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Original Research Article

Thyroid hormones and tinnitus in individuals with temporomandibular disorder

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Abstract

Introduction: TMD has a multifactorial etiology, involving biopsychosocial factors, and is more prevalent in women. This condition presents various signs and symptoms, including headaches, otalgia, and joint noises, with facial pain being the most common symptom. Tinnitus is an auditory perception with or without an external acoustic stimulus; its origin is nonspecific and multifactorial. Somatic tinnitus may be associated with musculoskeletal conditions and metabolic alterations. Its perception can be modulated by cervical stretching, anterior cervical posture, muscle contractions, mandibular movements, and pressure on the temporomandibular joints (TMJs). Thyroid dysfunctions, such as hypothyroidism and hyperthyroidism, affect the function of various organs and are more common in women. These endocrine alterations can impact the auditory, muscular, articular, and thermoregulatory systems. **Objective:** Through laboratory tests, this study aimed to assess thyroid hormone levels in women with temporomandibular disorders (TMD), with and without tinnitus symptoms. **Material and methods:** All participants who sought treatment and diagnosis at the center with orofacial pain and temporomandibular disorders underwent an

initial interview and assessment at the speech therapy department. Given this, the inclusion criteria included females over >18 years with TMD. The diagnosis was defined through the DC/TMD, and the participants who reported tinnitus complaints answered a tinnitus perception questionnaire (THI). All participants underwent laboratory tests that evaluated the dosage of Free T3, Free T4, and TSH. **Results:** 35 female patients were included, with a mean age of 44.61. Ranging from 20 to 66 years old without hearing loss. Through the DC/TMD, 100% of the participants were diagnosed with muscular TMD; among them, 65.71% had joint TMD, classified as mixed TMD. According to the questionnaire (THI), 52.9% reported a complaint of tinnitus. **Conclusion:** There was no direct relationship between the existence of tinnitus and changes in thyroid hormones; further studies on the subject are recommended.

Introduction

Temporomandibular disorder (TMD) is a broad term for pain and dysfunction involving the masticatory muscles, the temporomandibular joints (TMJs), and associated structures [12]. The condition has a multifactorial etiology and may be triggered by physical, emotional, and social factors. It frequently negatively impacts quality of life [4, 12]. Current studies report a general prevalence of approximately 31% in adults and the elderly and 11% in children and adolescents [26].

Numerous comorbidities are associated with TMD [25], including tinnitus, which plays an important role. The risk of experiencing tinnitus symptoms is 8.37 times higher in patients with TMD [1]. Tinnitus is an auditory sensation with or without an external acoustic stimulus. Its origin is nonspecific and multifactorial [23]. Individuals with metabolic alterations such as hypothyroidism may also experience vestibular system interference, with tinnitus being the most prevalent symptom [10, 11].

It is believed that somatosensory tinnitus may arise from the convergence of somatic afferents (from the masticatory muscles and TMJ) with auditory pathways in the dorsal cochlear nucleus [18]. Thyroid dysfunction may enhance this sensitivity through neuroendocrine mechanisms and central sensitization, amplifying pain and perceiving non-external sounds [5, 20]. These changes include dysfunctions in neurotransmitters and neuronal excitability, promoting a state of hypersensitivity to pain and possibly influencing the perception of tinnitus [5, 21].

The thyroid gland is an endocrine organ that produces hormones by absorbing iodide. The main hormones produced are free triiodothyronine (T3) and thyroxine (T4), regulated by thyroid-stimulating hormone (TSH), which is released in response to thyrotropin-releasing hormone (TRH). These hormones work together to regulate the entire thyroid function, enhancing homeostasis and metabolic regulation of all organs [7]. Thyroid hormones act on differentiation, maturation of muscle cells, and muscle development, contraction, and regeneration. Studies have shown that hormonal alterations and thyroid gland dysfunction are often accompanied by musculoskeletal manifestations such as myalgia, joint pain, proximal myopathy, and osteoarthritis [5, 7, 11]. Clinical signs and symptoms vary among individuals, the most common being weakness, sweating, depression, myalgia, and muscle fatigue [7].

On the other hand, hyperthyroidism is an endocrine condition with a prevalence of 1% to 3% in the general population, though 25% to 50% of cases are considered subclinical. It is characterized by excessive synthesis and secretion of thyroid hormones, leading to a hypermetabolic state that may result in atrial fibrillation, osteoporosis, cardiac and hepatic failure, and, if untreated, death. Thyrotoxicosis is the clinical syndrome of excess circulating thyroid hormones, regardless of origin [3].

Korean studies have shown that 14% of individuals with thyroid dysfunction present with TMD [22]. However, the relationship between thyroid function and TMD remains controversial. A cohort study involving 712 patients with thyroid dysfunction and a control group of healthy adults found no significant difference in the incidence of TMD between the groups [22]. Conversely, more recent observational studies controlling for socioeconomic and behavioral variables have demonstrated a positive association between thyroid dysfunction, especially hypothyroidism, and TMD. It is also noteworthy that TMD has a high comorbidity rate

with Hashimoto's thyroiditis, the primary etiology of hypothyroidism [7, 11, 22].

Given the discrepancies in findings across the literature, this study aimed to evaluate the relationship between thyroid hormone profile in women with temporomandibular disorder and tinnitus complaints.

Material and methods

This study was approved by the Research Ethics Committee of the University Tuiuti of Parana (protocol n. 4.649.175). All participants signed the Informed Consent Form. The sample consisted of women diagnosed with temporomandibular disorder (TMD) with or without tinnitus complaints, who attended the Diagnostic and Treatment Center for Temporomandibular Joint and Dentofacial Functional Disorders (CDATM/UTP).

Inclusion criteria were adult female participants over 18 years old, regardless of ethnicity, with a TMD diagnosis established through DC/TMD criteria, with or without tinnitus. Participants were excluded if they had hearing loss, a history of craniofacial congenital deformities, genetic syndromes, neurological diseases, cognitive or emotional impairments preventing questionnaire comprehension, or were children, adolescents, or pregnant.

The presence and impact of tinnitus were assessed using the Tinnitus Handicap Inventory (THI), a 25-item questionnaire covering three domains: functional (11 items), emotional (9), and catastrophic (5). Participants responded using three options: "yes" (4 points), "sometimes" (2 points), and "no" (0 points). The total score ranges from 0 to 100 and is classified as follows: negligible perception (<16%), mild (18-36%), moderate (38-56%), severe (58-76%), and catastrophic (78-100%). This instrument measured tinnitus's functional, emotional, and social impact in daily life.

Participants underwent blood collection for thyroid hormone measurement in a single clinical laboratory to ensure standardization and avoid reference value variation. The analyzed hormones were TSH, T3, and free T4. Measurements were performed using the chemiluminescence technique with the UniCel DxI 800 equipment (Beckman Coulter.™), following the lab's protocol. Reference values are show in table I.

Table I – Reference values for thyroid hormones

Hormones	Reference values
T3	0,60 e 1,81 ng/ml
T4	4,5 a 12,3 mg/dl
TSH	0.48 a 5,6 microUl/ ml

Statistical analysis

Statistical analysis was performed using Jamovi™ software (version 2.4, 2023, Sydney, Australia). The Shapiro-Wilk test was used to assess the normality of the numerical data distribution, adopting a significance level of $p > 0.05$. The Mann-Whitney test was applied to compare hormone levels between groups classified by the presence or absence of tinnitus, and between the TMD diagnosis groups. The significance level adopted for all analyses was 5% ($p < 0.05$).

Results

35 female participants were evaluated, with a mean age of 44.61 years (range 20 to 66 years), and none reported hearing loss. According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), all participants were diagnosed with painful TMD of muscular and joint origin (myalgia and arthralgia), with 65.71% classified as mixed TMD.

52.9% of participants reported tinnitus complaints. According to the THI questionnaire, the average score was 36.88, with variations in perceived severity. Among those with tinnitus, 50.0% had moderate to catastrophic grades (one with catastrophic tinnitus, two with severe, six with moderate), and nine participants reported mild to negligible perception. Table II presents the distribution of tinnitus severity categories according to THI.

Table II – Frequency of THI categories

THI Result	Counts	% of total	Cumulative %
Grade 1 – Mild (negligible)	6	33.3%	33.3%
Grade 2 – Mild	3	16.7%	50.0%
Grade 3 – Moderate	6	33.3%	83.3%
Grade 4 – Severe	2	11.1%	94.4%
Grade 5 – Catastrophic	1	5.6%	100.0%

Thyroid hormone levels (T3, T4, and TSH) were compared between the two groups (with and without tinnitus). No statistically significant differences were observed, as shown in table III.

Table III – Relationship of thyroid hormones in pacientes with and without tinnitus

Test	Tinnitus	Without tinnitus	p-value*
	median (IQR)	median (IQR)	
T3	1.15 (0.28)	1.13 (0.3)	0.849
T4	8.60 (3.27)	8.80 (2.72)	0.959
TSH	1.84 (1.67)	0.478 (1.72)	0.479

Legend: p-value from the Mann-Whitney test at a 5% significance level; IQR – Interquartile Range

Additionally, the association between TMD types (muscular or mixed) and thyroid hormones was evaluated, with no statistical differences between the groups, as shown in table IV.

Table IV – Relationship of thyroid hormones with types of TMD

Test	Muscular TMD	Mixed TMD	p-value*
	median (IQR)	median (IQR)	
T3	1.13 (0.23)	1.13 (0.3)	0.797
T4	8.30 (2.85)	8.70 (3.35)	0.897
TSH	2.84 (1.14)	1.61 (1.82)	0.101

Legend: p-value from the Mann-Whitney test at a 5% significance level; IQR – Interquartile Range

Discussion

Although several studies have investigated the association between TMD and otologic symptoms, the existence of a cause-and-effect relationship remains controversial [23]. While early hypotheses suggested that posterior condylar displacement due to dental occlusion abnormalities might explain this association, these mechanisms have not stood the test of time [6, 14]. Nonetheless, I commonly observed that TMD patients also report otologic symptoms such as tinnitus, vertigo, and otalgia [4, 23]. Literature data suggest that otologic symptoms are more prevalent in TMD patients than in those without TMD [13]. Specifically, a recent study showed that the prevalence of tinnitus was eight times higher in individuals with TMD [1, 16]. In our study, all participants were female and diagnosed with painful TMD (myalgia and arthralgia) based on DC/TMD, with 51.42% reporting tinnitus symptoms.

Tinnitus perception without any internal or external acoustic stimulus is called subjective tinnitus. One subtype is somatosensory tinnitus [15]. Various severity levels, including mild, moderate, severe, and catastrophic, were observed in all participants who reported tinnitus.

It is believed that somatosensory tinnitus may arise from the convergence of somatic afferents (masticatory muscles, TMJ, cervical spine) with auditory pathways in the dorsal cochlear nucleus, altering auditory input modulation and amplifying abnormal sound perception [20]. Other proposed mechanisms include mechanical activity of the discomalleolar ligament [24] (linking TMJ to the middle ear), masticatory muscle tension [16], anatomical variations of the tympanic bone [17], emotional factors [18] and metabolic alterations [7, 10].

Regarding metabolic alterations, thyroid dysfunction – the focus of this study – can increase sensitivity through neuroendocrine mechanisms and central sensitization, amplifying pain and perception of non-external sounds [9]. Despite the pathophysiological plausibility for thyroid dysfunction contributing indirectly to the onset or worsening of tinnitus through its association with muscular TMD and central sensitivity, no association was found between tinnitus and thyroid hormone profiles in our sample.

A variety of musculoskeletal manifestations, including myalgia, joint pain, proximal myopathy, and osteoarthritis, frequently accompany hypothyroidism [5]. Hypothyroid myopathy may be present in up to 80% of patients, primarily affecting proximal muscles such as the thighs and shoulders, and compromising basic functional activities. Additionally, joint involvement may include polyarthralgia, stiffness, erosive osteoarthritis, and carpal tunnel syndrome, which is one of the most common rheumatologic manifestations in patients with uncontrolled hypothyroidism [2].

Hypothyroidism may also be associated with impairment of the peripheral vestibular region. There is no comprehensive explanation regarding the mechanisms by which altered thyroid hormone levels may lead to tinnitus. However, it is known that any thyroid dysfunction may increase predisposition to tinnitus, as it influences the auditory system, particularly the organ of Corti. It may also cause an imbalance in the sympathetic nervous system, altering the function of adrenergic receptors in the tissues and affecting physiological function and blood flow [8, 19]. In the present sample, only two participants presented thyroid hormone imbalance.

Although this was a clinical study in which all individuals had TMD (diagnosed using the DC/TMD), were of the same sex, and had a comparable age range, allowing them to be divided into two groups (with and without tinnitus), the assessment of tinnitus was performed solely through a questionnaire, without additional examinations. Furthermore, other comorbidities that could have influenced the results were not investigated. Future studies with larger sample sizes and a more specific focus on this topic may yield relevant findings for healthcare and clinical practice.

Conclusion

Based on the data analysis of this study, it was found that in women diagnosed with temporomandibular disorders, there was no statistically significant relationship between tinnitus symptoms and alterations in thyroid hormone levels. Further studies involving this triad with larger sample sizes are recommended.

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