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The Correlation of Postoperative Cognitive Dysfunction and Cerebral Oximetry in Geriatric Patient Undergoing Orthopedic Surgery: A Prospective Randomized Trial

Ortopedik Cerrahi Geçiren Geriatrik Hastalarda Postoperatif Kognitif Disfonksiyon ve Serebral Oksimetri Korelasyonu

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ÖZ

Amaç: Bu çalışmada birincil amacımız, ortopedik cerrahi uygulanan geriatrik hastalarda anestezi tipinin serebral oksijen satürasyonu değerleri ve Mini Mental Test (MMT) skorları ile karşılaştırılmasıdır. Bu çalışmadaki ikincil amacımız, serebral oksijen satürasyon değerleri ile MMT puanları arasındaki ilişkiyi değerlendirmekti.

Gereç ve Yöntemler: Çalışmamıza Proksimal Femoral Çivi Antirotasyon (PFN-A) operasyonu planlanan 65 yaş üstü toplam 40 hasta dahil edildi. Olgular Genel Anestezi ve Spinal Anestezi olarak 2 gruba ayrıldı. Preoperatif dönemde postoperatif 48. saate kadar düzenli aralıklarla serebral doku oksijen satürasyonu sağ ve sol değerleri ve hemodinamik veriler ölçüldü. Ameliyat öncesi ve ameliyat sonrası 48. saatteki MMT skorları değerlendirildi. Tüm veriler grup I ve grup II arasında karşılaştırıldı. Serebral oksijen satürasyon değerleri ile MMT skorları arasındaki ilişki değerlendirildi.

Bulgular: Ameliyat sonrası 48. saatte yapılan MMT skorlarında ameliyat öncesi döneme göre azalma olmasına rağmen, gruplar arasında istatistiksel olarak anlamlı fark gözlenmedi (p>0,05). Perioperatif dönemde serebral oksijen satürasyonu sağ ve sol değerleri karşılaştırıldığında, serebral oksijen satürasyonu değerlerinde azalma olmasına rağmen gruplar arasında istatistiksel olarak anlamlı fark yoktu(p>0,05). Perioperatif serebral oksijen satürasyonu sağ ve sol değerleri ile MMT skorları arasındaki ilişki incelendiğinde istatistiksel olarak anlamlı bir ilişki bulunamadı (CI% 95:0,318-35,364) (p>0,05).

Sonuç: Minimal invaziv ortopedik cerrahi uygulanan geriatrik hastalarda hem spinal anestezide hem de genel anestezide perioperatif dönemde serebral doku oksijen satürasyon değerlerinde ve MMT skorlarında azalma görülebilmektedir. Ancak serebral doku oksijen satürasyon değerleri ile MMT skorları arasında ilişki yoktu. Bu konuda daha kapsamlı çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Postoperatif kognitif komplikasyon; geriatrik ortopedik cerrahi; near-infrared spektroskopi;genel anestezi, spinal anestezi

ABSTRACT

Aim: The purpose of this study was comparing the type of anesthesia in geriatric patients undergoing orthopedic surgery with cerebral tissue oxygen saturation values and Mini Mental Test (MMT) scores. The relationship between cerebral tissue oxygen saturation values and MMT scores was also evaluated.

Material and methods: A total of 40 patients over the age of 65 and above who were scheduled for Proximal Femoral Nail Antirotation (PFN-A) operation were included in our study. Cases were divided into 2 groups as general anesthesia (Group I) and spinal anesthesia (Group II). Cerebral tissue oxygen saturation right and left values and hemodynamic data were measured at regular intervals in the preoperative period until the postoperative 48th hour. MMT scores at the preoperative and 48th postoperative hours were evaluated. The relationship between cerebral oxygen saturation values and MMT scores were evaluated.

Results: Although there was decreased in the MMT scores performed at 48th postoperative hours compared with the preoperative period, no statistically significant difference was observed between the groups (p>0.05). When the cerebral tissue oxygen saturation right and left values in the perioperative period were compared, there was no statistically significant difference between the groups, although there was a decrease in the cerebral tissue oxygen saturation values (p>0.05). When the relationship between perioperative cerebral tissue oxygen saturation right and left values and the MMT scores were examined, no statistically significant relationship was found (CI%95:0.318-35.364) (p>0.05).

Conclusion: In elderly patients who undergo minimally invasive orthopedic surgery, a decrease in cerebral tissue oxygen saturation values and MMT scores can be seen in the perioperative period in both spinal anesthesia and general anesthesia. However, there was no relationship between cerebral tissue oxygen saturation values and MMT scores.

Keywords: Postoperative cognitive complication; geriatric orthopedic surgery; near-infrared spectroscopy; anesthesia general; anesthesia spinal

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Introduction

With the improvements in general living standards, innovations in health care, nutrition and education, the number of elderly individuals is seen to be increasing day by day. Therefore, it has been reported that 50% of this elderly population will undergo surgical procedure at least once. Postoperative cognitive dysfunction (POCD) is known as a condition that may cause anxiety in the elderly population exposed to anesthesia (1-4).

The Mini Mental Test (MMT) is still the most widely used cognitive assessment test in the world. MMT may be the first step in assessing cognitive status and detecting cognitive decline that has occurred over time is its primary goal (5-8).

Near-infrared spectroscopy (NIRS) is a non-invasive optical measurement technique increasingly used clinically to assess cerebral oxygenation. Cerebral tissue O_2 saturation (ScO_2) measured by NIRS is mostly determined by the O_2 saturation of the venous compartment and possibly reflects cerebral venous O_2 saturation (9-12).

The most common risk factors for postoperative cognitive dysfunction (POCD) are hypoxia, hypotension, increased perioperative stress, glucocorticosteroids, and drugs affecting the cholinergic system. Factors that play a role in increasing this risk following surgery include pain, preoperative dysfunction in neurocognitive function, metabolic disorders, duration/type of surgery, hypoxemia, advanced age, and use of certain anesthetics (9). Our hypothesis in this study is that if we keep cerebral oxygen saturation between normal values, there will be no decrease in the postoperative mini-mental test. For this, it was planned to optimize the hemodynamic and pulse oximetry values of the patient by applying treatments such as fluid and blood products treatment, administration of inotropes when necessary, heart rate and rhythm control, mechanical ventilator adjustments, and additional oxygen support when necessary.

In our study, the primary objective was to investigate the effect of general anesthesia and spinal anesthesia on perioperative NIRS values and MMT scores in geriatric patients undergoing orthopedic surgery. Our secondary objective was to determine the relationship between cerebral tissue oxygen saturation values monitored intraoperatively with postoperative MMT scores.

Materials and Methods

This study started on 09.01.2019 and ended on 12.07.2019. It was approved by the local ethics committee dated 04.04.2018 and numbered 2018-GOKAE-0349 and registered at http://www.clinicaltrials.gov (NCT03827083). It was conducted in geriatric patients aged 65 years and older, in the ASA I-II group, without preoperative comorbidities, and to undergo elective Proximal Femoral Nail Antirotation (PFN-A) which was a minimally invasive orthopedic surgery. Our prospective randomized study was planned to include more than 60 cases in total, considering the lost observations according to the power analysis (Power analysis was performed under repeated measurement ANOVA test in order to find the difference between the groups significant. 30 cases, as 15 cases from each group, were found to be sufficient, with 80% power, $\alpha = 0.05$ and by taking the correlation between repeated measurements as 0.5 in the analysis) result. A total of 63 patients were evaluated. Before randomization, 22 cases were excluded from the study since they did not meet the inclusion criteria. After randomization, the cases were divided into 2 groups as Group I (n=20) and Group II (n=21).

The patients whose consents were obtained were divided into two groups as Group I (n=20)/general anesthesia group and Group II (n=21)/spinal anesthesia group. To include the first patient in Group I, the coin flip method was used as one of the simple randomization methods.

After establishing vascular access in all patients to be operated from the back of their left hand with a 20-gauge intracath, 1000 mL of Isolyte-S was administered. Cerebral tissue oxygen saturation (ScO_2) (INVOS ™ 5100C, Cerebral/somatic oximeter, Covidien; USA) probes were placed on the right and left frontal skin in addition to standard ASA monitoring. It was checked whether the bottom heaters on the operation tables were working. No premedication was administered to any patient since it could cause delirium and postoperative cognitive dysfunction (POCD). The heart rate (HR), systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), pulse oxygen saturation (SpO2), cerebral oxygen saturation right side (ScO2_R), cerebral oxygen saturation left side (ScO2_L) values of all patients before induction (T1), after general anesthesia induction or spinal anesthesia (T2), at surgical incision (T3), at 15 minutes after surgical incision (T4), at 30 minutes after surgical incision (T5), at 45 minutes after surgical incision (T6), at 60 minutes after surgical incision (T7), when discharged from the operating room (T8), at 45 minutes in the recovery room (T9), and at the 48th postoperative hour (T10) were recorded. The Modified MMT was applied to all cases. MMT and hemoglobin values at the preoperative and 48th postoperative hours were recorded.

Our aim in this study was to detect cognitive changes according to the Mini-Mental Test values of the patients rather than diagnosing postoperative cognitive dysfunction according to DSM-5 (Diagnostic and Statistical Manual for Mental Disorders, fifth edition) criteria. Confusion Assessment Method (CAM)-ICU screening test was performed to exclude patients from postoperative diagnosis of delirium.

In Group I (n=20), general anesthesia induction was provided by propofol (1.5-2 mg/kg) and fentanyl (1 mcg/kg) intravenously. 0.6 mg/kg rocuronium was administered intravenously for the purpose of muscle relaxation. Endotracheal intubation was performed with direct laryngoscopy in the patients with sufficient muscle relaxation. Anesthesia was maintained with 1-2% sevoflurane in O_2/air mixture. Postoperative analgesia of

the patients was provided by administering 10 mg/kg Paracetamol with 1 mg/kg Tramadol HCL intravenously. Standard postoperative analgesia was administered to keep the visual analogue scale (VAS) values below 4 in the postoperative period. 2 mg/kg sugammadex was administered intravenously at the end of the operation, and the patients were extubated after sufficient muscle strength was achieved.

In Group II (n=21), after the patient was placed in a sitting position, the injection site was cleaned from the center to the periphery, and the surgical site was limited with a sterile perforated drape. The site was cleaned considering sterility in order to prevent the staining solution from passing into the subarachnoid space. An imaginary line connecting the two posterior-superior iliac crests was used to administer spinal anesthesia. Lumbar puncture was usually performed through the L3-L4 vertebral space. A 25-gauge Quincke-type spinal needle was passed through the skin, subcutaneous tissues, ligamentum supraspinale, ligamentum interspinale and ligamentum flavum. The free flow of the cerebrospinal fluid was controlled. After the cerebrospinal fluid was seen, the local anesthetic agent (Bupivacaine Heavy; Bustesin® 0.5% and spinal heavy VEM drugs; Istanbul, Turkey) was injected slowly into the spinal space in appropriate doses (12-14 mg) according to age and height, the spinal needle was withdrawn, and the spinal injection was completed. The effectiveness and level of spinal anesthesia were evaluated by the pin -prick test. The operation was started after positioning the patient when the sufficient sensory level was achieved. In the postoperative period, 10 mg/kg Paracetamol and 1 mg/kg Tramadol HCL were administered to the patients intravenously to keep VAS values below 4 in general anesthesia follow-ups and after the sensory blockade ended.

A cerebral tissue oxygen saturation (ScO_2) decrease more than 20% compared to its basal value was taken as the cut-off value for cerebral desaturation (ScO_2<basal$ScO_2$20%) (13,14). Additional O_2 treatment was provided in cases where the pulse oxygen saturation (SpO_2) values decreased below 92% in Group I (n=20) and Group II (n=20).

The mini mental test (MMT) values decreasing 2 points below the preoperative values were considered as regress in MMT (15).

Statistical Analysis

Numerical data are summarized as mean, standard deviation, median, minimum, and maximum values and categorical data as frequency and percentage values by using IBM SPSS Statistics 25.0 (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) package program. The statistical significance level was set at 0.05 for all analyses (excluding interaction, $p< 0.1$).

The Pearson Chi-Square test was used to evaluate gender and position distributions in the anesthesia groups. The normality assumption of quantitative variables was separately checked by the Shapiro-Wilk test in the groups to be compared. Accordingly, the independent sample t-test or Mann-Whitney U test was preferred in the comparison of demographic data between the two groups. The relationship between preoperative MMT and Cerebral oxygen saturation (ScO_2) values at T1 time point and postoperative MMT and Cerebral oxygen saturation (ScO_2) values at T10 time point were evaluated by Spearman correlation analysis.

Time-dependent changes of the heamodynamic variables in the anesthesia groups were analyzed using the random effect (as a random cut-off point for each person), and the linear mixed model (LMM) where time and anesthesia group were taken as fixed effects. When the anesthesia group-time interaction was found statistically significant, time-dependent changes were separately examined in each group, and dual time comparisons were performed by applying the Bonferroni correction to the t-test results using the differences between the least squares estimates. Subsequently, the anesthesia groups were compared at basal and at later time points by taking the basal measurements as covariates. A similar approach was used for the cerebral oxygen saturation (ScO_2) by adding the side (right-left) effect to the model. As a result, the interaction between the anesthesia group and side was found to be statistically significant; therefore, the model with separate time, anesthesia groups and interactions on the right and left sides and the model with separate time, sides and interactions in the groups were examined. All linear mixed models were implemented using the PROC MIXED procedure of SAS software (Version 9.3; SAS Institute, Cary, NC, USA).

The non-parametric method was used for time-dependent changes of the mean arterial pressure (MAP) and pulse oxygen saturation (SpO_2) variables in the groups, with the help of Brunner-Langer model (F1-LD-F1 design), R 3.5.2 software (R software, version 3.3.1, package: nparLD, R Foundation for Statistical Computing, Vienna, Austria; http://r-project.org). As a result of the Brunner-Langer model, when time-dependent changes in the groups were not similar (interaction of <0,1), the time comparison was made separately in each group with the Brunner Langer (LD-F1 design) (presented as Bonferroni-corrected), and the differences between the values at basal and values at later time points were observed and compared by the Mann-Whitney U test.

Results

The postoperative mini mental test (MMT) could not be performed in 1 case in Group II due to mortality at the 10th postoperative hour, and the case was excluded from the study (Figure 1).

Demographic data

A total of 40 cases were included in our study. Gender distribution between the groups was similar, with 25 females and 15 males. When examined in terms of age, the youngest case was 65 years old, and the oldest case was 94 years old. When the demographic data were compared between the groups, there was no statistically significant difference (Table 1) ($p>0.05$).

Comparison of Perioperative Data Between the Groups

When the hemodynamic data between Group I (n=20) and Group II (n=20) were compared, there was no statistically significant difference between HR data (p=0.671) and there was a significant decrease in MAP and SpO_2 values in Group II compared to Group I (respectively p<0.001, p<0.001). However, these low

Table 1. Comparison of demographic data between groups

Data	Group I (n = 20) GA Mean ± SD Med (Min-Max)	Group II (n = 20) SA Mean ± SD Med (Min-Max)	Total (n = 40) Mean ± SD Med (Min-Max)
Age (years)	76.20±6.77 77(66-94)	80.40±6.66 82(65-94)	78.30±6.96 80(65-94)
Weight (Kilogram)	64.75±14.48 61(40-92)	64.20±11.33 63(50-86)	64.47±12.84 62(40-92)
BMI	23.98±4.57 23.56(15.85-31.25)	23.53±3.84 22.05(19.53-32.44)	23.76±4.17 22.39(15.85-32.44)
Gender M (n,%)	8, 40%	7, 35%	15, 37.5%
F (n,%)	12, 60%	13, 65%	25, 62.5%
Position RLD (n,%)	9, 45%	13, 65%	22, 55%
LLD (n,%)	11, 55%	7, 35%	18, 45%
Time of anesthesia (min)	121.4±47.84 110(55-240)	107.50±28.85 107.50(65+160)	114.45±39.62 107.50(55-240)
Time of surgery (min)	85.90±44.36 80(35-195)	75.00±26.30 65(40-130)	80.45±36.42 72.50(35-195)

GA = General Anesthesia, SA = Spinal Anesthesia, M = Male, F = Female, RLD = Right lateral decubitis, LLD = Left lateral decubitis, SD: Standard Deviation, Med = Median, Min: Minimum, Max: Maximum, Statistical analysis: chi-square and Mann-Whitney U test.

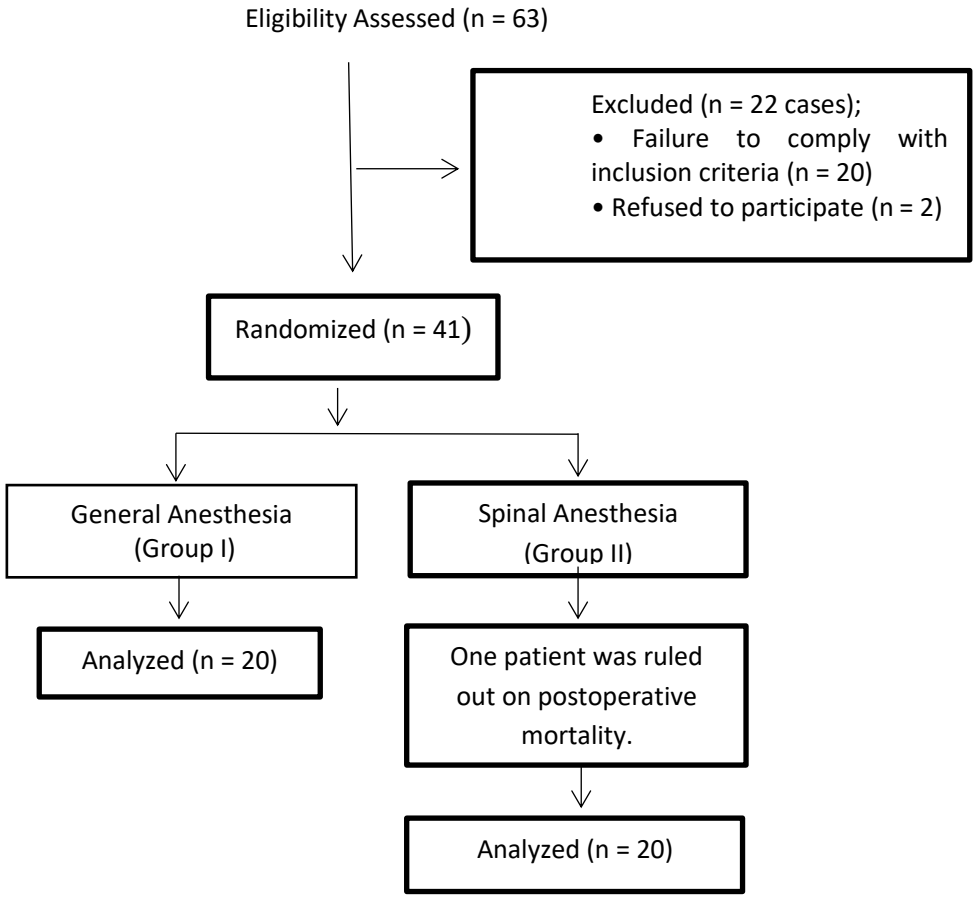

Figure 1. CONSORT flow diagram

values were at levels that required no intervention (Figures 2,3, and 4)

The cerebral oxygen saturation right side (ScO_2_R) and cerebral oxygen saturation left side (ScO_2_L) values were compared between the groups according to time points. While the change in ScO_2_R and ScO_2_L values over time was similar in Group 1 (n=20)/GA group (p=0.998), a significant relationship was found in both values decreasing over time (p<0.001). No significant difference was found between ScO_2_R and ScO_2_L values in terms of time-dependent changes (p=0.448). Although the change in ScO_2_R and ScO_2_L values over time was similar in Group 2 (n=20)/SA group (p=0.998), a significant relationship was found in both values decreasing over time (p<0.001). No significant difference was found between ScO_2_R and ScO_2_L values in terms of time-dependent changes (p=0.448).

Comparison of MMT values

Both groups were observed to have a decrease in the MMT values. Preoperative and postoperative changes in the MMT values were similar between groups (p=0.294), this change was in the direction of decrease and found to be statistically significant (p<0.001). In addition, there was no statistically significant difference between the groups at both time points (p=0.207) (Table 2).

When preoperative and postoperative MMT values were compared within the groups, a decrease more than 2 points was observed in 5 patients in Group 1 (n=20), while it was observed in 4 patients in Group 2 (n=20). The ScO_2<basal$ScO_2$20% and regress in MMT were detected in 4 of these 9 patients.

Relationship of MMT with cerebral oxygen saturation (ScO_2) Between the Groups

Relationship between the incidence of ScO_2<basal ScO_2 20% in patients with regress in MMT between groups was examined. No statistically significant difference was found between the groups (p=1.0, p=0.061, respectively) (Table 3).

The data on the ScO_2<basal ScO_2 20%, decrease 2 or more point MMT and decrease of 2 or more point MMT+ScO_2<basal ScO_2 20% were compared between the groups. Although the ScO_2<basal $ScO_2$20% was observed in 4 (20%) patients in Group 1 (n=20) and 7 (35%) patients in Group 2 (n=20), no statistically significant difference was found between the groups (p=0.288 OR=2.154 CI95%=0.515-9). Although decrease of 2 or more point MMT was observed in 5 (25%) patients in Group 1 (n=20) and in 4 (20%) patients in Group 2 (n=20), no statistically significant difference was found between the groups (p=0.705 OR=0.75 95% CI=0.164-3.333). Although the ScO_2<basal ScO_2 20% and decrease of 2 or more point MMT were observed together in 1 (5%) patient in Group 1 (n=20) and 3 (15%) patients in Group 2 (n=20), no statistically significant difference was found between the groups (p=0.292 OR=3.353 95% CI=0.318-35.364) (Table 4).

Discussion

Postoperative cognitive dysfunction (POCD) is a complication that can significantly affect the quality of life of the patients. In most cases, cognitive dysfunction can be quite mild and can only be diagnosed by evaluation using certain neuropsychological tests; however, no official psychiatric diagnostic criterion is available (1). In our study, there was decreased in the MMT scores performed at 48th postoperative hours compared with the preoperative period, no statistically significant difference was observed between the groups (p>0.05). When the relationship between perioperative cerebral tissue oxygen saturation right and left values and the MMT scores were examined, no statistically significant relationship was found (CI 95%:0.318-35.364) (p>0.05).

Hoppenstein et al. evaluated the effect of spinal and general anesthesia on cerebral oxygen saturation in a total of 60 patients aged 60 years or older, in the ASA I-III group in terms of anesthesia risk undergoing femoral neck fracture surgery (16). They found the decrease in the cerebral oxygen saturation (ScO_2) values of the spinal anesthesia group statistically significantly lower compared to the general anesthesia group and concluded that cerebral oxygen saturation varied from person to person and spinal anesthesia was associated with cerebral desaturation (16).

In our study, the ScO_2<basal ScO_2 20% was detected in 4 patients (20%) in the general anesthesia group and 7 patients (35%) in the spinal anesthesia group. However, there was no statistically significant difference between the groups (p=0.288).

Mandal et al. evaluated the effect of general and epidural anesthesia on early postoperative cognitive dysfunction after hip and knee surgeries in 60 patients over 60 years of age (17). All patients were evaluated using the mini mental test (MMT) in the 1st preoperative and postoperative weeks. In general, a significant difference was found between the two groups in terms of MMT scores (17). Shi et al. divided 100 patients with hip prostheses into two groups as general anesthesia and epidural anesthesia groups in their study evaluating cognitive functions after hip replacement in the patients aged between 60-75 years. They used the MMT method for POCD evaluation of the patients in both groups and showed that general anesthesia reduced the MMT scores compared to epidural anesthesia (18). They concluded that the epidural anesthesia method was better than the general anesthesia method for hip replacement in elderly patients (18).

In our study, POCD was detected at the rate of 25% in the general anesthesia group and 20% in the spinal anesthesia group. However, no statistically significant difference was found between the groups.

Papadopoulos et al., Kim et al., Slater et al. and Colak et al. examined the relationship between the ScO_2 and POCD in their studies on geriatric patients (15,19-21). While the decrease in the ScO_2 value below 40% was found to be associated with POCD. In our study, POCD

was detected in 25% of the patients in the general anesthesia group and 20% of the patients in the spinal anesthesia group. The ScO_2<basal ScO_2 20% was detected in 20% of the general anesthesia group and 35% of the spinal anesthesia group. POCD was observed in a total of 9 patients, and the

Table 2. Comparison of preoperative and postoperative MMT between groups

Data	**Group 1 (n = 20) GA Mean ± SD Med [min-max]**	**Group 2 (n= 20) SA Mean ± SD Med [min-max]**	**p values**	**Total n = 40 Mean ± SD Med [min-max]**
Preoperative MMT	25.45±3.33 26.50 (18-29)	23.85±3.45 24 (18-29)	Interaction: p=0.294* Time: p<0.001** Group: p=0.207**	24.65±3.44 25.50 (18-29)
Postoperative MMT	23.55±4.34 24.50 (16-29)	22.65±3.57 23 (18-28)		23.10±3.95 23 (16-29)

GA = General Anesthesia, SA = Spinal Anesthesia, Med = Median, SD: Standard Deviation, Min: Minimum, Max: Maximum, Statistical analysis: Mann Whitney U model * Brunner-langer model **, p <0.1 statistical meaningful value.

Table 3. Relationship between the incidence of ScO_2<Basal$ScO_2$20% in patients with regress in MMT between groups

		ScO_2<Basal$ScO_2$20% (-) n, %	**ScO_2<Basal$ScO_2$20% (+) n, %**	**P**
Group 1 (n = 20) GA	MMT (-)	12, 60%	3, 15%	p=1.0
	MMT (+)	4, 20%	1, 5%	
Group 2 (n = 20) SA	MMT (-)	12, 60%	4, 20%	p=0.061
	MMT (+)	1, 5%	3, 15%	
Total (n = 40)	MMT (-)	24, 60%	7, 17,5%	p=0.196
	MMT (+)	5, 12,5%	4, 10%	

GA: General Anesthesia, SA: Spinal Anesthesia, MMT (+) : Regress in MMT (decrease 2 and more points in MMT). Statistical Analysis: Chi Square test and Fisher exact test p <0.05 statistically significant.

Table 4. Relationship between the groups ScO_2<Basal$ScO_2$20% , MMT(+) and MMT (+) + ScO_2<Basal $ScO_2$20%

	ScO_2<Basal$ScO_2$20% n, %	**MMT (+) n, %**	**MMT(+) + ScO_2<Basal$ScO_2$20% n, %**	**OR/ CI95%/ P**
Group 1 (n = 20) GA	4, 20%	5, 25%	1, 5%	OR:3.353 CI95%: 0.318-35.364 p=0.292
Group 2 (n = 20) SA	7, 35%	4, 20%	3, 15%	
Total (n = 40)	11, 27,5%	9, 22,5%	4, 10%	

GA: General Anesthesia, SA: Spinal Anesthesia, MMT (+): Regress in MMT (decrease 2 and more points in MMT). OR: Odds Ratio, CI 95%: Confidence Interval 95%, Statistical Analysis: Chi Square test p <0.05 statistically significant.

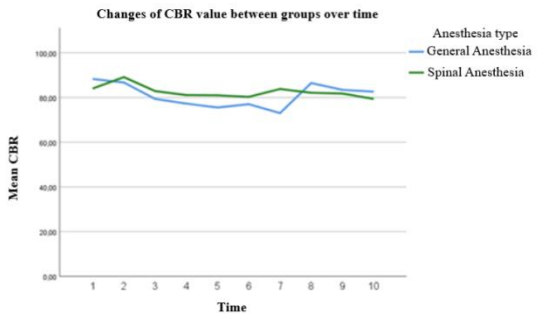

Figure 2. Changes of HR value between groups over time (HR=Heart rate)

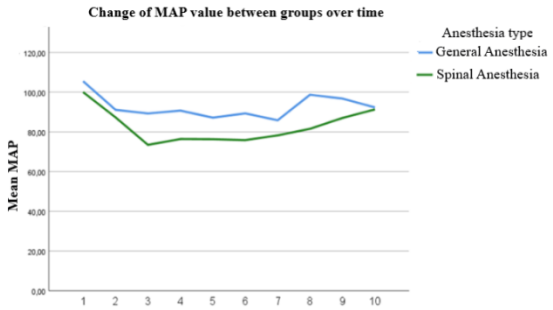

Figure 3. Change of MAP value between groups over time (MAP=Mean Arterial Pressure)

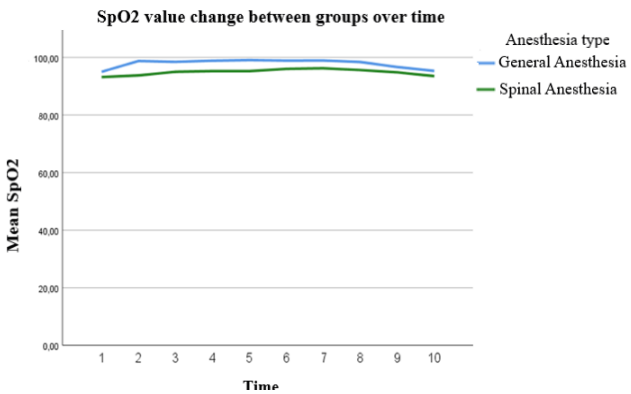

Figure 4. SpO_2 value change between groups over time

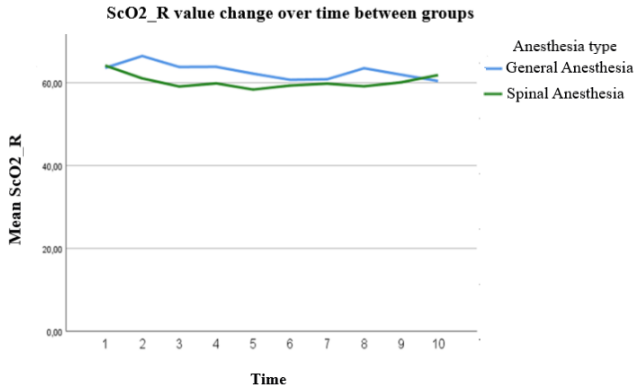

Figure 5. ScO_2_R value change over time between groups

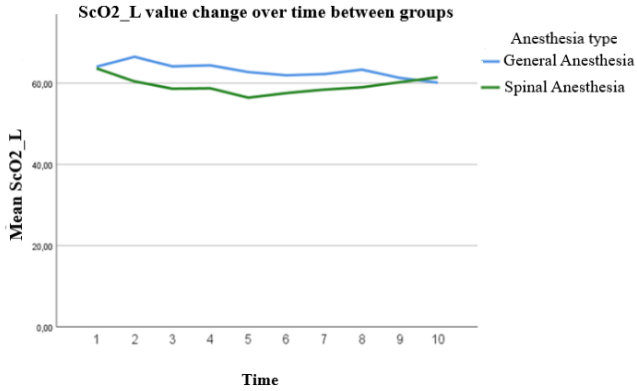

Figure 6. ScO_2_L value change over time between groups

ScO_2<basal$ScO_2$20% was present in 4 of these 9 patients in our study. No statistical significance was found when the relationship between the ScO_2<basal$ScO_2$20% and POCD was examined.

The limitations of our study were that we could not monitor the temperature due to insufficient probes despite having the bottom heaters on the operation tables, we used a single test while evaluating cognitive functions, and we evaluated only early cognitive functions due to early discharge of the patients.

In conclusion**,** we think that spinal anesthesia and general anesthesia have no effect on cerebral oximetry and cognitive functions in geriatric patients when the above-mentioned optimal conditions are met. Although no relationship was found between the ScO_2 and Decrease in MMT values in our study, larger and more sensitive studies are needed to be conducted on this subject.

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References

1.Steinmetz J, Christensen KB, Lund T, Lohse N, Rasmussen LS, postoperative cognitive dysfunction (POCD) group. Long-term consequences of postoperative cognitive dysfunction. Anesthesiology. 2009;110:548-55.

2.Kotekar N, Shenkar A, Nagaraj R. Postoperative cognitive dysfunction – current preventive strategies. Clin Interv Aging. 2018;13:2267-73.

3.Rasmussen LS, Johnson T, Kuipers HM, Kristensen D, Siersma VD, Vila P et al. Does anaesthesia cause postoperative cognitive dysfunction? A randomised study of regional versus general anaesthesia in 438 elderly patients. Acta Anaesthesiol Scand.2003;47:260-6.

4.Fitzpatrick S, Owen K. Postoperative cognitive disorders : postoperative delirium and postoperative cognitive dysfunction. Anaesth Tutor Week. 2018;152(August):1-6.

5.Chaudhari AP, Mazumdar K, Mehta PD. Anxiety, depression, and quality of life in women with polycystic ovarian syndrome. 2018;40:239-46.

6.Figuls RM, Cosp BX, Arevalo-Rodriguez CS. Cochrane database of systematic reviews mini-mental state examination (MMSE) for the detection of Alzheimer's disease and other dementias in people with mild cognitive impairment (MCI). 2015;5;2015:CD010783.

7.Güngen C, Ertan T, Eker E, Yaşar R, Engİn F. Standardize

Mini Mental Test'in Türk toplumunda hafif demans tanısında geçerlik ve güvenilirliği. Türk Psikiyatri Dergisi 2002;13:273-81.

8.Myrberg K, Hydén LC, Samuelsson C. The mini-mental state examination (MMSE) from a language perspective: an analysis of test interaction. 2020;34:652-70.

9.Owczuk R. Guidelines for general anaesthesia in the elderly of the Committee on Quality and Safety in Anaesthesia, Polish Society of Anaesthesiology and Intensive Therapy. Anaesthesiol Intensive Ther. 2013;45:57-61.

10. Elwell CE, Cooper CE. Making light work: Illuminating the future of biomedical optics. Philos Trans R Soc A Math Phys Eng Sci. 2011;369(1955):4358-4379.

11. Ito H, Kanno I, Iida H, Hatazawa J, Shimosegawa E, Tamura H et al. Arterial fraction of cerebral blood volume in humans measured by positron emission tomography. Ann Nucl Med. 2001;15:111-6.

12. Grubhofer G, Plöchl W, Skolka M, Czerny M, Ehrlich M, Lassnigg A. Comparing Doppler ultrasonography and cerebral oximetry as indicators for shunting in carotid endarterectomy. Anesth Analg. 2000;91:1339-44.

13. Tang L, Kazan R, Taddei R, Zaouter C, Cyr S, Hemmerling TM. Reduced cerebral oxygen saturation during thoracic surgery predicts early Postoperative cognitive dysfunction. Br J Anaesth. 2012;108:623-9.

14.Çelik EC, Çiftçi B. Cerebral oximetry and applications under anesthesia. İstanbul Tıp Fakültesi Derg. 2018;8:33-6.

15. Slater JP, Guarino T, Stack J, Vinod K, Bustami RT, Brown JM 3rd et al. Cerebral oxygen desaturation predicts cognitive decline and longer hospital stay after cardiac surgery. Ann Thorac Surg. 2009;87:36-45.

16. Hoppenstein D, Zohar E, Ramaty E, Shabat S, Fredman B. The effects of general vs spinal anesthesia on frontal cerebral oxygen saturation in geriatric patients undergoing emergency surgical fixation of the neck of femur. J Clin Anesth. 2005;17:431-8.

17. Mandal S, Basu M, Kirtania J, Sarbapalli D, Pal R, Kar S et al. Impact of general versus epidural anesthesia on early post-operative cognitive dysfunction following hip and knee surgery. J Emergencies, Trauma Shock. 2011;4:23-8.

18. Shi HJ, Xue XH, Wang YL, Zhang WS, Wang ZS, Yu AL. Effects of different anesthesia methods on cognitive dysfunction after hip replacement operationin elder patients. Int J Clin Exp Med. 2015;8:3883-8.

19. Papadopoulos G, Karanikolas M, Liarmakopoulou A, Papathanakos G, Korre M, Beris A. Cerebral oximetry and cognitive dysfunction in elderly patients undergoing surgery for hip fractures: a prospective observational study. Open Orthop J. 2012;6:400-5.

20. Kim J, Shim JK, Song JW, Kim EK, Kwak YL. Postoperative cognitive dysfunction and the change of regional cerebral oxygen saturation in elderly patients undergoing spinal surgery. Anesth Analg. 2016;123:436-44.

21. Colak Z, Borojevic M, Bogovic A, Ivancan V, Biocina B. In fl uence of intraoperative cerebral oximetry monitoring on neurocognitive function after coronary artery bypass surgery : a randomized, prospective study. 2015;47:447-54.

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