A Comparative Study of Two-Hour Daytime and Overnight Polysomnography in High Risk Snorers

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Objective: *To compare two-hour daytime polysomnography (DPSG) and overnight polysomnography (ONPSG) (as the gold standard) in screening for high risk snorers.*
Study design: *Descriptive study (Diagnostic test).*
Setting: *Snoring Clinic, Phramongkutklao Hospital.*
Material and Method: *The present study was carried out among patients attending the Snoring clinic at Phramongkutklao hospital from September 2005 to February 2006 who had high risk of sleep apnea (pre-test) and scheduled for overnight PSG. Additionally, subjects were willing to take a two-hour daytime polysomnography. Both tests were performed less than two months apart. Each case was assessed using the Epworth Sleepiness Scale (ESS) $\geq$ 8/24 and/or BMI $\geq$ 27.5 kg/sqm as criferia to define as high risk snorer. After performing polysomnography, the subjects were categorized as high risk obstructive sleep apnea syndrome (OSAS, AHI $\geq$ 20/hour) and low risk OSAS (AHI < 20/hour). Regarding snoring sound, subjects were divided into three groups: mild, moderate and severe.*
Results: *Fifty subjects, 33 males and 17 females, were enrolled in the present study. Two males were excluded due to a daytime PSG recording less than two hours. The mean age was 48.3 $\pm$ 10.64 years (22-65), mean BMI was 27.69 $\pm$ 3.95 kg/sqm (22.5-36.9) and ESS 10.56 $\pm$ 2.25/24. The mean AI and AHI for daytime PSG vs. overnight PSG were 24.31 $\pm$ 21.36, 28.30 $\pm$ 21.44 vs. 22.39 $\pm$ 20.43 and 25.30 $\pm$ 20.91 respectively. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of daytime PSG compared with overnight PSG were 92%, 91.3%, 92% and 91.3% respectively. The agreement of snoring during day and night (K-value) was 0.716 $\pm$ 0.1 (p = 0.03).*
Conclusion: *Sleep parameters (AI, AHI) for daytime PSG had high sensitivity, specificity, PPV and NPV compared with standard overnight PSG. These can be used as reliable screening tests for high risk snorers and also be used to assess the outcome of OSAS patients undergoing surgical intervention.*

Keywords: *Daytime PSG, Snoring intensity, Overnight PSG, Midazolam, Sleep disorder breathing, Obstructive sleep apnea*

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Sleep disorder breathing (SDB) is one of the most common health problems affecting two percent of females and four percent of males[1]. It is a disease of severity in continuum; mild form as snoring and severe form as obstructive sleep apnea (OSA). Severe form of SDB as sleep apnea leads to short term neurobehavioral consequences such as daytime sleepiness, impaired work performance, disturbed partner sleep at night[2] and long term cardiovascular complications including hypertension, cardiac arrest, arrhythmia, myocardial infarction and cerebrovascular complications[3,4]. It is imperative to differentiate simple snorers from people with sleep apnea or high risk snorer before treatment. Polysomnography is accepted as the gold standard for diagnosis.

The challenges in diagnosing PSG involve high costs, much time consumption, long waiting periods and limited resources (trained score readers, expensive equipment) and impede high risk groups of patients from access to polysomnography. Many procedures have been introduced to screen people with SDB before undergoing polysomnography for definite diagnosis such as the Epworth Sleepiness Scale (ESS), sonography, Snap Test, pulse oxymetry, actigraphy, home monitoring of PSG or nap/daytime polysomnography. A few studies have investigated daytime polysomnogram (DPSG) or nap PSG. Saeed et al (2000) retrospectively studied 143 children with overnight PSG and one-hour nap PSG and found no individual nap study had good sensitivity in predicting

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abnormal overnight PSG, but had good specificity and positive predictive value[5]. While Van Keimpema et al also compared one-hour DPSG with ONPSG, revealing a sensitivity of 66%, specificity of 88%, positive predictive value of 70%, negative predictive value of 86% and concluded that one-hour PSG was not sufficient to diagnose or exclude SAS with certainty[6]. Suzuki et al demonstrated that two-hour nap PSG were not different among groups[7]. Mizuma et al compared two-hour DPSG with overnight PSG (ONPSG) and found no significant differences between apnea index and SaO_2. A positive correlation was found between DPSG and ONPSG, so DPSG was useful not only in diagnosing SAS but also in evaluating the severity[8].

Yoshiko's study also suggested that DPSG was a useful screening tool for SAS[9]. Most previous studies reported the low sensitivity of the daytime polysomnography. One probable factor was the patient did not fall into deep sleep enough during the daytime sleep test. Moreover, the recording time is crucial; an one-hour recording is too short and three hours is too long. A two-hour recording time was appropriate for the present study because the normal sleep cycle is 90 to 120 minutes. The present study also simulated nighttime conditions such as nasal obstruction by cold room temperature and deep sleep induced respiratory muscle relaxation by sleeping pill and Midazolam has such a property. Due to inconclusive data whether daytime PSG was a reliable diagnostic tool for a high risk snorer. So it deserved further study.

Aim of study

The aims of the present study were to compare the sensitivity, specificity, PPV, NPV and likelihood ratio of DPSG and ONPSG in high risk snorers by screening test and evaluate the agreement between daytime and overnight snoring intensity rating.

Research design

The present study employed a descriptive design (diagnostic test).

Operative definition

Overnight PSG was a conventional PSG performed overnight. Daytime PSG was a polysomnography performed in daytime during 1,000-1,700 and recorded PSG at least 2 hours for each patient. Room environment provided for all sleep test was the room temperature which was set at 25°C and keep the room as quiet and dark as night time environment. High risk group before polysomnography (before test) was a patient who has Epworth sleepiness scale 8 or more of 24[12]. High risk group after polysomnography (post test) was a patient who has apnea hypopnea index (AHI $\geq$ 20 /hour).

There are 3 reasons to define 20 /hour as cut off point for high or low risk group.

1) Patient who had AHI 20 or more per hour had 9 times mortality rate higher than those who had AHI less than 20/hour[10].

2) Criteria for surgical intervention (UPPP) allow for a patient only who less than 20/hour (Riley-Powell-Stanford Surgical Protocol)[11].

3) Successful criteria for surgical intervention is defined as AHI less than 20/hour or AHI decrease 50% before surgery[11].

Snoring intensity (loudness) was rated by 3 trained score raters and categorized in 3 groups.

Mild was defined as in bed annoyance (~ 25 dB).

Moderate was defined as open door annoyance (~26-55dB).

Severe was defined as close door annoyance (~ >55dB).

Research methodology

Patient selection was comprised of a consecutive sample of snorers who were high risk for sleep apnea syndrome undergoing or scheduled for overnight PSG within two months. The target population included snorers with symptoms related to sleep disorder breathing. The present study population was comprised of all snorers attending the Snoring Clinic, Phramongkutklao Hospital, scheduled for ONPSG, who volunteered to take a DPSG and who met the following criteria:

Inclusion criteria

The high risk snorers aged 19-65 years, both gender who signed informed consent and cooperated with study protocols.

Exclusion criteria

The patient who had unstable medical condition such as congestive heart failure or chronic cough interfering with polysomnography, Epworth Sleepiness Scale score less than 8 of 24 (less likely to have sleep apnea)[12] history of anaphylaxis, sensitivity or tolerance to sedative agents, structural abnormality in the nasal cavity such as severe nasal deviation, nasal polyp and sinusitis and subjects undergoing ONPSG more than two months.

Intervention

All eligible patients scheduled for overnight PSG were enrolled in the present study and signed informed consent forms and completed sleep questionnaires. Patients undergoing overnight PSG within two months were asked to revisit to perform a daytime PSG. Daytime PSG was performed in the same room and same conditions as overnight PSG. Patients were induced to sleep during daytime with 1 tablet Midazolam (15 mg) taken orally. After the patient fell asleep, PSG was recorded for two hours and average snoring intensity (loudness) was rated.

Statistical analysis

All data was analysed by SPSS program version 10.5. Baseline characteristics including age, gender, Epworth sleepiness scale, comorbid conditions were presented as percentage and mean $\pm$ SD. The main outcome was analysed and reported in terms of sensitivity, specificity, positive predictive value, negative predictive value, accuracy and likelihood ratio. Degree of agreement was reported as kappa value. A p-value of < 0.05 was considered significant.

Results

Fifty patients, undergoing DPSG and ONPSG from September 2005 to February 2006 attending the Snoring clinic, Phramongkutklao Hospital were enrolled in the present study. Two male cases were excluded due to an inadequate recorded time (less than two hours). Average age of patients was 48.3 $\pm$ 10.64 years (range, 26 to 65 years), 31 males (68.9%) and 17 females (31.1%), mean $\pm$ SD of body mass index and Epworth Sleepiness Scale Scores were 27.69 $\pm$ 3.95 (22.5 to 36.9) and10.56 $\pm$ 2.25 (8 to 16 of 24), respectively as shown in Table 1. Forty of forty-eight patients (83.3%) had nasal symptoms, 20/48 (41.7%) had mild, 14/48 (29.1%) had moderate and 6/48 (12.5%) had severe nasal symptoms. Thirty-four of forty-eight patients (71%) had hypertension and 18/48 (38%) had diabetes mellitus. The mean ($\pm$ SD) apnea index, (AI) for DPSG and ONPSG were 24.31/hour ($\pm$ 21.36) and 22.39/hour ($\pm$ 20.43), respectively. Apnea and hypopnea index (AHI) for DPSG and ONPSG were 28.30/hour ($\pm$ 21.44) and 25.30/hour ($\pm$ 20.91) respectively. Difference in AHI between the DPSG and ONPSG for each individual patient is illustrated in Fig. 1. AHI of ONPSG recording and was depicted as an black bar. A white bar indicated as a AHI of DPSG. Statistical analysis of the two AI and AHI measurements demonstrated a good agreement with Pearson correlation of 0.87 and 0.86, respectively. Comparing apnea index and hypopnea and apnea hypopnea index between DPSG and ONPSG was no significant difference between the groups was found (as shown in Table 2). Categorizing AHI as high risk (AHI $\geq$ 20/hour) and low risk groups (AHI $<$ 20/hour) (Table 3) revealed that the correlation of DPSG and ONPSG was also high, Kappa = 0.875. The results indicated a sensitivity = 0.92, specificity = 0.91, positive predictive value = 0.92, negative predictive value = 0.91, 95% CI for sensitivity was 0.92 $\pm$ 0.11, 95% CI for specificity was 0.91 $\pm$ 0.12, accuracy was 0.80 and likelihood ratio was 10.2.

Regarding snore score

Daytime snoring was over estimated at 2/48 (4.17%) compared with overnight snoring results and daytime snoring results were under estimated at 5/48 (10.42%). The rest, comprising 41/48 (85.42%) were

Table 1. Demographic data BMI & ESS of patients

	Minimum	Maximum	Mean $\pm$ Std. Deviation
AGE	26.00	65.00	48.30 $\pm$ 10.64
BMI	22.49	36.91	27.87 $\pm$ 3.96
ESS	8.00	16.00	10.56 $\pm$ 2.25

BMI = Body Mass Index, ESS = Epworth Sleepiness Scale Score

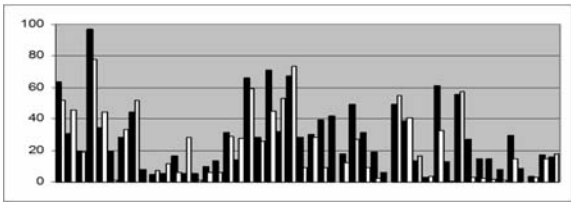

Fig. 1 Result of AHI between ONPSG and DPSG. Black and white bar represented AHI of ONPSG and DPSG respectively

Table 2. Shown mean $\pm$ SD of AI, AHI of DPSG and ONPSG

	DPSG (events/hr)	ONPSG (events/hr)	Significant
AI	24.31 $\pm$ 21.36	22.39 $\pm$ 20.43	p = 0.22
HI	3.99 $\pm$ 4.69	2.99 $\pm$ 4.37	p = 0.26
AHI	28.30 $\pm$ 21.44	25.30 $\pm$ 20.91	p = 0.07

Data were presented as mean $\pm$ SD, AT = apnea index, HI = hypopnea index, AHI = apnea hypopnea index

graded at corresponding results as shown in Table 4. The measurement of agreement (Kappa) was 0.716 ± 0.1 (p = 0.03) indicating a good correlation between daytime and over night snoring results.

Discussion

The ONPSG is accepted as gold standard to detect patient with sleep apnea. It is an expensive, limit resource and time consuming procedure. SDB is one of the common health problems leading to cardiovascular and neurobehavioral consequence. It is imperative to diagnose and treat properly. To screen or to assess the outcome of surgical intervention such as tongue base surgery or maxillo-mandibular advancement, repeating ONPSG could burden patient expenses and create a lengthy waiting list. The alternative sleep test must be considered.

DPSG has many advantages over other alternative sleep tests such as the SNAP test, pulse oximetry, Sonography, MESAM and ambulatory PSG (limited channel PSG); Firstly, it is recorded by full scale PSG under close monitoring. Secondly, it adds more value of PSG by daytime usage and lastly it is a only a two hour recording.

The one hour PSG as the present study of Saeed et al[5] and Van Keimpema et al[6] demonstrated insufficient to diagnose or exclude SAS with certainty. The present study found that two hour DPSG had high sensitivity and specificity corresponding to other studies such as Sergi et al who showed no difference in AHI and mean oxygen saturation between ONPSG and DPSG. The sensitivity was 91% and specificity was 100%[13]. Urgeijo et al demonstrated the nap PSG was a technique for rapid diagnosis of SAS and found that 70% of DPSG were diagnosed on SAS patients[14]. Suzuki et al had studied two hour nap PSG in long distance drivers compared with ONPSG and found that they were not different between both tests[7]. Regarding other sleep tests such as pulse oximetry, White et al demonstrated that sensitivity and specificity of pulse oximetry in severe OSA patients were higher than other groups[15].

Van Surell et al studied CID 102 in diagnosis OSA (RDI ≥ 5/hour) the sensitivity and specificity were only 73% and 62% respectively but positive predictive value of CID 102 was 94%[16]. Zucconi et al compared alternative method as microdigitrappers and found that sensitivity and specificity were 91% and 94% respectively, but the device could not predict the severity of OSA precisely enough[17].

Liesching et al evaluated the accuracy of SNAP compared with conventional PSG and found that overall agreement with K-value of 0.23 (p = 0.008) which suggest that SNAP studies do not appear to accurately assess severity of OSA[18].

Esnaola, et al demonstrated MESAM (monitor breathing sound, heart rate, arterial oxygen saturation and body position) a portable recording device in identifying obstructive sleep apnea (OSA) as an exclusion test it reached a sensitivity of 98% and specificity of 78%, as a confirmation test the value was 69% and 97% respectively[19].

Meanwhile Koziej et al found that the sensitivity and specificity of MESAM for oxygen desaturation index were 100% and 27%, heart rate variation index 81% and 74%. For intermittent snore index were 92% and 16%. It was a high sensitivity but low specificity diagnostic tool so it is good only as a screening test[20].

Table 3. Cross table of high risk group (AHI ≥ 20) and low risk group (AHI < 20)

DPSG	AHI ONPSG		Total
	AHI ≥ 20	AHI < 20	
AHI ≥ 20	23 (92%)	2 (8.7%)	25
AHI < 20	2 (8%)	21 (91.3%)	23
Total	25	23	48

Table 4. Cross table showed grading of snore between daytime and night time (1 = mild, 2 = moderate, 3 = severe)

Daytime snore		Overnight snore			Total
		Mild	Moderate	Severe	
Mild	Count	17 (35.4%)	5 (10.4%)	0 (0.0%)	22 (45.8%)
Moderate	Count	2 (4.2%)	23 (47.9%)	0 (0.0%)	25 (52.1%)
Severe	Count	0 (0.0%)	0 (0.0%)	1 (2.1%)	1 (2.1%)
Total	Count % of Total	19 (39.6%)	28 (58.3%)	1 (2.1%)	48 (100.0%)

There were a few limitations of the present study such as midazolam used in the present study for inducing patients to fall sleep in daytime sleep test had some effect on sleep pattern. Dosing depends on patient history of sleeping pill usage. It will be more acceptable to use other sleeping pills without effect on the sleep pattern. Due to limitation of budget, esophageal pressure monitoring was not included to detect respiratory arousal events. So the present study did not report the RDI.

In conclusion, the present study demonstrated that daytime PSG was acceptable as a screening test and also using as assessment tool for outcome of surgical intervention, when compared with standard overnight PSG. Because the sensitivity, specificity, positive predictive value and negative predictive value were high.

Potential conflicts of interest

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การศึกษาเปรียบเทียบตรวจการนอนหลับในเวลากลางวันและกลางคืนในผู้ป่วยที่เสี่ยงสูงต่อภาวะนอนกรนหยุดหายใจ

ประสิทธิ์ มหากิจ

วัตถุประสงค์*: การศึกษานี้เป็นการเปรียบเทียบการตรวจการนอนหลับเวลากลางวันใช้เวลา 2 ชั่วโมง กับการตรวจการนอนหลับเวลากลางคืน ซึ่งเป็นวิธีมาตรฐานที่ใช้ในการวินิจฉัยผู้ป่วยที่มีความเสี่ยงสูง ต่อการเกิดภาวะนอนกรนหยุดหายใจ*

วัสดุและวิธีการ*: การศึกษานี้ทำการศึกษาในผู้ป่วยที่มารับการรักษาที่คลินิกนอนกรน โรงพยาบาลพระมงกุฎเกล้า ตั้งแต่ เดือนกันยายน พ.ศ. 2548 ถึงเดือนกุมภาพันธ์ พ.ศ. 2549 ที่มีความเสี่ยงสูงต่อการเกิดภาวะนอนกรนหยุดหายใจ ซึ่งจำเป็นต้องได้รับการตรวจวินิจฉัยโดยการตรวจการนอนหลับด้วยวิธีมาตรฐานและยินยอมเข้ารับการตรวจการนอนหลับในเวลากลางวันเป็นเวลา 2 ชั่วโมง โดยการตรวจทั้ง 2 ครั้งห่างกันไม่เกิน 2 เดือน ผู้ป่วยจะได้รับการประเมินโดยดูจากค่า Epworth Sleepiness Scale (ESS) ซึ่งต้อง ≥ 8 ใน 24 และ/หรือ มีค่าดัชนีมวลกายมากกว่า 27.5 จึงถือว่าเป็นกลุ่มเสี่ยงที่จะเกิดภาวะนอนกรนหยุดหายใจ หลังการตรวจการนอนหลับ (Ploysomnography) จะแบ่งผู้ป่วยตามผลการตรวจออกเป็น 2 กลุ่ม คือ กลุ่มเสี่ยงต่อการเกิดภาวะแทรกซ้อนสูงโดยใช้เกณฑ์ (AHI ≥ 20/ชั่วโมง) และกลุ่มเสี่ยงต่ำ (AHI < 20/ชั่วโมง) ตามลำดับ สำหรับเสียงกรนจะแบ่งเป็น 3 กลุ่ม คือ 1 = ดังเล็กน้อย, 2 = ดังปานกลาง, 3 = ดังมาก*

ผลการศึกษา*: ผู้ป่วยที่เข้าร่วมโครงการมี 50 ราย เป็นชาย 31 คน หญิง 17 คน มีผู้ป่วยชาย 2 ราย ต้องคัดออกจากการศึกษาเนื่องจากนอนหลับในเวลากลางวันน้อยกว่า 2 ชั่วโมง อายุเฉลี่ย 48.3 ± 10.64 ปี (22-65 ปี) ดัชนีมวลกาย 27.69 ± 3.95 (22.5-36.9) ค่า ESS 10.56 ± 2.25/24 ค่าเฉลี่ยดัชนีการหยุดหายใจ และหายใจแผ่วในเวลากลางคืนเทียบกับค่าเฉลี่ยดัชนีการหยุดหายใจและหายใจแผ่วในเวลากลางวัน (AI, AHI) เท่ากับ 24.31 ± 21.36, 28.30 ± 21.44 กับ 22.39 ± 20.43 และ 25.30 ± 20.91 ตามลำดับ แบ่งกลุ่มเป็นกลุ่มเสี่ยงสูงต่อการเกิดภาวะแทรกซ้อนสูง (AHI ≥ 20/ชั่วโมง) และกลุ่มเสี่ยงต่ำ (AHI < 20/ชั่วโมง) เมื่อเปรียบเทียบการตรวจการนอนหลับเวลากลางคืน พบว่าการตรวจการนอนหลับเวลากลางวันมีความไว ร้อยละ 92 ความจำเพาะร้อยละ 91.3 ค่า Positive predictive value ร้อยละ 92 ค่า Negative predictive value ร้อยละ 91.3 ค่าความสอดคล้องของเสียงกรนในการตรวจเวลากลางวันและกลางคืนพบมีค่า K = 0.716 (p = 0.03)*

สรุป*: จากการศึกษานี้พบว่าการตรวจการนอนหลับเวลากลางวันมีค่าดัชนีการหยุดหายใจและหายใจแผ่วตลอดจนเสียงกรนต่างกันอย่างไม่มีนัยสำคัญทางสถิติและมีความไว และความจำเพาะสูง เมื่อเทียบกับการตรวจการนอนหลับด้วยวิธีมาตรฐานการตรวจการนอนหลับในเวลากลางวัน น่าจะใช้แทนการตรวจการนอนหลับในเวลากลางคืน ในแง่การคัดกรองผู้ป่วยและติดตามผลการผ่าตัดผู้ป่วยนอนกรนหยุดหายใจ*