The characteristics of sleep in headache patients

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이 논문을 석사 학위논문으로 제출함

2008년 **12**월 일

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윤 승 현

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감사의 글

본 논문이 완성되기 까지 저를 이끌어주신 많은 분들에게 감사의 말씀을 전하고자 합니다. 우선 많이 부족한 저를 세심한 지도와 날카로운 비판으로 지도해 주신 안형준 교수님께 먼저 감사의 말씀을 드리고 싶습니다. 그리고 제게 늘 넓은 세상을 깨우치게 해 주시는 김종열 교수님, 항상 제 생활의 멘토 역할을 해주시는 최종훈 교수님께도 감사의 말씀을 드립니다. 제게 늘 학문적인 모티브를 주시는 김성택 교수님, 세심함으로 항상 제게 힘이 되어주신 권정승 교수님께도 감사드립니다. 또한 항상 제게 학문적 조언을 아끼지 않아주신 신경진 교수님께도 감사드립니다.

항상 의국의 든든한 후배가 되어준 영섭이, 의국의 화사한 분위기 메이커가 되어준 주현이, 힘든 일도 묵묵히 열심히 하는 성실한 영찬이, 어떤 일도 항상 깔끔하게 잘해내는 영주, 그리고 항상 저를 이끌어주신 이상섭 선생님, 심우현 선생님, 유지원 선생님, 김기서 선생님, 강진규 선생님, 신준한 선생님, 강승철 선생님, 태일호 선생님, 전영미 선생님을 비롯한 의국 선/후배님들과 구강내과 식구들에게도 고마운 마음을 전합니다.

부족한 점이 많아 항상 걱정만 끼쳐드리는 부족한 아들을 애정으로 보살펴주시고 헌신적으로 지원해주신 아버지와 어머니께 진심으로 감사드립니다. 또한 항상 친아들처럼 따뜻하게 마음써주시는 장인어르신과 장모님께도 진심으로 감사드립니다.

마지막으로 바쁘고 힘든 직장 생활 때문에 힘들어하면서도, 항상 저의 든든한 후원자가 되어준 아내에게 미안한 마음과 함께 고마움과 사랑을 전합니다.

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ABSTRACT

The characteristics of sleep in headache patients

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(Directed by Prof. Hyung-Joon Ahn, D.D.S., M.S.D., Ph.D.)

Background: The relationship between headache and sleep has been investigated by many studies, but it remains controversial and poorly understood.

Objectives: This study investigated the relationship between headache and sleep by evaluating sleep quality, daytime sleepiness, and specific features related to sleep-disordered breathing (SDB).

Method: A total of 101 subjects suffering from headache and 128 healthy controls were enrolled. In order to collect information on various aspects of headache attacks, those in the headache group completed a self-reported questionnaire about the characteristics of headache attacks and the Migraine Disability

Assessment (MIDAS) questionnaire. The subjective quality of sleep was evaluated in all of the subjects using the Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS). In addition, the following specific features of sleep were evaluated in 28 subjects selected randomly from each group: apnea-hypopnea index (AHI), prevalence of SDB, nocturnal oxygen saturation (SaO_2), and oxygen desaturation index (ODI) as measured using a portable monitoring device (ApneaLink™, Resmed Inc., Poway, California, USA).

Results:

1. Sleep quality was significantly associated with headache. The global PSQI and the prevalence of poor sleeping (global PSQI >5) were significantly higher in the headache group than in the control group (both $p<0.0001$).

2. Daytime sleepiness was significantly associated with headache. ESS scores and the prevalence of daytime sleepiness (ESS score >10) were significantly higher in the headache group than in the control group (both $p<0.0001$).

3. Sleep quality was significantly associated with headache severity. The mean scores on the numerical rating scale and the MIDAS were significantly higher in the poor-sleeper group than in the good-sleeper group ($p=0.0347$ and $p=0.0016$, respectively). However, daytime sleepiness was not significantly associated with headache severity.

4. Headache chronicity was significantly associated with sleep quality and daytime sleepiness. The global PQSI and prevalence of daytime sleepiness were significantly higher in the chronic-headache group than in the acute-headache group ($p=0.0003$ and $p=0.0312$, respectively). However, morning

headache was not significantly associated with sleep quality or daytime sleepiness.

5. The AHI, ODI, prevalence of SDB, and nocturnal SaO_2 did not differ significantly between the headache and control groups.

6. The AHI, ODI, prevalence of SDB, and nocturnal SaO_2 did not differ significantly between the morning-headache group and no-morning-headache group.

Conclusion: The obtained results indicate that there is a significant association between headache and sleep. Among various characteristics of headache, severity and chronicity were significantly associated with sleep quality and daytime sleepiness, while no statistically significant association was evident between headache and nocturnal hypoxia or SDB.

Key words : headache, sleep quality, daytime sleepiness, nocturnal hypoxia, sleep disordered breathing.

The characteristics of sleep in headache patients

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I. Introduction

There are many reports on the relationship between sleep and pain. This relationship might be reciprocal, with pain disturbing both the continuity and quality of sleep. Also, poor sleep exacerbates pain (Smith & Haythornwaite, 2004). Headache is one of the most common, widespread, and debilitating pain disorders experienced by humans. The lifetime prevalences of headache of any type in men and women are up to 93% and 99%, respectively (Rasmussen et al.,

1991). The relationship between sleep and headache has been widely studied for more than a century, and many population surveys have found an association between sleep and headache. It is well known that a sound sleep can alleviate headache, and that sleep disturbances or a change in sleep patterns can trigger headache (Rasmussen, 1993; Silberstein, 2001). Reciprocally, headache might induce various degrees of sleep disruption and sleep disturbances (Sahota & Dexter, 1990; Inamorato et al., 1993; Paiva et al., 1995). Many clinical studies also suggested that there are numerous sleep disorders related to primary headache syndromes, among which obstructive sleep apnea (OSA) appears to be the most strongly related to headache, especially morning headache (Rains & Poceta, 2005, 2006). The prevalence of headache is reportedly significantly higher in OSA patients than in the general population (Aldrich & Chauncey, 1990; Jennum & Sjol, 1994; Poceta & Dallesio, 1995; Paiva et al., 1997; Loh et al., 1999). In the International Classification of Headache Disorders – second edition (ICHD-II) of the International Headache Society, there is specific code for "headache attributed to sleep apnea". Also, the International Classification of Sleep Disorders (ICSD) lists morning headache as a feature of OSA syndrome (ICSD-revised, 1997).

Some hypotheses have been proposed for explaining the relation between headache and OSA. Some authors have reported that fluctuation in the nocturnal oxygen saturation (SaO_2) decreases the sleep quality and triggers headache (Sugita et al., 1985; Jennum & Borgesen, 1989; Jennum & Jensen, 2002; Diomedi et al., 1998;Dodick et al., 2003). Loh et al. (1999) suggested that oxygen desaturation in OSA patients causes cerebral vasodilation, and that this can induce headache.

However, other studies have obtained conflicting results. Some authors have reported no relation between morning headache and OSA (Aldrich & Chauncey, 1990; Jensen et al., 2004) or between morning headache and nocturnal

SaO_2(Greenough et al., 2002; Neau et al., 2002; Idiman et al., 2004). Thus, the exact relationship between the OSA and headache remains controversial.

This study investigated the possible relationship between headache and sleep by evaluating sleep quality, daytime sleepiness, and specific features related to sleep-disordered breathing (SDB)－including nocturnal SaO_2, apnea-hypopnea index (AHI), and oxygen desaturation index (ODI)－in headache patients

II. Subjects and methods

1. Subjects

A total of 101 subjects (aged 30.3±12.9 years, mean±SD) of both genders (23 males, 78 females) suffering from headache were enrolled in this study. All of the subjects were recruited from TMJ and the Orofacial Pain Clinic, Dental Hospital of Yonsei University, from June to November 2008. The diagnosis of headache was based on the ICHD-II. Subjects who had taken preventive medication for headache or other medications that can affect sleep (e.g.,hypnotics, barbiturates, antidepressants, and muscle relaxants) within the previous 3 months were excluded. A total of 128 healthy subjects (aged 31.80±12.62 years) of both genders (56 males, 62 females) without headache were enrolled as a control group. The study protocol was approved by the Institutional Review of Boardof Yonsei University Hospital, and written informed consent was obtained from all subjects.

2. Methods

2.1. Headache questionnaire

At the first visit, subjects in the headache group completed a self-reported questionnaire in order to collect information on various aspects of headache attacks. The questionnaire included the headache attack frequency, duration, severity, intensity, characteristics of pain (e.g. pressing/tightening or pulsating), localization, accompanying symptoms, and aggravating and alleviating factors, the presence of morning headache, and the chronicity of headache (chronic headache

was defined as the presence of headache attacks on more than 15over more than 3 months).

Based on the information obtained from the questionnaire, headache was diagnosed according to the ICHD-II criteria and the subjects were classified into the following three groups:

1. Migraine(MIG) group: migraine or probable migraine.
2. Tension-type headache (TTH) group: TTH or probable TTH.
3. Other-headache group: cluster headache, other primary headache, or secondary headache.

2.2. Migraine Disability Assessment(MIDAS) questionnaire

All of the subjects with headache completed the MIDASquestionnaire. The MIDAS questionnaire is based on the number of days when productivity is reduced byat least half for both work outside the home and household work, as well as the number of days of nonwork activities (family, social, and leisure) during a 3-month period. The MIDAS questionnaire comprises five disability questions, with the MIDAS score calculated as the sum of responses to these questions. The MIDAS score is categorized into four disability grades (MIDAS grades). The MIDAS questionnaire exhibits high reliability and internal consistency for estimating migraine-related disability (Lipton et al., 2001; Stewart et al., 2001; Park et al., 2008).

2.3. Sleep-related questionnaire

The subjective quality of sleep was evaluated in all of the subjects using the Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS).

2.3.1 Pittsburgh Sleep Quality Index(PSQI)

The PSQI assesses sleep quality during the previous month. It consists of 19 self-rated questions that assess a wide variety of factors related to sleep quality, including sleep duration, latency, and/or frequency and severity of specific sleep-related problems. These 19 items are grouped into the following 7 component scores, each weighted on a scale from 0 to 3: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medications, and daytime function. The seven component scores are then summed to yield a global PSQI, which ranges from 0 to 21. Relative to clinical laboratory measures, a global PSQI of greater than 5 represents a sensitive and specific measure of poor sleep quality (i.e., global PSQI$\leq$5: good sleeper, global PSQI>5: poor sleeper). The sensitivity and specificity of the PSQI were reportedly 89.6% and 86.5%, respectively (Buysse et al. 1989).

2.3.2 Epworth Sleepiness Scale(ESS)

The ESS is a questionnaire that assesses sleepiness. This questionnaire contains eight items for the self-reported disclosure of the expectation of dozing in various situations. The dozing probability is rated from 0 to 3, giving a maximum possible score of 24. Sleepiness is severe when the sum exceeds 10, and the ESS scores for healthy people without OSA and for patients with OSA were reportedly 5.9±2.2 and 11.7±4.5, respectively (Johns, 1991, 1992).

2.4. Sleep evaluation using a portable monitoring device

With their consent, 28 subjects selected randomly from each group participated in a sleep evaluation using a portable sleep-monitoring device. Polysomnography (PSG) performed over a full night in a laboratory and with a technician in attendance is currently considered the gold standard for diagnosing SDB-like conditions such as OSA. However, certain disadvantages of PSG, such as its high

cost and inconvenience, have led to a portable monitoring device being proposed as a substitute for PSG.

ApneaLink™ (Resmed Inc., Poway, California, USA; Fig. 1) is a portable recording device with three data channels: respiration, oximetry, and pulse. The device consists of a nasal cannula and pulseoximeter attached to a small case that houses a pressure transducer. The ApneaLink™ device has shown high sensitivity and specificity (>80%) compared with PSG (Erman et al., 2007). This device was used in the present study to estimate the AHI, ODI, and the mean and lowest nocturnal SaO_2. AHI was calculated by dividing the total number of apnea and hypopnea episodes by the total recording time(in hours). An apnea episode was defined as a decrease in airflow by at least 80% relative to baseline for at least 10seconds, and a hypopnea episode was defined as a decrease in airflow by 50% to 80% relative to baseline for at least 10 seconds.

Fig. 1. ApneaLink™, Resmed Inc., Poway, California, USA

2.5. Analysis

Statistical analyses were performed to compare the PSQI and ESS score and the ApneaLink™ parameters between the headache and control groups. Groups were compared using the *t*-test for continuous variables and the chi-square test for analyzing cross tabulations. SAS Version 9.1 (Statistical Analysis System, SAS Institute, USA) was used for all statistical analyses. The level of significance was set at 95%.

III. Result

3.1. Subject demographics

Table 1. Demographic characteristics in headache group and control group

	Headache group (n=101)	Control group (n=118)
Age (years)	30.3±12.9	31.8±12.6
Gender (% female)	77.2%	52.5%
BMI	21.0±3.1	21.9±2.9

The characteristics of the headache and control groups are reported in Table 1. In the headache group, 49 (48.5%) subjects were classified into the migraine group (migraine: 30, probable migraine: 18), and 49 (48.5%) subjects were classified into the TTH group (TTH: 38, probable TTH: 11). Three (3%) subjects were classified into the other-headache group (secondary headache: 2, cluster headache: 1; Table 2). The other-headache group was excluded from statistical analyses because of the very small number of subjects.

The gender distribution differed significantly between the migraine and TTH groups (p=0.0155), whereas the age and duration of headache suffering did not. The prevalence of morning headache and chronicity of headache were higher in the migraine group than in the TTH group, but the difference did not reach the level of statistical significance. The scores on the numerical rating scale (NRS) and MIDAS were significantly higher in the migraine group than in the TTH group (NRS: 6.51±1.53 vs 5.02±1.94, p<0.0001; MIDAS score: 31.78±54.29 vs 12.67±22.50, p=0.0263). The characteristics of the headache group are summarized in Table 3.

Table 2. Diagnostic classification of headache group

	Headache type	n	n(%)
Migraine group (MIG; n=49)	Migraine	30	29.7
	Probable migraine	19	18.8
Tension type headache group (TTH; n=49)	Tension type headache	38	37.6
	Probable tension type headache	11	10.9
Other headache group (n=3)	Secondary headache	2	2
	Cluster headache	1	1
Total		101	100

Table 3. Comparison of headache features in the two subgroups of headache group

	MIG(n=49)	TTH(n=49)	p
Age (years)	29.8±12.9	30.7±14.3	0.7331
Gender (% female)	87.8%	67.3%	0.0155*
NRS	6.51±1.53	5.02±1.94	<0.0001*
HA duration (years)	6.58±6.16	4.84±5.64	0.1606
Chronicity (%)	40.8%	24.5%	0.0848
Morning headache (%)	32.7%	16.3%	0.0602
Mean MIDAS score	31.78±54.29	12.67±22.50	0.0263*

* Statistically significant at significance level of 95%

3.2. Results for the PSQI

Table 4 presents the PSQI results. The mean global PSQI was significantly higher in the headache group (8.63±3.48) than in the control group (5.80±2.71; p<0.0001). The prevalence of poor sleepers (PSQI>5) was 81.6% in the headache group and 45.8% in the control group (p<0.0001).

According to headache type, there were no significant differences in mean global PSQI (migraine group=9.12±3.70, TTH group=8.14±3.20; p=0.1643) and prevalence of poor sleepers (migraine group=83.7%, TTH group=79.6%; p=0.6018).

Table 4. Analysis of PSQI result

	Total headache group (n=98)	Control (n=118)	p	Headache type		
				Migraine group (n=49)	TTH group (n=49)	p
Mean global PSQI	8.63±3.48	5.80±2.71	<0.0001*	9.12±3.70	8.14±3.20	0.1643
Poor sleeper(%)	80(81.6%)	54(45.8%)	<0.0001*	10(83.7%)	39(79.6%)	0.6018
Good sleeper(%)	18(18.4%)	64(54.2%)		8(16.4%)	41(20.4%)	

* Statistically significant at significance level of 95%

3.3. Results for the ESS

Table 5 presents the ESS results. ESS scores were significantly higher in the headache group (10.48±4.35) than in the control group (7.53±3.95; p<0.0001). The prevalence of severe daytime sleepiness (ESS>10) was 50.5% in the headache group and 22.0% in the control group (p<0.0001).

According to headache type, there were no significant differences in ESS score (migraine group=10.37±4.78, TTH group=10.59±3.92; p=0.7999) and prevalence of severe daytime sleepiness (migraine group=51.0%, TTH group=49.0%; p=0.8399).

Table 5. Analysis of ESS result

	Total headache group (n=98)	Control (n=118)	p	Headache type		
				Migraine group (n=49)	TTH group (n=49)	p
Mean ESS score	10.48±4.35	7.57±3.95	<0.0001*	10.37±4.78	10.59±3.92	0.7999
Severe daytime sleepiness(%)	49(50.0%)	26(22.0%)	<0.0001*	25(51.0%)	24(49.0%)	0.8399
No sleepiness(%)	49(50.0%)	92(78.0%)		24(49.0%)	25(51.0%)	

* Statistically significant at significance level of 95%

3.4. Analysis of NRS and MIDAS scores according to PSQI and ESS score

Table 6 presents the NRS and MIDAS scores according to the PSQI and ESS. According to the PSQI, the NRS score was significantly higher in the poor-sleeper group (4.92±1.52) than in the good-sleeper group (5.53±1.93, p=0.0347). The MIDAS score was also significantly higher in the poor-sleeper group (25.55±46.19) than in the good-sleeper group (7.44±8.75, p=0.0016). However, the NRS (p=0.2218) and MIDAS score (p=0.9060) did not differ significantly between the severe-daytime-sleepiness group and the no-sleepiness group.

Table 6. The analysis of NRS and MIDAS scores according to PSQI and ESS score

	Global PSQI			ESS		
	Poor-sleeper (n=80)	Good-sleeper (n=18)	p	Severe-daytime sleepiness (n=49)	No-sleepiness (n=49)	p
NRS	5.53±1.93	4.92±1.52	0.0347*	5.53±1.96	6.00±1.81	0.2218
MIDAS score	25.55±46.19	7.44±8.75	0.0016*	22.74±34.08	21.71±49.78	0.9060

* Statistically significant at significance level of 95%

3.5. Analysis of PSQI and ESS score according to chronicity of headache and presence of morning headache

Table 7 presents the PSQI and ESS score according to headache chronicity and severity. The global PSQI was significantly higher in the chronic-headache group (10.69±4.01) than in the acute-headache group (7.64±2.70, p=0.0003). However, the prevalence of poor sleepers did not differ significantly between the chronic-headache group (87.5%) and the acute-headache group (78.8%, p=0.2963).
The ESS score did not differ significantly between the chronic-headache group (11.5±4.78) and the acute-headache group (9.98±4.07, p=0.1063). However, the prevalence of severe daytime sleepiness was significantly higher in the chronic-headache group (65.6%) than in the acute-headache group (42.4%, p=0.0312).
The global PSQI, ESS score, prevalence of poor sleepers, and severe daytime sleepiness did not differ significantly with the presence of morning headache.

Table 7. The analysis of PSQI and ESS score according to chronicity of headache and presence of morning headache

		Chronic headache (n=32)	Acute headache (n=66)	p	Morning headache (n=24)	No-morning headache (n=74)	p
PSQI	Mean	10.69±4.01	7.64±2.70	0.0003*	9.0±3.76	8.51±3.40	0.5542
	Poor sleeper(%)	28(87.5%)	52(78.8%)	0.2963	21(87.5%)	59(79.7%)	0.3930
ESS	Mean	11.5±4.78	9.98±4.07	0.1063	11.08±4.85	10.28±4.19	0.4369
	Daytime sleepiness(%)	21(65.6%)	28(42.4%)	0.0312*	13(54.2%)	36(48.7%)	0.6385

* Statistically significant at significance level of 95%

3.6. Results of evaluation by ApneaLink™

Sleep was evaluated in 32 subjects of the headache group and 28 subjects of the control group using a portable sleep-monitoring device (ApneaLink™). The recording time was insufficient in four subjects in the headache group, so their data were excluded from the analysis. The age, gender, and BMI did not differ significantly between the headache and control groups. The characteristics of the headache and control groups are presented in Table 8.

AHI was higher in the headache group (5.86±6.26) than in the control group (3.43±3.57), but the difference did not reach the level of statistical significance (p=0.0816). The prevalence of SDB (AHI>5) was 35.7% in the headache group and 25.0% in the control group (p=0.3833). The ODI and mean and lowest nocturnal SaO_2also did not differ significantly between the two groups.

Table 8. Comparison of ApneaLink™ results between headache group and control group

	Headache group (n=28)	Control group (n=28)	p
Age (years)	34.0±14.1	29.9±11.5	0.2335
Gender (% female)	67.9%	50.0%	0.1744
BMI	21.2±2.9	22.2±2.9	0.2376
Mean AHI	5.86±6.26	3.43±3.57	0.0816
AHI≥5 (%)	35.7%	25.0%	0.3833
ODI	3.61±4.79	2.29±3.60	0.2486
Average SaO_2	96.10±1.95	95.86±1.72	0.6126
Lowest SaO_2	90±4.19	91.71±3.73	0.1117

The AHI, prevalence of SDB, and ODI were slightly higher and the mean and lowest nocturnal SaO_2 were slightly lower in the morning-headache group than in the no-morning-headache group. However, none of these differences reached the level of statistical significance (Table 9).

Table 9. Comparison of ApneaLink™ results according to presence of morning headache

	Morning headache (n=8)	No-morning headache (n=20)	p
Age (years)	31.4±13.7	35.1±14.5	0.5380
Gender (% female)	75.0%	65.0%	0.6088
BMI	21.7±4.1	21.0±2.4	0.6288
Mean AHI	7±8.28	5.4±5.44	0.5511
AHI≥5 (%)	37.5%	35.0%	0.9007
ODI	3.75±5.15	3.55±4.78	0.9228
Average SaO_2	95.75±1.83	96.20±2.02	0.5500
Lowest SaO_2	89.63±3.81	90.15±4.42	0.7708

IV. DISCUSSION

Paiva et al. (1995) proposed three mechanisms for explaining the relationship between sleep and headache. The first possible mechanism is that sleep disturbance is the cause of the headache. It is well known that sleep deprivation, excessive sleep, inadequate sleep duration, and poor sleep are common triggering factors for migraine and that a change in sleep patterns is one of the most common precipitating factors of both migraine and TTH (Sahota & Dexter, 1990). The second possible mechanism is that headache is the cause of the sleep disturbance. Many studies have found that headache can cause sleep disruption and sleep loss (Sahota & Dexter, 1990; Paiva et al., 1992; Aaltonen et al., 2000). The third possible mechanism is that there is an association between sleep disturbance and headache, and that they can occur together for various reasons such as medical conditions (e.g., analgesic overuse) or psychiatric disorders (e.g., depression or anxiety) (Dodick et al., 2003). However, despite many previous studies, the mechanism underlying the relationship between sleep and headache remains unclear.

Many clinical studies have also suggested that numerous sleep disorders—not only sleep deprivation or sleep disturbance—are associated with primary headache syndromes. Among the various types of headache, particularly morning headache (or "awakening" headache) and chronic headache could be strongly related to sleep disorder, and management of the sleep disorder might improve or resolve the headache (Rains & Poceta, 2006). OSA is one of the most common sleep disorders and it includes morning headache as a diagnostic feature (ICSD-revised, 1997). Several studies have investigated the relationship between morning headache and sleep disorders including OSA. Paiva et al. (1995) applied PSG to 25 patients with morning headache, which revealed sleep disorders

including OSA in 13 (52%) patients (Paiva et al., 1995). Ulfberg et al. (1996) reported that morning headache was about three times more common in heavy snorers and patients with OSA than in the general population. In the retrospective study of Loh et al. (1999) involving 80 consecutive OSA patients, 41% reported morning headache. Those authors suggested that the severity of headache is positively correlated with OSA severity and nocturnal oxygen desaturation. Göder et al. (2003) examined morning headache in 432 sleep-disordered patients who underwent PSG and 30 healthy controls, and found that the prevalence of headache was significantly higher in patients with sleep disorder than in controls (34% vs 7%). Alberti et al. (2005) also reported that morning headache was present in 74% of OSA patients and that its occurrence was significantly correlated with nocturnal oxygen desaturation and OSA severity. The association of cluster headache with sleep disorders including OSA has also been investigated. Graff-Radford and Newman (2004) studied 31 cluster headache patients who underwent PSG, and found that 80% of the patients experienced OSA. Similarly, Nobre et al. (2005) found that the incidence of OSA was 8.4-fold higher in 37 cluster headache patients who underwent PSG than in age- and gender-matched controls.

However, contradicting studies have also been reported. Aldrich and Chauncey (1990) reviewed clinical and PSG data of 304 patients with sleep apnea, and compared the findings with normal control subjects. They concluded that the presence of frequent morning headaches is a nonspecific symptom in patients with sleep disorders and hence is not a consistent or reliable indicator of sleep apnea syndrome. Jensen et al. (2004) used PSG to examine whether sleep apnea is more prevalent in patients with headache, and found that the frequency of OSA was no higher in patients referred to specialists for headache problems than in the general population. Greenough et al. (2002) examined the relationship between nocturnal $SaO_2$and headache syndrome, and found that the percentage

of time spent with nocturnal hypoxia did not differ between headache patients and non-headache controls. Also, Neau et al. (2002) demonstrated that the nocturnal SaO_2 and AHI did not differ significantly between patients with headache and controls without headache. Idiman et al. (2004) found no statistically significant relationship between headache and AHI and minimal SaO_2 in 75 patients with sleep apnea syndrome.

The above results together indicate that the exact relationship between headache and sleep is not fully understood, and remains controversial. This prompted the present study to investigate the relationship between headache and sleep quality using self-administered questionnaires including the PSQI and ESS, and to evaluate specific features of sleep (e.g., AHI, ODI, and nocturnal SaO_2) using a portable sleep-monitoring device in headache patients.

As expected, the subjective quality of sleep was significantly worse in our headache group than in our control group. The global PSQI, prevalence of poor sleepers, and severity of daytime sleepiness were higher in the headache group than in the control group. These results are in agreement with the study of Gori et al. (2005) on the relationship between headache and sleep quality. They reported that subjective sleep quality was worse in migraine patients than in controls (as evaluated by the PSQI), and that among migraine patients, the morning-headache group showed worse sleep quality and higher MIDAS score (Gori et al., 2005).

The present study also investigated the relationships of specific headache features with sleep quality and sleepiness. Sleep quality tended to be worse in patients with more subjectively severe headache (as estimated by the NRS and MIDAS score). The NRS and MIDAS score were higher in the poor-sleeper group than in the good-sleeper group. However, headache severity was not related to the severity of daytime sleepiness. Chronicity of headache also showed some association with sleep quality and daytime sleepiness. The global PSQI was

significantly higher in the chronic-headache group than in the acute-headache group. The ESS score was also higher in the chronic-headache group, but the difference did not reach the level of statistical significance. However, the prevalence of severe daytime sleepiness was significantly higher in the chronic-headache group. Therefore, it can be concluded from the present results that sleep quality tends to be worse along those with more chronic and severe headache.

However, the presence of morning headache was not significantly associated with sleep quality or daytime sleepiness. Although the sleep quality was worse and the prevalence of daytime sleepiness was higher in the morning-headache group than in the no-morning-headache group, the differences did not reach the level of statistical significance. These findings do not agree with a previous study finding that sleep quality tended to be worse in morning headache sufferers (Gori et al., 2005), but the discrepancy might be due to the relatively small morning-headache group. Therefore, further study with a larger number of subjects is needed to clarify the association between morning headache and sleep quality.

The ApneaLink^{TM} data revealed that the AHI, ODI, and both the mean and lowest nocturnal SaO_2 did not differ significantly between the headache and control groups. Although the AHI was slightly higher in the headache group than in the control group, the difference was not statistically significant (p=0.0816). This result is in agreement with the study of Idiman et al. (2004). Also, the prevalence of SDB (AHI$\geq$5)did not differ significantly between the headache and control groups. The prevalence of SDB in the control group was 25%, similar to the prevalence in normal middle-aged Koreans (men: 16%, women: 27%; Kim et al., 2004). The prevalence of SDB in our headache group was 35.71%, but did not differ significantly from that in the control group.

Several previous studies have found a significant relationship between AHI, nocturnal SaO_2, and presence of morning headache (Loh et al., 1999; Alberti et al., 2005), whereas the present study found that the AHI, prevalence of SDB, and nocturnal SaO_2did not differ significantly with the presence or absence of morning headache. These results conflict with the hypothesis that nocturnal hypoxia is a cause of morning headache, and confirm previous studies finding no association between morning headache and nocturnal hypoxia (Greenough et al., 2002; Neau et al., 2002; Idiman et al., 2004).

The present study was subject to some limitations. First, the study was based only on self-reported and subjective information about headache and sleep. Second, the analysis of sleep was not based on PSG. Although the gold standard diagnostic technique for the sleep study is attended overnight PSG, as suggested by the American Sleep Disorders Association, problems of its high cost, patient agreement, and some clinical regulations led to this study employing a portable sleep-monitoring device. Third, this study included a fairly small number of subjects, which resulted in some difficulties controlling external factors such as the age and gender distributions.

In summary, the present study has confirmed previous studies suggesting that there are significant associations between sleep quality, daytime sleepiness, and headache. On the other hand, nocturnal hypoxia was not found to be associated with headache. Future studies applying PSG to larger samples are needed to further elucidate the association between sleep and headache.

V. Conclusion

This study investigated the relationship between headache and sleep by evaluating sleep quality, daytime sleepiness, and specific features related to SDB (including mean AHI, prevalence of SDB, nocturnal SaO2, ODI) in 101 patients with headache and 128 healthy controls without headache. The results are summarized as follows.

1. Sleep quality was significantly associated with headache. The global PSQI and the prevalence of poor sleeping (global PSQI >5) were significantly higher in the headache group than in the control group (both $p<0.0001$).

2. Daytime sleepiness was significantly associated with headache. ESS scores and the prevalence of daytime sleepiness (ESS score >10) were significantly higher in the headache group than in the control group (both $p<0.0001$).

3. Sleep quality was significantly associated with headache severity. The mean scores on the numerical rating scale and the MIDAS were significantly higher in the poor-sleeper group than in the good-sleeper group ($p=0.0347$ and $p=0.0016$, respectively). However, daytime sleepiness was not significantly associated with headache severity.

4. Headache chronicity was significantly associated with sleep quality and daytime sleepiness. The global PQSI and prevalence of daytime sleepiness were significantly higher in the chronic-headache group than in the acute-headache group ($p=0.0003$ and $p=0.0312$, respectively). However, morning

headache was not significantly associated with sleep quality or daytime sleepiness.

5. The AHI, ODI, prevalence of SDB, and nocturnal SaO_2 did not differ significantly between the headache and control groups.

6. The AHI, ODI, prevalence of SDB, and nocturnal SaO_2 did not differ significantly between the morning-headache group and no-morning-headache group.

The obtained results indicate that there is a significant association between headache and sleep. Among various characteristics of headache, severity and chronicity were significantly associated with sleep quality and daytime sleepiness, while no statistically significant association was evident between headache and nocturnal hypoxia or SDB.

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국문요약

두통환자의 수면 양상에 대한 연구

두통과 수면과의 상관관계는 여러 연구들에 의해 보고되어 왔다. 하지만 이들 간의 정확한 상관관계는 아직 명확히 밝혀지지 않았으며 현재까지도 논란이 계속되고 있다. 본 연구는 두통 환자의 수면 양상에 대한 분석을 통하여 두통과 수면과의 상관관계에 대하여 조사 하는 것을 목적으로 하였다.

총 101명의 두통 환자 및 128명의 두통이 존재하지 않는 건강한 대조군이 본 연구에 참여하였다. 두통군은 두통의 특성에 대한 문진 및 Migraine Disability Assessment (MIDAS) 설문을 시행하였으며, 모든 참가자는 Pittsburgh Sleep Quality Index (PSQI) 와 Epworth Sleepiness Scale (ESS)를 이용하여 수면의 질 및 주간졸리움증의 정도를 평가하였다. 추가적으로 두통군과 대조군 각각 28명의 참가자를 임의 선정하여 간이수면검사기인 ApneaLink^{TM} (Resmed Inc., Poway, California, USA)를 이용하여 수면무호흡-저호흡지수 (AHI, Apnea-hypopnea index), 산소불포화지수 (ODI, Oxygen desaturation index), 야간산소포화도 (nocturnal oxygen saturation) 및 수면장애호흡 (SDB, sleep disordered breathing)의 유병률에 대하여 조사하였다. 연구 결과는 다음과 같다.

1. 두통과 수면의 질 사이에는 유의한 상관관계가 관찰되었다. Global PSQI 는 대조군에 비하여 두통군에서 현저히 높게 나타났으며 (p<0.0001), 수면의 질이 저하된 poor sleeper (Global PSQI score>5)의 비율 또한 두통군에서 현저히 높았다 (p<0.0001).

2. 두통과 주간졸리움증 사이에는 유의한 상관관계가 관찰되었다. ESS scores는 대조군에 비하여 두통군에서 현저히 높게 나타났으며 (p<0.0001), 주간졸리움증 (ESS score>10)이 유병률 또한 두통군에서 현저히 높았다 (p<0.0001).

3. 수면의 질은 두통의 강도와 유의한 연관성을 보였다. poor sleeper group은 good sleeper group에 비하여 높은 NRS (p=0.0347) 및 MIDAS score (p=0.0016)를 나타내었다. 반면, 주간졸리움증은 두통의 강도와 유의할 만한 연관성을 보이지 않았다.

4. 두통의 만성도는 수면의 질 및 주간졸리움증과 유의한 연관성을 보였다. 만성 두통군은 급성 두통군에 비하여 높은 global PSQI (p=0.0003) 및 주간졸리움증의 유병률 (p=0.0312)을 나타내었다. 하지만 기상 시 두통 (morning headache)의 존재 유무는 수면의 질 또는 주간졸리움증과 유의할 만한 연관성을 보이지 않았다

5. 두통군과 대조군간의 수면무호흡-저호흡지수, 산소불포화지수, 수면장애호흡의 유병률, 야간산소포화도는 유의할만한 차이를 보이지 않았다.

6. 기상 시 두통이 존재하는 군과 그렇지 않은 군 간의 수면무호흡-저호흡지수, 산소불포화지수, 수면장애호흡의 유병률, 야간산소포화도는 유의할만한 차이를 보이지 않았다.

상기 연구 결과에 기초하였을 때, 두통과 수면 사이에는 유의한 연관성이 존재하는 것으로 보인다. 특히 두통의 강도 및 만성도는 수면의 질과 주간졸리움증과 유의한 연관성을 나타냈다. 하지만, 본 연구에서는 두통과 야간저산소증 (nocturnal hypoxia) 또는 수면장애호흡의 존재 유무 사이의 유의할만한 연관성을 발견할 수 없었다.

핵심되는 말 : 두통, 수면의 질, 주간졸리움증, 야간저산소증, 수면장애호흡

APPENDIX

두통 평가 설문지(Migraine Disability Assessment)

병록번호 : _____ 환자 이름 : _____ _____년 ____월 ____일

이 설문지는 두통의 정도와 두통으로 인해 유발되는 불편감이 어느 정도인지를 평가하고 가장 적절한 치료를 결정하는데 도움을 주기 위한 것입니다. 지난 3개월 동안 있었던 두통에 대해 다음 질문에 답해주십시오. 각 질문에 있는 괄호 안에 답을 적어 주시면 됩니다. 지난 3개월간 아래 질문과 관련된 일을 하지 않았으면 0을 적어주시면 됩니다.

1. 두통으로 인해 지난 3개월간 직장을 쉬거나 학교에 가지 못한 날이 몇 일 정도 됩니까? (만약 직장이나 학교를 다니지 않는다면 괄호 안에 0을 적으십시오.) ( )일

2. 두통으로 인해 지난 3개월간 직장이나 학교에서의 업무 능률이 반 이상 감소했다고 생각되는 날이 몇 일 정도 됩니까? (1번 질문에 해당되는, 직장이나 학교를 쉰 날은 포함하지 않습니다. 직장이나 학교를 다니지 않는다면 괄호 안에 0을 적으십시오.) ( )일

3. 두통으로 인해 지난 3개월간 집안일을 하지 못한 날이 몇 일 정도 됩니까? ( )일

4. 두통으로 인해 집안일을 하는 정도가 반 이상 감소했다고 생각되는 날이 몇 일 정도 됩니까? (3번 질문에 해당되는, 집안일을 전혀 하지 못한 날은 포함하지 않습니다.) ( )일

5. 두통으로 인해 지난 3개월간 가족모임, 사교활동, 여가활동 등에 참석하지 못한 날이 몇 일 정도 됩니까? ( )일

(1-5 항목) 합계		

A. 지난 3개월간 두통이 있었던 날이 몇 일 정도 됩니까? (두통이 하루 이상 지속된 경우, 지속된 날만큼 일수를 적으십시오.) ( )일

B. 0-10 사이의 숫자를 이용하여 평균적인 두통의 정도를 표시하십시오. (통증이 전혀 없는 경우 0에 해당하고, 상상할 수 있는 가장 심한 통증은 10에 해당합니다.) ( )

MIDAS GRADE	DEFINITION	MIDAS SCORE (1-5 항목 합계)
Ⅰ	Little or no disability	0-5
Ⅱ	Mild disability	6-10
Ⅲ	Moderate disability	11-20
Ⅳ	Severe disability	21+

The Pittsburgh Sleep Quality Index (수면의 질 지수)

다음의 질문들은 지난 한달 동안의 당신의 수면 습관들에 관련된 문항들입니다.

1. 지난 한달 동안 몇 시에 잠자리에 들었습니까? ____시 ____분
2. 지난 한달 동안 밤마다 잠드는데 얼마나 오래 걸렸습니까? ____시간 ____분
3. 지난 한달 동안 아침에 몇시에 일어났습니까? ____시 ____분
4. 지난 한달 동안 실제로 잠잔 시간은 하루에 평균 얼마나 됩니까? ____시간 ____분
   (잠자리에서 누워있는 시간과 실제로 잠잔 시간은 다릅니다.)

5. 지난 한달 동안 잠자는데 얼마나 자주 어떤 문제가 있었습니까? (해당 칸에 체크표시 해주세요)	한번도 없었다	한주에 한번보다 적게	한주에 한두 번 정도	한주에 세 번 이상
a. 30분 이내로 잠들 수 없다.				
b. 한밤중이나 새벽에 깬다.				
c. 화장실에 가려고 일어난다.				
d. 편안하게 숨 쉴 수 없다.				
e. 기침을 하거나 시끄럽게 코를 곤다.				
f. 너무 춥다.				
g. 너무 덥다.				
h. 악몽을 꾼다.				
i. 통증이 있다.				
j. 그 외에 다른 이유가 있다면 아래에 적어주시고 빈도도 표시해 주세요. : _____				
6. 지난 한달 동안 당신의 전반적인 수면의 질은 어느 정도라고 평가하십니까?	매우 좋은	상당히 좋은	상당히 나쁜	매우 나쁜
7. 지난 한달 동안 잠들기 위해 얼마나 자주 약을 복용하였습니까?	한번도 없었다	한주에 한번보다 적게	한주에 한두 번 정도	한주에 세 번 이상
8. 지난 한달 동안 운전하거나, 식사 때 또는 사회활동을 하는 동안 얼마나 자주 졸음을 느꼈습니까?	한번도 없었다	한주에 한번보다 적게	한주에 한두 번 정도	한주에 세 번 이상
9. 지난 한달 동안 하는 일에 열중하는데 얼마나 많은 어려움이 있었습니까?	전혀 없음	아주 약간	약간	매우 큼

성명 :　　등록번호 :

Epworth Sleepiness Scale (주간 졸음 진단표)

아래 척도를 이용하여 각 상황에서 자신에 가장 적합한 사항을 선택하세요.

0 - 전혀 졸리지 않음
1 - 약간 졸림
2 - 상당히 졸림
3 - 매우 많이 졸림

※각 상황을 잘 읽어보시고 본인이 느끼는 졸리움의 정도에 체크표시 하십시오.

상 황	졸리움 정도(0~3)			
앉아서 책을 읽을 때	0	1	2	3
TV를 볼 때	0	1	2	3
공공장소에서 가만히 앉아 있을 때(예, 극장에서나 회의를 할 때)	0	1	2	3
한 시간 이상 계속 운행 중인 차 속에 승객으로 있을 때	0	1	2	3
오후에 쉬면서 혼자 누워 있을 때	0	1	2	3
앉아서 상대방과 대화 하고 있을 때	0	1	2	3
술을 마시지 않고 점심 식사 후 조용히 앉아 있을 때	0	1	2	3
교통체증으로 몇 분 동안 정차해 있는 차 안에서	0	1	2	3
총 점				

신장 :

체중 :