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Original Article

A comparison of general versus regional anesthesia in patients over 100 years old: A retrospective cohort study

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Abstract

Aim: As the life expectancy maintains to rise, the number of centenarians applied for surgery is increasing. Functional and anatomical changes in elderly patients may cause postoperative morbidity and mortality. The aim of this retrospective cohort study is to analyze and compare general and regional anesthesia in centenarians underwent different surgeries.

Material and Methods: Patients aged over 100 years (American Society of Anesthesiology scores of II–IV) were included in our study. The centenarians were divided into two study groups: general anesthesia (Group GA, n=20) and regional anesthesia (Group RA, n=18). The demographic characteristics, procedure, and hospital data were evaluated.

Results: There were no significant differences betveen two groups with regards to gender, height, weight, body mass index, ASA scores, perioperative colloid and crystalloid fluid consumptions. Duration of anesthesia and procedure in Group RA was shorter than that in Group GA. The requirement for invasive arterial monitorization, central venous catheterisation, and nasogastric tube in Group GA was higher than that in Group RA. Postoperative delirium was similar in both groups. Heart rate, mean arterial pressure, and peripheral oxygen saturation were similar. In-hospitality mortality was 26.3% in the entire group of centenarians.

Conclusions: This study examined the role of different anesthetic methods in extremely elderly patients over 100 years old during different surgeries. Anesthetic agent preferences, long duration of anesthesia and surgery, and hemodynamic instability can cause serious complications. We therefore conclude that careful considerations are required in extremely elderly patients.

Keywords: Anesthesia management; centenarians; general anesthesia; geriatrics; regional anesthesia

INTRODUCTION

As the life expectancy maintains to rise, the number of centenarians applied for surgery is increasing. Life expectancy at birth is generally 78 years in Turkey. In 2017, Turkey had 5.416 centenarians (≥100 years old), who constituted 0.1% of the elderly population. Turkey ranked 66 among 167 countries (1). Functional and anatomical changes with aging occur in the cellular, tissue, and organ structures. In most of the centenarians, anesthesia and surgery are usually required in emergency situations. On the other hand, anesthesia and surgery in elderly patients require a differentiation. Many studies related to the anesthesia management of elderly patients were reported before, but centenarians have not been investigated sufficiently regarding to the anesthesia management (2).

In recent years, different anesthesia techniques, such as central and peripheral blocks, have become increasingly popular with the development of medical technology. The preferred anesthetic technique may vary according to the type of surgery. Specifically elderly patients may have some neurological and cardiovascular complications during general anesthesia (GA). Covert and Fox reported that hypotensive episodes and blood loss during GA significantly emerged less than during regional anesthesia (RA) (3). On the contrary, another study reported that GA, compared with RA, caused postoperative cognitive dysfunction (4). Therefore, the preference for anesthetic technique, that is, whether GA or RA, is important in elderly patients. Moreover, these changes may affect morbidity and mortality. Warner et al reported that the 30-day mortality was 16% in 31 centenarian patients, and that overall, the type of anesthesia did not affect the morbidity and mortality rates (5).

The term elderly is generally considered to indicate a chronological age of 65 or 80 years or older. However, studies including patients aged over 100 years are rare in the literature. The aim of this retrospective cohort study is to analyze and compare GA and RA in centenarians underwent different surgeries with respect to demographic characteristics, hemodynamics, and mortality.

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MATERIALS and METHODS

Study protocol

We conducted a retrospective cohort clinical study after approving by local ethics committee on 38 patients aged over 100 years who had undergone different surgeries from January 2007 to December 2017 at a university hospital.

Study participants

Patients aged over 100 years old (American Society of Anesthesiology scores of II–IV) were included in this study. Centenarians were excluded if they had incomplete or missing anesthesia records, uncontrolled diabetes mellitus, pulmonary disease, or cerebrovascular disease, started with RA and then converted to general anesthesia at a time during the procedure, and refused to give informed consent.

Preoperative procedures

The centenarians were entered to the operating theatre and performed standard monitoring procedures [heart rate (HR), noninvasive blood pressure (NIBP), electrocardiogram, peripheral oxygen saturation (SpO_2), and body temperature monitoring]. Preoperative blood preparation was conducted for each patient before the procedure.

Study design

Thirty-eight centenarians were retrospectively allocated into two cohort study groups: general anesthesia (Group GA, n=20) and regional anesthesia including spinal anesthesia (Group RA, n=18).

Anesthesia procedures

For the patients in Group GA, a standardized GA protocol was carried out by an anesthesiologist. The patients were induced with propofol (0.5–2 mg kg^{-1}), rocuronium (0.4–0.6 mg kg^{-1}), and fentanyl (0.1 μg kg^{-1}) through the intravenous route. The patients were intubated and then ventilated mechanically with a tidal volume of 5-10 mL kg^{-1} and a frequency of 8–14 breaths min^{-1} using a standard anesthesia machine. End-tidal carbon dioxide (EtCO2) was frequently monitored and observed to keep the EtCO2 at 35–45 mmHg during ventilation. Anesthesia was maintained at desflurane or sevoflurane inhalation in approriate oxygen–air mixture. Rocuronium or atracurium was intermittently injected as necessary. In patients having no complication or side effect during the procedure, sugammadex (IV, 2–8 mg kg^{-1}, Bridion®, MSD, Greenville, USA) was administered to reverse the residual muscle relaxation at the end of surgery. Then, they were extubated in the operating theatre before being taken to the intensive care unit (ICU).

In Group RA, spinal anesthesia was performed with a 20-G or 22-G needle, and 10–15 mg of 5% bupivacaine was injected to the subarachnoid space for the spinal block. The spinal anesthesia procedure was conducted by an experienced anesthetist according to the standard spinal anesthetic technique. Midazolam (0.03–0.2 mg kg^{-1}) was administered as necessary. The anesthesiologist was responsible for the patients' comfort, hemodynamic stability, immobility, adequate analgesia, and airway management.

Procedure data

The duration of anesthesia was described as the time from the patient is taken to the operating theatre until transfer to the post-anesthesia care unit or ICU. The duration of the procedure was described as the time from the first incision until the closure of the last skin suture. The length of hospital stay and the mortality rate were achieved from the University Patient Database. The duration of ICU was described as the time from the post-anesthesia care unit until discharge. In-hospital mortality was described as death from admission to the hospital.

Outcome measures

We evaluated the demographic characteristics, procedure data, and hospital records of the 38 patients undergoing different surgeries. Medication, comorbities, and laboratory values were obtained from the Patient Database. Postoperative ICU records were also analyzed.

HR, MAP, SpO_2 and $EtCO_2$ were recorded at clinically important time points (T_0: 5 min before anesthesia, T_1: 5 min after intubation, T_2: perioperative 30th minute, and T_3: 10 min after awakening from anesthesia). Additionally, the duration of anesthesia and surgery, perioperative and postoperative complications, duration of discharge, postoperative delirium and mortality were recorded. Postoperative delirium was evaluated by mini mental scale examination (MMSE) and confirmed by psychiatrist.

Postoperative management

The centenarians in both groups were observed in the post-anesthesia care unit (PACU). Then, the centenarians who had an indication of postoperative ICU were transferred. Postoperative analgesia was administered to all patients using tramadol (0.5–1 mg kg^{-1}, IV) and paracetamol (20 mg kg^{-1}, IV) before surgery was ended.

Statistical Analysis

Statistical analyses were made using the Statistical Package for the Social Sciences version 24.0 (SPSS, Inc., Chicago, USA) statistical software. Quantitative data were summarized as the mean ± standard deviation (SD), and categorical data were summarized as numbers or percentages. The differences between groups were evaluated by chi-square test and Student's t-test.

RESULTS

Demographic characteristics

Our data emphasized an extremely elderly population. The mean age of the 38 patients was 103.52±2.74 years old. There was no significant difference between two groups according to gender, height, weight, body mass index, and ASA physical status. The mean age in Group GA and Group RA was 102.85±2.85 and 104.27±2.49 years old, respectively ($p>0.05$). The number of smokers in Group GA and Group RA was 4 and 1, respectively ($p>0.05$). The average time from admission to hospital to surgery was 14 h (4–27 h). The number of patients using medications

(antihypertensive, anticoagulant, etc.) in Group GA was greater than that in Group RA (p>0.05). The demographic characteristics of the two groups are presented in Table 1.

Procedure data

Thirteen cases in Group GA and 12 cases in Group RA were performed as emergency surgery procedures. All patients in Group RA had single-shot spinal anesthesia with bupivacaine, and no complication in the spinal anesthesia occurred. There was no significant difference between the groups in terms of perioperative colloid and crystalloid fluid consumption (p>0.05). The duration of anesthesia in Group RA (97.77±25.33 min) was significantly shorter than that in Group GA (132.5±50.95 min) (p=0.013). Similarly, the duration of procedure in Group RA (86.11±23.85 min) was significantly shorter than that in Group GA (120.00±50.36 min) (p=0.013) (Figure 1). The duration of discharge in Group GA (5.30±3.09 days) was shorter than that in Group RA (7.28±6.91 days) (p=0.254). The duration of discharge of all patients was 6.24±5.27 days. The number of patients taken to the postoperative ICU in Group RA (6 patients, 33%) was higher than that in Group GA (2 patients, 10%) (p>0.05) (Figure 2). Six patients in Group GA and 4 patients in Group RA had postoperative delirium and the both groups were similar (p=0.587). The requirement for invasive arterial monitorization, central venous catheterisation, and nasogastric tube in Group GA was significantly higher than that in Group RA (p<0.01). The procedure data are presented in Table 2.

Table 1. Demographic Characteristics

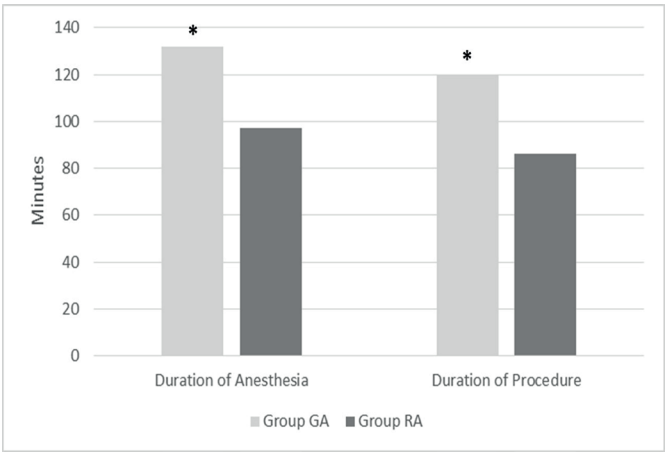
	Group GA (n=20)		Group RA (n=18)		
	Range	Mean±std	Range	Mean±std	p value
Age, years	100 – 109	102.85 ± 2.85	100 – 109	104.27 ± 2.49	0.111
Sex, male/female	5/15	-	6/12	-	0.724
Height, cm	150 – 173	167.65 ± 5.51	150 – 180	165.22 ± 6.67	0.228
Weight, kg	55 – 88	70.10 ± 10.80	55 – 80	71.77 ± 7.03	0.579
BMI, (kg m^{-2})	21 – 30	24.95 ± 2.85	23 – 29	26.44 ± 1.91	0.069
ASA, I/II/III/IV	0/2/15/3	-	0/3/14/1	-	0.740
Mallampati, I/II/III	6/8/6	-	4/9/5	-	0.916
Smoking status, n (%)	1 (5%)	-	4 (22%)	-	0.170
Use of drug, n (%)	19 (95%)	-	14 (77%)	-	0.170

ASA; American Society of Anesthesiology, BMI; Body Mass Index, GA: General Anesthesia, RA: Regional Anesthesia, n: number of cases

Table 2. Procedure Data

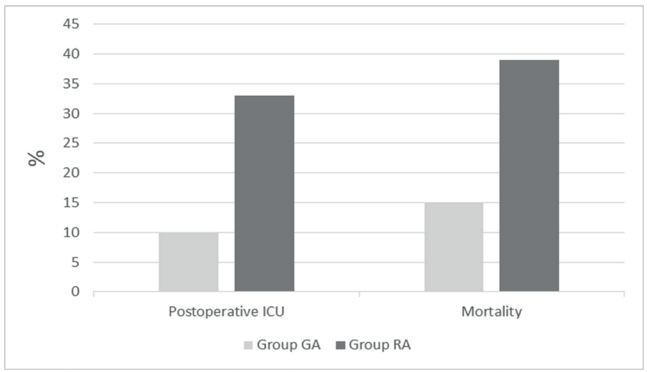
	Group GA (n=20)		Group RA (n=18)		
	Range	Mean±std	Range	Mean±std	p value
Emergency / Elective surgery, n	-	13/7	-	12/6	0.914
Invasive Arterial Monitorization, n	-	20	-	7	**<0.001***
Central Venous Catheter, n	-	15	-	0	**<0.001***
Nasogastric tube, n	-	12	-	0	**<0.001***
Urinary catheter, n	-	20	-	17	0.474
Total crystalloid, ml	1000 – 3000	1385 ± 576	900 – 2000	1105 v 326	0.079
Total colloid, ml	0 – 1000	350 ± 313	0 – 500	277 v 236	0.432
Duration of anesthesia, min	70 – 300	132.50 ± 50.95	45 – 150	97.77 ± 25.33	**0.013***
Duration of procedure, min	60 – 290	120.00 ± 50.36	40 – 140	86.11 ± 23.85	**0.013***
Duration of discharge, day	2 – 17	5.30 ± 3.09	3 – 32	7.28 ± 6.91	0.056
Postoperative ICU, %	-	10%	-	33%	0.117
Postoperative delirium, %	-	30%	-	26.3%	0.587
Mortality, %	-	15%	-	38,9%	0.095
General Surgery, n	-	1	-	0	-
Thoracic Surgery, n	-	3	-	0	-
Neurosurgery, n	-	5	-	0	-
Urology, n	-	0	-	3	-
Plastic Surgery, n	-	2	-	0	-
Orthopedic Surgery, n	-	8	-	15	-
Gynecological Surgery, n	-	1	-	0	-

GA: General Anesthesia, RA: Regional Anesthesia, ICU: Intensive Care Unit, std; Standard Deviation, n: number of cases, * p<0.05, compared with each other



GA: General Anesthesia, RA: Regional Anesthesia, * p<0.05, compared with each other

Figure 1. Duration of Anesthesia and Procedures



GA: General Anesthesia, RA: Regional Anesthesia

Figure 2. Postoperative ICU and In-hospital Mortality Rate

Hemodynamics

The heart rate, mean arterial pressure, and peripheral oxygen saturation were similar in both groups (p>0.05). The heart rate, mean arterial pressure, and peripheral oxygen saturation values are presented in Tables 3, 4, and 5, respectively.

Mortality

In-hospitality mortality was 26.3% in this entire group of centenarians. Mortality in Group GA and Group RA was 15% and 38.9%, respectively (p=0.95) (Figure 2).

Table 3. Heart Rates

Time	Heart Rate (/min) (Mean±std) Group GA (n=20)	Group RA (n=18)	p value
T_0	87.20 ± 17.99	86.50 ± 18.86	0.907
T_1	82.10 ± 13.67	78.55 ± 14.52	0.444
T_2	79.20 ± 11.54	82.16 ± 16.56	0.522
T_3	79.35 ± 25.06	77.72 ± 17.66	0.820

T_0; 5 min before anesthesia, T_1; 5 min after intubation, T_2; perioperative 30th minute, T_3; 10 min after awakening from anesthesia, GA: General Anesthesia, RA: Regional Anesthesia

Table 4. Mean Arterial Pressures

Time	Mean Arterial Pressures (mmHg) (Mean±std) Group GA (n=20)	Group RA (n=18)	p value
T_0	102.20 ± 20.84	98.11 ± 19.46	0.537
T_1	84.70 ± 17.69	86.77 ± 14.77	0.699
T_2	80.90 ± 14.60	80.50 ± 12.07	0.928
T_3	76.50 ± 20.94	83.22 ± 10.80	0.230

T_0; 5 min before anesthesia, T_1; 5 min after intubation, T_2; perioperative 30th minute, T_3; 10 min after awakening from anesthesia, GA: General Anesthesia, RA: Regional Anesthesia

Table 5. Peripheral Oxygen Saturation (SpO2) values

Time	Peripheral Oxygen Saturation (Mean±std) Group GA (n=20)	Group RA (n=18)	p value
T_0	92.45 ± 3.94	90.38 ± 4.91	0.160
T_1	94.90 ± 2.55	93.88 ± 3.44	0.308
T_2	96.10 ± 1.86	94.83 ± 3.71	0.185
T_3	95.30 ± 3.52	94.55 ± 3.91	0.541

T_0; 5 min before anesthesia, T_1; 5 min after intubation, T_2; perioperative 30th minute, T_3; 10 min after awakening from anesthesia, GA: General Anesthesia, RA: Regional Anesthesia

DISCUSSION

As the life expectancy maintains to rise, the number of centenarians applied for surgery is increasing. Many studies found the anesthesia management of centenarians to be remarkable. In this retrospective cohort study, we compared and analyzed GA and RA in centenarians underwent different surgeries. Our study showed that many surgeries, especially orthopedic surgeries, were performed in most of the centenarians. Invasive procedures were mostly performed under GA, and the duration of anesthesia and that of surgery were significantly longer. Interestingly, the duration of discharge was shorter in Group GA, and we considered this group to have a higher rate of being taken to postoperative ICU. In-hospitality mortality was 26.3% among all the centenarians. Mortality in the GA Group and RA group was 15% and 38.9%, respectively.

Different anesthetic techniques are preferred for centenarians. Specifically, spinal or epidural anesthesia is commonly preferred for orthopedic surgery in this population as most of these patients have to return to their daily lives. Combined spinal anesthesia (CSA) is an optimal anesthetic technique for centenarians undergoing orthopedic surgery because it prevents the high reduction of arterial blood pressure (6). The need for intrathecal local anesthetic of middle-aged adult patients is significantly greater than that of elderly patients requiring similar surgery (7). In our study, we observed that spinal anesthesia was more frequently preferred. However,

because of the lack of data, we were unable to report the patients' postoperative cognitive function and return to their daily lives. Lower initial doses of local anesthetics were preferred to be administered.

Substantial case specifies that anesthesia type affects clinical outcomes after hip fracture surgery, but the definitive effects are elusive and controversial (8). Matsuo et al found that spinal anesthesia was more frequently performed in the oldest old group with hip fracture (9). Anesthesia preference can even affect the length of stay (LOS) in the hospital. In the literature, studies interpreting the relationship between anesthesia type and LOS are limited. Neuman et al found that RA was related with a shorter LOS after hip fracture patients (10). In the current study, spinal anesthesia was specifically preferred for orthopedic surgery. GA was initially preferred in other surgeries.

Relevant studies have been performed on the relationship between anesthesia preference and postoperative complications. In the literature, although the average incidence of delirium reported was 35% after the treatment of hip fracture, no clear relationship was found between postoperative delirium (POD) and type of anesthesia, that is, GA versus RA (11). However, to predict the postoperative cognitive status, we used perioperative monitoring methods, such as monitoring brain oxygenation/perfusion and depth of anesthesia, in the elderly patients. Zheng et al found a relationship between cerebral oxygen desaturation by intraoperative near-infrared spectroscopy and poor cognitive results (12). However, this issue remains controversial and unclear because we cannot state for sure that a relationship exists between cognitive changes and anesthetic drugs. Yang et al reported that mortality increased when patient have the hypoactive form of POD (13). POD improved in approximately 10% of elderly surgical patients, and POD incidence could increase by 30%–65% after hip fracture, cardiovascular, and emergency surgery (14). Many anesthetists perform RA to avoid POD in elderly patients. Anesthetists avoid using anesthetics such as opioids and benzodiazepines in these patients. In the current study, postoperative complications were not reported because of the lack of data.

In elderly patients, a careful follow-up of hemodynamics during the perioperative period is important. Specifically, hypotension, which is highly likely to develop because of the type of surgery, should be monitored. Perioperative hypotension is frequently observed in elderly patients with limited function of the cardiovascular system (15). It is caused by sympathetic activity blockade, which usually increases even at rest in the elderly population. Long-term hypotension, especially low diastolic pressure, may be harmful for the myocardium by causing ischemia and thus compromising coronary perfusion. Beta-receptor responsiveness declines when the heart ages, and the heart rate does not increase to maintain an adequate cardiac output in hypovolemia in elderly patients (16). Enough oxygen delivery to the central nervous system decreases during hypotension and/or blood loss in surgery. A minimum of 50% risk of cardiac ischemia can occur in patients over 70 years old because of the cardiovascular changes in advanced age and the effect of poor blood circulation. Hypovolemia and dehydration may easily develop after bleeding during the hours between trauma and surgery and while taking diuretic medication in elderly patients (17). Conversely, some studies reported that the use of small doses of local anesthetic in CSA along with an intrathecal opioid resulted in lesser hypotension than conventional CSA doses, and that local anesthetic gave a sufficient block in most elderly patients (18). In our study, hemodynamics such as HR, MAP, and SpO_2 was similar in both groups. However, the consumption of more colloids and crystalloids in Group GA could be related to the type of surgery, as general, thoracic, neuro, and gynecological surgeries are performed under GA. Furthermore, invasive procedures could have been implemented more in Group GA because of this reason. The duration of anesthesia and surgery could be longer because of the more invasive access and the type of surgery in Group GA.

Studies on the risks and/or advantages of different anesthesia techniques in mortality reported inconsistent outcomes. These results are not astonishing given that the overall reported mortality of anesthesia is 1 in 200.000–300.000 patients (19). Unfortunately, only a few studies specifically interpreted anesthesia technique and in-hospital mortality. Warner et al (20) reported that mortality was 25%, 42%, and 50% at 30 days, 6 months, and 1 year in a group of centenarian patients, respectively. These results are similar to those in the study of Forster et al on centenarian hip fracture patients (21). This difference in mortality rates was not significant (p=0.078). Moreover, Forster et al found that mortality rates were lower when under sedation and in small surgical interventions. Chunyuan et al indicated that GA was related with higher in-hospital mortality. Moreover, Group GA had more discharges to a health center and had a longer time to discharge than Group RA (22). Neuman et al indicated RA patients to have lower odds for mortality than GA patients (23). On the contrary, Patorno et al indicated no difference among the RA, GA, and combined groups in evaluating in-hospital mortality (24). In the current study, in-hospital mortality was higher in RA patients. This result could be due to the length of stay in intensive care. The higher mortality rate in Group RA may be attributed to the impairment of the general condition of RA patients.

LIMITATIONS

Our study has some limitations. This retrospective study was based on a hospital records. There is major bias as to why is general or regional anesthesia chosen for the individual patient. All the patients were from a single center, and the sample size was relatively small. Patients were not assigned randomly, and this condition could have prevented the standardization of the patients. There should be more pre- and postoperative outcome measures such as pre-existing illness, baseline and postoperative cognitive function, and ambulatory status. The patients underwent different types of surgery and

that was overlooked because these patients were rare. Moreover, not all results could be generalizable to other races and countries.

CONCLUSION

Our study examined the role of different anesthetic methods in extremely elderly patients, especially those over 100 years old, during different surgeries. Anesthetic agent preferences (either RA or GA), long duration of anesthesia and surgery, and hemodynamic instability (especially bradycardia and hypotension) can cause serious complications that may be life threatening. We therefore conclude that careful considerations are required with regard to the surgical indication and procedure in extremely elderly patients. The current study may serve as a guide for future works.

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Competing Interests: The authors declare that they have no competing interest.

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Ethical Approval: This study was approved by the local ethic committee of Inonu University, Malatya, Turkey, (05.06.2018, Protocol no: 2018/12-6).

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