AUTONOMIC CORRELATES OF DAYTIME SLEEPINESS

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Introduction

- While fatigue is mostly diagnosed according to subjective measures, excessive daytime sleepiness can be objectively measured by Multiple Sleep Latency Test (MSLT).
- Fatigue and sleepiness are different behavioral and physiological entities. Preliminary results show no significant correlation between the two.
- Heart Rate Variability (HRV) analysis in the time frequency domain provides a non-invasive tool to estimate autonomic function.
- It is unclear whether ECG derived measures of autonomic tone, based on HRV, reflect levels of daytime sleepiness or arousal.
- We aimed to determine whether ECG derived measures of autonomic function correlate with MSLT derived measures of daytime sleepiness.

Methods

- Subjects were selected from a population-based study on CFS conducted by the Centers for Disease Control (CDC). [1]
- Sleepiness was gauged by MSLT on 208 subjects.
- Patients with extreme sleepiness (MSLT<5) were excluded (57 subjects).
- The remaining subjects were divided into two categories: 5 < MSLT ≤ 10 (sleepy); and MSLT > 10 (not sleepy).
- Whole-night PSG was performed on the nights prior and subsequent to the MSLT. Recordings were screened for ECG signal quality, those below an acceptable threshold were excluded.
- Separate analysis was conducted on results from the first night of testing (N= 136 subjects: 68 sleepy, 68 not sleepy) and the second night (N=138: 71 sleepy, 67 not-sleepy).
- Sleep stages, Respiratory Disturbance Index (RDI) and cortical arousals were detected manually from the PSG according to gold standard criteria to assess sleep quality, architecture and the presence of sleep related breathing disorder..
- The ECG obtained during the PSG was analyzed to yield values of mean RR intervals (RRI), number of autonomic arousals, and spectral parameters of the RRI, namely:
  - VLF (0.008-0.04Hz)- vasomotor and thermoregulation
  - LF (0.04-0.15Hz)- sympathetic and parasympathetic modulation at the sinus node
  - HF (0.15-0.5Hz)- parasympathetic modulation
  - Sympatho vagal balance- LF/HF

  These values were calculated using the HC1000P, a proprietary diagnostic system developed by HypnCore.
- Two tailed t-test was used to determine statistical significance of differences between the groups.

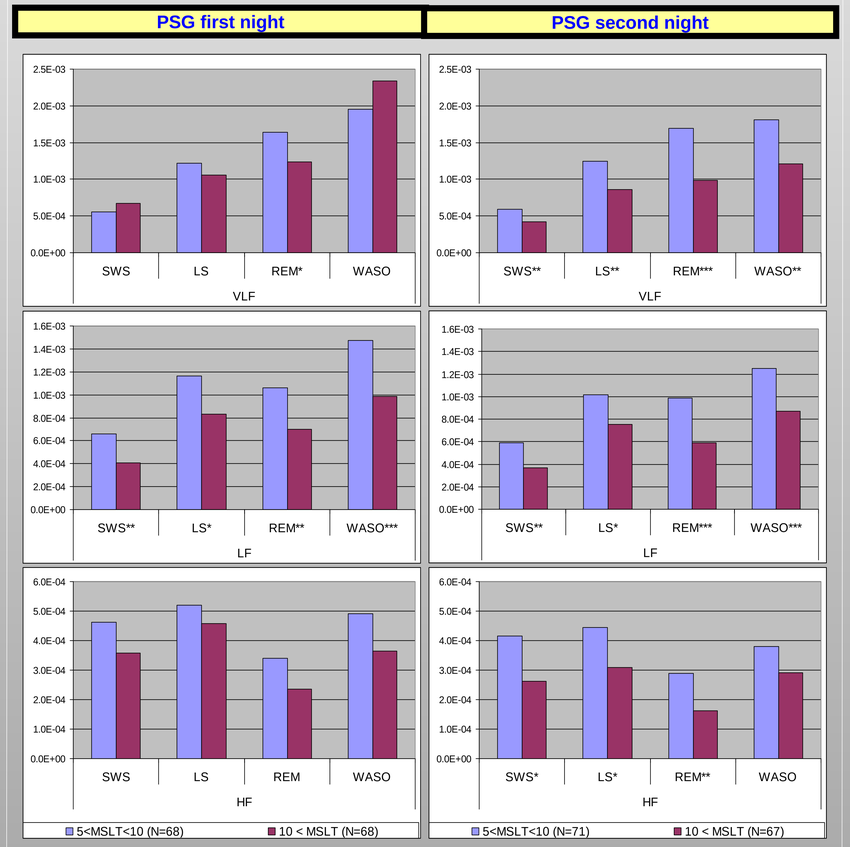

Figure 1: Spectral analysis of HRV calculated from two consecutive night PSG yields three parameters: VLF, LF and HF. Recordings were divided by night of recording and then into low-MSLT (>5 but ≤ 10, sleepy) and high-MSLT (>10, not sleepy) groups. The parameters were averaged by sleep stage: Slow Wave Sleep (SWS), Light Sleep (LS), Rapid-eye movement (REM) and Wake after Sleep Onset (WASO). Student T-Test was performed to assess statistical significance of the differences between the low-MSLT and high-MSLT groups.

Asterisks indicate level of confidence in figure 1 and 2:
*** = P ≤ 0.01 ** = P ≤ 0.05 * = P ≤ 0.1

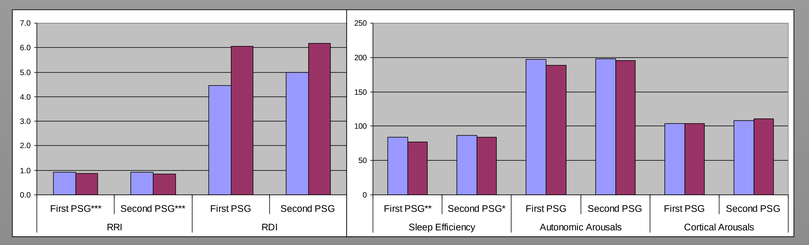

Figure 2: Different parameters of sleep were divided by night of testing, then into low-MSLT and high-MSLT as defined in figure 1, statistical significance was determined by student's T-Test. RR Interval (RRI) is the inverse of the instantaneous heart rate. Respiratory disturbance index (RDI) indicates the density of respiratory events per hour of sleep. Sleep efficiency is the percentage of time spent sleeping out of the total time allowed for sleep. Autonomic and cortical arousals are an indication of changes in sleep fragmentation, either cortical or sub-cortical. Excluding RRI, these measures are indicators of quality of sleep prior to and subsequent to the MSLT.

Results

✓Analysis was performed on PSG of 136 subjects from the first night, and PSG of 138 subjects from the second night of testing (57 subjects with extreme sleepiness (MSLT < 5) were excluded. Individual PSG recordings which did not have sufficient signal quality were also excluded).

✓There were no significant differences in arousals (either cortical or autonomic) or RDI between the low-MSLT (sleepy) group or the high-MSLT (not sleepy) group for both the first and the second PSG.

✓Mean sleep efficiency was significantly higher for the low-MSLT group in both the first PSG and the second (P=0.005 for PSG1 and P=0.07 for PSG2).

✓Mean RRI was significantly higher (lower heart rate) for the low-MSLT group on both nights of testing (for both P=0.001).

✓Mean VLF was significantly higher in the low-MSLT group for all sleep stages on the second night of testing. On the first night only in REM sleep were significant differences observed, again VLF was higher for the low-MSLT group but with a lower degree of confidence.

✓Mean LF was significantly higher in the low-MSLT group in every stage on both nights of testing.

✓Mean HF was higher in the low-MSLT group in every sleep stage but not while awake after sleep onset on the second night of testing. On the first night of testing differences in mean HF were not statistically significant.

✓Differences in mean Autonomic Balance (HF/LF) were not statistically significant for any sleep stage on either night of testing.

Discussion

✓Patients with higher propensity to sleep during the day have also higher sleep efficiency at night, i.e. higher sleep propensity at night.

✓Sleepy patients overcome daytime sleepiness with an increase in sympathetic activity as reflected mainly by higher LF (observed on both nights) and VLF (observed on second night only).

✓These findings suggest that autonomic function plays an important role in maintaining wakefulness/ preventing falling asleep during the daytime.

References:

[1] Reeves WC, Wagner D, Nisenbaum R, Jones JF, Gurbaxani BM, Solomon L, Papanicolaou DA, Unger ER, Vernon SD, Heim C. Chronic fatigue syndrome – a clinically empirical approach to its definition and study. BMC Med 2005, 3:19.