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The role of individual biological rhythm differences and sleep quality on tinnitus symptom severity

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Tinnitus is a common health complaint in the general population and many personal and psychological factors play a role in the induction and exacerbation of it. Hence, the aim of the present study was to assess, for the first time in the literature, whether individuals' biological rhythms differences, i.e. morningness vs. eveningness, have an impact on the severity of tinnitus. We included 93 tinnitus patients who did not have any underlying systemic or metabolic diseases. The morningness–eveningness questionnaire was used to determine chronotypes and the Pittsburgh Sleep Quality Index was used to assess subjective sleep quality. A Visual Analog Scale was used to assess the severity of tinnitus, using a scale from 0 (no tinnitus) to 100 (most severe tinnitus). The evening-type patients reported more severe tinnitus symptoms than morning-types. These findings suggest that individual chronobiological factors affect subjective estimates of tinnitus severity.

Keywords: chronotype; tinnitus; biological rhythm; life quality; sleep-wake rhythm

Introduction

Tinnitus, from the Latin tinnitus or ringing, is a situation characterized by ringing, swishing, or other noises that seem to be originating in the ear or head (Lockwood et al. 2002). The prevalence of tinnitus in the general population appears to be 8–15% (Kuttila et al. 2005). In most cases, no specific organic cause is found and the symptoms can only be subjectively reported (Krog et al. 2010). Many personal and psychological factors play a role in the induction and exacerbation of tinnitus. For instance, problems at work and home, worse sleep quality, lifestyle dysregulation, frustration, poor communication, and emotional problems all negatively influence the overall quality of life of its sufferers (Weise 2001). There is a link between lifestyle dysregulation, distress and tinnitus severity. Subjective tinnitus severity was associated with emotional distress in patients with maladaptive coping and lifestyle dysregulation (Budd & Pugh 1996). Further evidence for an interaction between tinnitus and stress comes from the observations that tinnitus, which is affected by lifestyle dysregulation, can precipitate a stress response, and symptoms can be exacerbate by the stress of tinnitus itself (Weise 2001; Hiller & Goebel 2006). In addition, in states of stress, the tensor tympani muscle shows increased activity; and increased activity in the masticatory muscles might increase or even cause the perception of tinnitus (Rubinstein

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1993). On the other hand, despite the high prevalence of tinnitus, there are no clinical standards or best practice guidelines for managing it (Gudex et al. 2009).

It is well established that humans display distinct interindividual differences in the timing of biological and behavioral rhythms. From a chronobiological perspective, chronotypes are individual characteristics that refer primarily to preference in timing of the sleep-wake cycle, morning-types getting up, and going to bed early, and performing mentally and physically best in the morning hours; while evening-types prefer to get up at a later time, stay out late, and performing mentally and physically in the evening (Kerkhof 1985; Natale & Cicogna 2002; Korczak et al. 2008).

Individuals also differ in a number of psychological and behavioral variables including normal mealtimes, mood states, alertness, appetite, and task performance (Kerkhof 1985; Tankova et al. 1994; Selvi et al. 2007; Jankowski & Ciarkowska 2008). An individual's preference for the timing of daily activities is associated with markers of circadian time, especially the peak times of 24-h melatonin, body temperature, and cortisol rhythms (Bailey & Heitkemper 1991; Baehr et al. 2000; Griefahn 2002; Selvi et al. 2012).

With regard to general health status, many studies have examined physical and psychological differences with regard to diurnal preference. Evening-types have more psychosomatic disturbances than morning-types and may also exhibit lifestyles which are generally associated with stress (Mecacci & Rocchetti 1998); morning-types have a healthier lifestyle, and there is also a significant and positive correlation between morningness and satisfaction with life (Randler 2008).

We have assessed whether an individual's chronotype, i.e. morningness vs. eveningness, has an impact on perceived severity of tinnitus. We hypothesize that evening-type patients are likely to have a higher severity of tinnitus.

Method

Participants

Our study was conducted over a three month span between August, 2013 and December, 2013 at Inonu University, Department of Otorhinolaryngology, Malatya, Turkey. The study protocol was approved by the Inonu University Ethics Committee. We restricted our study to morning- and evening-types, to assess whether differences in the severity of tinnitus could be detected in the most divergent chronotypes. The routine physical examination and laboratory tests included biochemistry, blood count, and serological tests. Patients were informed about the aims of the study and their written approvals were obtained. They were not compensated in any way for their participation. Patients were excluded from the study ($n = 32$) if they: had a current or lifetime history of any functional or organic mental disorder; had a neurological disorder that significantly affects hearing functions; had met criteria for substance abuse or dependence in the previous 12 months; or were taking medications that may cause or exacerbate tinnitus and sleep disorders. Finally, 93 tinnitus patients who did not have any underlying systemic or metabolic diseases and who were of either a morning- or evening-chronotype were included. Of the sample, 67 patients were women (72%). Age of the participants ranged between 19 and 57; mean age was 38.7 years ($SD \pm 8.2$), 38.6 ± 7.9 for males, and 39.2 ± 9.1 for females.

A Visual Analog Scale (VAS), was used to assess the severity of tinnitus, using a scale from 0 (no tinnitus) to 100 (most severe tinnitus). The VAS was assessed once, patients describing their tinnitus severity at that moment.

The morningness–eveningness questionnaire (MEQ) of Horne and Östberg was used to determine chronotypes (Horne & Östberg 1976). The MEQ is a 19-item questionnaire, which assesses habitual rising and bed times, preferred times of physical and mental performance, and subjective alertness after rising and before going to bed. The scoring range is from 16 to 86; the participants scoring between 59 and 86 are considered morning-types; those scoring 42–58 as neither-types, and those scoring 16–41 as evening-types (Horne & Östberg 1976). Agargun et al. (2007) translated the questionnaire into Turkish and tested the Turkish version for its psychometric properties. The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality and disturbances over the previous month interval. Nineteen individual items that were weighted equally on a 0–3 scale generate seven component scores: (1) subjective quality of sleep, (2) sleep latency, (3) sleep duration, (4) sleep efficiency, (5) sleep disturbances, (6) medication use for sleep, and (7) daytime dysfunction. The sum of scores for these seven components yields one global score, which has a range of 0–21, with higher scores indicating worse sleep quality. The PSQI has been shown to be valid and reliable in Turkish population studies (Agargun et al. 1996).

Statistical analyses

Descriptive statistics were calculated for the sample. One-way analysis of variance models were utilized to assess statistical differences between the morning- and evening-chronotypes on their mean tinnitus severity and sleep quality scores. A multiple regression model in which tinnitus severity was regressed on age, gender, chronotype and sleep quality was performed. Data were evaluated by SPSS for Windows, version 16.0 (SPSS Inc., Chicago, IL). Significance threshold was $p < .05$.

Results

Scale scores of the VAS and PSQI were compared between morning-type and evening-type individuals by using one-way analysis of variance. Evening-type patients reported significantly higher scores on both the VAS ($F_{1,91} = 7.776$; $p < .01$) and PSQI ($F_{1,91} = 7.708$; $p < .01$) than morning-type patients. Results of the ANOVA are shown in Table 1.

Predictive value of age, gender, chronotype, and sleep quality was assessed by a multiple regression model in which the VAS scores were the dependent variable. The model showed that age was significantly associated with higher scores on the VAS ($\beta = .50$ $t = 5.708$; $p < .01$), and evening-type patients reported higher scores on the VAS ($\beta = -.31$ $t = -3.391$; $p < .01$). The model accounted for 35% of the total variance of tinnitus severity. Findings are presented in Table 2.

Table 1. One-way ANOVA comparisons between chronotypes.

	Morning-type ($n = 51$) Mean ± SD	Evening-type ($n = 42$) Mean ± SD	F (1, 91)	p	η^2
VAS	27.94 ± 7.84	32.83 ± 9.07	7.776	.006	.079
PSQI	5.33 ± 2.45	6.76 ± 2.50	7.708	.007	.078

Table 2. Multiple regression analysis.

	R^2	β	t	p
	.35			
Age		.50	5.708	*.000*
Gender		−.06	−0.701	*.485*
MEQ		−.31	−3.391	*.001*
PSQI		.10	1.100	*.274*

Notes: Gender: 0 = female; 1 = male, β = standardized beta coefficient.
Standardized beta coefficients were computed in the model, and can be interpreted as partial correlation coefficients. Correlations were strong between age or chronotype and tinnitus severity.

Discussion

The aim of our study was to investigate the impact of circadian preferences (chronotype or morningness–eveningness) on intensity of tinnitus. We found that evening-type patients scored higher on a VAS of tinnitus severity as compared to morning-types.

It is well established that individuals' emotional and cognitive differences affect subjective tinnitus severity. Similarly, the prevalence of sleep disturbance has been reported to be between 25 and 60% among patients with tinnitus (Eysel-Gosepath & Selivanova 2005; Crönlein et al. 2007). Many explanations have been advanced to explain this association; it has been considered to be a reaction to the acoustic perception of tinnitus, or secondary to other, common causes. Sleep disturbance has been related to functional deficiency and decrease in the quality of life among tinnitus patients (Folmer & Griest 2000). However, there is no any study investigating the effect of sleep-wake differences on tinnitus severity.

The results of the present study might be explained by the stress-diathesis model of tinnitus (Andersson & Mckenna 1998; Lee et al. 2004; Andersson & Westin 2008). A vulnerable person might be distressed by low tinnitus intensity and a more stress-tolerant person might be less distressed by higher symptom intensity (Andersson & McKenna 1998; Krog et al. 2010). Individual sleep-wake differences, coping strategies, life quality, and personality factors are the main factors that influence reported tinnitus severity. These differences are also well determined between morning- and evening-types. It has been found that evening-types have the most irregular sleep-wake habits and have difficulties falling asleep (Giannotti et al. 2002; Vardar et al. 2008). Selvi et al. (2012) showed that evening-types have significantly poorer sleep quality and higher daytime dysfunction than morning-types. Conversely, morning-types were more satisfied with their sleep. Additionally, healthy evening-types have more psychological and somatic symptoms, and morning-types have a healthier lifestyle (Mecacci & Rochetti 1998; Randler 2008). Monk et al. (2004) showed that lifestyle regularity (i.e. social rhythms) was decreased in evening-types compared to morning-types.

It is well shown that sleep disturbance is a common and frequent complaint reported by tinnitus sufferers. Sleep problems impair the quality of life of these patients, and the impairment correlates with the severity of the tinnitus. Poor sleep quality exacerbates the severity of tinnitus by increasing discomfort, and it is a factor that strongly predicts decreased tolerance to tinnitus (Eysel-Gosebath & Selivanova 2005; Crönlein et al. 2007). In addition, irregular daytime activities and impaired quality of life negatively affect the severity of tinnitus. Tinnitus may well be a significant contributor to reduced mental health and well-being, and tinnitus patients with lifestyle dysregulation, social problems, and lack of energy have more severe symptoms (Erlandsson & Holgers 2001;

Krog et al. 2010). Our study results are consistent with previous studies suggest chronobiological factors might play a deterministic role with regard to symptom severity (Selvi et al. 2010; Bilgili et al. 2013). Having an evening-type chronotype may impair many emotional functions and secondarily exacerbate symptoms, as for many physical and mental disorders (Gulec et al. 2013). Evening-types may exhibit lifestyles which are generally associated with stress (Mecacci & Rocchetti 1998) and irregular lifestyle and sleep disturbances make evening-types more vulnerable to physical and psychological problems.

Although there is high prevalence of tinnitus in the population, no effective treatment has yet been found. Our study provides the possibility of an innovative treatment for tinnitus – by decreasing tinnitus severity and increasing the quality of life. Individual advice and counseling from the viewpoint of chronobiological aspects may help improve the quality of life of patients suffering from tinnitus. Thus, regulation of sleep-wake times, to approach those of morning-types, might also lead to increases in sleep quality, improvements in responses to stressful life events, and a general improvement in social rhythms – as found in morning-types – and might decrease the perception of tinnitus intensity.

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