Screening of Track Driver’s Sleep Apnea by Subjective and Objective Measure

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Abstract: Usefulness of subjective sleep quality assessment by a questionnaire (OSA-MA sleep inventory) was examined in ten track drivers (age, 23-62 yr) in reference to the objective measure by cyclic variation of heart rate (CVHR) in electrocardiogram (ECG) during sleep. Total CVHR suggesting moderate-to-severe sleep apnea (average >15 cycles/h) was observed only in one subject and frequent CVHR in a limited time was detected in the same subject and two other subjects. Subjective sleep quality assessed less sleepiness on rising, good initiation and maintenance of sleep, less frequency of dreaming, refreshing feeling, and subjective sleep length as factors 1-5, respectively. The subject with high total CVHR showed factor scores <-1 SD for factors 1, 2, and 3 and reported subjective sleepiness during driving. In the two subjects with frequent CVHR in limited time, one showed factor score <-1 SD for factors 3 and 5, while the other subject did not show score <-1 SD for any of the factors. Although this is preliminary study in a small sample size, it suggests the possible associations between the subjective assessment of sleep quality and the objective measure of CVHR.

Keywords: Sleep apnea, cyclic variation of heart rate, questionnaire, sleep quality

1. INTRODUCTION

Sleep apnea [1-3] is an important cause of traffic accident due to drowsiness during driving [4] and its screening is essential among professional drives. However, since the state of sleep apnea may change day by day depending on the driver's condition, it is ideal to evaluate apnea state every night before the day of driving. For this purpose, a simple and repetitively-measurable method is necessary for screening sleep apnea. We examined the possibilities of a subjective evaluation by questionnaire and an objective evaluation by electrocardiogram (ECG) [5-9] as the method for daily screening for sleep apnea.

2. METHODS

2.1 Subjects

The subjects of this study were 10 healthy workers (age, 42±12 [23-62] yr, 9 male and 1 female) of a transport company. Seven of them were track drivers.

2.2 Protocol

The protocol of this study has been approved by that has been investigated and approved by the Institutional Review Board of Nagoya City University Graduate School of Medical Sciences and Nagoya City University Hospital (No. 60160133). All subjects gave their written informed consent to participate in this study.

On the day of ordinary work, subjects were told about notes on Holter ECG recording and were instructed on how to fill out the questionnaire. After that, they wore Holter ECG electrodes and started working. The ECG was recorded continuously for 24 h. When they drove a car/track during the 24 h, they recorded the time they felt drowsy by pressing the buttons on the remote switch connected to the ECG recorder by Blue Tooth. When they got to sleep during the 24 h, they filled out the questionnaire immediately after getting up.

2.3 Measurements

The 24-h ECG was recorded at 125 Hz with Holter ECG recorder with built-in triaxial acceleration sensors (Cardy 303 pico+, Suzuken Co., Ltd., Nagoya, Japan). This recorder included a remote switch (Cardy Memo, Suzuken Co., Ltd., Nagoya, Japan) for event recording, which was used for recording the times of drowsiness in this study.
Subjective sleep quality was assessed with the Oguri-Shirakawa-Azumi sleep questionnaire MA version (OSA-MA sleep inventory) [10]. OSA-MA is a standardized sleep inventory consisted of 16 items of question with a 4-point Likert scale. It provided 5 factor scores concerning sleep qualities: less sleepiness on rising (factor 1), good initiation and maintenance of sleep (factor 2), less frequency of dreaming (factor 3), refreshing feeling (factor 4), and subjective sleep length (factor 5). The factor scores had been standardized to have average ± SD of 50 ± 10 for the general population [10].

2.4 Data analysis

For each Holter recording, the sleeping period (time in bed) was estimated from the tri-axial acceleration signals indicating that the subject was in a recumbent position. All QRS waves were detected from ECG during the sleeping period and labeled as sinus or ectopic beats or noise with the ECG analyzer (Cardy Analyzer 5, Suzuken Co., Ltd., Nagoya, Japan). Normal-to-normal R-R intervals (NN intervals) were measured as intervals between consecutive QRS waves of sinus rhythm. CVHR was detected by the automated algorithm of auto-correlated wave detection with adaptive threshold (ACAT) [9].

We calculated the frequency of CVHR (Fcv) as the average number of CVHRs (dips meeting the criteria) per hour of time in bed. We used Fcv ≥ 15 that had been determined by a previous study [9] as the criterion for identifying subjects with moderate-to-severe sleep apnea. We also calculated the mean of NN interval (MNN) and their SD (SDNN) for the entire time in bed.

3. RESULTS

3.1 CVHR in sleep time ECG

CVHR and other indices from ECG during time in bed are presented in Table 1. Increased Fcv suggesting moderate-to-severe sleep apnea (average >15 cycles/h) was observed only in one subject (008) and high Fcv in a limited time (Fcv max) was detected in the same subject and two other subjects (003 and 006).

2.4 Subjective sleep quality

Subjective sleep quality assessed by the OSA-MA sleep inventory was presented in Table 2. The subject with increased Fcv (subject 008) showed factor scores < -1 SD for 3 factors and reported subjective sleepiness for 3 times during driving. In the two subjects with high Fcv max, one subject (006) showed factor score < -1 SD for factors 3 and 5, while the other subject (003) did not show score < -1 SD for any of the factors.

4. DISCUSSIONS

We examined the usefulness of subjective sleep quality assessment by a questionnaire (OSA-MA sleep inventory) in reference to the objective measure by CVHR in sleep time ECG. We observed that subject with increased CVHR suggesting moderate-to-severe sleep apnea reported significantly decreased scores (< -2 SD) of subjective sleep quality including sleepiness on rising, poor initiation or maintenance of sleep, and frequent dreaming.

In this study, we used the frequency of CVHR as an objective measure of sleep apnea. In a previous study of 887 consecutive subjects undergone a diagnostic polysomnography, we observed that CVHR measured by...
the ACAT algorithm with cutoff criteria >15/h detected patients with apnea-hypopnea index ≥15 with 83% sensitivity and 88% specificity [9].

Although this is preliminary study in a small sample size, it suggests the possible associations between the subjective assessment of sleep quality and the objective measure of CVHR.

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