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Editorial

Sleep Study: PSG *versus* WatchPAT

Everyone sleeps; most of the people spend about one-third of their life in sleep. Sleep is a dynamic process during which the brain is very active. There are recognised stages of sleep, each of which is characterised by a different type of brain-wave activity. Sleep is not just "time out" from daily life. It is active state important for renewing our mental and physical health each day.

Sleep can be divided in two main broad types: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. NREM consists of N_1, N_2 and N_3 sleep stages. When alpha rhythm decreases, N_1 sleep begins, consciousness decreases at the start of N_1 sleep. N_2 sleep stage is characterise by sleep spindles, K complexes and slow wave activity, whereas N_3 stage has delta waves. REM sleep consists of tonic and phasic REM. In REM sleep, electro-encephalogram (EEG) is same as it is in N_1 sleep, also activity is reduced in many muscles, rapid eye movements are seen, and dreams are frequently reported by the patients when awakened from REM sleep.

To record and monitor normal and abnormal physiological activity during sleep, a sleep study is conducted. The various aspects of sleep study include recording of electroencephalogram, electromyogram, electrooculogram, peak airflow, respiratory efforts, snoring, oxygen saturation with pulse oximetry, limb movements, electrocardiograph (ECG), video recording of the whole study, PCO_2 levels.

Majority of patients seen in sleep centres have obstructive sleep apnoea syndrome (OSAS). The gold standard for diagnosis of OSAS remains full-night polysomnography (PSG). Recommended treatment for OSAS is continuous positive airway pressure(PAP)/ bi-level PAP/ surgery.

Polysomnography is a non-invasive, pain-free procedure that usually requires spending a night or two in a sleep laboratory. During a PSG, a sleep technologist records multiple biological functions during sleep, such as brain-wave activity, eye movement, muscle tone, heart rhythm and breathing via electrodes and monitors placed on the head, chest and legs. After an overnight sleep is recorded, data can be tabulated for interpretation of the results and to differentiate various types of sleep disorders. Manually revalidation of PSG raw data is a must, which is a lengthy process because accuracy of auto-analysed data is 60% only.

Other types of studies are full-night PSG, multiple sleep latency test (MSLT), maintenance of wakefulness test (MWT), split-night PSG, screening with portable device. Full-night sleep testing is required for narcolepsy (excessive sleepiness), periodic limb movement disorder, parasomnias, REM sleep behaviour disorder, and nocturnal seizures. Usually sleep study is not routinely required for insomnia and restless legs syndrome, actigraphy to measure sleep-wake cycle.

Waiting time for a patient for PSG test at all Government sleep centres is very long. To overcome the problem of waiting time, a new technique "WatchPAT" for sleep study has been introduced. WatchPAT is the only non-EEG (electroence-phalogram), FDA, USA approved home sleep testing (HST) portable diagnostic device for patients of OSAS,[1] that uses the most innovative technology for precise screening, detection, and follow-up treatment of OSAS and measures "Total Sleep Time" (rather than total recording time) that provides complete sleep architecture. WatchPAT is like a small wrist watch with single button easily unattended operation, only one finger probe, occupying only one arm and have no wires, that allows testing to be done in the comfort of patient's own bedroom; an environment that best reflects the pattern of patient's sleep habits. It is also cost effective, simple for physicians because of automatic analysis, automatic comprehensive reports generated within minutes, high class easy to use viewer, low failure rate (<1%) and no technician involvement throughout the study. WatchPAT is the most clinically validated home sleep test against in-lab PSG. WatchPAT technology avoids contact with the face and head, a major benefit (and large cause of study failure) when compared to other ambulatory devices,[1] whereas in full in-lab PSG; polysomno-graphic recording system including computer, video camera, amplifier, electrodes and application material, pulse oximeter, abdominal and thoracic belts, nasal and oral thermistor / nasal pressure transducer are required.

In a comparison between PSG and WatchPAT; WatchPAT positioned in between >8 parameters of full in-lab PSG and 4-5 parameters of home sleep testing systems on the basis of functionality and simplicity. On the basis of clinical features; full in-lab PSG gives actual sleep, all sleep stages (N_1, N_2, N_3, wake, rapid eye movement); respiratory disturbance index (RDI), apnoea-hyponea index (AHI), oxygen desaturation index (ODI), differentiates between obstructive sleep apnoea and central apnoea, snoring quantitatively and body position. WatchPAT detects wake/sleep, REM/deep/light sleep stages and also differentiates between obstructive sleep apnoea and central apnoea but measures snoring

qualitatively. The accuracy of AHI/RDI is high by WatchPAT compared to full in-lab PSG. The only limitation of WatchPAT is that the PAT-probes are disposable and have cost issues.[1]

In WatchPAT, the finger is used due to its unique physiology. Finger has high vascular density, convenient site for measurement, tremendous blood flow variability (1-100ccm/100g/sec), projects sympathetic activation, that terminates any apnoea episode. The peripheral arterial tone (PAT) signal is equal to pulsatile arterial volume at the finger tip.[1]

Previously, the "WatchPAT™200" (Itamar Medical, Caesarea, Israel), a two-finger, 6-channel unattended home device, and categorised as Level 3 device by the American Academy of Sleep Medicine was used. Recently, modified version of WatchPAT has been introduced, it has same 6 channels, consists of the following: (1) a unified PAT probe, i.e. combined PAT and pulse oximetry, used to detect the PAT signal as well as measures blood oxygen saturation; (2) an embedded actigraph used to determine periods of sleep based on the motion of the wrist; and (3) an external integrated snoring and body position sensor-SBP/RESBP (optional). Another change in the WP200U is the introduction of new sleep disorder parameters, generated by the WatchPAT Central PLUS™ are PAT central apnoea-hypopnea index (pAHIc) and percent of sleep time with cheyne-stroke respiration (%CSR). The new WatchPAT Central PLUS™ enables specific identification of central sleep apnoea (CSA). This new technology can diagnose all patients of OSAS more accurately, particularly patients with cardiovascular diseases. The WatchPAT Central PLUS™ automatically analyse the distinguished central sleep apnoea, including CSR, from obstructive events.

Exclusion criteria for WatchPAT includes age less than 17 years, patients on medications (alpha blockers and short-acting nitrates); the wash out period for such medications was 24 hours for alpha blockers and 3 hours for short-acting nitrates, patients with permanent pacemaker, finger deformity, patients with obesity hypoventilation syndrome, coronary artery disease, REM sleep behaviour disorder, and restless leg syndrome.

On the basis of sleep-wake stages detection, a number of studies have compared WatchPAT to PSG to detect sleep stages.[2-4] Breseler *et al*[3], compared light and deep sleep assessments in patient through WatchPAT and PSG simultaneously and observed that sensitivity, specificity and agreement of the automatic algorithm to identify standard 30 second epochs of light and deep sleep stages were 66%, 89%, 82%, and 65%, 87%, 80% for the training and validation sets, respectively. In another study[4] with a validation set of 30 patients overall sensitivity, specificity, and agreement of the WatchPAT automatic algorithm with PSG to identify standard 30 second epochs of REM sleep were 77.5%, 90%, 88%, respectively. Hedner and colleagues[2], in a multicentre study in normal subjects and patients with OSA, based on an epoch-by-epoch comparison of WatchPAT to standard PSG, observed an overall sensitivity and specificity to be 89% and 69%, respectively. The agreement ranged from 86% in the normal to 86%, 84% and 80% in patients with mild, moderate, and severe OSA, respectively. There was a tight agreement between WatchPAT and PSG in determining sleep efficiency, total sleep time and sleep latency.[2]

In other meta-analysis, it has been observed that respiratory indexes calculated using PAT-based home sleep testing devices (WP100 and WP200) are highly correlated with PSG-calculated scores.[5,6] These validation studies establish the reliability of WatchPAT to provide an accurate, and reproducible diagnosis of OSA. Both PSG and WatchPAT technology use total sleep time to calculate AHI and provide information to aid in the diagnosis of OSA.[2, 5-22] Camilon and colleagues,[6] in their study at the Medical University of South Carolina showed no significant difference between PSG and WatchPAT. They also observed that the sleep indexes has a high degree of correlation between PSG and WatchPAT results.

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