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Outcome of Different Treatment Methods in Patients with Tinnitus and Temporomandibular Joint dysfunction

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ORIGINAL STUDY

Outcome of different treatment methods in patients with tinnitus and temporomandibular joint dysfunction

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Abstract

Introduction: **Otology symptoms can be the presenting complaint among patients with temporomandibular joint (TMJ) dysfunction. Hearing loss and tinnitus are among the ear-related symptoms associated with TMJ dysfunction. Tinnitus related to TMJ dysfunction is referred to as a type of somatic tinnitus, and it is caused by a musculoskeletal problem, which should be investigated with different methods of treatment to increase the best efficiency of treatment.**

Objective: **Evaluation of different outcomes of different treatment modalities for patients with tinnitus and TMJ dysfunction by using the advantage of tinnitus retraining therapy (TRT) versus night guard and medication to determine which of these methods can greatly improve tinnitus symptoms.**

Patients and methods: **The current study was implemented in four groups, which consist of a control group (group A), which included 20 normal individuals with bilateral peripheral normal hearing sensitivity and not complaining of any symptom of TMJ dysfunction or tinnitus, and 60 participants who complained of TMJ dysfunction and tinnitus subdivided into three groups, where group B comprised 20 individuals treated with TRT, group C contained 20 participants treated with placement of night guard and group D comprised 20 participants treated with medication.**

Results: **TRT is the best method to improve perception of the loudness of tinnitus in patients with TMJ dysfunction.**

Conclusion: **TRT and medication are the most sensitive procedure in the management of patients complaining of tinnitus and TMJ dysfunction, and they are able to minimize the perception of tinnitus loudness in these patients.**

Keywords: Medication in tinnitus, Temporomandibular dysfunction, Tinnitus retraining therapy of somatic tinnitus, Tinnitus

1. Introduction

Tinnitus is a symptom and it is a very heterogeneous condition defined by the perception of sound in the absence of any external sound source [1]. These sounds are within the nervous system without any kind of external stimulation [2]. It represents a symptom of different pathologies and any pathologies of the neurological system may cause the manifestation of tinnitus symptoms [3]. Many theories explain the pathology of tinnitus. Vielsmeier et al. [4] and Henry et al. [5] reported that tinnitus caused by changes in neuroplasticity in the central auditory center. These occur when pathology in the cochlea changes the normal input to the brain. Seidman et al. [6] reported that persons with hearing loss had a higher prevalence of tinnitus than in the normal-hearing population. In addition, Seidman et al. [6] reported a higher incidence of tinnitus in persons with hearing loss compared with the normal-hearing population. There are many classification systems for tinnitus due to its complexity. One of these classification systems

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divided tinnitus into two categories: subjective and objective tinnitus. Subjective is audible only to the affected individual. The severity of sounds ranges from a quiet background noise to a loud noise [7]. Otherwise, objective tinnitus (sometimes referred to as somatic tinnitus) is generated by muscular structures or vascular structures in the head and neck area. It is audible to anyone in addition to the affected individual [8]. Other classifications of tinnitus are classified tinnitus based on the function and anatomy of the auditory system. It classified tinnitus into three divisions including conductive, sensorineural, and central tinnitus [9]. Coles [10] classified tinnitus into five main types: (a) physiological, (b) spontaneous otoacoustic emissions, (c) temporary dysfunctional, (d) pathological, and (e) pseudotinnitus. Pathological tinnitus is the largest group of these five types. It is subdivided into extraauditory, intraauditory, and associated tinnitus. Extraauditory is related to muscular and vascular structures in the area of the head and neck while intraauditory includes conductive tinnitus and sensorineural tinnitus (sensorineural tinnitus containing peripheral and central subtypes) and associated tinnitus containing cervical and temporomandibular subtypes. Temporomandibular joint (TMJ) dysfunction may be a root cause of tinnitus more than hearing loss, and there are associations between present tinnitus and TMJ dysfunction [11]. This type of tinnitus, called somatic tinnitus, is caused by spasms or movement to or in the jaw [12,13]. Patients with temporomandibular dysfunction had an incidence of tinnitus of 11.46 % [14]. The assessment of the perception of tinnitus is difficult; fundamentally, it is only reported by the patient himself (self-phenomenon), and specific details regarding the characteristics of tinnitus are important [15]. Tinnitus is one of the most frustrating clinical problems for the patient; it leads to a total disruption of lifestyle and causes disturbances in sleep and concentration [16]. As regards assessment of specific aspects of tinnitus, there are different questionnaires available, one of these questionnaires is the Tinnitus Handicap Inventory (THI) [17] and this questionnaire is widely used. In the management of tinnitus, our golden goal is the reduction of perception of the annoyance caused by tinnitus or perception of tinnitus itself [18]. Tinnitus retraining therapy (TRT) is a method used in the management of tinnitus with two important items, which include directive counseling and sound therapy. In directive counseling, the patient must change his thought about tinnitus and must take simple information about the auditory system as regards its anatomy, its function, and the pathophysiology of the mechanism of tinnitus generation [19]. The second item of TRT is sound therapy, which takes a long time for habituation to the sound. This duration may be 12 months, in addition the patients must continue to use this therapy for another 6 months to confirm from established neural plasticity of the brain [20]. The sound used in this method is adjusted at or just below the mixing point (where the tinnitus and the noise begin to mix known as the mixing point).

Another approach to the treatment of tinnitus is oral appliances that protect the teeth from harm caused by clenching or grinding. There is evidence regarding their effects on muscular activity; some studies reported that some participants had decreased muscle activity while using them while others found an increase [21] (Fig. 1).

2. Aim

This study aims to evaluate the best methods of treatment for patients complaining of tinnitus and TMJ dysfunction.

3. Patients and methods

For this comparative, prospective cohort study conducted from December 2022 to May 2023, we recruited 80 individuals who consented to take part in this study. The Research Ethics Committee (REC) of the General Organization of Teaching Hospitals and Institute with acceptance code IHS 00053 and the College of Dental Medicine for Girls, Al-Azhar University gave its approval with the final code REC-PD-23-17 and the study was conducted in accordance with guidelines.

Patients were recruited from Hearing and Speech Institute's Otolaryngologist Outpatient Clinics and from the Faculty of Dental Medicine.

The dentist from the Oral Medicine assessed vulnerable patients, who had TMJ dysfunction to confirm the diagnosis method based on the Research Diagnostic Criteria of TMDs [22].

All candidates were evaluated according to the inclusion criteria and fully examined by an otolaryngologist. Patients' age group ranged from 18 to 60 years; acceptance by ENT, Oral Medicine, and audiological assessment were required to complete this research. The control group of normal people (i.e. those who not complaining of tinnitus or temporomandibular dysfunction) were collected from patient relatives and hospital staff. The exclusion criteria included: patients older than 60 years, patients with inflammation affecting either the external or middle ear, parotitis, acute teeth

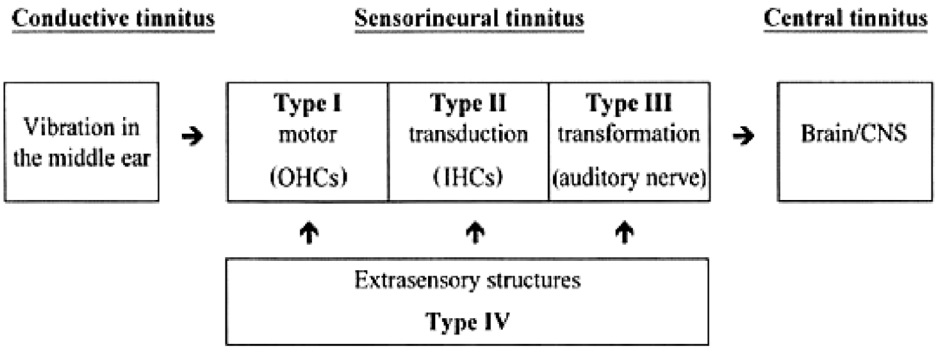

Fig. 1. Systematic generation mechanisms of subjective tinnitus [9].

infection, or intracranial pathology as detected by history. We apply the same exclusion criteria to the control group.

A systemic review of the body systems was conducted to evaluate cardiovascular, endocrine, and renal systems to exclude other causes of tinnitus. It was mandatory to examine the head and neck, which included thyroid examination, TMJ function, neck mobility, and the effect of neck turning; in addition, auscultation of specific areas including area over the neck, periauricular area, orbits, and mastoid should be performed. It is essential to conduct jugular vein compression tests on tinnitus (to rule out pulsating tinnitus). The venous origin of the tinnitus was examined by compression of the ipsilateral jugular vein.

The THI questionnaire was available in Arabic form to assess specific aspects of patients with tinnitus. The THI questionnaire consists of 25 items divided into three subscales: functional, emotional, and catastrophic. The functional subscale consists of 11 items assessing role limitations, while the emotional subscale consists of nine items assessing affective responses to tinnitus, and the catastrophic subscale consists of five items assessing the most severe reactions of tinnitus itself and we used the total score (if the total score is < 0−25 %, it indicates a mild degree of distress; if the total score is < 25−50 % it indicates a moderate degree of distress; if the total score is < 50−75 % it indicates moderate to severe degree of distress; if the total score is < 75−100 %, it indicates a severe degree of distress) [23].

3.1. Sample size calculation

The study's sample size was calculated using the formula $n=(Z2+p\ (1p)/e2)$, where $Z = 1.96$ for a 95 % confidence level (a), P the proportion (provided as a decimal), and e is the margin of error. $Z = 1.96$, $P = 0.04$, $e = 0.05$, $n = 8$. The final sample sizes for this study are 80 for all groups, which were divided into 20 participants in each group [24].

The study groups consisted of 80 participants divided into four groups. Group A, the control group, consisted of 20 individuals who had not complained of TMJ dysfunction or tinnitus and this group had not received any intervention. The other three groups consisted of 60 patients who had complained of TMJ dysfunction of not less than 3 months duration and tinnitus, and each group consisted of 20 individuals treated using different methods. Group B underwent TRT (which includes directive counseling and sound therapy). In group C, patients received oral appliance therapy, and they underwent a stabilization splint, which was manufactured as described by the author, and any additional adjustments would be performed if needed. The occlusal splint was being worn by the patients 12 h per day for 3 weeks. All patients were provided care by the same dentist. The fit of the splints on the occlusal surfaces on teeth 16 and 26 was noted [25].

In group D, patients had taken medications and were treated for 4 weeks with topical applied anti-inflammatory nonsteroidal gel by massaging four times per day with diclofenac diethylammonium 1 % gel over the masseter and temporalis area) with oral anti-inflammatory nonsteroidal (ibuprofen 400 mg tablets three times a day for 3 weeks) and muscle relaxant (cyclobenzaprine tablet once daily before bedtime which is centrally acting for 2 weeks) [26,27]. Testing was implemented in a room that is sound isolated from the surrounding noise. The number of model of that room is RE. 24; in addition, we used an immettancemeter which is a calibrated acoustic; its model is AZ26 (interacoustics) with a tone of 220 Hz (which delivered a low-frequency tone). We used the pure tone audiometer model AC40 to deliver pure tone to the participant manually through its headphones and a bone vibrator. The headphone models are AC40 and the bone

vibrator B71. All participants underwent through history taking, which included a full history of audiological diseases, and the audiological evaluations which included calibrated pure tone tests for both air conduction within a frequency range of 250–8000 Hz and calibrated bone conduction within a frequency range 500–4000 Hz. We also carried out both speech perception threshold (SRT) and discrimination of word score (WDS) for all participants.

3.2. Specific tinnitus tests

Tinnitus matching tests for the study group included pitch matching, loudness matching, minimal masking level (MML), and residual inhibition (RI). These tests were applied to the tinnitus ear. These tinnitus tests are important for TRT by individualized counseling purposes.

3.2.1. Pitch matching procedure

A series of pure tones are presented in an ascending manner, and the patient has to decide the frequency at which the tone most resembles his dominant tinnitus sound [28].

3.2.2. Loudness matching measure

Tinnitus loudness matching is obtained at the pitch-matched frequency. The examiner varies the stimulus in an ascending mode to diminish the effect of RI [28].

3.2.3. Minimum masking level

The MML is defined as the level at which broadband noise higher to the level that tinnitus become inaudible by the individual [29]. First we used the masking noise at zero intensity level, and then we gradually increased the amplitude slowly and with each step we asked the patient to indicate when the noise becomes audible and we must record this point. Then we increased amplitude of the noise in small steps until the patient indicated that his tinnitus was no longer not audible. This point is known as the complete masking level and the sound level corresponding to this point is known as the MML and it is recorded in dBSL [29].

3.2.4. Residual inhibition

RI involves a temporary decrease or complete removal of tinnitus, after a period of masking. RI is induced by using masking noise above the MML by 10 dB intensity for 60 s. Subsequently, the masking noise is removed and the patient is asked to report how their tinnitus sounds [30]. The following were the assessments:

(1) Complete positive RI: this means complete absence of tinnitus following the offset of masking noise.
(2) Partial positive RI: this means decreased perception of loudness level of tinnitus for a small period and this loudness of perception of tinnitus returning to its normal level.
(3) Negative: no change in tinnitus loudness.
(4) Rebound: increase in tinnitus loudness level above its original level.

4. Result

The present study conducted on a total number of 80 adult participants, who were classified into four groups: each group comprised 20 individuals. The group A (control group) comprise 20 individuals free from TMJ dysfunction or tinnitus; the mean age for this group was 35.35 ± 8.70 years with an age range of 21–53 years (11 females, nine males). Group B comprised 20 individuals who complained of TMJ dysfunction and tinnitus treated with TRT, and the mean age for this group was 35.2 ± 9.35 years with an age range of 22–55 years (12 females, eight males). Group C comprised 20 individuals who complained of TMJ dysfunction and tinnitus treated a night guard; the mean age for this group was 34.65 ± 8.60 years with an age range of 23–55 years (10 females, 10 males). Group D comprised 20 patients who complained of TMJ dysfunction and tinnitus treated with medication; the mean age of this group was 35.8 ± 10.14 years with an age range of 20–52 years (nine females, 12 males).

The onset of TMJ dysfunction among group B is 11.2 ± 10.87 months, while in group C is 5.45 ± 6.49 months, finally among group D, it is 11.15 ± 4.49 months (Table 1).

All participants have a normal peripheral hearing thresholds in the frequency range of 250–8000 Hz, according to selection criteria.

Table 2 shows the highly statistically significant difference before and after the use of TRT in patients who complained of TMJ dysfunction and tinnitus.

Table 3 shows no statistically significant difference before and after using a night guard in patients complaining of TMJ with tinnitus.

Table 4 shows a statistically significant difference before and after the use of medication in patients who complained of TMJ dysfunction and tinnitus.

Table 5 shows a highly statistically significant difference in patient complaining of TMJ dysfunction and tinnitus used TRT (group B) before and after using therapy and group C (patients complained of TMJ dysfunction and tinnitus used a

Table 1. Pure tone threshold of both ears among all candidates.

Group A	Variables	Right		Left	
		Mean	SD	Mean	SD
	250 Hz	14.75	3.97	17.25	4.93
	500 Hz	17.00	4.23	15.00	3.99
	1000 Hz	18.75	3.44	17.75	3.75
	2000 Hz	20.00	4.75	20.75	3.75
	4000 Hz	17.50	6.23	17.75	6..97
	8000 Hz	18.00	3.23	20.00	5.62
Group B	250 Hz	22.25	4.06	20.00	3.75
	500 Hz	17.00	4.61	17.00	4.78
	1000 Hz	10.50	4.23	12.75	5.87
	2000 Hz	10.25	5.19	17.50	4.23
	4000 Hz	17.50	4.70	14.50	5.23
	8000 Hz	17.50	5.23	20.00	4.79
Group C	250 Hz	17	4.10	17.00	4.10
	500 Hz	22.75	2.91	18.75	21.91
	1000 Hz	19.25	2.44	17.25	2.44
	2000 Hz	18.75	2.75	18.75	2.75
	4000 Hz	18.75	3.93	18.75	3.93
	8000 Hz	20	2.81	20.00	2.80
Group D	250 Hz	13	6.78	15	4.18
	500 Hz	11.5	3.57	14.5	4.44
	1000 Hz	12.25	5.58	9.75	4.02
	2000 Hz	10.5	4.97	11	4.06
	4000 Hz	10.75	4.54	9.75	5.58
	8000 Hz	14.75	6.79	17	5.33

Table 2. The t test to compare Tinnitus Handicap Inventory questionnaire in group B (patients complained of temporomandibular joint dysfunction and tinnitus used tinnitus retraining therapy), before and after use of tinnitus retraining therapy.

Group B	THI				*t* test	*P* value
	Before TRT		After TRT			
	Mean	SD	Mean	SD	6.340	0.000[a]
	51.50	17.30	28.70	9.36		

TRT, tinnitus retraining therapy.
[a] Highly statistically significant difference ($P < 0.01$) and no statistically significant difference ($P > 0.01$).

night guard), and group D (patients complained of TMJ dysfunction and tinnitus used medication).

Table 6 shows that there is no statistically significant effect on the duration of TMJ dysfunction and tinnitus using the three methods of treatment of tinnitus in all study groups.

Table 3. The t test to compare Tinnitus Handicap Inventory questionnaire in group C (patients complaining of temporomandibular joint with tinnitus used a night guard), before and after using a night guard.

Group C	THI				*t* test	*P* value
	Before night guard		After night guard			
	Mean	SD	Mean	SD	5.77	0.526[a]
	47.00	15.08	44.00	15.12		

[a] Highly statistically significant difference ($P < 0.01$) and no statistically significant difference ($P > 0.01$).

Table 4. The t test to compare Tinnitus Handicap Inventory questionnaire in group D (patients complained of temporomandibular joint dysfunction and tinnitus used medication) before and after used medication.

Group D	THI				*t* test	*P* value
	Before medication		After medication			
	Mean	SD	Mean	SD	6.555	0.008[a]
	40.30	11.20	32.65	8.92		

[a] Statistically significant difference ($P < 0.01$) and no statistically significant difference ($P > 0.01$).

Table 5. Analysis of variance test of Tinnitus Handicap Inventory questionnaire test of the three study groups.

THI	Group B		Group C		Group D		*F*	*P* value
	Mean	SD	Mean	SD	Mean	SD		
Before	51.50	17.30	47.00	15.08	40.30	11.20	2.921	0.062
After	28.70	9.36	44.00	15.12	32.65	8.92	9.55	0.000[a]

[a] Highly statistically significant difference ($P < 0.01$) and no statistically significant difference ($P > 0.01$).

Figure 2 illustrates the receiver operating characteristic curve for group B (the patients complained of TMJ dysfunction and tinnitus using TRT). Receiver operating characteristic curve for group B, the area under the curve is 0.866 with a significant *P* value and a cutoff value of more than 0.34 with a sensitivity 75 %, specificity of 85 % with a95 % confidence interval from 0.721 to 0.953.

Figure 3 shows that the receiver operating characteristic curve for group C (patients complaining of TMJ dysfunction and tinnitus used a night guard). Receiver operating characteristic curve for group C, the area under the curve is 0.57 with a significant *P* value and a cutoff value of more than 0.44 with a sensitivity of 45 %, specificity of 55 % with a 95 % confidence interval from 0.411 to 0.732.

Figure 4 demonstrates the receiver operating characteristic curve for group D (patients complaining TMJ dysfunction with tinnitus used medication). Receiver operating characteristic curve for

Table 6. Pearson's correlation coefficient between three methods of treatment of tinnitus and duration of temporomandibular joint.

THI questioner	Group B	Duration	
		r	*P* value*
	Before	−0.006	0.981
	After	−0.312	0.181
	Group C		
	Before	−0.036	0.881
	After	−0.047	0.844
	Group D		
	Before	−0.01	0.966
	After	0.177	0.456

**P* value more than 0.05 not significant.

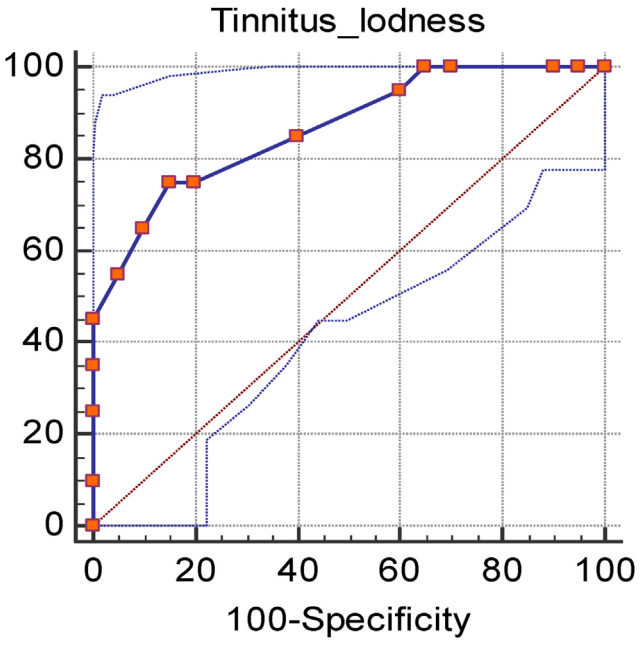

Fig. 2. ROC curve for group B (patients complaining of TMJ with tinnitus used sound therapy and a night guard). ROC, receiver operating characteristic; TMJ, temporomandibular joint.

group D, the area under the curve is 0.713 with a significant *P* value and a cutoff value of more than 0.32 with a sensitivity of 60 %, specificity of 60 % with a 95 % confidence interval from 0.548 to 0.844.

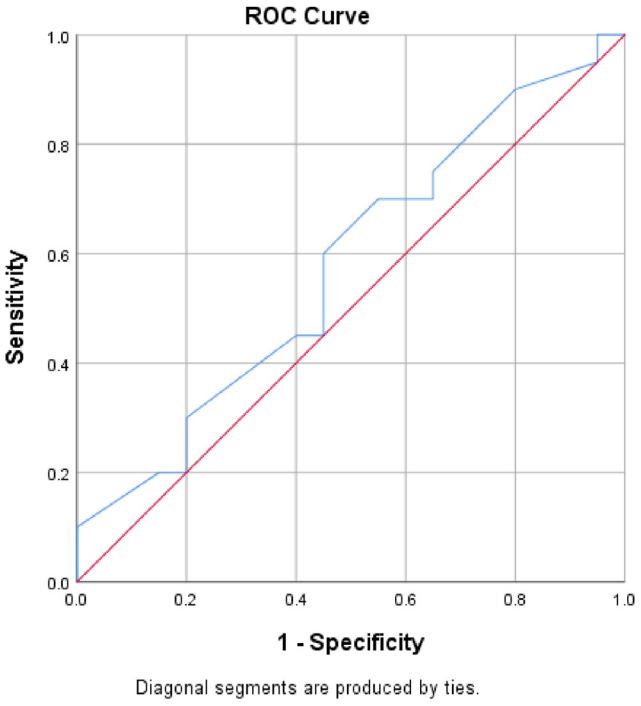

Fig. 3. ROC curve for group B (patients complained of TMJ dysfunction and tinnitus used a night guard). ROC, receiver operating characteristic; TMJ, temporomandibular joint.

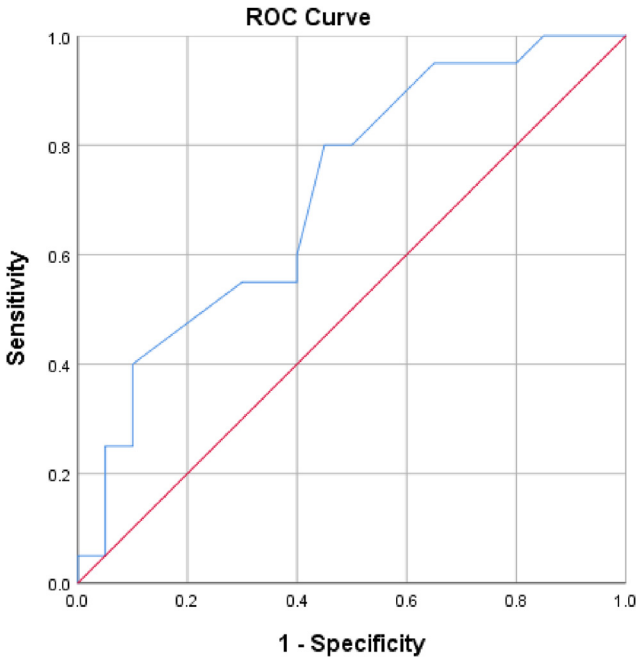

Fig. 4. ROC curve in group D (patients complaining of TMJ dysfunction with tinnitus used medication). ROC, receiver operating characteristic; TMJ, temporomandibular joint.

5. Discussion

Tinnitus has an impact on the quality of life [31]. More than 25 % of patients experience tinnitus and the intensity of loudness of tinnitus increase over time [32]. Tinnitus causes multiple psychological and somatic disorders that can alter the patient's quality of life [15]. The ultimate goal of our research is to investigate the different best methods of treatment in patients with tinnitus and TMJ dysfunction. This type of tinnitus is called objective or somatic tinnitus [8]. Somatic or objective tinnitus is associated with nonauditory structures. In this type, tinnitus is reinforced by many factors such as movements and manipulations of the eyes or movement of the head, neck, jaw, and shoulders. These movement can alter the perception of tinnitus loudness and pitch [33].

In this study, we compare the three groups of patients who complained of TMJ dysfunction and tinnitus treated with three different methods, which were TRT (group B), night guard (group C), and medication (group D). In our research, we used the THI questionnaire, which offers many advantages: it is easily administered and scored, required short time. In addition, it assesses many available treatment interventions, covering the domains of function in the management of tinnitus. We used the

THI questionnaire before starting and after completing any method of treatment. The reliability of these methods (including test–retest data) help physicians in assessing the treatment's effectiveness [34].

When comparing the results of the THI questionnaire in group B, which included patients complaining of TMJ dysfunction and tinnitus treated with TRT, we found a highly statistically significant difference before and after using this therapy (Table 2). These findings agree with Baracca et al. [35] who reported that directive counseling changes the way of perception of tinnitus and the patient must change his thought about tinnitus and must take simple information about the auditory system as regards its anatomy, its function, and pathophysiology of mechanism of tinnitus generation. In addition, sound therapy decreases the difference between tinnitus and a silent environment, which leads to a reduced detection of tinnitus [35]. When comparing the results of the THI) questionnaire in group C, which assessed patients who complained of TMJ dysfunction and tinnitus using a night guard, we found a nonstatistically significant difference before and after using the night guard (Table 3). As regards studies that investigated the effect of conservative TMJ treatment on somatic tinnitus, they coincide with evidence-based practices for TMJ treatment. Patients with TMD and tinnitus are thought to be improved clinically if the TMJ dysfunction is treated. So, the use of best treatment to TMJ dysfunction consequently improves the tinnitus complaint. Bosel et al. [36] applied self-therapy alongside splint therapy, whereas Tuncer et al. [37] observed that home physical therapy alone was less effective in treatingTMD pain and achieving pain-free maximal mouth opening.

On comparing the results of the THI questionnaire in group D, which assessed patients complaining of TMJ dysfunction and tinnitus using medication, a significant difference was observed before and after using treatment method (Table 4). According to our results, regarding group D that improved by medication, the patient's satisfaction may be due to decreased pain and the anti-inflammatory effect of medical therapy, leading to a sense of tinnitus improvement, which agrees with the results of Ouanounou et al. [38]. Pharmacotherapy for the treatment of TMJ dysfunction is widely used and easily tolerated by patients.

In the study, Table 5 displays a statistically significant high score method of improvement of the perception of the loudness of tinnitus using TRT followed by the use of medication. However, the night guard demonstrated a statistically significant low score in improving the perception of tinnitus loudness. Our findings agree with Jastreboff [39] and Hallam et al. [40], who speculated that directive counseling have a big role in managing tinnitus. Moreover, all therapies available in the management of tinnitus based on sound therapies basically used counseling [41].

In this study (Table 6), there are no statistically significant differences noticed for patients with TMJ dysfunction with tinnitus as regards the duration of effect of TMJ dysfunction across all study groups. The absence of correlation does not support the absence of feedback connection. Our speculation regarding these scenarios is that the onset of TMJ dysfunction symptom flare-ups that last from a few hours to many days and even with a short duration of TMJ dysfunction does not lead to a different perception of the loudness of tinnitus either before or after using any of the three methods used in managing the patients.

In assessing the sensitivity and specificity of each method in managing tinnitus with TMJ dysfunction (Tables 7–9) using the receiver operating

Table 7. Sensitivity and specificity of tinnitus retraining therapy test in group B (patients complaining of temporomandibular joint dysfunction with tinnitus used tinnitus retraining therapy).

Group B	Area under curve	Cut off value	Asymptotic significance[b]	Asymptotic 95 % confidence interval		Specificity	Sensitivity
				Lower bound	Upper bound		
	0.866	>0.34	.0001	0.721	0.953	85 %	75 %

Table 8. Sensitivity and Specificity of sound retraining therapy test in group C (patients complaining of temporomandibular joint dysfunction with tinnitus and used a night guard).

Group C	Area under curve	Cut off value	Asymptotic significance[b]	Asymptotic 95 % confidence interval		Specificity	Sensitivity
				Lower bound	Upper bound		
	0.57	>0.44	0.39	0.411	0.732	55 %	45 %

Table 9. Sensitivity and specificity of sound retraining therapy test in group D (patients complaining of temporomandibular joint dysfunction and tinnitus used medication).

Group D	Area under curve	Cutoff value	Asymptotic significance[b]	Asymptotic 95 % confidence interval		Specificity	Sensitivity
				Lower bound	Upper bound		
	0.713	>0.32	0.0.009	0.548	0.844	60 %	60 %

characteristic curve, we notice that the more specific and sensitive approach is TRT followed by the medication. In addition, using a night guard is a less sensitive and less specific method than the two previously mentioned methods. We speculate that TRT is a method aimed at habituating tinnitus reactions of the brain and tinnitus perception and the best method of management.

5.1. Conclusion

For patients who complain of TMJ dysfunction and tinnitus, TRT and medication can improve tinnitus for these patients, and they are the most sensitive and specific method of management.

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Conflicts of interest

There are no conflicts of interest.

References

[1] Langguth B, Kleinjung T, Landgrebe M. Tinnitus: the complexity of standardization. Eval Health Prof 2011;34:429.
[2] Jastreboff P. Tinnitus as a phantom perception: theories and clinical implications. In: Vernon J, Møller A, editors. Mechanisms of tinnitus. Needham Heights, MA: Allyn & Bacon; 1995. p. 73–93.
[3] Jastreboff P. Phantom auditory perception (tinnitus): mechanisms of generation and perception. Neurosci Res 1990;8: 221–54.
[4] Vielsmeier V, Kleinjung T, Strutz J, Burgers R, Kreuzer PM, Langguth B. Tinnitus with temporomandibular joint disorders: a specific entity of tinnitus patients? Otolaryngol Head Neck Surg 2011;145:748.
[5] Henry J, Larry E, Donald M, Sarah M, Richard J. Underlying mechanisms of tinnitus: review and clinical implications. J Am Acad Audiol 2014;25:5–22.
[6] Seidman M, Jacobson G. Update on tinnitus. Otolaryngol Clin 1996;29:455–65.
[7] Stouffer J, Tyler R. Characterization of tinnitus by tinnitus patients. J Speech Hear Disord 1990;34:197.
[8] Lockwood A, Salvi R, Burkard R. Tinnitus. New Engl J Med 2002;347:904–10.
[9] Zenner H, Pfister M. Systematic classification of tinnitus. In: Proceeding of the sixth international tinnitus seminar. vols. 17–19. Special edition; Germany, 1999.
[10] Coles R. Epidemiology, aetiology and classification. In: Vernon J, Reich G, editors. Proceedings of the fifth international tinnitus seminar. Portland: American Tinnitus Association; 1996. p. 25–30.
[11] Henry J, Larry E, Donald M, Sarah M, Richard J. Underlying mechanisms of tinnitus: review and clinical implications. J Am Acad Audiol 2014;25:5–22.
[12] Hilgenberg-Sydney PB, Saldanha AD, Lopes AC, Conti PC. Audiological evaluation of patients with somatosensory tinnitus attributed to temporomandibular disorders. Am J Audiol 2020;29:930–4.
[13] Michiels S, Ganz Sanchez T, Oron Y, Gilles A, Haider HF, Erlandsson S, et al. Diagnostic criteria for somatosensory tinnitus: a delphi process and face-to-face meeting to establish consensus. Trends Hear 2018;22:233121651879 6403.
[14] Çebi AT. Presence of tinnitus and tinnitus-related hearing loss in temporomandibular disorders. Cranio 2020;2:1–5.
[15] Shargorodsky J, Curhan G, Farwell W. Prevalence and characteristics of tinnitus among US adults. Am J Med 2010; 123:711–8.
[16] Parnes S. Current concepts in the clinical management of patients with tinnitus. Eur Arch Oto-Rhino-Laryngol 1997; 254:406–9.
[17] Newman C, Jacobson G, Spitzer J. Development of the tinnitus Handicap inventory. Arch Otolaryngol Head Neck Surg 1996;122:143–8.
[18] Clark J. Counseling in audiological practice: helping patients and families adjust to hearing loss. New York: Pearson Education; 2004.
[19] Jastreboff P, Jastreboff M. Tinnitus retraining therapy (TRT) as a method for treatment of tinnitus and hyperacusis patients. J Am Acad Audiol 2000;11:162–77.
[20] Jastreboff P, Gray W, Gold S. Neurophysiological approach to tinnitus patients. Am J Otolaryngol 1996;17:236–40.
[21] Beddis H, Pemberton M, Davies S. Sleep bruxism: an overview for clinicians. Br Dent J 2018;225:6.
[22] Em Ashour FA, Khalifa GA. Khalifa - Al-Azhar dental Journal for Girls, vol. 8, No. 1. January (2021). journals.ekb.eg. p. 91–7.
[23] Baguley D, Andersson G. Factor analysis of the tinnitus Handicap inventory. Am J Audiol 2003;12:31–4.
[24] Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med 2013;35:121–6.
[25] Laurent M, Scheer P, Dejou J, Laborde G. Clinical evaluation of the marginal fit of cast crowns-validation of the silicone replica method. J Oral Rehabil 2008;35:116–22.
[26] Mujakperuo H, Watson M, Morrison R, Macfarlane T. Pharmacological interventions for pain in patients with temporomandibular disorders. Cochrane Database Syst Rev 2010;10:CD004715.
[27] Ouanounou A, Goldberg M, Haas D. Pharmacotherapy in temporomandibular disorders: a review. J Can Dent Assoc 2017;83:h7–8.
[28] Henry J, Dennis K, Schechter M. General review of tinnitus: prevalence, mechanisms, effects, and management. J Speech Lang Hear Res 2005;48:1204–35.
[29] Jastreboff P, Hazell J, Graham R. Neurophysiological model of tinnitus: dependence of the minimal masking level on treatment outcome. Hear Res 1994;80:216–32.
[30] Vernon J, Meikle M. Measurement of tinnitus: an update. In: Kitahara M, editor. Tinnitus. Pathophysiology and management. Tokyo: Igaku-Shoin; 1988. p. 36–52.

[31] Henry J, Wilson P. The psychological management of chronic tinnitus. Needham Heights, MA: Allyn & Bacon; 2001.
[32] Stouffer J, Tyler R. Characterization of tinnitus by tinnitus patients. J Speech Hear Disord 1990;34:197.
[33] Simmons R, Dambra C, Lobarinas E, Stocking C, Salvi R. Head, neck, and eye movements that modulate tinnitus. Semin Hear 2008;29:361–70.
[34] Langguth B, Searchfild G, Biesinger E, Greimel K. History and questionnaires. In: M0ller A, Langguth B, DeRidder D, Kleinjung T, editors. Textbook of tinnitus. New York: Springer; 2010. p. 103–12.
[35] Baracca G, Forti S, Crocetti A, Fagnani E, Scotti A, Bo L, et al. Results of TRT after eighteen months: our experience. Int J Audiol 2007;46:217–22.
[36] Bosel C, Mazurek B, Haupt H, Peroz I. Chronic tinnitus and craniomandibular disorders. Effectiveness of functional therapy on perceived tinnitus distress. HNO 2008;56:707–13.
[37] Tuncer AB, Ergun N, Tuncer AH, Karahan S. Effectiveness of manual therapy and home physical therapy in patients with temporomandibular disorders: a randomized controlled trial. J Bodyw Mov Ther 2013;17:302–8.
[38] Ouanounou A, Goldberg M, Haas D. Pharmacotherapy in temporomandibular disorders: a review. J Can Dent Assoc 2017;83:h7–8.
[39] Jastreboff P. Tinnitus habituation therapy (THT) and tinnitus retraining therapy (TRT). In: Tyler R, editor. Tinnitus handbook. San Diego: Singular Publishing Group; 2000. p. 357–76.
[40] Hallam R, Rachman S, Hinchcliffe R. Psychological aspects of tinnitus. In: Rachman S, editor. Contributions of medical psychology, vol. 3. Oxford: Pergamon Press; 1984. p. 31–53.
[41] Tyler R. Neurophysiological models, psychological models, and treatments for tinnitus. In: Tyler R, editor. Tinnitus treatment: clinical protocols. New York: Thieme Medical Publishers; 2006. p. 1–22.