Turkish Journal of Geriatrics
2013; 16 (3) 299-304

Melike YÜCEEGE
Hikmet FIRAT
Sadık ARDIÇ

RESEARCH

THE FEATURES OF SLEEP ARCHITECTURE AND SLEEP APNEA IN THE ELDERLY

ABSTRACT

Introduction: Sleep related disorders are mostly seen in the elder population. Sleep apnea increases with the age. In this research, it was aimed to investigate the sleep architecture in older people with obstructive sleep apnea and the reasons of higher apnea-hypopnea indexes as reported in literatures.

Materials and Method: Patients referred to our sleep center with snoring, witnessed apnea and/or daytime sleepiness between November 2010-December 2011 were taken and the polysomnograpy reports were analyzed retrospectively. Patients with sleep efficiency less than 40% and younger than 25 years old were excluded.

Results: 343 patients (220 patients <65 years' old; mean 50.2±9.3 years' old, 123 patients >65 years' old; mean 69.7±4.7 years' old) were accepted. Body mass indexes were similar in both groups. Sleep efficiency, deep sleep percentage were less, while light sleep and apnea-hypopnea indexes were higher in older group. Total number of apneas and hypopneas were similar. Mean apnea duration and periodic leg movement index were more and respiratory arousals were less in the older group.

Conclusion: Older people reach the similar total number of apnea-hypopnea events in a less sleep time than younger. As a result, apnea-hypopnea indexes are found to be higher in the older group. The decay in the respiratory arousal system may be the cause of the increase in the mean apnea duration in the older patients. Especially sleep apneic patients older than 65 years' old should be carefully examined for periodic leg movement disease, low ferritine levels and comorbidities.

Key Words: Aged; Sleep; Sleep Apnea Syndromes.

ARAŞTIRMA

YAŞLILARDA UYKU YAPISININ VE UYKU APNESİNİN ÖZELLİKLERİ

ÖZ

Giriş: Yaşlılarda uykuyla ilgili hastalıklar daha sık görülür. Uyku apnesi de yaşla artar. Bu araştırmada obstrüktif uyku apnesi olan yaşlı hastalarda litaratürlerde tanımlanan yüksek apne-hipopne indeksi nedenlerinin ve uyku yapısının araştırılması amaçlanmıştır.

Gereç ve Yöntem: Merkezimize Kasım 2010-Aralık 2011 tarihleri arasında horlama, tanıklı apne ve/veya gündüz uykululuk ile başvuran hastalar çalışmamıza alındı ve polisomnografi raporları retrospektif olarak incelendi. Uyku etkinliği %40'dan az olanlar ve yaşı 25'in altında olanlar çalışma dışı bırakıldı.

Bulgular: 343 hasta (220 hasta<65 yaş, ortalama yaş 50.2±9.3, 123 hasta> 65 yaş; ortalama yaş 69.7±4.7) çalışmaya alındı. Beden kitle indeksi değerleri iki grupta benzerdi. Yaşlı grupta uyku etkinliği, derin uyku daha az iken apne-hipopne indeksi ve hafif uyku daha yüksekti. Total apne-hipopne sayıları iki grupta benzerdi. Ortalama apne süresi ve periyodik bacak hareketleri indeksi yaşlı grupta daha yüksek, respiratuar arousal daha düşük bulundu.

Sonuç: Yaşlı hastalar, genç hastalarla benzer apne-hipopne sayılarına daha kısa sürede ulaşmışlardır. Uyku etkinliklerinin daha az olması nedeniyle sonuçta yaşlı grupta apne-hipopne indeksleri daha yüksek bulunmuştur.Yaşlı hastalarda respiratuar arousal sistemindeki bozulmalar ortalama apne süresinin uzamasına neden olabilir. Özellikle 65 yaş üstü uyku apneli hastalar, uykuda periodik bacak hareketleri, düşük ferritin düzeyleri ve komorbiditeler açısından dikkatli incelenmelidir.

Anahtar Sözcükler: Yaşlı; Uyku; Uyku apne sendromu.

İletişim *(Correspondance)*

Melike YÜCEEGE
Dışkapı Araştırma ve Eğitim Hastanesi, Göğüs Hastalıkları
ANKARA

Tlf: 0312 596 27 85
e-posta: melikebanuy@yahoo.com.tr

Geliş Tarihi: 24/07/2012
(Received)

Kabul Tarihi: 21/11/2012
(Accepted)

Dışkapı Araştırma ve Eğitim Hastanesi, Göğüs Hastalıkları
ANKARA

Introduction

Sleep related disorders are mostly seen in the elder population. A high prevalence of medical and psychosocial comorbidities and frequent use of multiple medications are the most important reasons of sleep disturbances in this age group. Many changes take place in the structure of sleep in the elderly (1). Sleep apnea increases with age (2,3). There are studies analyzing the prevalence of sleep apnea and other sleep disturbances in older populations (4, 5), the survival rates in the elderly with sleep apnea (6) and the features of sleep apnea in the old population (7). In this study we aimed to investigate the sleep architecture in older people with obstructive sleep apnea (OSA) and the reasons of higher apnea-hypopnea indexes (AHI) as reported in the above literature.

Materials and Methods

Study Subjects

The patients referred for snoring, witnessed apnea and/or day time sleepiness to our Sleep Center and who have undergone polysomnography (PSG) between November 2010-December 2011 were recruited and after applying the exclusion criteria, the remaining patients were accepted to the study. The study complied with the declaration of Helsinki and was approved by the local research ethics committee. The PSG reports were analysed retrospectively. The patients with PSG records with an efficiency of less than 40% and those under 25 years of age were excluded. BMI, neck circumference, abdomen circumference, arterial blood gas, Epworth sleepiness scale (ESS) (8), comorbidities and PSG values were recorded.

Polysomnography

The participants underwent daytime PSG using Compumedics E series (Compumedics®, Melbourne, Victoria, Australia). At least 6 hours of recording was taken and those with a sleep efficiency of less than 40% were excluded from the study. The PSG recordings included 6-channel electroencephalography, 2-channel electrooculography, 2-channel submental electromyography, oxygen saturation by an oximeter finger probe, respiratory movements via chest and abdominal belts, airflow both via nasal pressure sensor and oro-nasal thermistor, electrocardiography, and leg movements via both tibial anterolateral electrodes. Sleep stages and respiratory parameters were scored according to the standard criteria of the American Academy of Sleep Medicine (AASM). Based on the guidelines of the AASM published in 2007, apnea was defined as a ≥90% decrease in airflow persisting for at least 10 seconds relative to the basal amplitude. Hypopnea was defined as a ≥50% decrease in the airflow amplitude relative to the baseline value with an associated ≥3% oxygen desaturation or arousal, persisting for at least 10 s. (9).

Apnea-hypopnea index (AHI) was calculated based on the following formula: total number of obstructive apneas + hypopneas / total sleep time (h). Sleep stage scoring was done according to the AASM criteria using the software (Profusion PSG 3) in 30-s-epochs by a certified registered PSG technologist. Respiratory arousals and periodic limb movement index (PLMI) were scored according to the AASM 2007 standard criteria (9).

Statistical Analyses

Data analysis was performed by using SPSS for Windows, version 16.0 (SPSS Inc., Chicago, IL, United States). The distributions of continuous variables were determined by Shapiro Wilk test. Levene test was used for the evaluation of homogeneity of variances. The mean differences among groups were compared by independent sample t-test. Mann Whitney-U test was applied for comparisons of the median values. Nominal data (questions with yes/no answer) were analyzed by Pearson's Chi-square test. A p value less than 0.05 was considered statistically significant.

Results

A total of 343 patients, including 220 (130 male; 59.1%, 90 female; 40.9%) younger than 65 and 123 (76 male; 61.8%, 47 female; 38.2%) older than 65 were recruited. The mean ages were 50.2±9.3 (26-64) and 69.7±4.7 (65-93) respectively. BMI, neck and abdomen circumferences and ESS did not differ between the groups. The pO_2 levels obtained from arterial blood gases were significantly lower in the older group. The presence of hypertension, diabetes and anemia were significantly higher in the older group (Table 1). The sleep structures of both groups were shown in Table 2. The sleep latency and stage 3 percentage were lower while stage 1 and stage 1+2 percentages were higher in the older group.

The respiratory indices and PLMI in PSG are shown in Table 3. AHI, RDI and duration with oxygen saturation less than 90% were higher in the older group. Total number of obstructive, mixed, central apneas and hypopneas did not differ between the groups. AHI was higher in the older group. The mean apnea duration was significantly higher in the older group while mean hypopnea duration and the total apnea and

Table 1— Demographic Characteristics of the Study Population

Values	Age <65 Years (220)	Age ≥65 years (123)	p
Epworth	8.4±5.3	9.6±5.8	ns
Neck circumference (cm)	41±3.9	40.6±5.9	ns
Abdomen circumference (cm)	111±13,5	110.1±17.1	ns
Body Mass Index (kg/m^2)	33.8±7.1	33.2±7.1	ns
pO_2 (mm Hg)	77±10.9	71.6±13.4	<0.05
pCO_2 (mmHg)	37.3±5.9	37.5±6.3	ns
SaO_2 (%)	94.5±0.3	93.4±0.5	ns
Hypertension	69/220(31.4%)	80/123(65%)	<0.05
Diabetes mellitus	29/220(13.2%)	34/123(27.6%)	<0.05
Ferritine <50mg/dl	25/219(11.4%)	43/117(35%)	<0.001
COPD	10/220(4.59%)	20/122(16.3%)	<0.01
Hyperlipidemia	30/220(13.6%)	50/123(40%)	<0.001
CAD	7/220(3.2%)	13/123(10.6%)	<0.01

ns, non-significant; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease.

hypopnea durations were insignificantly higher in the older group. AHI severity is shown in Table 4. The total number of respiratory arousals and REM respiratory arousals were significantly lower in the older group. PLMI was significantly higher in the older group.

Discussion

Complaints of sleep disturbances are common in older adults with prevalence rates of over 50% in the community and 70% in the assisted living setting. There are changes due to age in the sleep structure; total sleep time, sleep efficiency, slow-wave and REM sleep decreases while stage 1 and stage 2 percentages increase (3,7,9,10). Our study results are concordant with previous reports.

The prevalence of sleep apnea increases with age. It is reported as 15% in men, 5% in women in general, 9% in middle aged women and 24% in middle aged men (11) and the prevalence continues to increase in older adults (2). The importance of sleep apnea in the older group lies in the additional worsening effect of the sleep apnea syndrome over cognitive functions of those patients (12). In this study, we planned to evaluate the factors leading to a higher prevalence of sleep apnea in the elderly. We found sleep efficiency to be lower and AHI to be higher in the older group. The total number of apneas and hypopneas was not significantly differ-

Table 2— Sleep Structure of the Study Population According to PSG

Datas	Age<65 years	Age ≥65 years	p
Total recording time	429.6±2.5*	412.5±5*	0,002
Sleep efficiency (%)	86.6±0,7*	79.5 ±1,3*	<0.001
Sleep latency (min.)	12.2±1.3*	18.3±2.4 *	0,002
N 1 (%)	8±6.1	10.3±7.7	0,03
N 2 (%)	55±13.1	56.8±15	ns
N1+2 (%)	63±13.8	66.6±17.6	0,04
N 3 (%)	23.1±12	19.8±13	0,02
Stage REM (%)	13.7±5.9	12.5±7	ns
REM latency (min.)	126.8±5.1*	110.6±7.7 *	ns

*SEM: Standart error of means (nonparametric test is used).
SD: Standart deviation (parametric test is used). ns:nonsignificant

Table 3— PSG Data Related with Sleep Apnea

Datas	Age<65 years	Age ≥65 years	p
AHI	35.5±2*	42.4±2.5*	0,03
RDI	38.1±1.9*	45.6±2.4*	0,02
Mean sleep sO2	78.2±0,7*	72.9±1,4*	<0.0001
ODI (3%)	28.9±1.9*	40±2.5*	0,001
Duration with <90%sat.	81.7±7.1*	119.8±10.2*	0,002
Total number of obstructive apneas	67,2±10,3*	58,7±8*	ns
Total number of mixed apneas	13,2±3,8*	7,2±1,5*	ns
Total number of central apneas	12,6 ±2,8*	8,8±1,3*	ns
Total number of apneas	93±12*	73,7±9*	ns
Mean apnea duration	13.7±6.9	17.2±6.9	<0.0001
Mean hypopnea duration	22.5±0.6*	23.7±0.9*	ns
Total number of hypopneas	141±8,8*	146±7,5	ns
PLMI	40.2±2	48.4±3.6	<0.0001
Arousal REM-res	32.2±2.1	24.9±2.7	0,03
Arousal NREM-res	184.8±10.5	151.5±12.8	0,04

*SEM: Standart error of means (nonparametric test is used).
SD: Standart deviation (parametric test is used) Arousal REM-res: REM stage respiratory arousal Arousal NREM-res: NREM stage respiratory arousal PLMI: Periodic Leg Movement Index ns:nonsignificant.

ent from the younger group, but the sleep efficiency was lower in the older group. As a result, the total number of apnea-hypopneas/reduced sleep time (hr) ratio; the AHI index was greater in the older group. Older patients experienced the same total number of respiratory disturbances, in a shorter time. Our patients were sleep apneic patients. The older patients were not able to sleep longer due to respiratory disturbances or to changes associated with aging. We estimate that if they sleep longer, total number of apnea-hypopneas will increase, so the ratio is "really" high. The anthropometric measures (BMI, abdomen and neck circumference) did not differ between the groups, so the age itself, can be the leading factor responsible for the changes.

In our study, the total number of apneas-hypopneas was not different, but mean apnea duration was significantly higher in patients ≥65 years. The mean hypopnea duration was insignificantly higher in the older group. Adding to that, the total number of respiratory arousals was significantly lower in the older group. According to conceptual framework of American Sleep Disorders association criteria, arousals are a marker of sleep disruption representing a detrimental feature of sleep. In Terzano and Parrino's studies, arousals were elements taking part in regulation of the sleep (13). Arousals may connect the sleeper with the surrounding world, adapting the organism to dangers and demands of the outer world, without it, it would be identical to coma. The sleep promoting system and the arousal promoting system are the two pillars that bridge the internal process of sleep to the external world. The capability for arousal from sleep is a protective mechanism and necessary for health and survival (14), but in excess, it has predictable adverse consequences (15,16). Increased amount of arousals are a finding of obstructive sleep apnea syndrome (17). The waking periods increase, while the total sleep time decreases with age. We found that the number of respiratory arousals were significantly lower in patients ≥65 years. The decay in the respiratory arousal system may contribute to the increase in mean apnea duration.

Table 4— The Distribution of Apnea-hypopnea Severity in the Study Population

Group	AHI<5	AHI=5-15	AHI=15-30	AHI>30
Age <65 years	4.5% (10/220)	30.9% (68/220)	18.2% (40/220)	46.4% (102/220)
Age ≥65 years	3.3% (4/123)	17.1% (21/123)	21.1% 26 (123)	58.5% (72/123)

The PLMIs were found to be significantly higher in the older group. The increase can be due to comorbidities and use of medical drugs. The comorbidities (hypertension, diabetes, COPD, coronary artery disease, hyperlipidemia) were significantly higher in the older group. The high PLMI may be one of the causes of shorter sleep time in the older group. Ferritin levels below 50 mg/dl was more frequent among patients ≥65 years. Low ferritin levels may contribute to a higher PLMI in the older group (18).

The older group had a significantly lower mean oxygen saturation and the time spent with sO2<90% was lower. These can be related with high AHI, but the total number of apnea-hypopneas was not different between the groups. We need more to explain this situation; 1. The daytime pO_2 was significantly lower in the older group (sO_2 was lower but not significantly), 2. Mean apnea duration was significantly higher in the older group. Both of these factors may contribute to this problem and explain the low saturation levels during sleep in older patients.

In our study, sleep parameters were similar to the previous studies performed in older groups and additionally, we found that:

1. The total number of apnea-hypopneas in patients older than 65 were not different from the younger group; older patients experience a similar total number of respiratory events in a shorter time, leading to higher apnea-hypopnea indexes.
2. The mean apnea duration was significantly higher in the older group.
3. The total number of respiratory arousals was significantly lower in the older group.
4. Ferritin levels below 50 mg/dl and comorbidities were more common among the older patients with a high PLMI.

Older people reach the same total number of apnea-hypopneas in a shorter sleep time than people younger than 65 years of age. Shorter total sleep time in older persons can be a protective mechanism; the longer the older sleep, the more apnea-hypopneas can occur. The decay in the respiratory arousal system may be the cause of the increase in the mean apnea duration in older patients. Sleep apneic patients over 65 years with higher PLMI should be examined for low ferritin levels and undiagnosed comorbidities.

Acknowledgement

We would like to thank to Yesim Yilmaz, MD for providing advice and internal review of the manuscript.

References

1. Crowley K. Sleep and sleep disorders in older adults. Neuropsychol Rev 2011;21(1):41-53. (PMID:21225347).
2. Ancoli-Israel S, Kripke DF, Klauber MR, et al. Sleep-disordered breathing in community-dwelling elderly. Sleep 1991;14(6):486-95. (PMID:1798880).
3. Bloom H, Ahmed I, Alessi CA, et al. Evidence-based recommendations for the assessment and management of sleep disorders in older persons. J Am Geriatr Soc 2009;57(5):761-89. (PMID:19484833).
4. Hoch, C.C.,Reynolds CF 3rd, Monk TH, et al. Comparison of sleep-disordered breathing among healthy elderly in the seventh, eighth, and ninth decades of life. Sleep 1990;13(6):502-11. (PMID:2126391).
5. Baldwin C.M., Erwin AM, Mays MZ, et al. Sleep disturbances, quality of life, and ethnicity: The Sleep Heart Health Study. J Clin Sleep Med 2010;6(2):176-83. (PMID:20411696).
6. Ancoli-Israel S, Kripke DF, Klauber MR, et al. Morbidity, mortality and sleep-disordered breathing in community dwelling elderly. Sleep 1996;19(4):277-82. (PMID:8776783).
7. Levent E, Sarıman N. Geriatrik hastalarda obstrüktif uyku apne sendromu. Turkish Journal of Geriatrics 2012;15:179-87.
8. Izci B, Ardic S, Firat H, et al. Reliability and validity studies of the Turkish version of the Epworth Sleepiness Scale. Sleep Breath 2008;12(2):161-8. (PMID:17922157).
9. Collop N, Badr S, Bradley D, et al. Sleep related breathing disorders. In: Hauri P, Sateia MJ (Eds). The International Classifications of Sleep DisordersDiagnostic and coding manuel. Second Edition. American Academy of Sleep Medicine.Westchester, IL, 2005, pp 33-79.
10. Zisberg A, Gur-Yaish N, Shochat T. Contribution of routine to sleep quality in community elderly. Sleep 2010;33(4):509-14. (PMID:20394320).
11. Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993;328(17):1230-5. (PMID:8464434).
12. Ayalon L, Ancoli-Israel S, Drummond SP. Obstructive sleep apnea and age:A double insult to brain function? Am J Respir Crit Care Med 2010;182(3):413-9. (PMID:20395556).
13. Terzano MG, Parrino L. Clinical applications of cyclic alternating pattern. Physiol Behav 1993;54(4):807-13. (PMID:8248361).
14. Voss U. Functions of sleep architecture and the concept of protective fields. Rev Neurosci 2004;15(1):33-46. (PMID:15046198).

15. Maschke C, Hecht K. Stress hormones and sleep disturbances - electrophysiological and hormonal aspects. Noise Health 2004;6(22):49-54. (PMID:15070528).
16. Raschke F. Arousals and aircraft noise-environmental disorders of sleep and health in terms of sleep medicine. Noise Health 2004;6(22):15-26. (PMID:15070525).
17. Halasz P, Terzano M, Parrino L, et al. The nature of arousal in sleep. J Sleep Res 2004;13(1):1-23. (PMID:14996030).
18. Walters AS. Toward a better definition of the restless legs syndrome. The International Restless Legs Syndrome Study Group. Mov Disord 1995;10(5):634-42. (PMID:8552117).