Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2023;48(3):1053-1061
DOI: 10.17826/cumj.1277791

RESEARCH

Effects of postoperative lateral positioning on outcomes of patients with subarachnoid hemorrhage

Subaraknoid kanamalı hastalarda ameliyat sonrası lateral pozisyonun hasta sonuçlarına etkisi

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Abstract

Purpose: This study was conducted to investigate the effects of postoperative lateral positioning on the patients' outcomes with subarachnoid hemorrhage.

Materials and Methods: This study, which is a randomized controlled intervention study, was conducted with 42 (experimental group: 21, control group: 21) patients who underwent subarachnoid hemorrhage surgery in the neurosurgery intensive care unit of a university hospital and met the sampling criteria. In the study, "Patient Descriptive Information Form" and "Patient Results Form" were used as data collection tools. A total of 42 patients operated on for subarachnoid hemorrhage were included in the study. While the patients in the intervention group were placed in the left lateral, right lateral, and semi-fowler position (30 degrees) every 2 to 4 hours for the first 72 hours, those in the control group were routinely placed in the semi-fowler position (20 to 45 degrees).

Results: The power of hydrogen value and partial oxygen pressure and arterial oxygen saturation at the 48th hour in the intervention group were statistically significantly higher than the control group at the 72nd hour. In the intervention group, a slight decrease was observed only in the heart rate at 72 hours, which was near normal.

Conclusion: Lateral and semi-fowler positions with a 2 to 4 hour interval contributed to improved oxygenation and prevented secondary complications of subarachnoid hemorrhage.

Keywords:. Subarachnoid hemorrhage, position, patient outcomes, intensive care unit

Öz

Amaç: Bu çalışma, subaraknoid kanamalı hastalarda ameliyat sonrası verilen lateral pozisyonun hasta sonuçlarına etkisini belirlemek amacıyla yapılmıştır.

Gereç ve Yöntem: Randomize kontrollü müdahale çalışması olan bu çalışma, bir üniversite hastanesinin beyin cerrahisi yoğun bakım ünitesinde subaraknoid kanama cerrahisi geçiren ve örneklem kriterlerini taşıyan 42 (deney grubu: 21, kontrol grubu: 21) hasta ile gerçekleştirildi. Araştırmada veri toplama aracı olarak "Hasta Tanımlayıcı Bilgi Formu" ve "Hasta Sonuç Formu" kullanılmıştır. Subaraknoid kanama nedeniyle opere edilen toplam 42 hasta çalışmaya dahil edildi. Müdahale grubundaki hastalar ilk 72 saat boyunca 2-4 saatte bir sol lateral, sağ lateral ve semi-fowler pozisyonunda (30 derece) yatırılırken, kontrol grubundaki hastalar rutin olarak semi-fowler (20 ila 45 derece) pozisyonuna yerleştirildi.

Bulgular: Müdahale grubunda 48. saatte hidrojen değerinin gücü ve parsiyel oksijen basıncı ve arteriyel oksijen satürasyonu 72. saatte kontrol grubuna göre istatistiksel olarak anlamlı derecede yüksekti. Müdahale grubunda sadece 72. saatte kalp hızında hafif bir azalma gözlendi, bu normale yakındı.

Sonuç: 2 ila 4 saatlik aralıklarla lateral ve semi-fowler pozisyonlarının oksijenizasyonun iyileşmesine katkıda bulunduğu ve subaraknoid kanamanın ikincil komplikasyonlarını önlediği saptanmıştır.

Anahtar kelimeler: Subaraknoid kanama, pozisyon, hasta sonuçları, yoğun bakım ünitesi

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Received: 05.04.2023 Accepted: 08.09.2023

INTRODUCTION

Subarachnoid hemorrhage (SAH) is sudden bleeding into the subarachnoid space caused by a ruptured spontaneous aneurysm, spontaneous partial venous ruptures, or head injury[1]. It has high morbidity and mortality with a mortality rate of 8 to 24% [2,3].

The main goals of SAH treatment are to minimize the possibility of rebleeding, prevent vasospasm via medical and surgical treatment, reduce brain edema and ischemia, and maintain oxygenation with antihypertensives and osmotic diuretics and fluid and electrolyte balance with replacement therapy[4]. Pharmacological and non-pharmacological interventions are often combined to reduce intracranial pressure (ICP) by decreasing carbon dioxide (CO_2) and capillary permeability[5]. Optimal oxygenation and proper patient positioning are the mainstays of SAH treatment. Prone positioning and increased flexion of the hip raise the intra-abdominal and intra-thoracic pressure, indirectly leading to the reduced venous return of the brain, while head rotation directly results in the reduced venous return. Elevation of the head of the bed is recommended in patients with SAH to reduce vascular congestion and ICP and increase cerebral venous drainage, thereby maintaining adequate cerebral perfusion pressure[5,6].

Although there is no consensus on the proper patient positioning for SAH in the Brain Trauma Foundation Guidelines for the Management of Severe Traumatic Brain Injury[7], the American Association of Neuroscience Nurses (AANN) recommends positioning the patient with the head elevated at 30 to 45 degrees and the neck in a neutral position[8]. Several studies have also shown that elevation of the head of the bed at 30 to 45 degrees reduces ICP and maintains cerebral perfusion pressure at an optimal level in patients with severe traumatic brain injury[6,9]. Patient positioning and oxygenation are of utmost importance to prevent postoperative complications and to improve outcomes in patients with SAH. In the literature, studies are comparing different degrees of elevation of the head of the bed, and most have emphasized that lateral position without head elevation is the most life-threatening one for patients with SAH and that elevation of the head of the bed should be maintained at 30 to 45 degrees to optimally reduce ICP[9,10]. Lateral and semi-fowler positions are the most appropriate positions to improve the outcomes in patients with traumatic brain injury undergoing cranial surgery[6,7,9]. Certain positions are associated with a transient but significant reduction in ICP and cerebral perfusion[9,11].

The positioning of the patient may affect oxygenation and hemodynamic stability, and particular care should be exercised to maintain vital signs within normal ranges and to improve oxygenation. In this context, neurosurgery nurses need evidence-based proper positioning practices that support recovery and do not cause complications on patient. The study could be an important reference that positions with the elevation of the head of the bed could affect the patient outcomes positively and have no adverse effect on hemodynamic parameters. We intent to present a resource to the literature on the effect of lateral position on patient outcomes in patients with SAH.

The hypothesis of this study is whether there is any relationship between patient outcomes and postoperative lateral position in patients with subarachnoid hemorrhage.

MATERIALS AND METHODS

Sample

This single-center, prospective, randomized-controlled intervention trial was conducted at neurosurgical intensive care units (ICUs) of a tertiary care center between December 2019 and September 2020. The study center is the largest-volume healthcare facility in the region with a bed capacity of 1,600 and two neurosurgical ICUs with a bed capacity of 25. A total of 11 intensive care nurses workday and night shifts.

Procedure

The study was approved by the Cukurova University, Faculty of Health Sciences, Department of Nursing, Academic Council (No: 28.08.2019/4), Cukurova University, Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (No: 04.09.2019/51), and Provincial Health Department of Adana (No: 05.12.2019/799). All relatives and/or legal guardians of the patients were informed about the nature of the study preoperatively, and a written informed consent obtained.

In daily practice, in addition to pharmacological treatment, non-pharmacological interventions such as patient positioning and oxygenation are provided by the nurses to maintain cerebral perfusion pressure at an optimal level. Despite the lack of a standardized protocol, patients are placed in the semi-fowler position at 20 to 45 degrees postoperatively until discharge, and lateral positioning is avoided to prevent hemodynamic instability. In the semi-fowler position, oxygen therapy at 3 L/min is usually given, depending on patient's oxygen saturation, and ICP measurement is not a routine examination. In the intensive care unit, each patient is given a standard 20 degree semi-fowler position, a proper position is not given according to the patient's hemodynamics or blood gases.

Bed and mattress were the same in both the control and experimental groups. The pressure redistributing mattress was used for all patients. A total of 42 patients who were operated on for SAH and hospitalized in the neurosurgical ICUs were included in the study. Inclusion criteria were as follows: *(i)* age ≥18 years; *(ii)* having aneurysm surgery; *(iii)* receiving mechanical ventilation; *(iv)* not having a diagnosis of brain death; *(v)* being an eligible candidate for lateral positioning; *(vi)* having no severe pulmonary diseases, such as chronic obstructive pulmonary disease (COPD), asthma, pneumonia, or pulmonary embolism; *(vii)* receiving intermittent sedation; *(viii)* having no vasospasm as confirmed by digital subtraction angiography (DSA); *(ix)* obtaining written consent from the patient's relatives and/or legal guardians. Since the majority of patients hospitalized for SAH in our hospital were admitted due to aneurysm surgery, these patients were included in the sample. Exclusion criteria were as follows: *(i)* having brain injury-related complications, such as convulsion, altered mental status, delirium, tremor, and myoclonus; *(ii)* having complications, such as pelvic fracture, pressure injury, or coronavirus, and *(iii)* lack of written consent for participation in the study from the patient's relatives and/or legal guardians. Before the implementation of the study, SAH was detected in 57 patients. Fifteen patients were excluded from the study because they did not meet the inclusion criteria (not fulfilling inclusion criteria n=7; not giving consent n=8). As a result, the study was completed with 42 patients, including 21 controls and 21 experiments, who met the inclusion criteria. There was no incomplete data during the study; the entire sample was reached. The study flow chart is shown in Figure 1.

A stratified randomization in a1:1 ratio was performed using the computer-generated random numbers via the STATA version 16 software (StataCorp LLC, College Station, TX, USA). Stratification was based on age, sex, and the site of SAH. Patients were divided into two groups: the intervention group (n=21) and the control group (n=21). All interventionists were unblinded and were completely aware of which intervention would be applied to which group.

Data collection

Data collection was performed using a Patient Information Form which consisted of sociodemographic and clinical characteristics of patients (i.e., age, sex, diagnosis, Glasgow Coma Score (GCS) score at the time of admission, comorbidities, and the site of SAH) and a Patient Outcomes Form which was developed by the authors by the literature [2,6,12] and consisted of vital signs, postoperative GCS score, and blood gas analysis results. The research was carried out in the Neurosurgery Intensive Care Units of Adana City Training and Research Hospital. The researcher carried out the practice is a 6-year neurosurgery nurse and a doctoral student in the department of surgical nursing.

In the hospital, patients with COVID-19 were placed in a separate intensive care unit. One floor of the two-story operating room is reserved for COVID cases. All staff working in COVID clinics left other units. The study was conducted with patients who were not diagnosed with COVID-19.

Interventions

The relatives and/or legal guardians of all patients were informed about the nature of the study preoperatively and written informed consent was obtained. From the second hour of surgery, the patients in the intervention group were placed in the right lateral, semi-fowler position (30 degrees) every 2 to 4 hours and in the left lateral, semi-fowler position (30 degrees) every 2 to 4 hours for the first 72 hours. The patients in the control group were routinely placed in the semi-fowler position (20 to 45 degrees) for the first 72 hours postoperatively.

Both groups were administered the Patient Information Form at 24 hours postoperatively and the Patient Outcomes Form at 2, 24, 48, and 72 hours postoperatively. Arterial blood pressure and blood gas monitoring were obtained from the right/left radial artery. Routine 4*1 blood gas monitoring was performed. Since the routine doctor examination order of patients in mechanical ventilation is 4*1 blood gas follow-up, blood gas was checked every 6 hours. The safety tolerance threshold for bradycardia intolerant of the lateral position was 60/min and the hypotension threshold was 90/60 mmHg. There were no adverse hemodynamic changes (such as reactive bradycardia and hypotension) requiring intervention in any patient during the study.

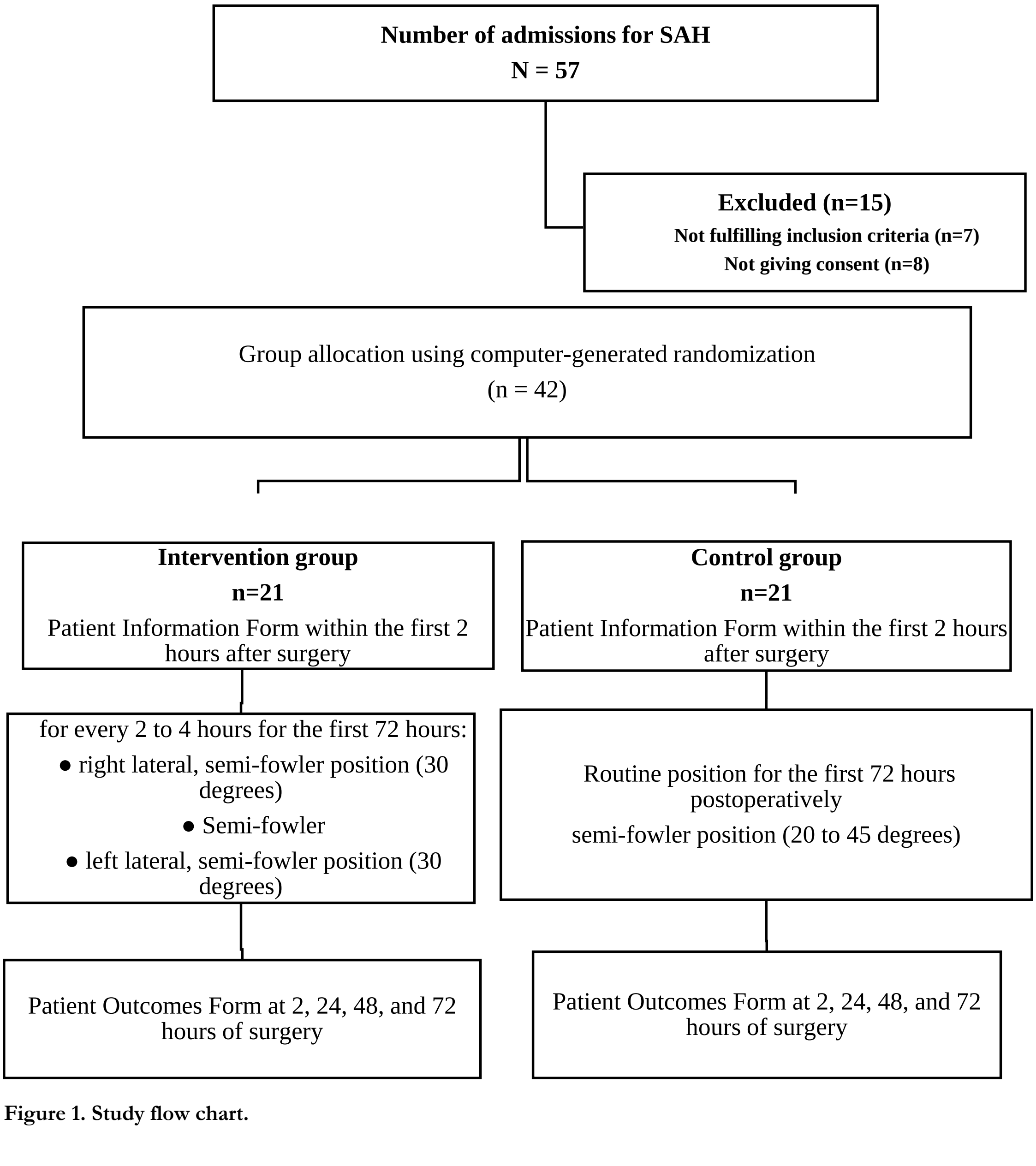

Figure 1. Study flow chart.

Statistical analysis

The power analysis and sample size calculations of the study were performed using the Number Cruncher Statistical System version 20.0 software and the Power Analysis and Sample Size (PASS) version 3.1.9.2 software (NCSS LLC, Kaysville, UT, USA). Accordingly, the alpha level was 0.05. The power of the study was calculated as 80%. As previously explained, at least 21 patients in each group were required to be included in the study[13].

SPSS for Windows version 20.0 software (IBM Corp., Armonk, NY, USA) was used. Descriptive data were expressed as mean ± standard deviation (SD), median (min-max), or number and frequency when valid. Among the most frequently used methods, descriptive, graphic, and hypothesis tests were the methods used to test the assumption of normality, respectively. The most common of the hypothesis tests is the Kolmogorov-Smirnov test.

The Kolmogorov-Smirnov test was utilized to assess whether numerical parameters, including age, GCS score, power of hydrogen (pH), partial pressure of carbon dioxide (PaCO2), partial pressure of oxygen (PaO2), arterial oxygen saturation (SaO2), mean arterial pressure (MAP), heart rate, respiration rate, and GCS, adhere to a normal distribution. The categorical variables, including sex, classified GCS score on admission, presence of chronic disease, and SAH site, were compared between the control and intervention groups using the Chi-square test and Fisher's exact test. Categorical variables were calculated as numbers and percentages. The Student's t-test was employed to compare the numerical variables with a normal distribution, including age, pH, PaCO2, PaO2, SaO2, MAP, heart rate, and respiration rate, between the control and intervention groups. The Mann-Whitney U test was utilized to compare the GCS scores, which were determined to be non-normally distributed, between the Control and Intervention groups.

In analyzing the postoperative changes in pH, PaCO2, PaO2, SaO2, MAP, heart rate, and respiration rate levels within each of the control and intervention groups, repeated measure analysis was employed. Besides, for the postoperative changes in GCS scores within each group, the Friedman test was used. Considering the normality distribution of the parameters and the presence of more than two time intervals, appropriate statistical tests were chosen for the analysis.

Mixed model analysis was employed to compare the changes of the numerical parameters over time intervals between the control and intervention groups. Mixed studies are studies in which qualitative and quantitative study data are handled in a single study. They are also studies in which different data sources are transformed and validated. Mixed model analysis was carried out to examine repeated measurements. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 42 patients with a mean age of 57.2±18.8 (range 19-90) were included in the study. Of the included patients, 24 were female and 18 were male. There was no significant difference between the groups in terms of gender and age distribution ($p>0.05$). At admission, a median GCS score of 10 (range 5 to 14) was calculated for the intervention group and 9 (range 4 to 14) for the control group. This shows us that there is no statistically significant difference ($p=0.310$). Both groups were compared in terms of basic demographic and clinical characteristics and there was no statistically significant difference (Table 1) ($p>0.05$).

The blood gas analysis results of patients are presented in Table 2. Accordingly, the pH value and partial oxygen pressure (PaO2) and arterial oxygen saturation (SaO2) at the 48th hour in the intervention group were statistically significantly higher than the control group at the 72nd hour ($p=0.044$, $p=0.006$, $p=0.050$, respectively). As of 24 hours when the effect of position appeared, all blood gas analysis results were in favor of the intervention group at all time points. However, mechanical ventilation parameters were similar between the experimental and control groups ($p>0.05$).

Vital signs and GCS scores at different time points are given in Table 3. Thereupon, there was no significant difference in GCS scores, mean arterial pressures, heart and respiratory rates at different time points between the experimental and control groups ($p>0.05$). In the intervention group, a slight decrease was observed only in the heart rate at 72 hours, which was near normal ($p=0.003$) (Table 3).

Table 1. Demographic and clinical characteristics of both groups

Variable*	All cohort N=42	Controln=21	Interventionn=21	*P* value
Age	57.2±18.8	60.7±18.1	53.7±19.3	0.229
Sex, n(%)				
Female	24(57.1)	12(57.1)	12(57.1)	0.999
Male	18(42.9)	9(42.9)	9(42.9)	
GCS score on admission, median (range)	9.5(4-14)	10(5-14)	9(4-14)	0.310
Severe (3-8)	15(35.7)	6(28.6)	9(42.9)	0.520
Moderate (9-12)	19(45.3)	10(47.6)	9(42.9)	
Mild (13-14)	8(19.0)	5(23.8)	3(14.3)	
Chronic disease, n(%)				
No	21(50.0)	8(38.1)	13(61.9)	0.217
Yes	21(50.0)	13(61.9)	8(38.1)	
SAH site, n(%)				
Right ICA	13(31.0)	6(28.6)	7(33.3)	0.839
AComA	11(26.2)	6(28.6)	5(23.8)	
MCA	6(14.3)	3(14.3)	3(14.3)	
Left ICA	5(11.9)	3(14.3)	2(9.5)	
Right MCA	3(7.1)	2(9.5)	1(4.8)	
PcomA	2(4.8)	0(.0)	2(9.5)	
PICA	1(2.4)	0(.0)	1(4.8)	
VBA	1(2.4)	1(4.8)	0	

*Data are given in mean ± standard deviation, median (min-max) or number and percentage, unless otherwise stated. GCS: Glasgow Coma Scale; SAH: subarachnoid hemorrhage; ICA: internal carotid artery; AComA: anterior communicating artery; MCA: middle cerebral artery; PComA: posterior communicating artery; PICA: posterior inferior cerebellar artery; VBA: vertebral basilar artery

Table 2. Blood gas analysis results of the patients

Variable*	Group	Postoperative period				pt	Δp
		First 2 hours	**24 hours**	**48 hours**	**72 hours**		
pH	Control	7.40±0.10	7.46±0.07	7.46±0.07	7.46±0.08	<0.001**	**0.004**(at 24 hours)**
	Intervention	7.43±0.08	7.42±0.10	7.42±0.06	7.43±0.09	0.167	
	(P)	0.210	0.090	**0.044****	0.294		
$PaCO_2$	Control	37(19.9-89.7)	34(24.7-76.8)	34.4(25.2-79.5)	33(28.5-62.4)	0.431	**0.027**(at 24 hours)**
	Intervention	31.4(20.3-43.9)	33(21.5-59.9)	35(23.1-49.3)	32.5(19.6-57.5)	0.135	
	(P)	**0.014****	0.308	0.580	0.274		
PaO_2	Control	88.9(65.3-235)	95.3(64.4-185)	100(62.8-189)	95.1(45.9-169)	0.100	**0.016**(at 48 hours)**
	Intervention	88.7(61.4-309)	92(68-348)	109(71.4-379)	111(80.7-244)	**0.050****	
	(P)	0.729	0.485	0.246	**0.006****		
SaO_2	Control	97.2±2.7	96.8±3.4	97.5±2.0	97.2±2.2	0.545	**0.043**(at 48 hours)**
	Intervention	96.5±2.5	97.3±1.7	98.3±1.3	98.3±1.2	**0.006****	
	(P)	0.433	0.579	0.127	0.050**		

*Data are given in mean ± standard deviation, median (min-max) or number and percentage, unless otherwise stated. (p): inter-group changes at different time points; p_t intra-group changes at different time points; Δp: the difference between two measured values.**$p<0.05$ indicate statistical significance. $PaCO_2$: partial pressure of carbon dioxide; PaO_2: partial pressure of oxygen; SaO_2: arterial oxygen saturation.

Table 3. Vital signs and GCS scores at different time points

Variable*	Group	Postoperative period				p_t	Δp
		First 2 hours	**24 hours**	**48 hours**	**72 hours**		
GCS[a]	Control	7(3-9)	7(4-9)	7(3-8)	7(3-8)	0.723	0.670
	Intervention	7(3-8)	7(3-9)	7(3-9)	7(3-9)	0.436	
(P)		0.651	0.481	0.748	0.471		
MAP[b]	Control	95.6±15.5	94.4±16.0	90.3±15.2	91.8±19.1	0.636	0.300
	Intervention	93.6±16.9	90±13.5	96.2±13.8	93.2±16.8	0.376	
(P)		0.698	0.333	0.192	0.798		
Heart rate	Control	85.8±20.6	86.5±19.4	85.2±25	84.7±23.7	0.966	**0.025** (at 24 and 72 hours)**
	Intervention	86.3±12.5	80.0±14.0	80.4±17.4	75.2±13.8	**0.003****	
(P)		0.914	0.218	0.470	0.121		
Respiration rate	Control	18.8±3.3	19.8±3.8	18.9±3.2	19.0±3.7	0.408	0.216
	Intervention	20.6±4.8	19.6±4.2	20.0±4.2	19.8±5.3	0.501	
(P)		0.161	0.878	0.348	0.617		

*Data are given in mean ± standard deviation or median (min-max), unless otherwise stated. (p): inter-group changes at different time points; p_t: intra-group changes at different time points; Δp: the difference between two measured values.**p<0.05 indicate statistical significance. [a]GCS: Glasgow Coma Scale; [b]MAP: mean arterial pressure.

DISCUSSION

Non-pharmacological interventions following SAH to maintain cerebral perfusion and to reduce ICP are provided by nurses in healthcare facilities. Patient positioning is of vital importance to maintain hemodynamic stability and improve patient outcomes. In this study, we investigated the effects of postoperative lateral position on the outcomes of patients with SAH. We believe that this study is valuable as it provides an evidence-based framework for lateral positioning of SAH patients and may be a useful guide for further research.

In this study, the blood gas analysis results were significantly higher in the intervention group from the 24 hours postoperatively, when the position of the patient showed its first effect. This finding is consistent with the literature[9,12,14,15]. In a study investigating the effect of postoperative lateral position on blood gas parameters in the surgical ICU setting, it was shown that the lateral position improved oxygenation[16]. Similarly, several studies including patients with impaired tissue oxygenation hospitalized in the ICUs and neurosurgical ICUs showed that right lateral position significantly increased the SaO_2 and PaO_2 compared to other positions[15,17]. In another study including patients with head injury, the oxygenation levels of patients in the ICU setting were assessed [9,16,18]. The patients were placed in four different positions (supine lying, right lateral lying, left lateral lying, and semi-fowler), and there was a statistically significant improvement observed in oxygen saturation in the semi-fowler position. Although studies are showing that lateral positioning does not affect respiratory mechanics of intubated patients with severe pulmonary disease, such as COPD, asthma, or acute respiratory failure[19], studies on the evaluation of the effects of patient positioning on SaO2 in patients with acute stroke and obesity, lateral positioning on the healthy side was found to provide optimal oxygen saturation in addition to medical treatment[20,21]. In light of these findings and our study results, lateral positioning seems to contribute to ventilation pump-driven gas exchange in critically ill patients.

In this study, the pH and partial pressure of CO_2 ($PaCO_2$) levels of the intervention group were not within normal ranges during the first couple hours of surgery (2 hours); however, with the lateral positioning, these levels returned to normal, indicating that lateral position positively affected oxygenation. In a study evaluating the effects of different positions (i.e., sitting up, supine, prone, left side lying, right side lying) on oxygen saturation, sitting and lateral positions were found to maintain the most optimal oxygenation in different groups of patients[22,23]. Based on these findings and our study results, we can suggest that patient positioning contributes to oxygen saturation positively, by improving respiratory mechanics and gas exchange.

Although the vital signs and GCS scores were comparable at all time points between the intervention and control groups in our study, a decline in the heart rate was noted at 72 hours in the intervention group (p=0.003). Similarly, in a study on the effect of 0 degrees (supine) and 45 degrees (semi-fowler) bed head positions on hemodynamic parameters of on hemodialysis ICU patients, it was shown that hemodynamic parameters were not significantly affected by position changes[24]. In another study on the analysis of the effect of lateral positioning on oxygenation and heart rate in trauma neurosurgical ICU patients, the lateral position did not significantly affect the oxygenation and heart rate[25,26]. Additionally, in a study including hemodynamically stable patients with a head injury, the patients were placed in four different positions (supine lying, right lateral lying, left lateral lying, and semi-fowler), and the heart rate, respiration rate, and blood pressure became stabilized at lower values at the end of 15 minutes in every position[16]. In another study on the examination of the effects of different positions on heart rate, the right lateral decubitus position decreased the heart rate, thereby attenuating sympathetic nerve activity[27]. However, these changes were not clinically significant for most of the patients. The authors concluded that if turning induced significant or prolonged changes in the heart rate, prompt repositioning is needed to avoid adverse hemodynamic effects. Likewise, previous studies including surgical and ICU patients showed that the heart rate was higher in the right lateral position than in the left lateral position[12,15]. Taken together, although a controversy remains regarding the effect of postoperative lateral positioning at 30 degrees on vital signs, its effect on heart rate has been extensively studied. Also, lateral positioning has been shown to reduce heart rate and improve oxygenation by attenuating sympathetic nerve activity without hemodynamic impairment[16].

In conclusion, lateral and semi-fowler positions with the elevation of the head of the bed appear to improve patient outcomes and have no adverse effect on hemodynamic parameters, vital signs, and GCS scores. Additionally, these positions with a 2 to 4-hour interval contribute to improved oxygenation and prevent secondary complications of SAH, such as increased ICP, cerebral ischemia, and embolism.

Developing a nursing practice protocol for intensive care nurses to position patients in a suitable position after traumatic brain injury may improve oxygenation and hemodynamic parameters. Well-designed and larger studies measuring long-term clinical outcomes are needed to understand how and when different positions may affect the management of severe traumatic brain injury. Moreover, further studies should be carried out to assess the effect of other body positions in other medical conditions.

Nonetheless, this study has some limitations. As there was no equipment for ICP measurement in the center where the study was conducted, ICP and cerebral perfusion pressure could not be measured. Therefore, patient outcomes were assessed based on vital signs and blood gas analysis.

In conclusion, lateral and semi-fowler positions with the elevation of the head of the bed appeared to improve patient outcomes with no adverse effect on hemodynamic parameters, vital signs, and GCS scores. The findings of this study may provide evidence to the literature that the correct positioning of patients improves oxygenation. Based on these findings, nurses should be encouraged of properly position patients with SAH, and it should be kept in mind that proper positioning is useful to enhance patient recovery. Additionally, further studies should be carried out to assess the effect of other body positions on other neurosurgical conditions.

Author Contributions: Concept/Design : CK, SE; Data acquisition: CK; Data analysis and interpretation: CK; Drafting manuscript: CK; Critical revision of manuscript: CK; Final approval and accountability: CK. SE; Technical or material support: SE; Supervision: SE; Securing funding (if available): n/a.
Ethical Approval: The study was approved by the Cukurova University, Faculty of Health Sciences, Department of Nursing, Academic Council (No: 28.08.2019/4), Çukurova University, Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (No: 04.09.2019/51), and Provincial Health Department of Adana (No: 05.12.2019/799). All relatives and/or legal guardians of the patients were informed about the nature of the study preoperatively, and a written informed consent obtained.
Peer-review: Externally peer-reviewed.
Conflict of Interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
Financial Disclosure: This study was financially supported by Cukurova University Scientific Research Coordination Unit with the Project No. TYL-2019-12633.
Acknowledgement: We thank all relatives and/or legal guardians of the patients for the participation in this study. Also, we would like to thank The Project Unit of Cukurova University for supporting this work within the scope of TYL-2019-12363 project.

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