type of Surgery	Open	6/162 (3.7%)			0.051[1]	29/162 (17.9%)			0.124[1]
	Closed	5/42 (11.9%)				12/42 (28.5%)			
Type of Anesthesia	General	9/107 (8.4%)			0.045[1]	36/107 (33.6%)			0.001[1]
	Neuraxial	2/97 (2.1%)				5/97 (5.1%)			
Blood transfusion	≤1 Unit	4/124 (3.2%)			0.115[1]	17/124 (13.7%)			0.005[1]
	>1 Unit	7/80 (8.8%)				24/80 (30.0%)			
Entrance to ICU	Yes	10/71 (14.1%)			0.001[1]	29/71 (40.8%)			0.001[1]
	No	1/133 (0.8%)				12/133 (9.0%)			
		Mean (SD)	Median	Q1/Q3	P	Mean (SD)	Median	Q1-Q3	P
Duration of Surgery (min)	Died	98.6 (27.4)	110	80/120	0.373[2]	96.5 (30.6)	107.5	65/1118.8	0.146[2]
	Alive	92.2 (21.7)	95	85/105		97.1 (19.4)	100	90/110	
Duration of ICU (hours)	Died	38.6 (28.2)	28	19/52	0.903[2]	34.1 (20.8)	28	19/44	0.853[2]
	Alive	33.2 (18.9)	27	20.8/36.8		33.6 (19.8)	27	21.5/38.5	
Duration of Hospital Stay (days)	Died	10.3 (6.2)	8	9/16.3	0.594[2]	14.7 (7.3)	13.5	8.3/22.3	0.003[2]
	Alive	13.4 (6.7)	11	6/13		12.2 (6.2)	11	9/14	

ASA, American society of anesthesiologist; CCI, Charlson comorbidity index; ICU, Intensive Care Unit. [1.] Chi-square Test; 2. Mann-Whitney U Test

Table 3. Risk factors affecting 3-month mortality (logistic regression analysis).

		OR	P	95% C.I. for OR	
				Lower	Upper
Step 1[a]	Intensive Care (yes)	6.962	<0.001	3.260	14.870
	Constant	0.099	<0.001		
Step 2[b]	Type of Anesthesia (GA)	6.365	<0.001	2.298	17.634
	Intensive Care (yes)	4.731	<0.001	2.132	10.496
	Constant	0.033	<0.001		
Step 3[c]	Age Groups		0.006		
	80-89	2.782	0.022	1.156	6.694
	90 and above	8.779	0.003	2.056	37.486
	Type of Anesthesia (GA)	8.069	<0.001	2.778	23.436
	Intensive Care (yes)	5.155	<0.001	2.233	11.903
	Constant	0.013	<0.001		

GA, general anesthesia

univariate analysis (Table 2) were insignificant in the logistic regression analysis. It was confirmed by Collinearity Statistics that there were no multiple linear linkages between independent variables to be included in logistic regression. Age groups, ASA, CCI, type of anesthesia, blood transfusion and intensive care stay variables were included in the Forward Stepwise (Conditional) model. As a result of the analysis, age, GA and need for intensive care were assessed as independent variables for mortality (Table 3). The most common cause of mortality was heart failure.

Clinically, it was thought that the 'entrance to ICU' variable might have a mediator role in the effect of 'Anesthesia type' on mortality, and mediation analysis was performed. Other variables were excluded from this analysis because they were eliminated in the logistic regression model and the 'age group' variable had no effect on the type of anesthesia.

According to the mediation analysis results, the independent variable "anesthesia type" (NA) affects mortality significantly and negatively (β = -2.233 P <0.001 95% CI = 0.040-0.287). 'Anesthesia type' (NA) affects the mediator variable "entrance to ICU" statistically significantly and negatively (β = -1.460 P <0.001 95% CI = 0.123-0.439). Similarly, entrance to ICU affects mortality (3 months) statistically significantly and positively (β = 1.941 P <0.001 95% CI = 3.260-14.870). In the last stage of the mediation analysis, it was observed that the effect of anesthesia type on mortality was still significant as in the first model when the entrance to ICU variable was included in the model, but there was a significant decrease in the Beta coefficient (= -1.851 P <0.001 95% CI = 0.057-0.435) (β -2.233 to -1.851). These findings show that the "entrance to ICU" variable has a partial mediator effect in the relationship between anesthesia type and mortality.

Discussion

Hip fracture surgery is a common medical procedure in elderly patients, which can result in high morbidity and mortality due to factors related to the patient and/or surgery [7]. Perioperative mortality and morbidity are affected by the choice of anesthesia method, concomitant diseases, and surgical technique [8].

Anesthesia techniques used in hip fracture surgery have often been compared previously, however, studies that evaluated different anesthesia techniques in terms of both patient results and cost- effectiveness were lacking. Our study focuses on this comparison.

This study has some limitations due to its retrospective design. In addition, the initial design and set-up of the dataset limited the use of ordinal data. Examples of this are the analysis of the Charlson Comorbidity Index values and the need for blood transfusion, both of which are evaluated as binary rather than ordinal data while creating the data set from the patient files. This approach may have reduced the sensitivity of the analysis performed with these two variables.

In the preoperative phase, 53/97 patients who received NA were predicted to be in need of intensive care, while eventually, only 18 needed it. Admission to intensive care, duration of intensive care stay, and duration of hospital stay were found to be significantly lower in the NA group compared to the GA group. Similarly, Kaufmann et al. stated that NA can reduce the postoperative intensive care requirements in high-risk patients who are to undergo hip prosthesis surgery. They also reported that NA reduces the duration of intensive care and hospital stay, and therefore reduces cost [3]. Ahn et al. also found that NA was associated with better outcomes than GA in terms of ICU admission and ventilator care in elderly patients undergoing hip fracture surgery [9]. There are other studies showing that regional anesthesia is associated with a shorter hospital stay compared to GA [10-12].

The decision of anesthesiologists or surgeons on the postoperative destination of these patients probably depends on the initiative of the caregiving physician because of the inadequacy of standard anesthesia intensive care admission guidelines. This relatively subjective decision may be based on the estimation of how well the patient will tolerate the surgical procedure. Patients who receive NA may seem more stable during the operation process, and this can affect the decision of the clinician regarding transfer to the intensive care unit. Additionally, intraoperative blood loss has been reported to be significantly lower in patients who receive NA, therefore, the need for blood transfusion, and probably fluid replacement is also relatively low [13-15]. Since NA has various intraoperative benefits that will affect the general physical status of the patient after surgery, this may affect the decision of the clinician on the need for intensive care.

Our study showed that there was less need for blood transfusion in the NA group, compared to the GA group (Table 2). The recent change in surgical methods and the increase in the rate of closed surgery may have been another factor reducing the need for blood transfusion in our study. Various studies have investigated the relationship between anesthesia techniques and intraoperative blood loss [1,16]. NA was reported to be related to less bleeding in patients with hip fracture surgery [16]. Venous pooling due to sympathetic blockage, vasodilation, and neuraxial blockage reduces the venous return to the heart. However, Urwin et al. showed in their meta-analysis of the data from 3 studies that there was no difference between general and NA in terms of blood transfusion [1].

Hip fractures in the geriatric population create an economic burden on the health system. In our study, a significant reduction was found in the use of intensive care, duration of intensive care stay, and duration of hospital stay, and therefore hospital costs, with the use of NA (Table 2). It has been suggested in a study that length of stay and surgical choice were linearly related to total hospital costs [17]. There are few studies on the economic burden of the type of anesthesia used in intensive care patients. There are some studies showing that neuraxial anesthesia can improve pulmonary outcomes and reduce resources (critical care services, hospital stay) compared to general anesthesia [3,18]. In a study in England, in 2000, the cost per hip fracture patient was calculated as 4760 pounds, whereas in 2008, this number was calculated as 8000 pounds [19].

Our logistic regression analysis showed that older age is an independent risk factor for mortality. Similarly, Mc Leod et al. have reported that the increase in systemic concomitant diseases in older age has an impact on mortality [13].

We found that high CCI risk scores, which indicate multiple medical problems were associated with mortality; 29.8% of the patients with a CCI score above 3 died. However, the CCI score was not found to be an independent risk factor in our logistic regression analysis (Table 3). Souza et al. investigated the use of CCI as a method for estimating 90-day mortality risk in elderly patients hospitalized for hip fracture, and they showed that as the CCI score increased, the mortality risk also increased [15].

In our study, 3-month mortality in ASA III patients (26%) was higher than ASA I and II patients (14%) among the 204 patients. While the difference between these rates was significantly high, ASA physical status scale was not determined to be an independent risk factor for mortality, based on multivariate statistical analysis. Holvik et al. found that those who died within 1 year had a higher ASA score (III, IV) and therefore more comorbid conditions [20]. In this study, the 3-month mortality (short-term mortality) was 25.2% in 107 patients in the GA group. On the other hand, it was found to be significantly lower in the NA group (3.2%). Logistic regression analysis showed that the mortality risk was found to be 8.07 times higher in the GA group compared to the NA group and 5.16 times higher in the group admitted to the ICU. In mediation analysis, it was seen that the effect of "anesthesia type" on mortality was partially through "admittance to intensive care". Therefore, this situation should be taken into consideration when evaluating odds ratios.

A limited number of studies have reported that postoperative mortality in NA patients is lower than in GA patients [9,14]. Desai et al. found that the use of general anesthesia was associated with a higher risk of mortality during the in-hospital stay compared with regional anesthesia, but this higher risk did not persist after hospital discharge [21]. Chen et al. also reported a similar result, general anesthesia was associated with an increased risk of in-hospital mortality [11]. However, many later studies have shown that, conversely, the type of anesthesia does not affect postoperative mortality [10,12,18].

Gilbert et al. found no significant difference between patients who received spinal or GA in long-term (two-year) mortality and incidence of serious morbidity, in a study with 741 patients operated for acute hip fracture [22] Katušin et al. showed that the mode of anesthesia (general and spinal) had no effect on postoperative mortality and suggested that the patient's comorbidities should be considered in the selection of anesthesia. [23]. Parker et al. found in their study that after NA, a 1-month mortality decrease is the limit [19]. Hospital mortality (up to 1 month) and short-term mortality (up to 3 months) are lower with spinal anesthesia, but this advantage disappears after 3 months [23]. Rodgers et al. have reported that mortality decreased by 30% with NA in major surgeries, including hip fractures [24].

Conclusion

Overall, the results of our study show that the use of NA in geriatric hip fracture surgery is related to a lower need for blood transfusion, treatment costs, shorter intensive care and hospital stay, and a reduced rate of intensive care necessity. Neuraxial anesthesia was found to reduce mortality by 8.06 times compared to GA. Our findings support the recommendations of the International Consensus on Anesthesia-Related Outcomes after Surgery group as stated "neuraxial anesthesia is recommended for hip arthroplasty given associated outcome benefits; evidence level: moderate-low, strong recommendation" [25].

Longer-term prospective prognosis and cost analysis studies should be conducted to establish criteria for the selection of the appropriate anesthesia type in hip fracture surgery in elderly patients.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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