



Maintenance of Wakefulness Test scores and driving performance in sleep disorder patients and controls[☆]



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ABSTRACT

Objective: Sleepiness at the wheel is a risk factor for traffic accidents. Past studies have demonstrated the validity of the Maintenance of Wakefulness Test (MWT) scores as a predictor of driving impairment in untreated patients with obstructive sleep apnea syndrome (OSAS), but there is limited information on the validity of the maintenance of wakefulness test by MWT in predicting driving impairment in patients with hypersomnias of central origin (narcolepsy or idiopathic hypersomnia). The aim of this study was to compare the MWT scores with driving performance in sleep disorder patients and controls.

Methods: 19 patients suffering from hypersomnias of central origin (9 narcoleptics and 10 idiopathic hypersomnia), 17 OSAS patients and 14 healthy controls performed a MWT (4 × 40-minute trials) and a 40-minute driving session on a real car driving simulator. Participants were divided into 4 groups defined by their MWT sleep latency scores. The groups were pathological (sleep latency 0–19 min), intermediate (20–33 min), alert (34–40 min) and control (>34 min). The main driving performance outcome was the number of inappropriate line crossings (ILCs) during the 40 minute drive test.

Results: Patients with pathological MWT sleep latency scores (0–19 min) displayed statistically significantly more ILC than patients from the intermediate, alert and control groups ($F(3, 46) = 7.47, p < 0.001$).

Interpretation: Pathological sleep latencies on the MWT predicted driving impairment in patients suffering from hypersomnias of central origin as well as in OSAS patients. MWT is an objective measure of daytime sleepiness that appears to be useful in estimating the driving performance in sleepy patients.

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1. Introduction

Over the last 15 years, major epidemiological studies have highlighted the prevalence of sleepiness and sleep disorders among the general population (Connor et al., 2001a, 2001b; Ohayon et al., 1997; Young et al., 1993). Sleepiness at the wheel has been identified as one of the major causes of highway accidents and fatal crashes

(Blazejewski et al., 2012; Connor et al., 2001a; Hakkanen and Summala, 2000; Philip and Sagaspe, 2011; Philip et al., 2010). Although alcohol and excessive speed are well known risk factors for traffic accidents (Huang and Lai, 2011) and are measured routinely among drivers, the evaluation of sleepiness at the wheel is more complex. Nevertheless, daytime sleepiness is a public health and safety issue that directly affects the patients with sleep disorders, but also the treating physicians, who in many countries are legally liable when permitting untreated sleepy patients to drive a motor vehicle or operate machinery. Thus, it is crucial from both clinical and traffic safety point of view to develop accurate measures of daytime sleepiness that can reliably assess the ability to drive safely.

In a recent study, Drake et al. (2010) showed that objectively measured sleep latencies using the Multiple Sleep Latency Test (MSLT)

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were a significant predictor of crash risk in drivers involved in traffic accidents. This epidemiological study was particularly important because it demonstrated that patients suffering from obstructive sleep apnea syndrome (OSAS) or hypersomnias of central origin have a much higher risk of traffic accidents than drivers free of sleep disorders. Sleepiness at the wheel is a key crash risk factor in these patients (George, 2007; Lloberes et al., 2000; Masa et al., 2000; Pack et al., 2006; Philip et al., 2010; Teran-Santos et al., 1999). Unfortunately, Drake et al. (2010) only used the MSLT scores to analyse the driving risk of sleepy drivers (Philip, 2010).

The MSLT and the Maintenance of Wakefulness Test (MWT) are currently used in sleep medicine for the evaluation of excessive daytime sleepiness. As indicated by the task force of the American Academy of Sleep Medicine (AASM) (Littner et al., 2005), the MSLT is not aimed to estimate the effects of sleepiness in patients facing potentially risky situations (i.e. automobile driving). Contrarily, the MWT which requires patients to fight against sleepiness in a soporific situation is better adapted to evaluate the severity of sleepiness in patients suffering from OSAS or hypersomnias of central origin. It is a robust and validated test measuring the ability to stay awake, suited for multi-centre studies thanks to a high degree of reliability (Wise, 2006).

Experimentally, impaired alertness causes an increase in lateral deviations during simulated (Davenne et al., 2012; George, 2000; George et al., 1996; Haraldsson et al., 1990; Juniper et al., 2000; Lenne et al., 1997; Reynier and Horne, 1998) and real driving (O'Hanlon et al., 1995; O'Hanlon and Volkerts, 1986; Philip et al., 2005; Sagaspe et al., 2007b, 2008). Banks et al. have compared the MWT with performance on a driving simulator in healthy sleep-deprived volunteers (Banks et al., 2005). This was the first evidence of the predictive value of MWT on driving performance. However, only a simplified 2 × 40-minute version of the MWT protocol was applied in this study, in contrast to 4 × 40 minute sessions described in the standard and validated MWT protocol. In our previous studies, we have shown that abnormal sleep latency during the 40-minute MWT (between 0 and 19 min) correlates with impaired driving as measured both on a driving simulator (Sagaspe et al., 2007a) and in real driving conditions (Philip et al., 2008) in untreated patients with OSAS. The study by Pizza et al. (2009) on untreated sleep apneics showed a stronger correlation between simulated driving performance and the ability to maintain wakefulness (MWT), compared with the propensity to fall asleep (MSLT). Previous epidemiological studies (Philip et al., 2010; Powell et al., 2007) have compared the driving risk of patients with hypersomnia with that of OSAS or insomniacs. However, to date there are no experimental studies that compared the efficacy of (4×) 40 minute MWT in predicting driving performances in patients suffering from excessive daytime sleepiness of different origins. For example, excessive daytime sleepiness could be due to a respiratory disorder such as in OSAS or it could be of neurological origin such as in narcolepsy or could have an undetermined origin such as in idiopathic hypersomnia (Bassetti et al., 2005).

The aim of this study was to determine the ability of the MWT in predicting driving performance in various patients suffering of excessive daytime sleepiness (untreated and treated patients suffering from OSAS, narcolepsy and idiopathic hypersomnia) compared to healthy controls.

2. Methods

2.1. Participants

Fifty volunteers participated in this study (Annex 1). Patients affected by sleep disorders (OSAS, narcolepsy and idiopathic hypersomnia) were recruited via the Sleep Clinic of Bordeaux University Hospital: Patients suffering from clinical OSAS and had an AHI > 10 (confirmed

by polysomnographic recordings) before treatment; patients suffering from narcolepsy fulfilled the diagnostic criteria for narcolepsy with or without cataplexy of the International Classification of Sleep Disorders ("American Academy of Sleep Medicine. International Classification of Sleep Disorders. Diagnostic and Coding Manual. 2nd edn. American Academy of Sleep Medicine, Westchester, IL," 2005) and presented with a high degree of pathological objective sleepiness (i.e. short < 8 min mean MSLT sleep latency). Patients suffering from hypersomnias of central origin fulfilled the diagnostic criteria for idiopathic hypersomnia according to A–B–C–D and F criteria of ICSD-2. The E criterion (the prolonged nocturnal sleep time (> 10 h)) was documented by interview and questionnaire ("American Academy of Sleep Medicine. International Classification of Sleep Disorders. Diagnostic and Coding Manual. 2nd edn. American Academy of Sleep Medicine, Westchester, IL," 2005) or presented a symptomatic narcolepsy-like phenotype. Thirteen out of 19 patients with idiopathic hypersomnia or narcolepsy were treated with wake enhancing medications (modafinil) and 9 out of 17 OSAS patients were treated with continuous positive airway pressure (CPAP). Fourteen healthy volunteers (8 men and 6 women, mean age: 32 ± 9.14 years, range: 20–51, BMI: 22 ± 2.97 kg/m²), were recruited via public announcements. Volunteers with pre-existing sleep disorders (diagnosed by clinical interview, polygraphy at home and actigraphy), who were night or shift workers or professional drivers were excluded. All participants had their driving licence.

2.2. Study design

The study lasted one night and one day. For patients, a nocturnal polysomnography to monitor their total sleep time before the objective evaluation of sleepiness with a 4 × 40-minute MWT was performed at the sleep clinic. For healthy volunteers, nocturnal polygraphy (nasal pressure, oximetry, thoracic and abdominal effort, ECG) was performed at home. The day after, the MWT test was performed at the laboratory. Subjective sleepiness was assessed using the Epworth Sleepiness Scale (ESS). For all participants, a 40-minute driving session on a real car driving simulator (Fig. 1) replicating a monotonous driving scenario was performed at 15:00 at the laboratory.

The local ethics committee (consultative committee for the protection of persons participating in biomedical research [CPP Bordeaux]) approved the study. Healthy volunteers were paid and

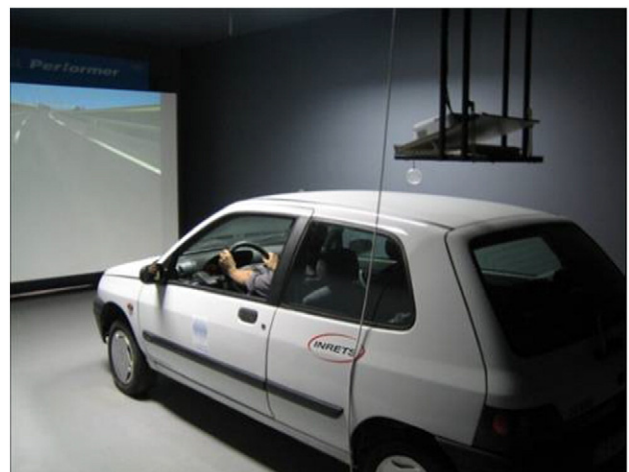


Fig. 1. Photography of the driving simulator.

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