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Daytime Alertness in Patients with Chronic Insomnia Compared with Asymptomatic Control Subjects

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Summary: Despite the subjective reports of patients with difficulty initiating and maintaining sleep (DIMS) that they are impaired during the day, consistent differences in daytime functions have not been found between normal sleepers and patients with insomnia. The present study compares polysomnography and Multiple Sleep Latency Test (MSLT) data from 70 clinic patients seeking evaluation for chronic insomnia with data from a group of 45 asymptomatic sleepers. The DIMS group was found to sleep significantly less than the control group; yet they were also significantly more alert than the control group the following day, as measured by MSLT. Within the insomnia diagnostic subgroups, a correlation of -0.67 ($p < 0.05$) was found between nocturnal total sleep time and mean MSLT. The results are interpreted as supporting the existence of a tendency towards physiological hyperarousal in patients with chronic insomnia. This tendency may be exacerbated by other factors (e.g., personality disorder, periodic leg movements) also associated with insomnia. **Key Words:** Chronic insomnia—Daytime sleepiness—Multiple Sleep Latency Test.

People who complain of difficulty initiating and maintaining sleep (DIMS) at night often also complain of being impaired in their ability to function during the day (1). However, objective measures of daytime functioning, such as performance testing and the Multiple Sleep Latency Test (MSLT), have failed to find consistent differences between patients with insomnia and normal sleepers.

Seidel et al. (2) combined data from studies of hypnotic efficacy in subjects with chronic insomnia to form a pooled group of 138 insomniac subjects. A comparison group of 89 asymptomatic sleepers was formed in the same way. There were no significant differences between groups on the MSLT or on card-sorting tasks. In fact, the authors report that 14% of the DIMS group did not fall asleep on any of the MSLT naps and hypothesize that a subset of DIMS subjects may respond abnormally to sleep loss.

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That is, DIMS subjects do not show the characteristic decline in daytime sleep latency seen in normal subjects following sleep loss (3).

A study of 10 DIMS subjects by Mendelson et al. (4) also failed to find significant differences in daytime alertness compared with normal sleepers. The MSLT and performance testing did not discriminate DIMS subjects and normal subjects, but total sleep time (TST) also did not differ significantly between groups. The only objective measure to show significant daytime impairment in DIMS subjects was a measure of semantic memory. Subjects with insomnia were less able to retrieve items from long-term memory than were normal sleepers, although the groups did not differ in their ability to learn new material.

Two other studies have measured daytime sleepiness with the MSLT in DIMS patients (5,6). Both studies found that DIMS patients were not significantly different from normal control subjects.

The four studies cited above are the only attempts to compare DIMS patients with normal control subjects using the MSLT. Methodological limitations prevent these studies from being definitive. First, three of the studies rely on a sample of 15 subjects or less in each group (4–6). Because of the high heterogeneity among patients complaining of insomnia, large samples are needed to accurately characterize this group. The one study with a large sample evaluated subjects who had been recruited for drug trials, rather than patients referred for clinical evaluation. A recent report comparing two groups of individuals complaining of insomnia, one selected from newspaper advertisements for research and another seeking clinical evaluation and treatment, found significant differences between the groups (7). It is important to note that the major difference between these groups was in their daytime function rather than the quality or quantity of their sleep. Specifically, significant differences were found in daytime functioning as measured by the Minnesota Multiphasic Personality Inventory (MMPI). There are two important implications of these findings: (a) that populations of subjects with insomnia selected with different methodologies may have distinct characteristics, and (b) that clinic patients with DIMS may have greater daytime impairment than those in other DIMS groups. Other measures of daytime functioning (e.g., MSLT) in clinic subjects with DIMS may also differ from research subjects with DIMS. The present study was undertaken to test for differences in daytime alertness between a large group of individuals complaining of insomnia seeking evaluation, and asymptomatic control subjects.

METHODS

Subjects

Seventy consecutive patients referred to the Henry Ford Hospital Sleep Disorders Center for evaluation of chronic insomnia were studied. There were 37 male and 33 female patients with a combined mean age of 46.7 ($\pm$ 13.8). Diagnoses according to the Association of Sleep Disorders Centers (ASDC) criteria (8) for these patients are presented in Table 1. Diagnoses were made on the basis of clinical history and clinical polysomnographic (CPSG) data and the final decision was the consensus of two clinical polysomnographers who reviewed each case. The only patients excluded from this study were those on whom an MSLT was not performed because their medication regimens would have precluded interpretation of the results (n = 6).

A control group of 45 asymptomatic sleepers was recruited from newspaper adver-

TABLE 1. *Diagnoses of DIMS patients*

Category	Number
Psychiatric: affective disorders	15
Persistent psychophysiological insomnia	11
No objective findings	11
Psychiatric: anxiety and personality disorders	7
DIMS: not otherwise specified	7
Medical, toxic, and environmental	5
Periodic leg movements	4
Restless legs syndrome	3
Chronic alcoholism	1
Sleep apnea DIMS syndrome	1
REM sleep interruption insomnia	1
Atypical polysomnographic features	1
Short sleeper	1
Circadian rhythm disorder: phase-delay syndrome	1
Circadian rhythm disorder: irregular sleep–wake pattern	1

DIMS, difficulty initiating and maintaining sleep.

tisements. This group was composed of 31 male and 14 female subjects with a mean age of 50.4 (±10.7). Sleep histories and medical histories were obtained for both groups.

Procedure

Individuals from both groups received a CPSG, followed the next day by an MSLT. The CPSG consisted of two electroencephalographic (EEG) channels (C3/A2 and OZ/A2); two electro-oculograms (EOG), right and left orbits; and chin and both leg electromyograms (EMG). Respiration was also recorded by use of a nasal/oral thermistor. Subjects were allowed to go to sleep at their usual time and remain in bed for 8 h, during which time they were continuously recorded. Sleep stages were subsequently scored according to standard criteria (9). On the day following the nighttime recording, a daytime measurement of sleepiness, the MSLT, was administered. The MSLT protocol allowed four 20-min opportunities to fall asleep. The four naps were scheduled at 1000, 1200, 1400, and 1600 h. During the MSLTs, all subjects, while lying in bed in a darkened room, were asked to close their eyes, relax, and try to fall asleep. While given the opportunity to nap, they were recorded polygraphically by EEG (C3 and OZ), chin EMG, and EOG, using standard placements (6). All of the sleep latency tests (SLTs) were terminated 15 min after the first epoch of any sleep stage, or after 20 min without sleep. Sleep latency was the time from lights-out to the first epoch of any sleep stage, or was scored as 20 if no sleep occurred. Subjects were not allowed any caffeinated beverages on the day of the MSLT.

RESULTS

Independent groups *t* tests (two-tailed) were used to test for statistical significance between means of the two groups. Equivalence of the variances was tested before using the *t* test, and a nonparametric median test was used if the variances were significantly different. To control for effects of multiple comparisons, a p value <0.025 was the criterion used to test for statistical significance.

While the control group was matched to the DIMS group, it was not matched for sex, since this was not anticipated to influence the variables under study. As a check of this

TABLE 2. *Mean total sleep times and MSLT scores according to sex*

	DIMS		Normal	
	Male	Female	Male	Female
TST (min)	366.5	362.0	415.5	427.5
SD	124.7	85.6	43.2	30.1
MSLT	14.2	15.2	12.2	12.4
SD	4.4	3.9	4.7	4.3

MSLT, Multiple Sleep Latency Test; DIMS, difficulty initiating and maintaining sleep; TST, total sleep time.

assumption, *t* tests were performed comparing male with female subjects on TST and MSLT scores for each group. There were no significant differences; indeed, the means were nearly identical (Table 2).

Sleep parameters

The normal group slept 7 h, which was significantly longer than the 6 h of sleep averaged by the DIMS group (Table 3). Latency to stage 2 sleep was significantly longer for the DIMS group than for the normal group, 44.2 min compared with 19.9 min. Wake during sleep (WDS) was significantly elevated at 95.7 min for DIMS patients compared with 38.3 min for the normal group. Sleep stage percentages did not differ significantly.

Daytime sleepiness

The average latency on the MSLT in the DIMS group was 14.7 min, and this was significantly longer than for the normal group at 12.2 min (Fig. 1). Eight DIMS subjects (11.5%) did fall asleep on any of the four maps, while only one normal subject (2%) did the same. Although the sample sizes of the various DIMS subgroups is too small to make any definitive conclusion, one significant difference was found. Specifically, the psychiatric–personality disorders group had significantly longer sleep latencies than all other groups except the psychiatric–affective disorders group. More importantly, a correlation between nocturnal total sleep time and mean MSLT performed among the

TABLE 3. *Sleep parameters, means and (standard deviations)*

	DIMS group (n = 70)	Normal group (n = 45)	*t* Value	p
TST (min)	364 (107)	419 (40)	3.28	0.001
Stage 1 (%)	18.0 (10.2)	18.1 (11.1)	0.03	NS
Stage 2 (%)	51.8 (10.8)	54.4 (7.8)	1.53	NS
Stages 3–4 (%)	10.8 (8.4)	7.0 (6.7)	2.53	0.01
Stage REM (%)	19.4 (7.5)	20.4 (4.9)	0.85	NS
Lat 2 (min)	44.2 (55.1)	19.9 (14.6)	3.50	0.0007
WDS (min)	95.7 (69.9)	38.3 (29.4)	6.09	0.0001

DIMS, difficulty initiating and maintaining sleep; TST, total sleep time; WDS, wake during sleep.

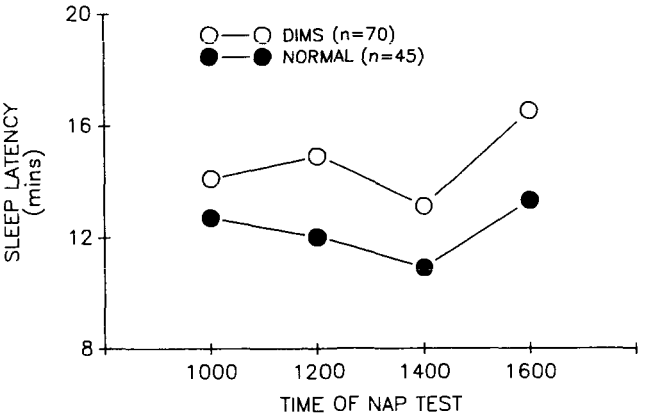

FIG. 1. Mean latency to sleep onset on each Multiple Sleep Latency Test nap for the insomnia group and normal control subjects. DIMS, difficulty initiating and maintaining sleep.

eight most common DIMS subgroups produced a correlation of $-0.67(df = 7, p < 0.05)$. Thus, the greater the sleep loss, the greater the daytime alertness.

On individual sleep latency tests, DIMS subjects consistently showed longer sleep latencies, but only naps two and four reached statistical significance. The temporal pattern of sleep latencies on individual naps was similar for both groups. However, diagnostic subgroups within the DIMS group showed varying patterns of individual sleep latencies (Fig. 2).

DISCUSSION

In contrast to an expected increase in daytime sleepiness in DIMS patients because of their sleep loss, these results demonstrate significantly greater alertness in insomnia patients following a night with significantly less sleep than the control group. This suggests that there may be a central dysfunction which is a stable 24-h phenomenon in this population. Unlike several of the sleep parameters (e.g., TST, latency to stage 2) that have significantly higher variability in the insomnia group, MSLT scores were

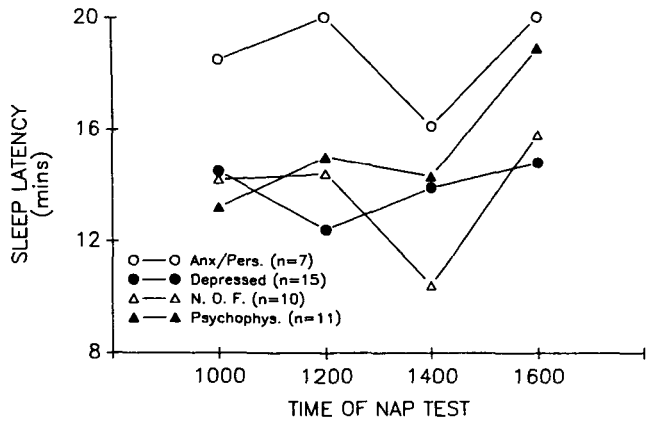

FIG. 2. Mean latency to sleep onset on each Multiple Sleep Latency Test nap for the various insomnia diagnostic subgroups. N. O. F., no objective findings.

very consistent. The significantly higher MSLT in DIMS patients is especially intriguing since it was found in a heterogeneous group of insomnia patients, suggesting a commonality among all patients with insomnia independent of their diagnosis. Perhaps a tendency towards physiological hyperarousal is that common attribute and is a predisposing factor in the evolution of chronic insomnia.

This hypothesis would be consistent with previous results (10,11) showing that individuals with difficulty sleeping at night show signs of hyperarousal before sleep onset. The present results suggest that this may not be restricted to the presleep period but may be present continuously. One cautionary note is that this hyperarousal may be restricted to the sleep environment.

Hyperarousal may be a necessary, but not sufficient, cause of insomnia, as it may be exacerbated by different conditions (e.g., periodic leg movements (PLMs), job stress, personality disorders) in subgroups of DIMS patients. The presence or absence of physiological hyperarousal may explain why some patients with PLMs have sleep–wake complaints while others are asymptomatic. The tendency towards physiological hyperarousal appears to be an entity distinct from anxiety or other psychopathological states, although they may interact. Several psychometric instruments—the State-Trait Anxiety Inventory, the Psychasthenia and Depression subscales from the MMPI, and the Zung Depression Index—all failed to correlate with MSLT scores within the DIMS group.

Seidel et al. (2) also noted that their DIMS group was surprisingly alert, although they were not significantly different from the normal group. This may have been because their DIMS subjects were research volunteers and not as severely insomniac as the DIMS patients in the present study, and this view is supported by the CPSG data. The DIMS group in Seidel's paper slept an average of 40 min longer and fell asleep an average of 16 min faster than the DIMS group in the present study. However, Seidel et al. conclude that "lack of daytime sleepiness . . ." in certain DIMS subjects ". . . may reflect a basic pathophysiological aspect of their insomnia."

An interesting issue raised by these results concerns the use of the MSLT in the evaluation of sleep tendency in DIMS patients. The MSLT has been validated in normal subjects under many conditions (e.g., sleep deprivation, sleep restriction, sleep extension, sleep fragmentation) and also in several patient populations with disorders of excessive daytime sleepiness (EDS) as a measure of sleep tendency (3,12–16). One of the chief strengths of the MSLT has been its freedom from mediating variables that interfere with sleep onset. Thus, in normal subjects and in EDS patients, the MSLT accurately measures sleep need. However, in a population of DIMS patients, it may be that the MSLT is confounded in that it simultaneously measures sleep need and hyperarousal, which is interfering with sleep onset. In effect, the MSLT measures sleep ability, not sleep need, in DIMS patients. Individuals with insomnia may indeed need sleep, but be unable to achieve a rapid sleep onset because of hyperarousal. In patients with EDS, the relation between MSLT score and sleep need is more straightforward.

Regardless of the explanation, the results of the present study and the previous results of Seidel et al. (2) indicate that patients with insomnia do not show impaired daytime alertness as compared with normal control subjects, despite having significantly less nocturnal sleep. In fact, they are significantly more alert, as defined by the MSLT, than control subjects. Whether this increased alertness in insomnia patients reflects a decreased sleep need or a chronic state of hyperarousal requires further research utilizing non-MSLT measures of alertness.

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