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The Incidence and Influencing Factors of Sleep Disorders in Cyber Knife Patients during Treatment

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Abstract

Objective: This study first analyzes the incidence and influencing factors of sleep disorders in Cyber Knife patients during treatment, in order to provide more accurate strategies for clinical prevention, early diagnosis, and treatment.

Methods: A total of 101 patients who underwent Cyber Knife treatment at Tumor Diagnosis and Treatment Center, Huashan Hospital Affiliated to Fudan University from April 2022 to April 2023 were selected as the research objects. The Pittsburgh Sleep Quality Index (PSQI) was used for evaluation. Patients with PSQI ≥ 8 points were included in the occurrence group, and patients with PSQI < 8 points were included in the non-occurrence group. The general sociological and disease-related characteristics of the patients, such as education, chemotherapy or targeted therapy, somatic symptoms and other features were collected. χ^2 test was performed first to determine the difference between two groups, and Logistic regression analysis was used to identify the predictors of sleep disorders in Cyber Knife patients.

Results: A total of 101 Cyber Knife patients were included in this study, of which 43 patients (42.58%) without sleep disorders were included in the non-occurrence group. There were 22 cases (21.78%) of mild disorder, 22 cases (21.78%) of moderate disorder, and 14 cases (13.86%) of severe disorder, all of which were included in the occurrence group. There were significant differences in educa-

tion level (primary and junior high schools: 32 (55.17%) vs. 15 (34.88%) patients, $p = 0.043$), family monthly income (≤ 5000 CNY (1 USD = 6.48 CNY): 36 (62.07%) vs. 15 (34.88%) patients, $p = 0.007$), somatic symptoms (35 (60.34%) vs. 17 (39.53%) patients, $p = 0.038$), self-rating anxiety scale (SAS) (> 50 : 32 (55.17%) vs. 15 (34.88%) patients, $p = 0.043$), self-rating depression scale (SDS) (> 53 : 35 (60.34%) vs. 18 (41.86%) patients, $p = 0.038$), numerical rating scale (NRS) (> 3 : 30 (51.72%) vs. 13 (30.23%) patients, $p = 0.031$) between the group of occurrence and no occurrence group. Education level (odds ratio (OR) = 2.845, $p = 0.038$), somatic symptoms (OR = 2.666, $p = 0.048$), SAS (OR = 2.889, $p = 0.042$), SDS (OR = 2.928, $p = 0.027$) and NRS (OR = 2.981, $p = 0.025$) had a statistically significant effect on sleep disorders in Cyber Knife patients.

Conclusions: Cyber Knife patients are prone to sleep disorders during treatment. It is necessary to pay more attention to and take measures to reduce the occurrence of sleep disorders in clinical practice.

Keywords

sleep disorders; Cyber Knife; the influencing factors

Introduction

Cyber Knife is a new type of whole-body stereotactic radiosurgery equipment, also known as a stereotactic cyber surgery platform, which can concentrate rays on lesions after irradiation from multiple angles. With intelligent operation, it provides a basis for selecting the best direction and path of beam irradiation and protects the normal tissues surrounding the tumor to the greatest extent [1]. According to statistics [2], Cyber Knife technology has been used in the treatment of 100,000 tumor cases worldwide and has achieved remarkable results.

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However, like radiation therapy, Cyber Knife treatment is not only expensive but also easy to cause normal tissue damage, alopecia, dizziness, edema, and other side effects after treatment. In addition, patients themselves are more worried about the condition, mild patients may have negative emotions such as anxiety, depression, and irritability, and severe patients may have sleep disorders.

A study [3] shown that the incidence of sleep disorders is about 27% worldwide, and the incidence of sleep disorders in cancer patients reaches 30–50%, becoming a common symptom in cancer patients. Sleep disorders mainly refer to patients' difficulty in falling asleep, waking up early, sleep maintenance disorders, and abnormal daytime function. Once they occur, they can directly affect the memory and immune ability of tumor patients and even cause nervous weakness. In severe cases, they may give up treatment or commit suicide [4].

Therefore, a comprehensive understanding of the occurrence and influencing factors of sleep disorders in Cyber Knife patients during treatment is very important, which can provide a reference for the subsequent development of relevant intervention measures. It has been reported in the past [5] that female, advanced age, education level, and marital status are all factors affecting sleep disorders. One study has found that smoking, drinking, and obesity are risk factors for sleep disorders [6]. It can be seen that although the influencing factors of sleep disorders have been studied in clinical practice, there are no relevant reports on the influencing factors of sleep disorders during Cyber Knife treatment.

This study aims to comprehensively analyze the risk factors of sleep disorders in Cyber Knife patients during treatment, deeply understand the lifestyle and basic characteristics of patients, and provide a scientific basis for prevention and treatment. Through the in-depth study of the risk factors of sleep disorders in Cyber Knife patients during treatment, we hope to provide more accurate strategies for the prevention, early diagnosis, and treatment of the disease. This has positive clinical significance for reducing the incidence of sleep disorders in patients and improving the treatment effect.

Materials and Methods

Inclusion and Exclusion Criteria

A total of 101 patients who underwent Cyber Knife treatment at Tumor Diagnosis and Treatment Center, Huashan Hospital Affiliated to Fudan University from April

2022 to April 2023 were selected as the research objects. This study has been approved by the ethics committee of Huashan Hospital Affiliated to Fudan University (approval no. KY2020-840). This study was conducted in accordance with the Declaration of Helsinki, and informed consent was obtained from all participants. Inclusion criteria: (1) patients who met the indications for Cyber Knife treatment; (2) age ≥ 18 years old; (3) clinical data were clear and complete; (4) no alcohol or other drug dependence; (5) patients could fully understand the content of this study, voluntarily participate in this study, and sign informed consent; (6) have basic listening, speaking, reading, and writing skills. Exclusion criteria: (1) patients with mental illness or cognitive impairment; (2) patients who did not complete the whole Cyber Knife treatment for various reasons; (3) poor compliance or audio-visual dysfunction; (4) the use of sedatives, hypnotics, psychotropic drugs or psychotherapy before the experiment; (5) in addition to tumor, other major stress events occurred in the past two weeks.

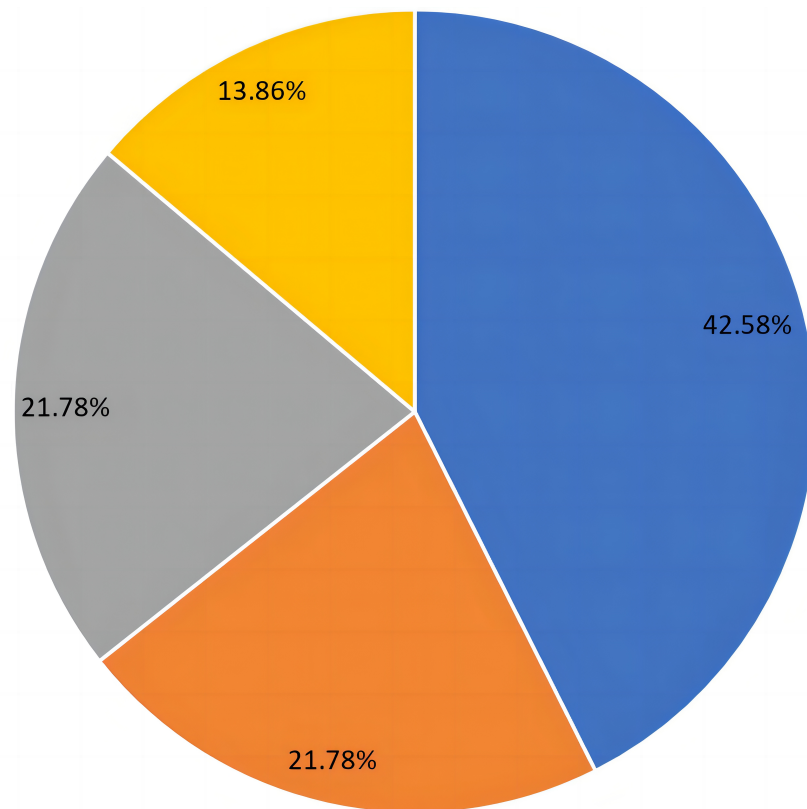
Questionnaire

A self-made questionnaire was used to collect the general sociological characteristics and disease-related characteristics of the patients.

The information included gender, age, body mass index, marital status, place of residence, education level, religious belief, occupational status, family monthly income, smoking, drinking, comorbidities, presence of frequent urination/constipation, number of Cyber Knife treatments, concurrent chemotherapy or targeted therapy, history of mental illness, somatic symptoms (pain, nausea, dry mouth, cough, vomiting, dermatitis, diarrhea, constipation), disease stage, treatment site, regular exercise, family history, medical insurance, self-rating anxiety scale (SAS), self-rating depression scale (SDS), numerical rating scale (NRS), etc.

Before the questionnaire was distributed, the professional staff introduced it in common language, informed the purpose, method and significance of this survey, and explained the method of filling in the questionnaire. After obtaining consent, the questionnaire was distributed, and all patients were required to fill in the questionnaire independently. The time was 20 minutes, and the questionnaire was collected on the site. Data were entered by double cross entry and check.

A total of 101 questionnaires were distributed and recovered, with a recovery rate of 100.00% and an effective rate of 100.00%.



■ Non-sleep disorder ■ Mild sleep disorder ■ Moderate sleep disorder ■ Severe sleep disorder

Fig. 1. Occurrence of sleep disorders.

Pittsburgh Sleep Quality Index (PSQI)

All patients were evaluated by the Pittsburgh Sleep Quality Index (PSQI) [7], which was compiled by Dr. Buysse and involved seven aspects such as sleep latency, sleep disorder and subjective sleep quality. According to the Likert 3-point scoring method, the full score was 21 points, and the higher the score, the more serious the sleep disorder. <8 points no sleep disorder, 8–13 points mild disorder, 14–18 points moderate, 19–21 points severe. The overall Cronbach's α coefficient of the scale was 0.926, and the split-half reliability coefficient was 0.961, which showed good reliability and validity.

SAS, SDS

The scale was developed by Shao [8], which mainly evaluates the severity of anxiety and depression and the changes during treatment. Each scale contains 20 items of subjective feelings. According to the Likert 4-point scor-

ing method, the full score is 80 points, the higher the score, the deeper the degree of anxiety and depression. Scores of more than 50 indicate anxiety, while >53 points indicated depression. The overall Cronbach's α coefficients of the scale were 0.954 and 0.927, and the split-half reliability coefficients were 0.935 and 0.918, which showed good reliability and validity.

NRS

It mainly evaluates the degree of pain, using a ten-point scale to rate by patients themselves, a total of 10 grades, corresponding to the degree of pain in order, 0 points no pain, 1–3 points mild, 4–6 points moderate, 7–9 points severe, 10 points severe pain.

Statistical Analysis

SPSS 25.0 statistical software (IBM Corp., Armonk, NY, USA) was used to calculate the data. The categor-

Table 1. Comparison of clinical data of each group (n, %).

Clinical data		Group of occurrence (n = 58)	No occurrence group (n = 43)	<i>p</i>
Age (years) [10]	>60	38 (65.52)	27 (62.79)	0.777
Gender	Male	35 (60.34)	23 (53.49)	0.491
Body mass index (kg/m ²) [11]	>24	31 (53.45)	19 (44.19)	0.357
30 marital status	Married	42 (72.41)	30 (69.77)	0.771
Place of residence	Cities	30 (51.72)	21 (48.84)	0.774
Degree of education	Primary and junior high schools	32 (55.17)	15 (34.88)	0.043
Religious beliefs	Yes	30 (51.72)	30 (69.77)	0.067
Status of occupation	Yes	41 (70.69)	32 (74.42)	0.679
Family monthly income (CNY) [12]	≤5000	36 (62.07)	15 (34.88)	0.007
Smoking	Yes	29 (50.00)	20 (46.51)	0.729
Drinking	Yes	28 (48.28)	18 (41.86)	0.522
Diabetes mellitus	Yes	30 (51.72)	20 (46.51)	0.604
Combined hypertension	Yes	23 (39.66)	21 (48.84)	0.357
Coronary heart disease	Yes	30 (51.72)	22 (51.16)	0.955
Presence of frequent urination	Yes	32 (55.17)	26 (60.47)	0.594
Presence of constipation	Yes	34 (58.62)	23 (53.49)	0.607
Number of cyberknife treatments (times)	>4	30 (51.72)	17 (39.53)	0.224
Concurrent chemotherapy or targeted therapy	Yes	34 (58.62)	18 (41.86)	0.095
History of mental illness	Yes	11 (18.97)	9 (20.93)	0.806
Somatic symptoms	Yes	35 (60.34)	17 (39.53)	0.038
SAS (score) [8]	>50	32 (55.17)	15 (34.88)	0.043
SDS (score) [8]	>53	35 (60.34)	18 (41.86)	0.038
NRS (score) [9]	>3	30 (51.72)	13 (30.23)	0.031
Stage of disease	I–II period	30 (51.72)	21 (48.84)	0.774
Site of treatment	Brain	34 (58.62)	26 (60.47)	0.852
Exercise regularly	Yes	23 (39.66)	19 (44.19)	0.648
Family history	Yes	18 (31.03)	12 (27.91)	0.734
Mode of medical insurance	self-financing	12 (20.69)	8 (18.60)	0.795
Tumor diagnostic type (n, %)	Laboratory	25 (43.10)	20 (46.51)	0.734
	Imaging	23 (39.66)	18 (41.86)	
	Other	10 (17.24)	5 (11.63)	

Note: SAS, self-rating anxiety scale; SDS, self-rating depression scale; NRS, numerical rating scale. The exchange rate is 1 USD = 6.48 CNY.

ical data were expressed as n (%) and χ^2 test was used. The Shapiro-Wilk (SW) test was used to assess whether the data follows a normal distribution. The measurement data were expressed as mean \pm standard deviation (SD) ($\bar{x} \pm s$). Through the Logistic regression equation, with the presence or absence of sleep disorders as the dependent variable, and the indicators with statistically significant differences in single factors as the independent variable. The difference was defined as statistically significant when $p < 0.05$.

Results

PSQI Scores of All Patients

A total of 101 patients treated with Cyber Knife were included in this study. The total score of PSQI was (10.95 \pm 5.41), and 43 patients (42.58%) without sleep disorders were included in the non-sleep disorder group. There were 22 cases (21.78%) of mild disorder, 22 cases (21.78%) of moderate disorder, and 14 cases (13.86%) of severe disorder, all of which were included in the occurrence group (Fig. 1).

Table 2. Multivariable analysis of factors affecting sleep disorders in Cyber Knife patients during treatment.

Influencing factors	β value	Standard error (SE)	p	Wald value	Odds ratio (OR) value	OR value 95% CI
Degree of education (reference: high school and above)	1.046	0.505	0.038	4.294	2.845	1.058–7.650
Monthly household income (reference: >5000 CNY (1 USD = 6.48 CNY))	0.634	0.473	0.180	1.796	1.886	0.746–4.769
Somatic symptoms (reference: no)	0.981	0.497	0.048	3.899	2.666	1.007–7.056
SAS (reference: ≤ 50)	1.061	0.522	0.042	4.131	2.889	1.039–8.035
SDS (reference: ≤ 53)	1.074	0.487	0.027	4.873	2.928	1.128–7.601
NRS (reference: ≤ 3)	1.092	0.489	0.025	4.997	2.981	1.144–7.766

Comparison of Clinical Data of Each Group

There were significant differences in degree of education, family monthly income, somatic symptoms, SAS, SDS and NRS between the occurrence group and the non-occurrence group ($p < 0.05$). See Table 1 (Ref. [8–12]) for details.

Multivariable Analysis of Influencing Factors of Sleep Disorders in Cyber Knife Patients during Treatment

Including education level, monthly family income, and somatic symptoms, we constructed a binary logistic regression equation. The Omnibus test for model coefficients $p < 0.001$. The results revealed that lower education levels increased the risk of sleep disorders significantly (odds ratio (OR) = 2.845, $p = 0.038$); increased somatic symptoms raised the risk of sleep disorders (OR = 2.666, $p = 0.048$); higher scores on the SAS (OR = 2.889, $p = 0.042$), SDS (OR = 2.928, $p = 0.027$), and NRS (OR = 2.981, $p = 0.025$) were linked to increased risk of sleep disorders (Table 2).

Discussion

Radiotherapy has been widely used in the treatment of tumor patients, and stereotactic radiotherapy is an image positioning technology and tumor radiation physics technology emerging in recent years. It mainly uses real-time digital images to accurately locate the specific location of the lesion, and produces biological effects on the lesion through low-fraction and high-dose radiation, so as to achieve the purpose of treatment [13]. Cyber Knife was developed by Professor John R. Adler in 1987. Since 2001, Cyber Knife has been approved for the treatment of tumors in all parts of the body. It has the characteristics of

no wound, no pain, no bleeding, no anesthesia, and no recovery period. And reduce the incidence of cerebral necrosis [14,15]. However, a study [16] has found that patients are prone to sleep disorders during Cyber Knife treatment, which directly affects the treatment results and prognosis. Therefore, it is crucial to understand the factors affecting the occurrence of sleep disorders in patients as early as possible, so as to provide a reference for the subsequent development of corresponding intervention measures.

Foreign scholars once conducted a cross-sectional study [17] and found that the incidence of sleep disorders in cancer patients was as high as 62%, while the prevalence of healthy volunteers was about 30%. In another large clinical study [18], 823 patients with different tumor types were investigated, and the results showed that the incidence of sleep disorders in cancer patients was as high as 79.6%. The PSQI score of 101 Cyber Knife patients was (10.95 ± 5.41), of which 43 cases (42.58%) had no sleep disorder; There were 22 cases (21.78%) with mild disorder, 22 cases (21.78%) with moderate disorder, and 14 cases (13.86%) with severe disorder. Sleep disorders are prone to occur during Cyber Knife treatment, as announced before [16], which needs to be paid attention to in clinical practice. The reason is that during Cyber Knife treatment, patients are conscious, so they are prone to fear, anxiety, tension and other emotions, and even produce delayed reactions and acute radiation reactions. In addition, patients themselves have great worries about the irreversible development of the disease and the threat of death, and the interference of night ward rounds and other factors can lead to serious mental and psychological problems in patients, which directly affect the functions of their circulation, nervous and endocrine systems and increase the probability of sleep disorders [19,20].

The results of this paper showed that there were significant differences between the occurrence group and the non-occurrence group in degree of education, family monthly income, somatic symptoms, SAS, SDS and NRS. Logistic regression equation further proved that education level, somatic symptoms, SAS, SDS and NRS were the influencing factors of sleep disorders in Cyber Knife patients during treatment.

Compared with those with lower education level, those with higher education level had a better understanding of the disease and Cyber Knife, and were able to seek help from many ways, effectively reduce the psychological stress caused by the disease, and thus reduce the incidence of sleep disorders. However, those with low education level have poor cognitive ability, lack of understanding of Cyber Knife related knowledge, and are more likely to have emotional fluctuations, which directly increases the incidence of sleep disorders [21,22].

Tumor patients are usually accompanied by pain, nausea, dry mouth, cough, vomiting, dermatitis, diarrhea, constipation and other somatic symptoms. With the gradual development of the disease, the patient's body function and tolerance are directly reduced. At the same time, patients with somatic symptoms are prone to anxiety and depression because of physical discomfort, and their symptoms cannot be explained by examination, and the treatment effect is limited. It is easy to improve patients' attention to symptoms and alertness, and even amplify somatic symptoms and poor efficacy, which becomes a potential factor for patients' psychological problems. It not only increases anxiety and depression, but also causes a greater probability of sleep disorders [23].

Besides, according to statistics [24], the incidence of depression in cancer patients is 14.7–18.44%, while the incidence of anxiety is 15.09–27.04%. In addition, the relationship between emotion and sleep is bidirectional, if the patient has a poor sleep, it may have a negative impact on emotional health. On the contrary, negative emotions can also affect the patient's sleep, making sleep quality problems in a vicious cycle. Sleep disorders at night are reflected in the dysfunction of the next day, and social inhibition, as a bad lifestyle of patients with chronic diseases, is easy to cause negative emotions such as anxiety and depression, which leads to difficulties in falling asleep or sleep maintenance.

Moreover, patients will experience different degrees of pain, because tumor cells will secrete chemicals during growth, which directly stimulate pain nerves [25,26]. In contrast, patients with severe pain are more likely to

have sleep disorders, mainly because patients with obvious cancer pain have higher levels of catecholamine in their blood, which excites sympathetic nerves, thus increasing the chance of sleep disorders.

This study has some limitations. First of all, our sample size was relatively small, resulting in a certain degree of limitation and bias. Secondly, this study is a single-center design, and this study was conducted in our hospital, but due to the particularity of our hospital, its promotion in medical institutions under different backgrounds may be limited. Finally, we failed to consider some possible confounding factors, such as the type of other medication used, duration and other relevant indicators. In the future study, we will take relevant factors into more comprehensive consideration, conduct multi-center and large-sample studies to verify our results, and further improve them based on the limitations of this study.

Conclusions

The occurrence of sleep disorders among Cyber Knife patients during treatment is notable. Factors such as education level, somatic symptoms, anxiety, depression, and pain levels significantly influence the likelihood of sleep disorders in these patients. Therefore, in clinical practice, it is essential to prioritize and implement measures to reduce the incidence of sleep disorders in Cyber Knife patients.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable request from the corresponding author.

Author Contributions

JS and TM designed the research study. LZ and TM performed the research. JS analyzed the data. TM and LZ drafted the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study has been approved by the ethics committee of Huashan Hospital Affiliated to Fudan University (approval no. KY2020-840). This study was conducted in accordance with the Declaration of Helsinki, and informed consent was obtained from all participants.

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Conflict of Interest

The authors declare no conflict of interest.

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