NHSJ Nursing and Health Sciences Journal
Volume 3, Number 3 (September 2023)
e-ISSN: 2798-5067
p-ISSN: 2798-5059

The Effect of Postoperative Pain on Sleep Quality in Patients with Brain Tumor Surgery

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Article Info:
Submitted:
25-04-2023
Revised:
04-07-2023
Accepted:
04-07-2023

DOI:
https://doi.org/10.53713/nhsj.v3i3.262

ABSTRACT

This descriptive study investigated the effect of postoperative pain on sleep quality in patients who underwent brain tumor surgery in neurosurgical clinics. The study population consisted of all patients who underwent surgery for a brain tumor between April and October 2022 in the neurosurgical units of a university hospital and a city hospital. The sample consisted of 90 volunteers. Data were collected using a patient information form, the Numerical Rating Scale for Pain (NRS), and the Richards-Campbell Sleep Scale (RCSQ). The data were analyzed using the number, percentage, mean, standard deviation, correlation, and regression analysis. Participants had a mean age of 47.36±16.17 years. Half of the participants were men (50%). Less than half of the participants had a primary school degree (44.4%). Most participants were married (82.2%). Less than half of the participants slept ≥8 hours before hospitalization (43.3%). Most participants had no sleep problems (88.9%) and were not on sleeping pills (98.8%). Participants' pain scores significantly differed by measurement times (χ^2=60.715; p=0.000). They had significantly lower mean second- (4.20±2.58) and third measurement (3.13±2.36) NRS scores than the first measurement NRS score (5.57±2.83) in the morning. In the morning, they had a significantly lower mean third-measurement NRS score (3.13±2.36) than the second measurement NRS score (4.20±2.58). There was a weak negative correlation between the mean first-measurement RCSQ score and the first measurement NRS (morning) and NRS (evening) scores ($p<0.05$). There is a negative correlation between sleep quality and pain in patients who underwent surgery for a brain tumor. As a result of the study, it was determined that the presence of pain after brain tumor surgery adversely affected the sleep quality of the patient. For this reason, it is important for nurses to plan interventions for pain and sleep in their care planning.

Keywords: brain tumor; pain; sleep quality; nursing

INTRODUCTION

Brain tumors are the abnormal growth of normal cells in the brain (Institute, 2022a; Şimşek & Dicle, 2013). Brain tumors are the third most common tumor in individuals over 50, compared to invasion from other organs (Institute, 2022). According to the National Cancer Institute (NCI) and the American Brain Tumor Association (ABTA), 35,000 people are diagnosed with primary brain tumors every year (Association, 2022; Institute, 2022b). According to the World Health Organization (WHO, 2020), it is 19th in the incidence ranking of all cancers worldwide and 0.30% in the mortality rate (World Health Organization, 2023a). In Turkey, the incidence of brain tumors is 0.63% (total 6102, female 906, male 3196), while the mortality rate is 0.51% (total 5070, female 2377, male 2693) (World Health Organization, 2023b).

While the treatment methods for brain tumors vary depending on the patient's condition, the location of the tumor, the type of tumor, or various combinations of these variables, the primary treatment method is primarily surgical removal of the tumor (Kirman, 2021; Perkins & Liu, 2016; Şimşek & Dicle, 2013). Possible complications after brain tumor surgery include sleep disturbance, nausea, vomiting, seizures, visual disturbances, infection, and cognitive problems. Pain is at the top of these complications (Aksoy, 2018; Kural, 2017; Willis, Ravyts, Lanoye, & Loughan, 2022). İlçe et al. (2010) found that patients experienced acute pain between the 0th and fourth days after surgery. Pain causes catecholamine release, pulse rate, and blood pressure, which occurs when pain activates the sympathetic nervous system. This prevents patients'

Volume 3, Number 3 (September 2023)
e-ISSN: 2798-5067
p-ISSN: 2798-5059

onset and maintenance of sleep, deteriorating their sleep patterns and comfort (Oral, Kıranşal, & Deniz, 2022). Willis et al. (2022) reported that four out of five patients with brain tumors had sleep disorders. These patients are at higher risk for cognitive impairment, and their sleeping problems may exacerbate neuropsychological deficits resulting from both the brain tumor and its treatment. Furthermore, the side effects of prescribed sleep medications may also impair cognition and increase the risk of falls, fractures, and motor vehicle accidents. Inadequate sleep may be accompanied by agitation, delirium, distraction, and sensitivity to pain, which may further increase pain intensity. Thus, the relationship between pain and sleep quality continues by triggering one another (Arabacıoğlu, 2021; Doğan Serkan, 2019; Gökbayrak, 2020; Jeon, Dhillon, & Agar, 2017; Şen, 2018; Willis et al., 2022). Doğan (2019) reported that patients experienced severe pain on the surgery day, adversely affecting their sleep quality. However, they noted that pain intensity gradually decreased, and sleep quality improved in the following days (Doğan Serkan, 2019). Akutay (2019) determined pain adversely affected sleep quality in the first three days after chest tube insertion. Xian Su and Wang (2018) documented that pain was the most critical factor affecting the sleep quality of patients hospitalized in surgical clinics (Su & Wang, 2018).

Sleep is an important factor for our lifelong health. Sleep disorders can appear in infancy, adolescence, and adulthood. Regular and adequate sleep patterns provide a healthier life for adults and babies (Agustina et al., 2022; Zainuri et al., 2022). The diseases that people experience throughout their lives and the symptoms and pain they experience due to them cause patients to experience sleep disorders. Researchers emphasize the importance of adequate sleep in the post-surgical recovery process and indicate the need to evaluate patients' sleep quality and pain levels (Cremeans-Smith, Greene, & Delahanty, 2016; Jeon et al., 2017; Willis et al., 2022). Nurses are responsible for identifying the pain causing sleep problems, meeting their patients' sleep, and performing interventions for sleep problems. Although there is a large body of research on postoperative sleep quality (Ak, Ongün, Şenel, & Kızılcay, 2022; Dolan, Huh, Tiwari, Sproat, & Camilleri-Brennan, 2016; Duman, 2016; Jeon et al., 2017), no researchers have examined the effect of pain on sleep quality after major brain tumor surgery. Despite a wide range of studies on sleep disturbance in neuro-oncology, studies on sleep in brain tumor patients remain limited (Willis et al., 2022). Therefore, this study investigated the effect of postoperative pain on sleep quality in patients who underwent brain tumor surgery. The innovation we plan to bring with this study is aimed to determine the effect of postoperative pain on sleep quality, to determine the interventions to be made to the patients, and to take measures to ensure adequate sleep.

METHOD

Study Design and Sampling

This descriptive and inter-sectional study was conducted in two state hospitals' neurosurgery departments between April and October 2022. A power analysis (G*Power, v. 3.0.10) was performed to determine the sample size (Okyar, Şen, & Durat, 2022). The results showed that a sample of 90 would be large enough to detect significant differences (5% margin of error, d=0.5 effect size, and 99.7% power ratio). The initial sample consisted of 91 patients who underwent surgery for brain tumors. However, the final sample consisted of 90 patients because one patient withdrew from the study at some point. The inclusion criteria were (1) volunteering, (2) being over 18, (3) having had surgery for a brain tumor, and (4) having no physical or cognitive disability. The exclusion criteria were (1) having undergone surgical intervention other than brain tumor surgery, (2) withdrawing from the study at any stage, and (3) failing to fill out the data collection tools.

Data Collection

The data were collected using a patient information form, the Numerical Rating Scale for Pain (NRS), and the Richards-Campbell Sleep Scale (RCSQ).

Patient Information Form: The patient information form was developed by the researchers (Akutay, 2019; Arabacıoğlu, 2021; Doğan Serkan, 2019; Gökbayrak, 2020; Jones & Dawson, 2012; Mashayekhi, Arab, Pilevarzadeh, Amiri, & Rafiei, 2013; Willis et al., 2022). It consisted of six items on sociodemographic characteristics (age, gender, education, etc.) and four items on sleep characteristics (hours of sleep per day before hospitalization, preoperative sleep problems, medication, etc.)

Numerical Rating Scale (NRS): The Numerical Rating Scale (NRS) displays numerical values between 0 (no pain) and 10 (the worst pain imaginable). The respondent chooses the number that best describes his/her pain. The scale can be applied verbally without the use of physical materials. The scale has been validated across many patient types and is the most commonly used in pain research.

Richards-Campbell Sleep Questionnaire (RCSQ): This Richards-Campbell Sleep Questionnaire (RCSQ) was developed by Richards to assess patients' perception of sleep. The questionnaire consists of six items that assess sleep depth, time to sleep onset, wake frequency, percentage of time awake, sleep quality, and ambient noise level. Each item is rated on a scale of 0 to 100 based on the visual analog scale technique. A score of 0 to 25 indicates very poor sleep, while 76 to 100 indicates perfect sleep. Higher scores indicate better sleep quality (Yurt & Cubukcu, 2021). The scale was adapted to Turkish by Özlü and Özer (2015). The Turkish version has a Cronbach's alpha of 0.91, which was 0.89 in the present study.

All patients were briefed on the research purpose and procedure. Informed consent was obtained from those who agreed to participate. On the first, second, and third postoperative days, pain intensity was recorded at 10.00 a.m. before pain medication administration and 10.00 p.m. before sleep. Sleep quality was determined at 09:00 a.m. on the first, second, and third postoperative days. Day 0 was not considered because participants could not answer the questions due to the effect of anesthesia, severe pain, and pain medication administered in the intensive care unit before coming to the ward (Doğan Serkan, 2019; Gökbayrak, 2020). We conducted 15 minutes of face-to-face interviews in the patients' rooms.

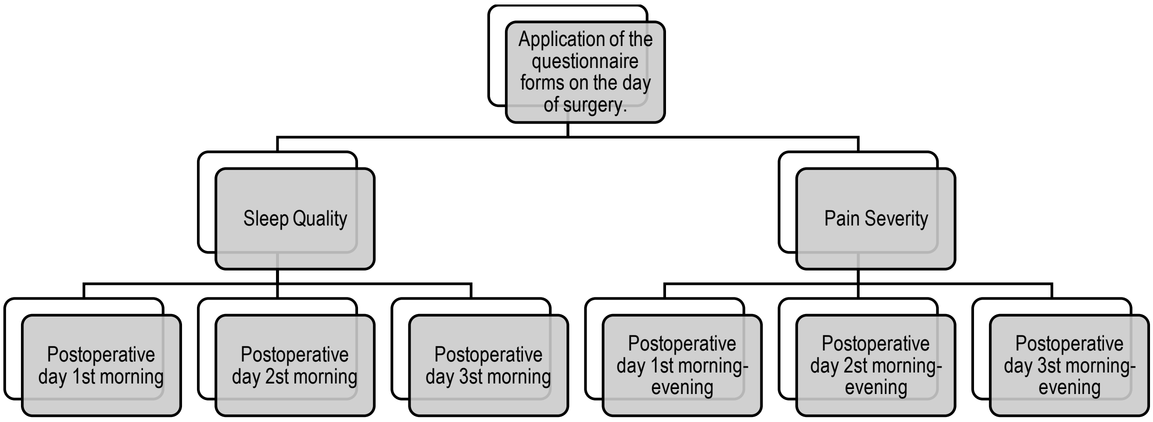

Figure 1. Flowchart

Data Analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS for Windows, v. 26.0) at a significance level of 0.05. Number, mean, standard deviation, and percentage were used for descriptive statistics. The normally distributed data were analyzed using t-tests and one-way analysis of variance (ANOVA), whereas the nonnormally distributed data were analyzed using the Mann-Whitney U test (Z-table value) and the Kruskal-Wallis H test (χ2-table value). Bonferroni correction was used for pairwise comparisons. Spearman's correlation coefficient was used to examine the relationship between scale scores.

Ethical Considerations

The study was approved by the Ethics Committee of Ankara Yıldırım Beyazıt University (Ref No: 2021-465 Date: 09.12.2021). The study was conducted according to the ethical principles of the World Medical Association's Declaration of Helsinki. Written permission was obtained from the hospitals (Ref No: E-72300690-799, Date: 18.04.2022 and Ref No: E-20481383-300-00002088001, Date:15.03.2022). All patients were briefed about the research purpose and procedure. They were informed that (1) participation was voluntary, (2) the data would be kept confidential, (3) their participation would not pose any risk to them, and (4) they were allowed to withdraw from the study at any time without any unfavorable consequences. Informed consent was obtained from all participants.

Research Questions

What level of postoperative pain do patients have? What is the postoperative sleep quality of patients? Is there a relationship between pain and sleep quality in postoperative patients? Do sociodemographic characteristics affect postoperative patients' pain levels? Do sociodemographic characteristics affect postoperative patients' sleep quality?

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e-ISSN: 2798-5067
p-ISSN: 2798-5059

RESULT

Participants had a mean age of 47.36±16.17 years. Half the participants were men (50%). Less than half of the participants had a primary school degree (44.4%). Most participants were married (82.2%). More than half of the participants had a history of surgery (56.7%). Less than half of the participants slept ≥8 hours before hospitalization (43.3%). Most participants had no sleep problems (88.9%) and were not on sleeping pills (98.8%). Most participants stated that their sleep was adversely affected in the hospital (90%). More than half of the participants noted that sleep was adversely affected by people entering and out of their rooms (Table 1).

Table 1. Characteristics (N=90)

Characteristics	Frequency	Percentage
Gender		
Man	45	50.0
Woman	45	50.0
Age (years)		
<40	31	34.4
40-49	15	16.7
50-59	21	23.3
≥60	23	25.6
Education		
Illiterate	8	8.9
Primary school	40	44.4
High school	22	24.4
Bachelor's	15	16.7
Master's	5	5.6
Marital status		
Married	74	82.2
Single	16	17.8
History of surgery		
Yes	51	56.7
No	39	43.3
Sleep duration before hospitalization (hour)		
≤6	35	38.9
7	16	17.8
≥8	39	43.3
Trouble sleeping before hospitalization		
Yes	10	11.1
No	80	88.9
Causes of negative impact*		
Pain	50	55.6
Noise (footsteps, phone ringing, etc.)	38	42.2
Room temperature / Ventilation	12	13.3
Entering and leaving the room at bedtime (at night)	50	55.6
Invasive interventions	24	26.7
Privacy violations	3	3.3
Adverse effects on sleep in the hospital		
Yes	81	90.0
No	9	10.0
Being on sleeping pills		
Yes	1	1.1
No	89	98.9

*More than one answer. Percentages were determined on a row basis according to the total number of samples.

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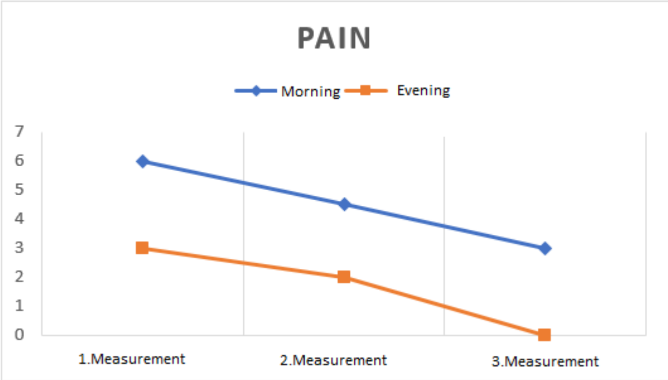

Figure 2. Mean pain scores by measurement time

Participants' NRS scores in the morning significantly differed by measurement times (χ2=60.715; p=0.000). They had significantly lower mean second- (4.20±2.58) and third measurement (3.13±2.36) NRS scores than the first measurement NRS score (5.57±2.83) in the morning. In the morning, they had a significantly lower mean third-measurement NRS score (3.13±2.36) than the second measurement NRS score (4.20±2.58). Their NRS scores in the evening significantly differed by measurement times (χ2=44.224; p=0.000). They had significantly lower mean second- (2.12±2) and third measurement (1.29±2.09) NRS scores than the first measurement NRS score (2.94±2.49) in the evening. They had a significantly lower mean third-measurement NRS score (1.29±2.09) than the second measurement NRS score (2.12±2.11).

Figure 3. Sleep quality scores by measurement times

Participants' RCSQ scores significantly differed by measurement times (χ2=87.199; p=0.000). They had significantly higher mean second- (59.42±25.97) and third measurement (71.04±23.61) RCSQ scores than the first measurement RCSQ score (38.00±31.23). They had a significantly mean third measurement RCSQ score (71.04±23.61) than the second measurement RCSQ score (59.42±25.97).

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Table 2. The Distribution of NRS Scores (Morning-Evening) by Characteristic

Characteristics	Pain (morning)						Pain (evening)					
	First measurement		Second measurement		Third measurement		First measurement		Second measurement		Third measurement	
	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]
Gender												
Man	5.00±2.89	5.0 [0.0-10.0]	4.04±2.27	4.0 [0.0-10.0]	2.62±2.04	2.0 [0.0-10.0]	2.71±2.39	3.0[0.0-10.0]	1.96±2.08	2.0 [0.0-10.0]	0.91±1.84	0.0 [0.0-10.0]
Woman	6.13±2.69	7.0 [0.0-10.0]	4.36±2.88	5.0 [0.0-10.0]	3.64±2.56	3.0 [0.0-10.0]	3.18±2.59	3.0 [0.0-8.0]	2.29±2.16	2.0 [0.0-8.0]	1.67±2.27	0.0 [0.0-8.0]
Statistical analysis*	Z=-2.128		Z=-0.515		Z=-2.148		Z=-1.010		Z=-0.696		Z=-1.472	
Probability	p=0.033		p=0.607		p=0.032		p=0.313		p=0.486		p=0.141	
Sleep problems before hospitalization												
Yes	7.50±2.12	8.0 [3.0-10.0]	6.40±2.07	6.5 [3.0-10.0]	4.20±2.53	3.5 [1.0-10.0]	5.00±2.00	5.0 [1.0-8.0]	3.50±1.71	3.0 [2.0-7.0]	1.60±2.41	0.5 [0.0-6.0]
No	5.32±2.83	5.5 [0.0-10.0]	3.93±2.52	4.0 [0.0-10.0]	3.00±2.32	3.0 [0.0-10.0]	2.69±2.48	3.0 [0.0-10.0]	1.95±2.10	2.0 [0.0-10.0]	1.25±2.06	0.0 [0.0-10.0]
Statistical analysis	Z=-2.365		Z=-2.938		Z=-1.539		Z=-2.808		Z=-2.452		Z=-0.487	
Probability	p=0.018		p=0.003		p=0.124		p=0.005		p=0.014		p=0.626	
Adverse effects on sleep in the hospital												
Yes	5.85±1.27	6.0 [0.0-10.0]	4.46±2.49	5.0 [0.0-10.0]	3.25±2.35	3.0 [0.0-10.0]	3.21±2.46	3.0 [0.0-10.0]	2.32±2.13	2.0 [0.0-10.0]	1.41±2.16	1.0 [0.0-10.0]
No	3.00±2.40	4.0 [0.0-6.0]	1.89±2.37	0.0 [0.0-6.0]	2.11±2.37	2.0 [0.0-6.0]	0.56±1.13	0.0 [0.0-3.0]	0.33±0.71	0.0 [0.0-20.0]	1.01±0.33	0.0 [0.0-1.0]
Statistical analysis	Z=-2.809		Z=-2.656		Z=-1.359		Z=-3.195		Z=-3.087		Z=-2.093	
Probability	p=0.005		p=0.008		p=0.174		p=0.001		p=0.002		p=0.036	

*The data were not normally distributed. Therefore, the Mann-Whitney U (Z-table) test was used for pairwise comparison, while the Kruskal-Wallis test (χ^2-table) was used to compare more than two independent groups.

There was a significant difference in the first- and third measurement NRS scores (morning) between male and female participants (Z=-2.128; p=0.033; Z=-2.148; p=0.032). Female participants had significantly higher mean first- and third measurement NRS scores (morning) than their male counterparts. Participants' first- and second measurement NRS scores in the morning significantly differed by their sleep problems before hospitalization (Z=-2.365, p=0.018; Z=-2.938; p=0.003). Their first- and second measurement NRS scores in the evening significantly differed by their sleep problems before hospitalization (Z=-2.808, p=0.005; Z=-2.452, p=0.014). Participants with sleep problems before hospitalization had significantly higher mean first- and third measurement NRS scores in the morning and the evening than those without sleep problems before hospitalization. Participants' first- and second measurement NRS scores in the morning significantly differed by the adverse effects on sleep in the hospital (Z=-2.809; p=0.005; Z=-2.656; p=0.008). Participants whose sleep was adversely affected in the hospital had significantly higher mean first- and second measurement NRS scores in the morning than those whose sleep was not adversely affected in the hospital. Participants' first-, second-, and third measurement NRS scores in the evening significantly differed by the adverse effects on sleep in the hospital (Z=-3.195; p=0.001; Z=-3.087; p=0.002; Z=-2.093; p=0.036). Participants whose sleep was adversely affected in the hospital had significantly higher mean first-, second-, and third measurement NRS scores in the evening than those whose sleep was not adversely affected in the hospital.

Table 3. The Distribution of RCSQ Scores by Characteristics

Characteristics	Sleep					
	First measurement		Second measurement		Third measurement	
	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]	Mean±SD	Median [Min-Max]
Gender						
Man	43.55±31.33	40.0 [0.0-100.0]	67.33±25.06	70.0 [10.0-100.0]	77.03±23.47	80.0 [10.0-100.0]
Woman	32.44±30.46	20.0 [0.0-100.0]	51.51±24.66	50.0 [0.0-100.0]	65.07±22.44	70.0 [20.0-100.0]
Statistical analysis*	Z=-1.744		Z=-2.995		Z=-2.926	
Probability	p=0.081		p=0.003		p=0.003	
Sleep problems before hospitalization						
Yes	30.00±27.89	20.0 [0.0-80.0]	43.00±25.41	50.0 [0.0-80.0]	56.00±25.47	65.0 [10.0-90.0]
No	39.00±31.64	30.0 [0.0-100.0]	61.48±25.45	60.0 [0.0-100.0]	72.93±22.84	80.0 [10.0-100.0]
Statistical analysis	Z=-0.730		Z=-1.937		Z=-2.097	
Probability	p=0.460		p=0.053		p=0.036	
Adverse effects on sleep in the hospital						
Yes	32.46±27.63	20.0 [0.0-100.0]	55.84±24.70	58.0 [0.0-100.0]	68.32±23.23	70.0[10.0-100.0]
No	87.78±10.92	90.0[70.0-100.0]	91.67±10.00	90.0 [70.0-100.0]	95.56±7.26	100.0 [80.0-100.0]
Statistical analysis	Z=-4.523		Z=-4.038		Z=-3.788	
Probability	p=0.000		p=0.000		p=0.000	

*The data were not normally distributed. Therefore, the Mann-Whitney U (Z-table) test was used for pairwise comparison, while the Kruskal-Wallis test (χ2-table) was used to compare more than two independent groups.

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There was a significant difference in the second- and third measurement RCSQ scores between male and female participants (Z=-2.995; p=0.003; Z=-2.926; p=0.003). Male participants had significantly higher mean second- and third measurement RCBS scores than female participants. Participants' RCSQ scores significantly differed by their sleep problems before hospitalization (Z=-2.097; p=0.036). Participants without sleep problems before hospitalization had a significantly higher mean third-measurement RCSQ score than those without. Participants' first-, second-, and third measurement RCSQ scores differed by adverse effects on sleep in the hospital (Z=-4.523; p=0.00; Z=-4.038; p=0.000; Z=-3.788; p=0.000). Participants whose sleep was not adversely affected in the hospital had significantly higher mean first-, second-, and third measurement RCSQ scores than those whose sleep was adversely affected in the hospital.

Table 4. Correlation between Pain and Sleep Quality

Correlation* (N=90)			Pain (morning)	Pain (evening)
Sleep	First measurement	r	-0.291	-0.367
		p	0.005	0.000
	Second measurement	r	-0.462	-0.549
		p	0.000	0.000
	Third measurement	r	-0.427	0.512
		p	0.000	0.000

*Spearman's correlation coefficient

There was a weak negative correlation between the first measurement RCSQ and NRS (morning) and NRS (evening) scores (p<0.05), suggesting that patients who experienced more pain in the morning and evening had lower sleep quality. There was a weak negative correlation between the second measurement RCSQ and NRS (morning) and NRS (evening) scores (p<0.05). There was a moderate negative correlation between the third measurement RCSQ and NRS (morning) and NRS (evening) scores (p<0.05), suggesting that patients who experienced pain in the morning and evening had lower sleep quality.

DISCUSSION

This is the first study to investigate the relationship between sleep quality and pain after surgery in brain tumor patients. Treatment of brain tumors involves major surgery (Chandana, Movva, Arora, & Singh, 2008). General anesthesia changes sleep patterns and leads to a high rate of sleep disturbances after major surgery (Jeon et al., 2017; Luo, Song, & Zhu, 2020). Sleep disorders negatively affect postoperative recovery (Xian Su & Wang 2018). Research shows that the highest incidence of sleep disorders ranges from 47% to 67% after major surgery (Atay & Aydin Sayilan, 2021; Jensen, Specht, & Mainz, 2021; Miller, Renn, Chu, & Torrence, 2019). Göğenur et al. (2001) found that patients subjectively slept better after laparoscopic cholecystectomy than those in the major abdominal surgery group. Chung et al. (2014) reported that patients who underwent major surgery had lower sleep efficiency than those who underwent minor surgery. Hussein and Abu (2019) found that almost two out of five patients had severe and moderate sleep problems. Çevik and Sarıtaş (2020) found that patients with myocardial infarction had below-average sleep quality. Kulpatcorong et al. (2020) found that 43% to 91% of patients had poor sleep quality. Oral et al. (2022) documented that surgical patient had moderate sleep quality. Our participants had lower sleep quality on the first day than on the second and third days. However, their sleep quality gradually improved and was found to be moderate (Figure 3). Sleep disturbance impairs cognitive function, prolongs postoperative recovery, and leads to more complications. Sleep disturbance sometimes leads to severe postoperative delirium (Allen et al., 2021). Therefore, our results suggest that health professionals should conduct additional screening to identify sleep deficiency in brain tumor patients. Moreover, sleep disturbance adversely affects patients' physical and psychological well-being. Therefore, specialists should plan nursing interventions to improve patients' sleep quality.

Noise and lights, the number of patients in the room, patients' condition, invasive vital signs, and disturbances from healthcare staff and other patients cause patients to experience poor sleep quality (Jensen et al., 2021; Kulpatcharapong et al., 2020; Luo et al., 2020). Dolan et al. (2016) found that pain, noise, and night procedures were the most common conditions that kept elective general and orthopedic surgery patients awake. Kulpatcorong et al. (2020) examined the factors affecting sleep disturbance during hospitalization. They documented that entering and exiting the patient's room affected his/her sleep during hospitalization. They also noted that patients had poor sleep quality on the first day of hospitalization but that it improved the following days because the patients adapted to the new setting. Nicalos et al. (2008) and Oral et al. (2022) found that preoperative sleep disorders, postoperative pain, environmental stresses, and treatment hours caused postoperative sleep disorders. Our participants with preoperative sleep problems had lower sleep quality than those without preoperative sleep problems (Table 3). Nine out of ten participants stated that their sleep was adversely affected by pain and nighttime entrances and exits (55.6%) and noise (42.2%) (Table 1). Our findings suggest that nurses should perform interventions at the right time to improve the sleep quality of patients with brain tumors. They should also consider environmental factors and provide appropriate nursing care management to ensure patients with brain tumors have high sleep quality.

There is little research on potential risk factors for sleep disturbance in patients with brain tumors (Willis et al., 2022). However, research shows that age, gender, marital status, work experience, chronic diseases, and pre-hospitalization sleep disorders cause patients to experience sleep disorders. These factors are subjective; sleep disturbance varies from person to person (Ge, Vetter, & Lai, 2017; Yilmaz, Sayin, & Gurler, 2012). Age, education, marital status, and work experience did not affect our participants' sleep quality. However, gender and prehospital sleep problems affected their sleep quality (Table 3), consistent with the literature (Yang et al., 2020; Yu, Xiong, Lu, & Xiong, 2022). On the contrary, some studies show that age (Cremeans-Smith et al., 2006) and chronic diseases (Uslu & Para, 2022) affect patients' sleep quality. Yılmaz et al. (2012) found that patients with pre-hospitalization sleep problems experienced more sleep problems in hospitals. Our results showed that one out of ten participants had pre-hospitalization sleep problems. They experienced more sleep problems than those without pre-hospitalization sleep problems (Table 3)

Sleep is essential for proper physiologic functioning and recovery. However, patients frequently experience sleep problems during hospitalization. Numerous postoperative factors cause sleep disturbances, the most important of which is pain (Yang et al., 2020; Yu et al., 2022). There is a bidirectional relationship between sleep and pain. Poor sleep increases pain sensitivity (Jensen et al., 2021). Akutay and Yilmaz (2021) found that patients with high pain levels after tube thoracostomy had worse sleep quality. Yu et al. (2022) focused on patients undergoing laparoscopic gynecological surgery under general anesthesia and claimed that postoperative sleep disturbances affected those patients' postoperative awakening quality and pain levels. There is an association between pain experience and sleep disturbances in patients with chronic pain or undergoing surgery. In other words, more severe pain is associated with more frequent awakenings during the night (Cremeans-Smith et al., 2016). Dolan et al. (2016) argue that postoperative pain is the most crucial factor leading to postoperative sleep disturbances in patients in general surgery and orthopedics units. Wylde et al. (2011) focused on pain and sleep after hip and knee arthroplasty and found that more than half of patients had poor sleep quality on the first postoperative night because of pain. Hussein and Abu Negm (2019) reported a negative correlation between pain and sleep quality. Boye Larsen et al. (2021) found that patients with high preoperative pain levels had worse sleep quality and higher postoperative pain levels. Jensen et al. (2021) documented those three out of five orthopedic patients had pain adversely affecting their sleep quality. Oral et al. (2022) determined that one out of two patients had sleep problems during their hospitalization, primarily due to pain (54.1%) (Oral et al., 2022). Our participants also had high pain levels on the first day, adversely affecting their sleep quality. However, they had less pain and better sleep quality in the following days. This finding suggests that nurses should assess pain at regular intervals and keep it under control through both pharmacological and nonpharmacological methods.

Research Question: What level of postoperative pain do patients have?

Participants' NRS scores in the morning significantly differed by measurement times ($\chi 2=60.715$; $p=0.000$). They had significantly lower mean second- (4.20±2.58) and third measurement (3.13±2.36) NRS scores than the first measurement NRS score (5.57±2.83) in the morning. In the morning, they had a significantly lower mean third-measurement NRS score (3.13±2.36) than the second measurement NRS score (4.20±2.58). We can deduce that the patients experience very severe pain on the first day after the operation, and that the severity of pain decreases in the following days.

Research Question: What is the postoperative sleep quality of patients?

Participants' RCSQ scores significantly differed by measurement times ($\chi 2=87.199$; $p=0.000$). They had significantly higher mean second- (59.42±25.97) and third measurement (71.04±23.61) RCSQ scores than the first measurement RCSQ score (38.00±31.23). They had a significant mean third measurement RCSQ score (71.04±23.61) than the second measurement RCSQ score (59.42±25.97). We can deduce that the sleep quality of the patients was low on the first day after the surgery and that their sleep quality increased in the following days.

Research Question: Is there a relationship between pain and sleep quality in postoperative patients?

There was a weak negative correlation between the first measurement RCSQ and NRS (morning) and NRS (evening) scores ($p<0.05$), suggesting that patients who experienced more pain in the morning and evening had lower sleep quality. There was a weak negative correlation between the second measurement RCSQ and NRS (morning) and NRS (evening) scores ($p<0.05$). There was a moderate negative correlation between the third measurement RCSQ and

Volume 3, Number 3 (September 2023)
e-ISSN: 2798-5067
p-ISSN: 2798-5059

NRS (morning) and NRS (evening) scores ($p<0.05$), suggesting that patients who experienced pain in the morning and evening had lower sleep quality. The results showed that, like other surgical studies, patients experienced pain in the first postoperative days and their sleep quality was adversely affected. In our study, pain intensity gradually decreases, and sleep quality increases in the following days.

CONCLUSION

Patients who undergo brain tumor surgery have moderate sleep quality. There is a negative correlation between pain and sleep quality. Female patients experience more pain than their male counterparts. On the other hand, male patients have better sleep quality than their female counterparts. Nurses should provide effective pain management for surgical patients (pharmacological and nonpharmacological methods), assess their sleep quality at regular intervals, take therapeutic measures to improve sleep quality and reduce pain, and make arrangements to enable their patients to sleep comfortably in their rooms. They should also teach patients pain-relief methods, such as deep breathing exercises, progressive relaxation exercises, and distraction.

LIMITATIONS

This study has four limitations. First, the results are sample-specific and cannot be generalized to all patients. Second, the sample consisted of patients from only two hospitals. Third, we could not assess the effect of nursing interventions on sleep quality because the nurses of the hospitals need to perform interventions to improve their patient's sleep quality. Fourth, we could not assess the effect of prolonged hospitalization on sleep quality because we collected data only for three days.

ACKNOWLEDGEMENT

We would like to thank all participants.

CONFLICTS OF INTEREST

All authors contributed to the conception and design of the manuscript. Sema Koçaşlı and Emine Öner Karaveli performed material preparation, data collection, and analysis. All authors read and approved the final manuscript. The authors declare no conflicts of interest.

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