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ORIGINAL ARTICLE

EFFECT OF GENERAL AND SPINAL ANESTHESIA ON POSTOPERATIVE MYOCARDIAL INJURY IN ELDERLY PATIENTS UNDERGOING HIP FRACTURE SURGERY: A RANDOMIZED STUDY

Abstract

Introduction: Postoperative myocardial injury following non-cardiac surgery is a clinically relevant complication in elderly patients and is related to worse postoperative outcomes. This study investigated whether anesthesia technique affects the development of myocardial injury after hip surgery in elderly patients.

Materials and Method: This prospective randomized single-blind study included 100 patients older than 65 years with hip fractures who were scheduled for hip fracture surgery classified as American Society of Anesthesiologists physical status II–III who were scheduled for hip surgery. Patients received either general or spinal anesthesia according to group allocation. Age, sex, baseline hemodynamic parameters, intraoperative heart rate, and mean arterial pressure values were monitored at 10-minute intervals. Troponin T levels were assessed before surgery and repeatedly during the first 72 postoperative hours. Intensive care unit stay, hospital stay, postoperative complications, and 30-day mortality were also evaluated.

Results: The general and spinal anesthesia groups showed no significant difference in MINS incidence, troponin changes, mortality, hospital stay, or ICU stay.

Conclusion: General and spinal anesthesia were related to similar postoperative myocardial injury rates in elderly patients undergoing hip surgery.

Keywords: Troponin; Anesthesia, Spinal; Anesthesia, General; Orthopedic Procedures.

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INTRODUCTION

Myocardial injury occurring after non-cardiac surgery (MINS) has gained attention as a relevant perioperative complication, particularly in elderly patients. It is typically identified through postoperative elevations in cardiac biomarkers such as troponin, even in the absence of overt clinical symptoms. Unlike classical myocardial infarction, MINS often presents without specific electrocardiographic findings but may lead to poorer postoperative outcomes and higher mortality rates (1,2).

Despite improvements in surgical and anesthetic practices, elderly patients continue to experience higher rates of perioperative complications. Advanced age and the presence of comorbid conditions contribute significantly to this increased risk. Hip fracture surgery, one of the most common emergency procedures in the geriatric population, is associated with substantial perioperative cardiovascular risk (3,4).

Previous research has highlighted the role of perioperative hemodynamic instability, particularly hypotension, in the development of myocardial injury. However, the influence of anesthesia technique on this process has not been clearly established. Differences in physiological responses between general and spinal anesthesia may affect cardiovascular stability and myocardial oxygen balance (5).

The present study investigated whether anesthesia technique was associated with myocardial injury development after hip surgery in elderly patients.

MATERIALS AND METHOD

A prospective, randomized, single-blind design was used for this study. The study protocol was approved by the local institutional ethics committee (approval no: 2167; date: May 30, 2023) and by the Turkish Medicines and Medical Devices Agency. The trial was registered with the identifier NCT06343259 before patient enrollment. The study procedures followed the ethical standards of the Declaration of Helsinki, and written consent was obtained from each participant or from a legal representative.

The study population consisted of 100 patients older than 65 years with ASA physical status II–III who were admitted with hip fractures and scheduled for hip fracture surgery in the Orthopedics Clinic. Patients with severe systemic conditions, including sepsis, pulmonary embolism, decompensated heart failure, chronic renal failure, recent cerebrovascular or myocardial infarction within the previous six months, postoperative intensive care requirement, or elevated baseline troponin T values (>20 ng/L), were not eligible for enrollment.

Patients were randomly allocated to the general anesthesia (GA) or spinal anesthesia (SA) groups through an envelope-based randomization process, with equal numbers in each group. The anesthesiologist performing the intraoperative management was informed about the assigned anesthesia method, while postoperative assessments were carried out by a clinician who was unaware of group assignment.

Preoperative assessment included demographic data, ASA classification, and accompanying conditions including hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD), peripheral vascular disease (PVD), cerebrovascular disease (CVD), and chronic obstructive pulmonary disease (COPD). Electrocardiographic evaluation was completed within 24 hours before surgery. Baseline high-sensitivity cardiac troponin T (hs-cTnT) levels were measured using the Elecsys hs-cTnT assay (Roche Diagnostics, Mannheim, Germany).

After arrival in the operating room, all patients were monitored with electrocardiography (ECG), peripheral oxygen saturation (SpO_2), and non-invasive blood pressure monitoring to obtain baseline hemodynamic measurements. Subsequently, an arterial catheter was placed in

all patients, and invasive arterial blood pressure monitoring was used throughout the intraoperative period. Hemodynamic variables, including heart rate (HR) and mean arterial pressure (MAP), were recorded before anesthesia induction and at 10-minute intervals until the completion of surgery.

Group GA: General anesthesia was initiated following preoxygenation with intravenous propofol (1-2 mg/kg), fentanyl (2 µg/kg), and rocuronium (0.6 mg/kg). Endotracheal intubation was subsequently performed using tubes sized between 7.0 and 8.0 mm. Maintenance of anesthesia was provided with sevoflurane at a MAC value of 0.7–1.0. Intraoperative analgesia was maintained using remifentanil infusion adjusted according to hemodynamic responses. At the completion of surgery, intravenous tramadol (1 mg/kg) and paracetamol (10 mg/kg) were administered. After reversal of neuromuscular blockade, patients achieving an Aldrete score of at least 9 were transferred to the recovery area.

Group SA: Spinal anesthesia was administered under sterile conditions while patients were positioned laterally. Using a 22–25-gauge Quincke needle, dural puncture was performed at the L3–L4 level. After cerebrospinal fluid return was confirmed, 7.5 mg of 0.5% hyperbaric bupivacaine was injected intrathecally. Patients were then placed in the supine position following a stabilization period of approximately 10 minutes. Sensory block assessment was performed with the pinprick method, whereas motor block was evaluated according to the modified Bromage scale, targeting a block level up to T10. No patient required conversion from spinal anesthesia to general anesthesia because of inadequate anesthesia or intraoperative pain. Therefore, all randomized patients completed the allocated intervention and were included in the final analysis.

Perioperative blood product requirements were documented. In cases where mean arterial pressure decreased below 60 mmHg, hypotension was treated with intravenous vasopressors and fluid administration. Continuous vasopressor infusion was initiated if necessary.

The duration of anesthesia covered the period between anesthesia induction and transfer to the recovery area, whereas surgical time was measured from skin incision until the end of the operation.

High-sensitivity cardiac troponin T (hs-cTnT) measurements were obtained preoperatively and at postoperative 0, 6, 12, 24, 48, and 72 hours. MINS was diagnosed using previously validated hs-cTnT thresholds, defined as a postoperative hs-cTnT concentration ≥20 ng/L with an absolute increase of ≥5 ng/L, or any postoperative value ≥65 ng/L.

Patients with MINS underwent electrocardiographic assessment, and cardiology evaluation was requested when necessary.

Duration of ICU stay and overall hospitalization time were documented. Postoperative complications and mortality were evaluated during the first 30 postoperative days.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed continuous variables are presented as mean ± standard deviation (SD), whereas non-normally distributed variables are presented as median and interquartile range (IQR). Categorical variables are expressed as numbers (n) and percentages (%). Comparisons between the general anesthesia (GA) and spinal anesthesia (SA) groups were performed using the independent-samples t-test for normally distributed continuous variables and the Mann–Whitney U test for non-normally distributed continuous variables. Categorical variables were compared using the chi-square test or Fisher's exact test, when appropriate. Troponin T changes between consecutive postoperative measurement time points (0–1,

1–6, 6–12, 12–24, 24–48, and 48–72 hours) were calculated for each patient, and the change values were compared between the GA and SA groups using the Mann–Whitney U test. Associations between MINS and clinical variables were analyzed using appropriate statistical tests according to the variable type and distribution. A two-sided p-value <0.05 was considered statistically significant.

Power Analysis

A priori sample size estimation was conducted using G*Power software (version 3.1.9.4), considering the incidence of postoperative myocardial injury as the primary endpoint. Based on an alpha level of 0.05 and a statistical power of 80%, at least 100 patients were required for the study.

RESULTS

A total of 108 patients aged over 65 years who underwent hip surgery were initially evaluated. Eight patients who did not provide informed consent were excluded, leaving 100 patients for final analysis (Figure 1).

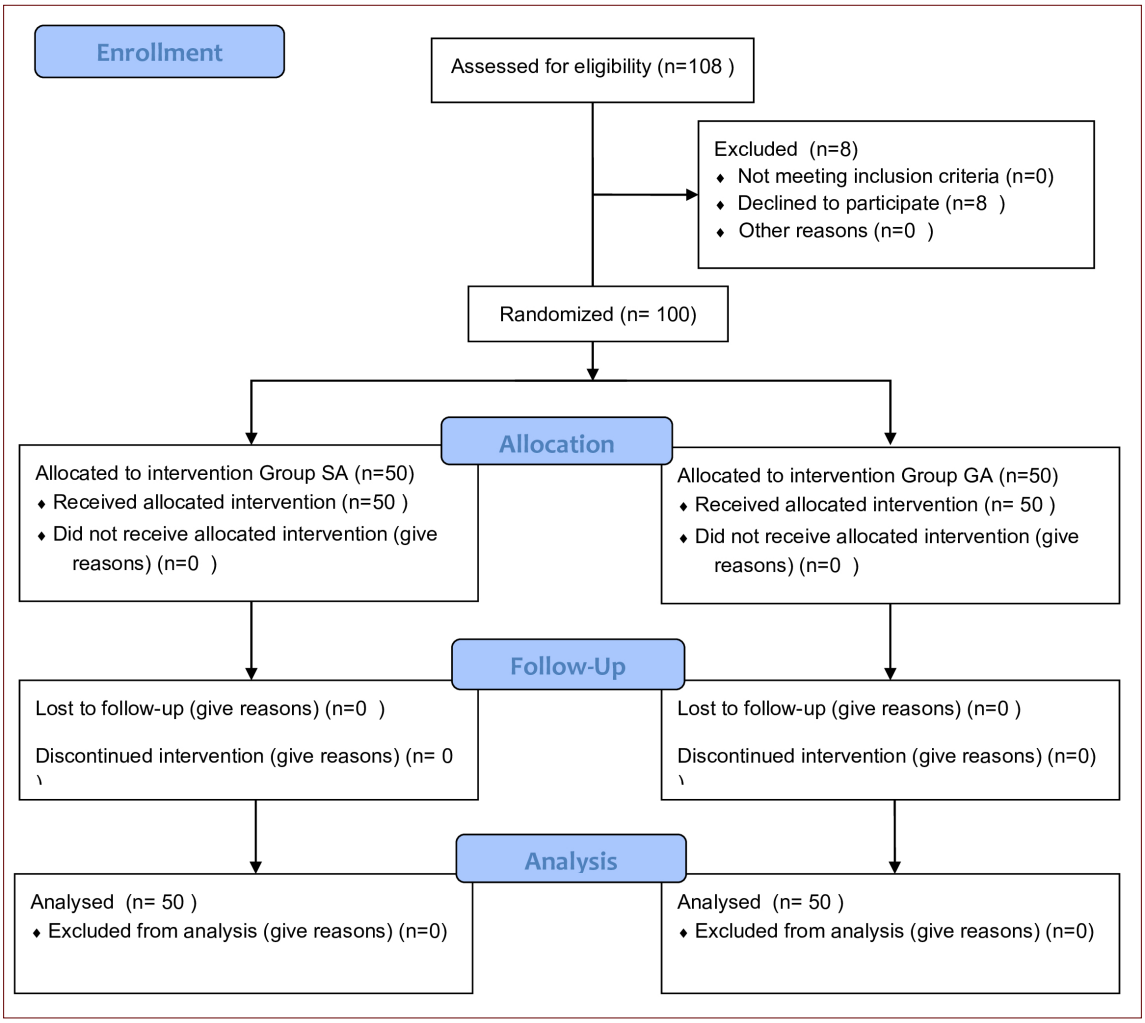


Figure 1. CONSORT 2010 Flow Diagram

Demographic characteristics and ASA classifications of the study groups are presented in Table 1. The groups showed similar distributions regarding age, sex, and ASA status (Table 1).

Rates of MINS, vasopressor requirement, blood product use, 30-day adverse events, and mortality were also comparable between the general anesthesia and spinal anesthesia groups (Table 1).

Hospital stay duration, ICU stay, and surgical duration did not differ between the groups. However, anesthesia duration was longer in patients receiving general anesthesia compared with those receiving spinal anesthesia (Table 2, p=0.025).

Serial postoperative troponin T measurements demonstrated comparable values between the two anesthesia groups throughout the follow-up period (Table 3).

Associations between baseline clinical characteristics and MINS are summarized in Table 4. Patients diagnosed with MINS were older and had higher ASA physical status scores than patients without MINS (p<0.001 and p=0.013, respectively).

Table 1. Demographic Data and ASA Distributions, MINS, 30-Day Adverse Events and Mortality, Perioperative Vasopressor Requirement, and Blood Product Usage

	Group GA N=50 n (%)	Group SA N=50 n (%)	p *
Male	15 (30)	17 (34)	0.668**
Female	35 (70)	33 (66)	
ASA 1	1 (2)	0 (0)	
ASA 2	8(16)	8 (16)	0.603***
ASA 3	41 (82)	42 (84)	
Age (mean±std.deviation)	79.6±8.4	80.7±8.6	0.505***
MINS	25 (50)	26 (52)	0.841**
30-day adverse events	8 (16)	9 (18)	0.790**
30-day mortality	5 (10)	7 (14)	0.538**
Vasopressor requirement	23 (46)	23 (46)	0.925**
Blood product usage	18 (36)	10 (20)	0.075**

*P<0.05 considered statistically significant; ASA:American Society of Anesthesiologists physical status classification; MINS: Myocardial Injury After Non-cardiac Surgery; ** the chi-square test was used; ***the mann-whitney test was used

Table 2. Hospital and ICU Length of Stay, Anesthesia Durations, and Surgery Durations

	Group GA N=50	Group SA N=50	P*
	Median (IQR)	Median (IQR)	
Hospital Length of Stay (Days)	10 (8-14)	11 (8-16.5)	0.474
ICU Length of Stay (Days)	2 (1-4)	2 (1-4.3)	0.466
Anesthesia Duration (Minutes)	140 (110-180)	120 (90-160)	0.025
Surgery Duration (Minutes)	120 (90-150)	110 (80-145)	0.188

* P<0.05 was considered statistically significant; the Mann-Whitney U test was used; ICU:Intensive Care Unit

Table 3. Comparison of Consecutive Postoperative Troponin T Changes

	Group GA N=50	Group SA N=50	P*
	Median (IQR)	Median (IQR)	
Δ1-0 Troponin	3.5(-0.5-5.6)	2 (0-8)	0.746
Δ6-1 Troponin	1.9 (-0.1-5.3)	3 (0.3-6.3)	0.323
Δ12-6 Troponin	2.2 (0-5.3)	1.6 (-0.8-5.5)	0.450
Δ24-12 Troponin	0.3 (-4.8-2.7)	1 (-1.8-3.5)	0.365
Δ48-24 Troponin	-0.8 (-4.7-2.1)	0 (-3.1-1.6)	0.738
Δ72-48 Troponin	-1 (-3.3-0.9)	-1.5 (-5-0.2)	0.441

*P<0.05 was considered statistically significant; the Mann-Whitney U test was used.

Table 4. Predictors Associated with MINS

	MINS Positive N=51	MINS Negative N=49	P**
	n (%)	n (%)	
Age	83.2±8.57	76.9 ±7.23	<0.001***
Gender			0.613
Man	18 (56.2%)	14 (43.8%)	
Woman	33 (48.5%)	35 (51.5%)	
Hypertension	23 (45.1)	15 (30.6)	0.136
DM	14 (27.5)	18 (36.7)	0.320
CAD	28 (54.9)	18 (36.7)	0.068
ASA1-2*	4 (7.8)	13 (26.5)	0.013
ASA3	47 (92.2)	36 (73.5)	
Vasopressor requirement	28 (54.9)	18 (37.5)	0.083
Blood product usage	17 (33.3)	11 (22.4)	0.226

*Because there was only one patient in the ASA 1 group, the groups were combined for analysis; ** P<0.05 Considered statistically significant; the chi-square test was used; *** The independent samples t-test was used; MINS: Myocardial Injury After Non-Cardiac Surgery; DM: Diabetes Mellitus CAD: Coronery Artery Disease

No significant associations were observed between MINS and sex, hypertension, diabetes mellitus, coronary artery disease, vasopressor requirement, or blood product use (Table 4)

Postoperative clinical outcomes according to MINS status are presented in Table 5. Patients with MINS had significantly longer ICU and hospital stays than those without MINS (p=0.001, p=0.003). In addition, 30-day mortality and adverse events were significantly more frequent in patients with MINS (p=0.003, p=0.001) whereas anesthesia duration and surgical duration were similar between the groups.

MAP values revealed that patients with MINS had significantly lower MAP measurements at multiple time points, including pre-induction and during the intraoperative period (p<0.05 at several intervals).

HR analysis showed significantly higher values in patients with MINS during the intraoperative period, particularly between 60 and 90 minutes (p<0.05).

Table 5. Postoperative Clinical Outcomes According to MINS Status

	MINS Positive N=51	MINS Negative N=49	P*
	Median (IQR)-%	Median (IQR)-%	
Hospital length of stay (day)	12 (9-16)	9 (7-11)	0.001
ICU length of stay (day)	3 (2.5)	2 (0.5-3)	0.003
Anesthesia Duration (minutes)	130 (100-170)	140 (105-180)	0.863
Surgery Duration (minutes)	110(90-150)	120 (90-145)	0.904
30-day mortality	11 (21.6)	1 (2)	0.003
30-day adverse events	15 (29.4)	2 (4.1)	0.001

* P<0.05 was considered statistically significant; the Mann-Whitney U test was used; MINS: Myocardial Injury After Non-Cardiac Surgery; ICU: Intensive Care Unit

When anesthesia groups were compared, MAP measurements at the 70th, 80th, 90th, 100th, and 120th minutes were higher in the spinal anesthesia group than in the general anesthesia group (p<0.05). No significant differences were observed between the groups regarding HR values.

DISCUSSION

In this prospective randomized study, the effects of anesthesia technique on postoperative myocardial injury were investigated in elderly patients undergoing hip surgery. Comparable MINS rates were observed in patients receiving either general or spinal anesthesia. Patients who developed MINS had longer ICU and hospital stays together with increased rates of adverse events and 30-day mortality. Older age, higher ASA scores, and perioperative hypotension appeared to be important contributors to MINS development.

Available data regarding MINS in orthopedic surgery are still limited. A subgroup analysis from the VISION study involving more than 15,000 patients undergoing non-cardiac surgery included nearly 3,000 orthopedic cases. In that analysis, MINS occurred in 11.9% of patients, while 30-day mortality rates were reported as 9.8% in patients with MINS and 1% in those without MINS (3).

In the present study, MINS was identified in 51% of the study population. The overall 30-day mortality rate was 12%, reaching approximately 21.6% among patients with MINS compared with 2% in patients without MINS. The higher incidence of MINS observed in our study compared with the VISION orthopedic substudy should be interpreted with caution. Unlike the heterogeneous orthopedic population included in the VISION study, our study exclusively enrolled elderly patients undergoing surgery for acute traumatic hip fractures. This patient population is characterized by advanced age, frailty, acute physiological stress following trauma, systemic inflammatory activation, and a high burden of cardiovascular comorbidities, all of which are recognized contributors to perioperative myocardial injury (6). Furthermore, the present study was conducted at a single center with a relatively small sample size, which may have contributed to the higher observed incidence of MINS and mortality. Therefore, direct comparisons with large multicenter cohorts should be interpreted cautiously.

Adverse events within 30 days were observed in 17% of the study population and occurred more commonly in patients with MINS. Consistent with previous observations, the presence of MINS was associated with prolonged hospital and ICU stays. These findings support the clinical relevance of MINS as an indicator of poorer postoperative outcomes (3).



Optimizing perioperative care in elderly patients undergoing hip surgery is essential to reduce complications and mortality. The selection of anesthesia technique is one component of this process. Although neuraxial techniques are often preferred in clinical practice, the available evidence does not clearly favor one anesthesia method over another in terms of major outcomes. Several studies comparing general and regional anesthesia have reported comparable complication rates and lengths of hospital stay (7-9).

Meta-analyses focusing on anesthesia techniques in hip fracture surgery have yielded mixed results. Certain studies have reported higher rates of in-hospital mortality, readmission, and respiratory complications with general anesthesia, while others demonstrated comparable outcomes between anesthesia techniques in terms of mortality, hospitalization duration, and postoperative complications (10,11). Current guidelines similarly emphasize the importance of individualized perioperative management rather than a specific anesthesia technique (12). Similar findings were obtained in the general and spinal anesthesia groups regarding hospital stay, ICU stay, 30-day adverse events, mortality, vasopressor requirement, and blood transfusion use.

Evidence specifically evaluating the relationship between anesthesia technique and MINS in elderly patients undergoing hip surgery remains scarce. George et al. (13), in a prospective observational study, reported higher MINS rates in patients receiving peripheral nerve blocks; however, this observation was linked to the greater baseline cardiovascular risk profile of those patients. Likewise, subgroup analyses from the VISION study failed to identify a clear relationship between anesthesia method and MINS development (3). Similar results were obtained in the current study, where MINS incidence was comparable between the general and spinal anesthesia groups.

High-sensitivity troponin measurements have been widely accepted as a reliable marker for the diagnosis of MINS. In accordance with previously established criteria, postoperative troponin thresholds were used in this study (14). Analysis of serial troponin measurements revealed no differences between the two anesthesia groups. However, the temporal pattern of troponin changes differed slightly, with earlier increases observed in the general anesthesia group and later increases in the spinal anesthesia group, although these differences were not statistically significant.

Perioperative hemodynamic instability, particularly hypotension, is considered a major contributor to myocardial injury. It is estimated that a substantial proportion of perioperative myocardial ischemic events are related to an imbalance between oxygen supply and demand (2). Earlier studies have linked intraoperative hypotension and tachycardia with MINS development (4). In our cohort, patients diagnosed with MINS showed lower MAP measurements at several perioperative time points, including pre-induction values, together with higher intraoperative heart rates. These observations reinforce the contribution of hemodynamic instability to MINS pathophysiology.

Advanced age, male sex, and comorbid conditions are well-recognized risk factors for MINS (1,15,16). In this study, patients who developed MINS were older and had higher ASA scores. Among comorbidities, CAD was the most frequently observed condition in patients with MINS, although no statistically significant association was identified.

This study has several limitations. First, it was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. Second, although several important perioperative variables were collected, factors such as preoperative hemoglobin levels, perioperative medication use, and sedation requirements in the spinal anesthesia group were not included

in the analyses. Finally, although the study was prospectively randomized, the results should be interpreted in the context of a single-center experience and confirmed by larger multicenter studies.

In conclusion, comparable rates of postoperative myocardial injury were observed in elderly hip surgery patients receiving either general or spinal anesthesia. Factors such as advanced age, higher ASA scores, and perioperative hypotension appear to play a more important role in the development of MINS. Furthermore, the occurrence of MINS was associated with prolonged hospitalization, increased ICU stay, and higher mortality rates.

Conflict of Interest: The authors report no conflicts of interest.

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