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Evaluation of the Results of Polygraphy and Polysomnography Performed at Consecutive Times in the Detection of Obstructive Sleep Apnea: a Retrospective Analysis

Obstrüktif Uyku Apne Tespitinde Ardışık Zamanlarda Gerçekleştirilen Poligrafi ile Polisomnografi Sonuçlarının Retrospektif Olarak Karşılaştırılması

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Abstract

Objective: Polysomnography (PSG) performed at a sleep center is the gold standard for diagnosing sleep apnea syndrome. When PSG cannot be performed due to late appointments or in pandemic conditions, the use of home devices such as polygraphs may be preferred. We aimed to investigate the adequacy and deficiencies of polygraphy (PG) in diagnosing obstructive sleep apnea syndrome in adults who underwent PSG and PG recording at our center.

Materials and Methods: Patients who underwent cardiorespiratory PG and then PSG at the sleep center with suspicion of sleep apnea syndrome were retrospectively analyzed. Apnea Hypopnea Index (AHI) values were compared. There was a total of 34 patients in the study, 10 females and 24 males.

Results: The mean AHI was 38.3±22.1 in PG and 43.5±27.5 in PSG. No statistically significant difference was found in AHI values between the two tests (p=0.065). In both groups, one (2.9%) patient had a normal AHI value. The AHI ratings of the patients on PLG were 4 (11.8%) mild, 8 (23.5%) moderate, and 21 (61.8%) severe, and on PSG, they were 5 (14.7%) mild, 6 (17.6%) moderate, and 22 (64.7%) severe.

Conclusion: In our study, we found similar AHI values in PG used at home and PSG in the sleep center. When sleep apnea syndrome is suspected, if the PSG appointment in the sleep center is long, or the patient cannot sleep in the sleep center due to the occurrence of a pandemic or other reasons, a PG devices used at home may be preferred.

Keywords: Poligraphy (PG), polisomnography (PSG), obstructive sleep apnea syndrome (OSAS)

Öz

Amaç: Uyku apne sendromu tanısında altın standart uyku merkezinde çekilen polisomnografidir (PSG). Uyku merkezi yatış sırasının uzun olması veya pandemi gibi nedenlerle işlemin yapılamadığı zamanlarda kardiyorespiratuvar poligraf (PG) gibi ev cihazlarının kullanımı gündeme gelmektedir. Merkezimizde farklı günlerde PSG ve PG kaydı yapılan erişkin hasta grubunda, obstrüktif uyku apne sendromu tanısını koymada PG'nin yeterlilik ve eksiklerini araştırmayı hedefledik.

Gereç ve Yöntem: Uyku apne sendromu ön tanısıyla önce kardiyorespiratuVar PG sonrasında Uyku Merkezi'nde yatırılarak PSG çekilen hastalar retrospektif olarak tarandı. Apne Hipopne İndeksi (AHİ) değerleri karşılaştırıldı.

Bulgular: Çalışmada 10 kadın, 24 erkek toplam 34 hasta incelendi. PG'de ortalama AHİ 38,3±22,1 iken PSG'de 43,5±27,5 saptandı. İki test arasında elde edilen AHİ değerleri açısından istatistiksel anlamlı fark yoktu (p=0,065). Her iki grupta da 1 (%2,9) hasta normal AHİ değerine sahipti. PG'de hastaların AHİ derecelendirmesi, 4 (%11,8) hafif, 8 (%23,5) orta, 21 (%61,8) ağırken PSG'de, 5 (%14,7) hafif, 6 (%17,6) orta, 22 (%64,7) ağırdı.

Sonuç: Çalışmamızda evde çekilen kardiyorespiratuvar PG ile uyku merkezi ortamında çekilen PSG'de saptanan AHİ değerlerinin benzer olduğunu bulduk. Uyku apne sendromundan şüphelenildiğinde, uyku merkezinde PSG randevusunun uzun olması, pandemi veya başka nedenlerle hastanın uyku merkezinde yatamadığı durumlarda evde kullanılan kardiyorespiratuvar PG cihazı tercih edilebilir.

Anahtar Kelimeler: Poligrafi (PG), polisomnografi (PSG), obstrüktif uyku apne sendromu (OUAS)

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Introduction

Obstructive sleep apnea syndrome (OSAS) is a sleep-related respiratory disorder caused by anatomic narrowing of the upper airways and/or dysfunction of the upper airway muscles, resulting in inadequate ventilation. A study conducted in our country reported an estimated prevalence of OSAS in patients with symptoms of snoring to be between 0.9% and 1.9%.[1] OSAS is often associated with systemic diseases such as hypertension, cardiovascular diseases, and stroke, and makes an adverse cause-and-effect cycle with metabolic disorders.[2] One of the most significant symptoms, excessive daytime sleepiness, leads to many negative outcomes if not diagnosed and treated, including traffic or workplace accidents and impaired quality of life.[3]

The gold standard diagnostic tool for OSAS is polysomnography (PSG). PSG is an electrophysiologic method performed in sleep centers, where patients usually undergo a full-night stay to assess abnormal respiratory events, movement disorders, or paroxysmal events during sleep. It includes electroencephalography (EEG), electrooculography (EOG), electromyography (EMG), electrocardiography (ECG), nasal cannula, thermistor, thoracic and abdominal movement sensors, pulse oximetry, and simultaneous video recording.[4] Another diagnostic tool recommended by the American Academy of Sleep Medicine (AASM) is cardiorespiratory polygraphy (PG).[5,6] PG includes a nasal cannula, a sensor to record respiratory effort, ECG, and pulse oximetry. It does not include EEG, EMG, or EOG recordings, thus sleep stages cannot be scored, and arousal cannot be assessed. It cannot be used to evaluate paroxysmal nocturnal events or sleep-related movement disorders because it lacks video EEG recording. The recording takes place at the patient's home, and the connection is made by the patient or their relative. An important and positive difference from PSG is that it does not require a sleep center stay.

When there is suspicion of OSAS, the diagnostic and treatment process can take a long time due to the limited number of centers capable of performing PSG and the limited number of beds in these centers. Additionally, the affordability of PG and the fact that it does not require a sleep center stay make it a valuable tool in the diagnostic process. During the COVID-19 pandemic, the long closure of elective centers and patients' reluctance to stay in sleep centers facilitated the use of PG.

In studies comparing PG and PSG for OSAS diagnosis, it has been reported that PG had no deficiency in diagnosing OASA when compared with PSG.[7] However, it is suggested that the inability to determine sleep duration in PG may lead to a lower Apnea Hypopnea Index (AHI).[8] On the other hand, in patients with mild OSAS detected using PG, higher AHI values have been reported when PSG was performed.[9]

During the pandemic, PG use became more prominent in some patients referred with a preliminary diagnosis of OSAS to our sleep center. However, according to the regulations of the social security institution in our country, the use of airway-supporting devices for OSAS treatment requires a PSG test result as a condition for reimbursement. As a result, performing PSG in the same patient became mandatory. In this study, we aimed to retrospectively investigate the adequacy and limitations of PG in OSAS diagnosis in an adult patient group where both PSG and PG recordings were performed at our center.

Materials and Methods

Procedure and Patient Selection

Patient data were retrospectively documented for individuals who visited the Sleep Center of Dokuz Eylül University Hospital between September 2020 and May 2022 with a preliminary diagnosis of OSAS, and who underwent PG followed by PSG. In patients with moderate or severe AHI values detected using PG, the social security institution did not accept the PG test for device provision. In patients with normal and mild AHI values, where OSAS symptoms were significant and PG was considered insufficient, a full-night PSG was performed. Patients aged over 18 years who underwent both PG and PSG with PG recordings longer than 3 hours were included in the study. Patients with severe cardiovascular diseases, daytime hypoxemia, or other sleep disorders such as central hypersomnia and parasomnias were excluded from PG use.[5] The following patient data were recorded: age, sex, Body Mass Index (BMI), comorbidities, and Epworth Sleepiness Scale (ESS) results.

Philips Respironics Alice Night One and ResMed AirView (version 4.37.0-2.0.0) cardiorespiratory PG devices were used. PG recordings included a nasal cannula, pulse oximetry, thoracic and abdominal effort sensors, ECG, and body position monitoring. Philips Respironics or ResMed Embla devices were used for PSG. PSG recordings included nasal cannula, pulse oximetry, ECG, thoracic and abdominal effort, body position, 6-channel EEG (F4-M1, C4-M1, O2-M1, F3-M2, C3-M2, O1-M2), 2-channel EOG, submental EMG, and 2-channel tibialis anterior EMG.

For PG, the following criteria were used for diagnosis: a >90% reduction in nasal airflow for apnea, a ≥30% reduction in nasal airflow with a 3% drop in oxygen saturation for hypopnea.[4] In PSG, the criteria for diagnosis were a >90% reduction in nasal airflow for apnea, a ≥30% reduction in nasal airflow with a 3% oxygen saturation decrease or the presence of an arousal for hypopnea.[4]

The method of connecting the PG was demonstrated to the patients, and the device was placed by the patients or their relatives. The recordings were delivered to the physicians the following day. The data were transferred to the computer. PSG recordings were obtained for a full night. PG and PSG evaluations were manually assessed by two physicians with at least 1 year of sleep medicine training (İ.Ş.Ö., C.A.) and at least one experienced sleep medicine physician (İ.Ö.).

AHI data from both PG and PSG results were evaluated. AHI values were classified as follows: <5 normal, 5-14.99 mild, 15-29.99 moderate, and ≥30 severe OSAS.[5] In patients with a general AHI ≥5, if non-supine AHI <5 and supine AHI ≥5, the diagnosis was considered as position-dependent OSAS.[10]

This study has been approved by the Non-interventional Research Ethics Committee of Dokuz Eylül University (approval number: 2023/20-11, date: 14.06.2023).

Statistical Analysis

In statistical analysis, the SPSS version 22 software was used. Normality distributions were evaluated using the Shapiro-Wilk test. Because the PG AHI and PSG AHI values followed a normal distribution, descriptive statistics were presented as mean and standard deviation (±SD). The frequencies of categorical variables were also reported. The role of the results obtained from PSG and PG in the diagnosis of OSAS was evaluated using the McNemar test for two dependent categorical groups. A p-value of <0.05 was considered statistically significant. The differences in AHI values obtained from PSG and PG for two dependent count data groups were analyzed using the paired t-test. AHI values obtained from PSG and PG were visually represented and interpreted using the Bland-Altman plot.

Results

The PG and PSG results of 34 patients were examined. Ten (29.4%) were female, and 24 (70.6%) were male. The mean age was 48.41±13.1 years, and the mean BMI was 30.6±4.6 kg/m^2. The mean Epworth Score was found as 10.3±6.1. Eleven (32.4%) patients had no comorbid diseases, hypertension was present in 11 (32.4%), three (8.8%) had diabetes mellitus, three (8.8%) had myasthenia gravis, two (5.9%) had hyperlipidemia, one (2.9%) had chronic inflammatory demyelinating polyneuropathy, one (2.9%) had hyperthyroidism, and one (2.9%) had epilepsy.

In both groups, one (2.9%) patient had a normal AHI value. In PG, the AHI classification of the patients was as follows: mild (n=4, 11.8%), moderate (n=8, 23.5%), and severe (n=21, 61.8%). In PSG, five (14.7%) were mild, six (17.6%) were moderate, and 22 (64.7%) were severe. The mean AHI in PG was 38.3±22.1, and in PSG, it was 43.5±27.5. There was no statistically significant difference between the AHI values obtained from the two tests (p=0.065). PG and PSG AHI results were evaluated using Bland-Altman plots, comparing the difference between AHI values and their averages. Upon examining the plot, most values were observed to fall within the confidence interval (1.96*mean ± SD) (Figure 1).

When comparing patients with mild OSAS with those with moderate and severe OSAS, no statistically significant difference was observed (p=0.052). Positional sleep apnea was detected in five patients using PG and in two patients using PSG, but this difference was not statistically significant (p=0.276).

During the recording period, the percentage of time with oxygen saturation below 90% was 19.41±16.8% in PG and 16.05±19.9% in PSG. There was no statistically significant difference between the groups (p=0.24). The results are summarized in Table 1.

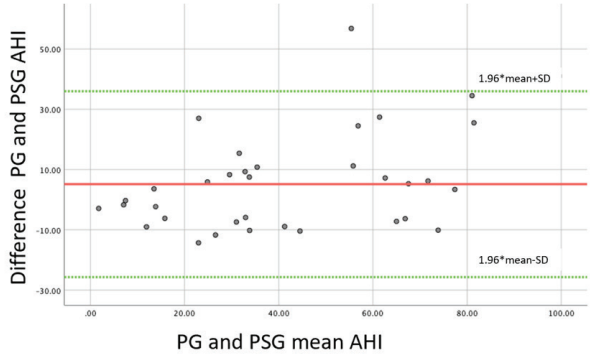

Figure 1. Bland-Altman graph comparing PSG-PLG AHI difference and AHI means
PSG: Polisomnography, PLG: Poligraphy, AHI: Apnea Hypopnea Index, SD: Standard deviation

Table 1. Comparison of polygraphy and polysomnography results

	Polygraph	Polysomnograhy	p
Total recording duration (min.)	413.93±98.2	444.62±40.6	0.096
Sleep time (min.)	413.93±98.2 (supposed)	428.14±39.6	
OSAS	33 (97.1%)	33 (97.1%)	
Positional OSAS n (%)	5 (14.7%)	2 (5.9%)	0.276
AHI/hour	38.37±22.1	43.52±27.5	0.065
AHI 0-4.99/hour n (%)	1 (2.9%)	1 (2.9%)	
AHI 5-14.99/hour n (%)	4 (11.8%)	5 (14.7%)	
AHI 15-29.99/hour n (%)	8 (23.5%)	6 (17.6%)	
AHI ≥30/hour n (%)	21 (61.8%)	22 (64.7%)	
Mean SpO_2 (%)	92.47±2.2	92.20±3.8	0.696
SpO_2<90 sleep percentage	19.41±16.8	16.05±19.9	0.24
Average pulse	70.52±15	68.35±10.8	0.49

p<0.05, min.: Minimum, AHI: Apne Hypopnea Index, OSAS: Obstructive sleep apnea syndrome, SpO_2: Oxygen saturation

Discussion

Although patients frequently present with symptoms such as snoring, breathing pauses during sleep, and excessive daytime sleepiness, the limited number of sleep laboratories and bed availability make it necessary to use PG to reduce the patient load waiting for PSG. During the pandemic, the use of PG became even more widespread because many centers were closed, and patients preferred not to stay in sleep laboratories for diagnosis. Sleep laboratory admission is always more costly and may require patients to sleep in an unfamiliar and less comfortable environment, potentially affecting sleep quality and efficiency. In contrast, PG allows patients to sleep in their home environment.

The use of PG in OSAS diagnosis is recommended by the AASM.[5,6] However, if non-obstructive sleep-related breathing disorders are suspected-such as central apnea, hypoventilation, sleep-related hypoxemia due to severe cardiopulmonary disease, neuromuscular disease causing respiratory muscle weakness, a history of stroke, chronic opioid use, central hypersomnolence, parasomnias, or sleep-related movement disorders-PSG is recommended instead of PG.[5] In our study, there were no patients with severe cardiopulmonary disease, wake-time hypoventilation, sleep-related hypoxemia, or central hypersomnolence/parasomnia history. In the three patients with myasthenia gravis, no hypoxemia or hypoventilation was detected.

Several studies comparing PG and PSG in the diagnosis and treatment of OSAS have demonstrated that PG is a viable option for diagnostic and therapeutic use.[7,8,11,12] Our study showed no significant difference in AHI values between home-based cardiorespiratory PG and PSG conducted in a sleep laboratory (p=0.065). A previous study where both PSG and PG were conducted on the same night reported that PG tended to classify mild sleep apnea as more severe and severe sleep apnea as less severe, although the average AHI values remained similar.[13] However, in our study, the number of patients with moderate and severe AHI values was similar between the two groups. No difference was observed between PG and PSG in identifying the presence of OSAS, its severity, or positional dependence.

Study Limitations

Despite its advantages, PG has certain limitations. When patients use PG at home, issues such as improper electrode placement or nasal cannula displacement during the night are not uncommon. An optimal PG recording duration of at least 3 hours is recommended. Generally, AHI values obtained from PG tend to be lower than those from PSG because PG cannot determine exact sleep onset times, leading to an overestimation of total sleep duration. Additionally, PG cannot detect arousal-related hypopneas, which can be identified in PSG. Nerfeldt et al.[9] examined patients with a high clinical suspicion of sleep apnea but normal PG results and found that 64% of these patients had moderate or severe AHI values when assessed using PSG. The inability of PG to detect arousal-related hypopneas was suggested as the reason for this discrepancy. In our study, only one patient had a normal PG result but was diagnosed as having OSAS using PSG.

One major limitation of our study is that PG and PSG were not performed on the same night. Changes in sleep position and deep sleep duration on different nights could affect the results. Additionally, when PSG is conducted after a prior PG recording, the first-night effect may be reduced, even if the initial test was performed using PG. These factors could contribute to variations in AHI values. However, despite these limitations, no significant difference was found between the PG and PSG groups in diagnosing positional OSAS.

Conclusion

In conclusion, when OSAS is suspected, and sleep laboratory admission is delayed due to long waiting times, pandemic conditions, or other reasons preventing in-laboratory sleep studies, home-based cardiorespiratory PG can be used for OSAS diagnosis, considering its limitations.

Ethics

Ethics Committee Approval: This study has been approved by the Non-Interventional Research Ethics Committee of Dokuz Eylül University (approval number: 2023/20-11, date: 14.06.2023).

Informed Consent: Since this was a retrospective study, patient consent was not required.

Footnotes

Authorship Contributions

Concept: İ.Ö., Design: İ.Ö., Data Collection or Processing: İ.Ş.Ö., C.A., Analysis or Interpretation: İ.Ş.Ö., D.M.D., İ.Ö., B.B., Literature Search: İ.Ş.Ö., D.M.D., Writing: İ.Ş.Ö., D.M.D., İ.Ö.

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