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# Sleep Disturbance Associated with Chronic Tinnitus

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*Sleep disturbance is a common and frequent complaint reported by tinnitus sufferers. Recent studies have shown that when insomnia and depression are associated with tinnitus there is decreased tolerance and increased discomfort with the tinnitus. The purpose of this study was to assess the reported prevalence and severity of sleep disturbance in chronic tinnitus patients. Patients (n = 80) were military personnel without major psychiatric disturbance and their tinnitus was associated with noise-induced permanent hearing loss (NIHL). Mini Sleep Questionnaire (MSQ) scores for sleep disturbance were found to be higher than those of normal controls in 77% of the patients. Highest MSQ scores in tinnitus patients with a sleep complaint were for delayed sleep, morning awakenings, mid-sleep awakenings, morning fatigue, and chronic fatigue. In contrast, a complaint of excessive daytime sleep (EDS) was not common. The self-rated severity of the tinnitus was greater in subjects with higher sleep disturbance scores. Self-rated depressive symptomatology was also highly correlated with sleep disturbance. Retrospective examination of sleep records and polysomnographic data for 10 patients with a complaint of chronic tinnitus revealed a combined effect for the tinnitus condition when associated with another conventional sleep disorder. In spite of the common complaint of sleep disturbance in tinnitus, only a minority seek a sleep examination.*

**Key Words:** Tinnitus, sleep, hearing loss, depression, REM

## Introduction

Tinnitus is a commonly seen, poorly understood, and hard to treat symptom of ear disease. The sensation of tinnitus is an auditory sound emanating from the ears or head in the absence of an external noise source. Different forms of sound such as ringing, roaring, hissing, or pulsatile clicking have been described (House 1978, 1981). There are two types of tinnitus: objective and subjective. In objective tinnitus, the less common type, the sound produced within the head can be heard by both the patient and the examiner. Vascular and mechanical causes of objective tinnitus include arterial bruits, venous hums, palatal myoclonus, and idiopathic stapedial myoclonus (House 1978, Moller 1984). In subjective tinnitus, the more common type, the tinnitus sensation is only perceived by the patient as coming from the ear or head.

Tinnitus can be caused by peripheral as well as central nervous system pathology of the auditory system anywhere along the pathway. These may include single or multiple sites of dysfunctions in the middle or inner ear primarily with hair cell damage or with retrocochlear lesions. In peripheral lesions the tinnitus is most commonly a result of noise-induced hearing loss (NIHL) (Barnea et al 1990), or with age-related hearing deterioration (Sullivan et al 1988). Tinnitus of central nervous origin can be caused by acoustic neuroma or other auditory space occupying lesions (House 1978).

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Although the tinnitus sensation itself is clinically considered a benign sensation, epidemiologic studies in Sweden and England similarly estimate that as much as 14%–18% of tinnitus sufferers complain of annoyance, whereas 2%–2.4% report chronic tinnitus with disability (Coles 1984; Axelsson and Ringdahl 1989). Among the hearing-impaired population it has been estimated that as many as 67% suffer from tinnitus, in 50% of these the tinnitus is considered at least as great a problem as the hearing impairment itself (Lindberg et al 1984). Psychological factors and coping mechanisms are more closely related to the degree of severity than the actual intrinsic properties of the tinnitus (House 1981; Gerber et al 1985; Jakes et al 1985; Attias et al 1990). For example, little association exists between the subjective rating of tinnitus severity and tinnitus pitch or loudness (Meikle et al 1984); however, tinnitus loudness is perceived as greater and more intense with the passing of time (Scott et al 1990). Self-rated complaints about tinnitus focus on emotional distress, auditory perceptual difficulties, and sleep disturbances. Depression and insomnia were found to be the psychosomatic factors that most strongly predict increased discomfort and decreased tolerance to the tinnitus (Scott et al 1990). Subjectively reported, sleep is disrupted by delayed sleep onset, mid-sleep awakenings, and early morning awakenings (Jakes et al 1985; Hallam et al 1988; Sullivan et al 1989).

The tinnitus sensation can occur before and during sleep because of the reduced masking effect of external noise, resulting in an increased awareness of the tinnitus sensation (House 1981). A number of studies have also found that getting to sleep was listed as the most frequently mentioned difficulty (Tyler and Baker 1983; Axelsson and Ringdahl 1989; Jakes et al 1985). Insomnia has been reported as the chief complaint in 50% of severe tinnitus sufferers (Jakes et al 1985) and tinnitus severity correlates highly with the incidence of sleep disturbance (Meikle et al 1984). Nonetheless, data on sleep has been limited to cursory probing for the answers to two or three questions about sleep quality via general psychological or tinnitus questionnaires.

In this study we examined the prevalence and severity of the sleep disturbance in patients suffering from chronic tinnitus both by sleep questionnaire and by retrospective review of the records of tinnitus patients referred for sleep laboratory evaluation.

## Methods

Eighty chronic tinnitus patients (76 men and 4 women aged 36 ± 11 years) who complained of tinnitus for at least 6 months were studied at the Institute for Noise Hazard Research. All patients were army personnel. Routine audiological examination, including the determination of the air- and bone-conduction thresholds at a frequency range of 0.125–8 kHz for each ear, were performed for each patient. Seventy-six of the patients demonstrated NIHL averaging 46 dB HL (±21 dB) in the frequency range of 2–8 kHz. Of these, 57 had moderate noise-induced hearing loss and 19 had severe NIHL. Four patients with a history of noise exposure exhibited normal audiograms, however, it is still most likely that the cause of their tinnitus was as a result of hazardous military noise exposure.

Following audiological testing, a routine Tinnitus Severity Questionnaire (TQ), was completed in which each patient was required to rank various properties of their tinnitus (Attias et al 1990; Barnea et al 1990). These consisted of 10 symptoms pertaining to his or her tinnitus on a 15-digit scale divided into degrees of severity: mild, moderate, and severe. The questions related to the frequency of occurrence of the tinnitus, the loudness, the pitch, degree of annoyance, distress, disturbance to concentration in a noisy and/or quiet place, general feeling, and one question about sleep quality. The mean responses to each question were then plotted on a graph representing the tinnitus symptom severity profile for the subjects. An interview with a psychiatrist was conducted in order to exclude any major psychiatric disorders according to the DSM-III-R criteria. For assessment of self-rated depressive symptomatology the Zung scale was used (Zung 1967). A 10-point Mini Sleep Questionnaire (MSQ) was completed focusing specifically on the sleep complaint. This consisted of questions about fatigue, daytime sleep, restless sleep, sleep medications, and other factors disturbing or affecting sleep. Items about sleep quality were indicated on a frequency scale of 1–7 (1 = never, 4 = sometimes, 7 = always). This questionnaire was chosen because data from an Israeli population of 1,217 normal controls for different age groups between 20–60 years is available (Zomer et al 1985). Another reason for using this questionnaire is that a general stability of the mean scores in normal sleepers across different age groups was found (from 2.1–2.5 with SD of 1.3 or 1.4). In addition, 30 male controls from military personnel (age 29.6 ± 8.6) who had no history of tinnitus or sleep complaint also completed the MSQ. This group was used in order to statistically compare differences in individual MSQ item scores between normal military controls and tinnitus patients.

Following the scoring of the MSQ, the tinnitus questionnaire and the Zung depressive symptomatology scale, the data was subjected to statistical analysis. To examine differences between MSQ items for normal controls and tinnitus patients with and without sleep complaint, one way analysis of variance (ANOVA) was performed. Two ANOVAs with repeated measures for main group effects [group (controls, tinnitus with normal MSQ scores and

patients with above normal MSQ scores) × 10 tinnitus symptoms)] was performed. Within-effect and post hoc analyses included unpaired *t*-test and contrast variable analyses. For exploring a possible relationship between sleep quality, tinnitus severity, and depressive symptomatology, Pearson correlations and regression analyses were conducted. Criterion probability levels under 0.05 were considered as statistically significant.

In addition to the subjective data acquired by the questionnaires, a retrospective review was conducted of the records of tinnitus patients referred to the Sheba Medical Sleep Research Center. It was expected that as well as being able to obtain objective data from the polysomnographic records (PSG), information about the help-seeking behavior for sleep complaint could also be attained. This was considered important as only a small portion of tinnitus sufferers seek help following the initial confirmation of the benign nature of their symptom (Sweetow 1986) as tinnitus symptoms can usually be latent, hidden, or suppressed (Neher 1991). Also, when the tinnitus sensation turns into a full-blown complaint, this is more related to psychological, cognitive, and personality factors than the loudness or pitch of the tinnitus itself (Sweetow 1986; Scott et al 1990; Attias et al 1992). Standard PSG measures included electrooculogram (EOG), facial and leg electromyogram (EMG), electroencephalogram (EEG), and respiration. Sleep stages were scored according to standard criteria (Rechtschaffen and Kales 1968). Sleep parameters such as sleep latency, REM latency, and sleep efficiency were measured as described by Kupfer (Kupfer et al 1978).

## Results

Figure 1 exhibits the MSQ item scores for the 80 tinnitus sufferers. The tinnitus sufferers were divided by their mean scores into two groups: those with total mean MSQ scores similar to a normal population (mean total MSQ score below an upper limit of 2.5; Zomer et al 1985), and those with above normal population mean scores. There were three times as many tinnitus patients with above normal mean population MSQ scores ($n$ = 62, 3.67 ± 0.77) as there were patients with normal mean scores ($n$ = 18, 2.08 ± 0.40). Also shown are the mean item scores of 30 military personnel controls. The mean score from the military personnel controls was even lower than the population mean at 1.62 ± 3.94. Comparing the tinnitus patients with normal MSQ scores to normal controls showed a clear significant group effect ($F[1] = 11.5, p < 0.0001$). However, contrast analysis showed that there was no significant difference for 2 of the 10 items: sleep medication and habitual snoring. From Figure 1 we can also clearly see that daytime sleep is much less of a complaint than morning fatigue or chronic fatigue. No significant differences were found between the tinnitus groups for age (34 ± 9.01 and 37 ± 11.72) or weight (71 kg ± 11.09 and 74 kg ± 10.68). In comparison to our tinnitus mean MSQ score of 3.67 ± 0.77, the mean MSQ scores for obstructive sleep apnea syndrome (OBSAS) and periodic leg movements of sleep (PLMS) were higher (Zomer et al 1985) with scores of 4.1 ± 2.1 for OBSAS, and 4.0 ± 2.1 for PLMS. Thus, although MSQ scores for our chronic tinnitus sufferers were above normal, they were less than those of the more conventional sleep disorders routinely seen at a sleep center.

The results of the Zung Depressive Scale for the tinnitus patients revealed that 63% ($n$ = 47) had scores within normal limits (Zung score <20), 26% ($n$ = 19) reported mild depressive symptomatology (20–30), and 11% ($n$ = 8) demonstrated moderate depressive symptomatology (>31).

Figure 2 shows the Tinnitus Severity Questionnaire scores for the tinnitus patients with and without sleep complaint as determined by the MSQ mean scores. As can be seen, severity for tinnitus in the sleep disturbed group was rated higher for all items except for general feeling. ANOVA showed that across all tinnitus symptoms, patients reporting above normal sleep scores demonstrated more severe tinnitus symptomatology than patients with normal sleep scores ($F[1] = 12.6, p < 0.0001$). Pearson correlations were made between tinnitus symptoms and sleep scores. In addition, correlations were also performed between the sleep scores and the depression index. Figure 3 shows a high positive and significant correlation between the Zung Depression Index and the mean MSQ score ($r = .65$, $p < 0.005$). Of the tinnitus symptoms, increased annoyance was highly correlated with sleep disturbance ($r = 0.50$, $p < 0.001$).

Audiological results were also compared with sleep disturbance. High mean MSQ scores were found in 25% of the patients with no hearing loss, in 76% of the patients with moderate hearing loss, and in 87% of the patients with severe hearing loss.

A retrospective review of sleep records revealed that out of 1,500 polygraphic studies performed over the past 3 years, only 10 patients complained of tinnitus. Table 1 exhibits the polysomnographic data from the ten tinnitus sufferers. As can be seen from the table, only two patients listed the tinnitus as a primary complaint that disturbed their sleep. Another four patients listed their tinnitus as a secondary sleep complaint, but not the main reason that they sought a sleep evaluation. The remaining four patients did not subjectively connect their tinnitus condition with their referral for a sleep examination. A complaint of excessive daytime sleep (EDS) was reported only by one patient (#8). The PSG results revealed that all patients had a conventional sleep disorder in addition to their tin-

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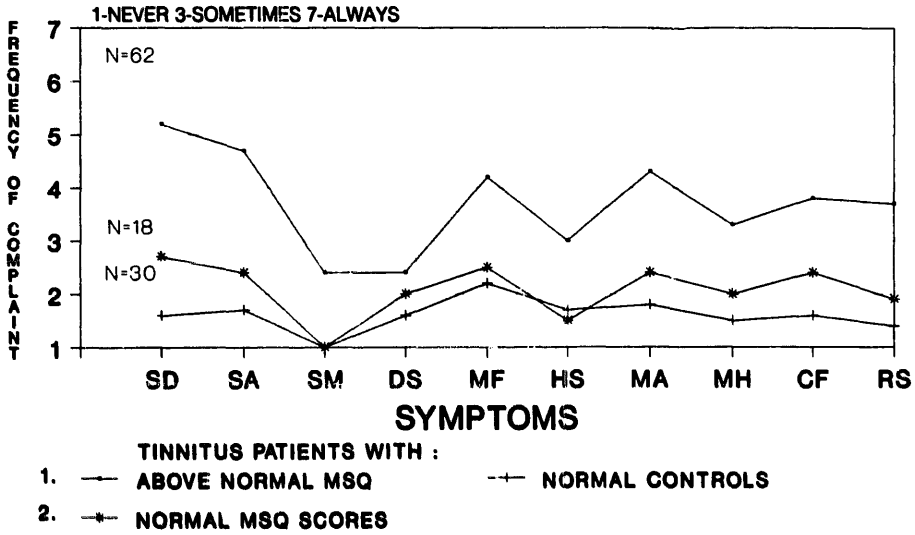


Figure 1. Mini Sleep Questionnaire (MSQ) scores for chronic tinnitus patients and normal controls. Patients with mean scores above upper limit normal population controls (>2.5) reveal a significant and general increase for items associated with a sleep disorder. MSQ items are: SD = sleep delay; SA = sleep awakenings; SM = sleep medications; DS = daytime sleep; MF = morning fatigue; HS = habitual snoring; MA = morning awakening; MH = morning headache; CF = chronic fatigue; RS = restless sleep.

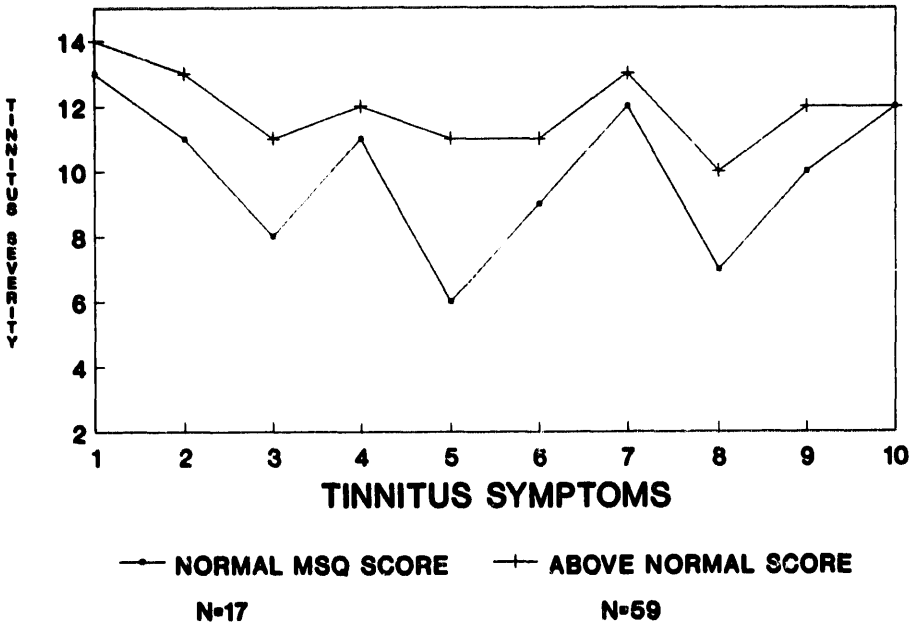


Figure 2. Tinnitus severity rating for patients with normal and above normal MSQ scores. Severity was significantly higher for most symptoms in those patients with sleep complaint. Tinnitus symptoms are: 1 = Frequency of occurrence; 2 = Loudness; 3 = Annoyance; 4 = Pitch; 5 = Disturbance to sleep; 6 = Disturbance to concentration; 7 = Disturbance in a quiet environment; 8 = Disturbance in a noisy environment; 9 = Restlessness; 10 = General feeling.

nitus. Patient #10, who reported severe insomnia, was not able to fall asleep during the sleep exam. The mean sleep scores were (excluding #10): sleep efficiency 70% ± 19%; total bedtime 345 ± 34.48 min; total sleeptime 242 ± 66.15 min; and number of awakenings per night 13.55 ± 6.69. Sleep latency (defined as the time from lights out until the appearance of stage-2 sleep) was delayed (>15 min) in four patients. The mean sleep latency was 14.44 ± 10.98 min. Compared to mid-sleep spontaneous awakenings in normal Israeli controls and even patients with PLMS or OBSAS who usually only exhibit short arousals (Alster and Lavie 1989), seven tinnitus patients demonstrated a high number of spontaneous mid-sleep awakenings (>8 mid-sleep awakenings per night). Sleep efficiency scores (defined as the ratio of time spent asleep to total recording time) were low for eight patients. Although eight patients were found to snore during the night, no patient reported this as aggravating his tinnitus. Evaluation of rapid eye movement (REM) parameters showed that six out of nine patients (67%) had early REM latencies of 70 min or less (Kupfer 1978). Because early REM latencies have also been reported in patients with obstructive sleep apnea, we examined REM latencies in 264 OBSAS patients studied at the sleep institute. Only 66 patients, or 25%, showed REM latencies of less than 70 min. Early morning awakenings occurred in three pa-

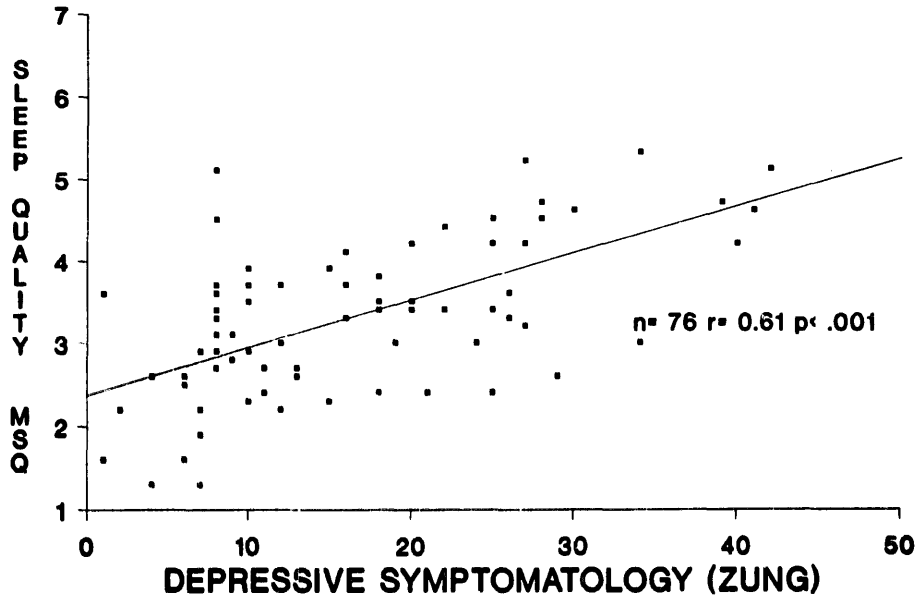


Figure 3. Regression analysis plotted for sleep disturbance versus depressive symptoms reveals a high significant correlation for both measures indicating the trend for increased sleep disturbance with increased depressive symptoms in chronic tinnitus sufferers.

Table 1. Polysomnographic Features in Tinnitus Patients

| Patients | Age | Total bed/ sleep time (min) | Sleep efficiency | Sleep latency (min) | Sleep awakenings | REM latency (min) | Early morning awakenings | Sleep complaint | Other medical disorders | Polygraphic sleep findings |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 40 | 376/203 | 54% | 35 | 11 | 302 | + | tinnitus<br>insomnia | | OBSAS<br>PLMS |
| 2 | 40 | 344/276 | 80% | 5 | 10 | 66 | | snoring<br>fatigue | | snoring |
| 3 | 38 | 338/102 | 30% | 17 | 23 | 5 | | tinnitus<br>insomnia | | high density<br>REMS/snoring |
| 4 | 65 | 331/273 | 82% | 28 | 7 | 70 | | insomnia<br>nightmares | hypertension | snoring<br>K-alpha |
| 5 | 37 | 408/319 | 78% | 9 | 15 | 61 | + | insomnia<br>tinnitus | | PLMS K-alpha<br>alpha-delta |
| 6 | 44 | 374/237 | 64% | 12 | 18 | 162 | | snoring | PTSD | hypopneas |
| 7 | 42 | 335/316 | 95% | 10 | 2 | 27 | | snoring<br>fatigue | PTSD | snoring |
| 8 | 57 | 303/225 | 75% | 9 | 12 | 103 | + | snoring<br>EDS | spondylitis | snoring<br>PLMS |
| 9 | 36 | 304/234 | 77% | 1 | 18 | 63 | | snoring<br>tinnitus | | OBSAS |
| 10 | 38 | 330/0 | 0% | N.A. | N.A. | N.A. | N.A. | insomnia<br>tinnitus | PTSD | insomnia |

Polysomnographic data for 10 tinnitus sufferers with combined conventional sleep disorders. Severe sleep disturbances and very fragmented sleep are exhibited including early REM latencies, low sleep efficiencies, a high number of sleep awakenings, long sleep latencies, and early morning awakenings. Without the combination of an additional sleep disorder the tinnitus sufferer was unlikely to seek a sleep examination. Abbreviations are: EDS-excessive daytime sleep; OBSAS-obstructive sleep apnea syndrome; PLMS-periodic leg movements of sleep; PTSD-posttraumatic stress syndrome; NA-nonapplicable.

tients, and REM eye movement density (the ratio of REM activity to REM time) was high in patient #3.

Subjective information about how the tinnitus condition is related to their sleep disturbance was obtained by telephone interview. This relationship seemed to vary from patient to patient. For instance, patient #1 with OBSAS and PLMS reported that while his tinnitus has been present for 10 years, his sleep has been disturbed only during the last 4 years. Although the tinnitus sensation at first only caused sleep-onset delay, the tinnitus is now related to mid-sleep awakenings. In contrast, patient #8 clearly stated that his tinnitus does not disturb his sleep. Patient #9 also suffering from OBSAS, reports that he is aware of his tinnitus at bedtime, but that he is so exhausted that he can easily fall asleep. Patient #10 (also suffering from posttraumatic stress disorder [PTSD]) considers that the tinnitus sensation is the main reason that he in unable to relax during the day but does not clearly make an association for his nighttime insomnia.

Also important to note is what our tinnitus patients did not report about their sleep. For instance, even though anxiety can be associated with chronic tinnitus (Collet et al 1990; Attias et al 1992) there does not seem to be a conditioned anxiety reaction to nighttime sleeping. This is interesting as the tinnitus sensation is perceived as greater just before sleep. Thus, in conclusion, the unusually poor PSG results and self-reports of the tinnitus patients show a combined effect for the tinnitus condition and conventional sleep disorder. When the tinnitus alone is the perceived cause of the sleep disturbance, the patient is not likely to seek a sleep examination.

## Discussion

As determined from the sleep questionnaire scores, tinnitus sufferers in general complained of a variety of sleep disturbances, except EDS and sleep medication abuse. The mean scores for the MSQ, however, were not as high as those scores reported for OBSAS and PLMS (Zomer et al 1985). Still, we must consider that functioning army personnel represent a group limited in the use of sleep medication and thus might not be representative of other tinnitus populations.

The low self-report of EDS and use of sleep medication partially supports the findings of Axelsson (Axelsson and Ringdahl 1989) who showed that sleep complaint in itself is not necessarily emphasized by the patient in spite of the strong relationship between tinnitus severity and sleep disturbance. Furthermore, scores for tinnitus severity and sleep disturbance were increased in a general way. These data most likely indicate that the sleep disturbance itself is not a sole factor in the tinnitus complaint behavior, but rather a sensitive indicator of other underlying causes leading the patient to seek treatment. For instance, a pattern of overall increase in tinnitus severity is a feature of the tinnitus condition when associated with depression (Sullivan et al 1988; 1989). Additionally, a general nonspecific decrease in tinnitus symptom severity is also obtained when antidepressive medication is given (Sullivan et al 1989). When depressed tinnitus sufferers were administered nortriptyline, self-reports of tinnitus severity, symptomatology, and psychosocial function all improved with the most significant improvements in sleep disturbance and bodily deterioration. Even in our group of well-functioning tinnitus patients, there was a high positive correlation between depressive symptomatology, sleep disturbance, and tinnitus severity.

The possible association between tinnitus and depression is well-known and has been briefly described previously. The high correlation between self-reported depressive symptomatology, tinnitus severity, and sleep complaints in our patients supports this association. For polysomnographic data, a shortened REM latency is considered a biological or vulnerability marker for an effective response to stressful life events (Cartwright et al 1991) even without meeting the strict criteria of major depression. The early REM latencies in six of nine of our tinnitus patients examined by sleep test might be some indicator of the stress the tinnitus patient is undergoing or has undergone. Although our subject data is too small to reach specific conclusions, the study of sleep and depression in tinnitus might increase our knowledge about the complaint process in the tinnitus condition where a low-level chronic stressor takes its toll with time. Still, even though only a small number of tinnitus patients seek a sleep examination relative to the high numbers of complainers, our results show that sleep parameters in those who finally do seek help will probably be severely disrupted as a result of a combined effect.

In conclusion, chronic tinnitus presents a multidimensional clinical picture of which sleep disturbance (but not necessarily in the form of a primary sleep complaint), is both frequent and common. Our data supports this and adds that the type of complaint is more varied than previously reported. In contrast, the sleep complaint alone is subjectively rated as not as severe as periodic leg movements of sleep or obstructive sleep apnea syndrome. Sleep lab records further supports this because very few tinnitus sufferers seek help for the sleep complaint when it is related to the tinnitus alone. However, the sleep complaint in tinnitus can also be the consequence of a combined effect. That is, sleep can be disrupted or delayed by the tinnitus sensation itself. Then the sleep is further disturbed by latent and increasing emotional disturbances, especially depression. An addition of a conventional sleep disorder can further exacerbate or predispose the situation enough so that the patient then seeks help for his sleep disorder.

This order of events would also explain why the tinnitus patient, on the one hand, does not clearly connect the sleep complaint with his tinnitus condition. On the other hand, when the patient is questioned, the sleep disturbance is more clearly associated as a factor for the decreasing tolerance to his tinnitus. A similar situation has been found for PTSD patients (Hurwitz et al 1991) where subjects demonstrate no significant parasomnias and sleep tends to be better in the laboratory than is predicted by history. Subjective sleep disturbance when accompanied with PTSD has been found to represent a combination of mild conventional sleep disorder and conditioned insomnia.

Thus, a sleep questionnaire and, if indicated, a sleep examination should be considered to be part of the evaluation and management of life disturbance in the chronic tinnitus patient. Because a serious combined effect can develop from a conventional and common sleep disorder, depressive symptomatology, and decreased tolerance to the tinnitus; special attention should be paid to the latent and hidden symptoms in the tinnitus patient.

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