Peripheral Arterial Tonometry based Home Sleep Apnea Testing compared to Home Polysomnography for the diagnosis of obstructive sleep apnea

Protocol:

Background:

Obstructive sleep apnoea (OSA) is the repetitive collapse of the upper airway during sleep and takes the form of either apnoeas (complete obstruction) or hypopnoeas (partial obstruction) leading to sleep fragmentation and/or hypoxaemia. OSA an extremely common condition affecting approximately 1 billion people globally.[1,2] OSA leads to symptoms of tiredness and excessive daytime sleepiness and is associated with increased motor vehicle accidents and adverse health outcomes such as hypertension, cardio and cerebrovascular disease, depression and cognitive decline.[3-7] OSA and its severity are defined by the frequency of obstruction, based on the Apnoea-Hypopnoea Index (AHI), which measures the average number of apnoeas or hypopnoeas per hour of sleep. Additional metrics, such as measures of oxygen desaturation (e.g. oxygen desaturation index [ODI]) are also used to assess OSA severity.

Historically OSA was predominantly diagnosed with laboratory-based polysomnography (PSG). Laboratory PSG is costly and labour intensive and therefore cannot adequately deal with the large burden of OSA in the community. With technological developments there has been a global trend to home-based sleep testing, both with full PSG at home and limited channel home sleep apnoea testing (HSAT) devices, in order reduce the cost and increase the access to OSA diagnosis. There are various types of HSAT which can measure of range of physiological variables overnight to derive an AHI and/or ODI. Most of these directly measure airflow and respiratory effort. An alternative type of HSAT is the WatchPAT™ (Itamar Medical Ltd, Israel) which is based on peripheral arterial tonometry (PAT) as a surrogate marker of autonomic tone.[8] The WatchPAT 300 is registered as a medical device on the Australian Register of Therapeutic Goods (ARTG) with the Therapeutic Goods Administration(TGA). It is a wrist worn device with an oximetry/PAT finger probe and an additional sensor on the sternal notch. It measures a PAT signal, pulse oximetry, heart rate, snoring, body position and chest motion and via a proprietary algorithm derives sleep time and staging, snoring, ODI and AHI. It can also distinguish between obstructive and central sleep apnoea. A potential advantage of the WatchPAT is its ease of use (minimal points of patient contact, therefore minimal patient disturbance) and automatic analysis algorithm, compared to PSG and more labour-intensive forms of HSAT.

WatchPAT has been well validated against laboratory PSG in terms of correlation and agreement, but has more limited validation in terms of clinical diagnostic classification (i.e. how accurately it diagnoses none, mild, moderate and severe OSA).[8,9] More importantly, WatchPAT has minimal validation against Home PSG. Knowledge of WatchPAT performance against Home PSG is of critical importance as it is specifically designed and used as an “out of centre” or home diagnostic device. To date only one study has compared WatchPAT to Home PSG.[10] This study used an earlier generation of device (WatchPAT-100) and although there was good correlation between WatchPAT and Home PSG for AHI, the limits of agreement on Bland-Altman analysis were relatively wide and there was not a systematic comparison of OSA severity classification with respect to mild, moderate and severe OSA. In addition, the study was performed in selected population with Hypertension and Diabetes as a sub-study of a separate cohort study and was not performed in a general sleep clinic population. Therefore, it remains uncertain how well the current WatchPAT-300 device performs in a general sleep clinic population in its intended clinical (home) environment, against simultaneously performed home PSG. A further critical consideration when comparing a new device such as the

WatchPAT to PSG is to take into account interscorer variability. It is well documented that AHI varies according to the individual scorer who marks sleep staging and respiratory events (apnoeas and hypopnoeas). Therefore, the diagnostic accuracy of any automatically analysed device (e.g. WatchPAT) only needs to perform comparatively as well as two separate experienced scorers perform against each other for it to be considered clinically useful.[11]

Study aim:

To assess the diagnostic accuracy of the WatchPAT-300 against Home PSG for the diagnosis of OSA.

Hypothesis:

The WatchPAT-300 will perform adequately compared to Home PSG, with any diagnostic misclassification occurring at a similar rate to interscorer variability for PSG analysis.

Participating Centres:

- Monash Sleep Centre, Monash Health, Melbourne, Victoria, Australia
- Austin Hospital Sleep Centre, Austin Health, Melbourne, Victoria, Australia
- Adelaide Institute of Sleep Health, Flinders Medical Centre, Adelaide, South Australia

Participants:

Inclusion criteria:

- All consecutive patients age ≥ 18 undergoing home PSG for assessment of snoring or suspected OSA. Participants will be offered enrolment into the study and sign consent on the evening of home PSG set up.

Exclusion criteria:

- Investigation for disorders other than OSA
- Inability to consent
- Cognitive or physical impairment which would prevent adequate test performance (lab PSG performed instead)
- < 4 hours sleep time on Home PSG
- < 4 hours adequate airflow or oximetry signal on Home PSG

Study procedures:

- All participants have standard home full PSG montage using Somte PSG (Compumedics™). WatchPAT 300 is simultaneously worn on the opposite finger and wrist to the oximeter probe from the home PSG.
- Time stamping for study commencement at bedtime for both devices

- Both devices removed upon waking and returned to the Sleep Centre the following morning as per standard practice
- Home PSG staged and scored using Compumedics Profusion PSG according to AASM criteria (recommended) by the experienced local academic centre by scorers who participate in recognised QA program (AASM or Qsleep), blinded to WP results. This will be used by the clinical services for patient care.
- All PSG data also transferred securely to Monash Sleep Centre, Monash Health for blinded analysis for 2nd staging and scoring by a single individual scorer
- WatchPAT data uploaded to CloudPAT™ data analysis platform and analysed using autoscoring algorithm

Data collection:

Home PSG and WatchPAT as described above. Parameters to be measured:

- Age, gender, height, weight, BMI, HADS, ESS, ethnicity
- AHI_{Total}, AHI_{supine}, AHI_{REM}, AHI_{NREM}, ODI3%, Heart rate mean during sleep, TST, Sleep efficiency, %REM sleep, %NREM sleep, % sleep time spent < 90%
- Data loss/failed studies

Data Storage:

All the data sets are in electronic form. The electronic copies of collated data will be stored in a single password protected folder on the Monash Health server. This folder will only be accessible by the Research Team. Access to the folder will be overseen by the Chief Investigator. Storage of electronic copies in other electronic locations or personal devices will not be permitted. In the unlikely event that hard copy printouts are required they will be kept secure in a locked filing cabinet in a secure office. Participant data maintained by the Data Manager will be stored in a separate, password protected folder on the Monash Health server. Only the Data Manager will have access to this folder.

Primary analysis:

- 4-way AHI severity classification (none, mild, moderate, severe) comparing WP to Home PSG with raw agreement and Cohen's kappa

Secondary analysis:

- Agreement using Bland-Altman plots for AHI, ODI3%, time spent with SpO2 < 90%, TST, %REM sleep and %NREM sleep
- Sens/spec/PPV/NPV for WP to diagnose OSA at different thresholds (AHI ≥ 10/hr, 15/hr and 20/hr)
- Correlation co-efficient for AHI and ODI3% for WP vs Home PSG
- Near Boundary Double-Labelling of OSA severity classification (method of Van Peet et al, Sleep, 2022)[11,12] – allows assigning of individuals with AHI within a pre-defined boundary zone to 2

different categories of severity (e.g. AHI of 14 = “mild” and “moderate”, AHI of 6 = “mild” and “normal”). Allows for more clinically relevant comparison between Home PSG and WatchPAT when AHI is near standard OSA severity cut-offs

- Comparison of 4-way severity classification for WP to Home PSG, to Interscorer reliability for home PSG (i.e WP to PSG human scoring compared to human scorer 2)

Power calculation:

Based on the 4-way diagnostic severity classification performance of WatchPAT vs Laboratory PSG,[9] we conservatively assume a diagnostic category discordant rate of up to 50%. Therefore, to detect a 10% difference in the prevalence of moderate/severe OSA between WatchPAT and HomePSG, with 80% power and alpha 0.05, required n = 392. Allowing for a dropout/data loss rate of 10% this increases the number of participants required to 431. We therefore plan to recruit n = 450 to cater for any higher than predicted dropout rate.

Dissemination of results:

Results will be available in a peer-reviewed sleep journal.

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