

# The Relationship between Tinnitus and Temporomandibular Disorder (TMD) Therapy

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**Abstract:** Many TMD patients with coexisting tinnitus find TMD therapy improves or resolves their tinnitus in conjunction with their TMD symptoms (Table I). Forty TMD patients rating their tinnitus as moderate or severe, were asked questions and participated in clinical tests. Upon completion of TMD therapy, 21, 12, 7 and 0 reported their tinnitus was resolved, significantly improved, unchanged and worse, respectively. The subjects' ages, question results and clinical test results were statistically evaluated for an association with their tinnitus change. The following were identified as significantly associated with tinnitus improvement when the patient reports: they are younger in age, their tinnitus is moderate rather than severe, their hearing is normal, their tinnitus began approximately when their TMD symptoms began, their tinnitus is worse when their TMD symptoms are worse, their tinnitus is related to stress, their tinnitus is unrelated to loud noise and their tinnitus is reproduced or intensified from one minute of maximum voluntary clenching on their posterior teeth. These findings may help forecast which tinnitus patients with concomitant TMD may obtain tinnitus improvement through TMD therapy.

## INTRODUCTION

S hulman<sup>1</sup> reported that a temporomandibular disorder (TMD) can be the etiology for subjective idiopathic tinnitus (SIT) and speculated that one of the problems physicians have in identifying TMD's role in SIT is due to the difficulty in diagnosing TMD.<sup>1</sup>

TMD encompasses a collection of medical and dental conditions affecting the temporomandibular joint (TMJ), masticatory muscles and/or contiguous structures. These conditions are linked by their common signs and symptoms which include one or more of the following: pain or tenderness of the masticatory muscles and/or the TMJ, sounds in the TMJ during jaw movement, and/or limitation of opening.<sup>2</sup>

These findings are very prevalent. It is estimated that 75 percent of the general population have at least one sign and 33 percent have at least one symptom but only 5-7 percent have symptoms severe enough to warrant them seeking TMD treatment.<sup>3</sup>

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TMD symptoms greatly vary from patient to patient. A study summarizing the symptoms of a group of 164 patients with TMD symptoms, reported the two most common words patients used to describe the quality of their pain were pressure (48%) and dull (27%), but throbbing (26%), sharp (18%), burning (16%) and heavy (14%) were also frequently used.<sup>5</sup> The location of the pain also greatly varies. These patients reported the most frequent locations of their pain were in the jaw (64%), TMJ (56%), temple (52%), ear (42%) and post-auricular (37%).<sup>4</sup>

TMD patients often have associated complaints. Many of these patients complained of masticatory fatigue (40%), stiffness (20%), swelling (12%), and weakness (18%) in spite of no observable cranial nerve deficit. Otologic symptoms are also commonly reported among TMD patients. Many of these patients reported tinnitus (42%), ear pain (42%), dizziness (23%) and diminished hearing (18%).<sup>4</sup>

The most frequent TMD signs are masticatory muscle, TMJ noise and/or TMJ tenderness upon palpation. TMJ noise may be noticeable to the patient, consisting of single or multiple clicks and/or crepitus that are often associated with a TMJ disc displacement and/or osteoarthritis.<sup>5</sup> TMJ noise per se does not constitute the need for TMD therapy,<sup>6</sup> but can be associated with

**Table I:** Tinnitus change following TMD therapy

Study	Percent of TMD Patients with Tinnitus	Number of Subjects	Results with TMD Therapy			
			Tinnitus Resolved Percent (#)	Tinnitus Improved Percent (#)	Tinnitus Resolved or Improved Percent (#)	No Change in Tinnitus Percent (#)
Kelly et al. <sup>9</sup>	—	46	43 (20)	37 (17)	80 (37)	20 (9)
Gelb et al. <sup>10</sup>	58	26	65 (17)	31 (8)	96 (25)	4 (1)
Gelb et al. <sup>11</sup>	34	38	37 (14)	45 (17)	82 (31)	18 (7)
Bernstein et al. <sup>12</sup>	42	28	—	—	75 (21)	25 (7)
Rubinstein et al. <sup>13</sup>	25	57	—	—	46 (26)	54 (31)
Kerstein <sup>14</sup>	23	23	—	—	83 (19)	17 (4)
Bush <sup>15</sup>	33	35	31 (11)	54 (19)	86 (30)	14 (5)

more severe TMD symptoms, if progressive, interfering or painful.<sup>7</sup>

Tinnitus prevalence among TMD patients is reported higher than age matched controls.<sup>8</sup> Studies monitoring TMD patients with coexisting tinnitus report 46 to 96 percent have tinnitus improvement or resolution from TMD therapy (Table I).<sup>9-15</sup> A survey taken two years after TMD therapy suggests the tinnitus improvement is sustained over time.<sup>13</sup> Many hypotheses have been proposed for the TMD/tinnitus association but no consensus for any one theory appears to be developing.<sup>16,17</sup>

Some tinnitus characteristics, associations and clinical tests have been suggested as helpful in identifying which patients with coexisting TMD and tinnitus will obtain tinnitus improvement from TMD therapy. Erlandsson et al.<sup>18</sup> suggested TMD patients with normal hearing, low tinnitus intensity and fluctuations in tinnitus intensity would obtain tinnitus improvement from TMD therapy.

Through a questionnaire, Vernon et al.<sup>19</sup> attempted to separate tinnitus patients in an otolaryngology clinic into TMD and non-TMD groups. Significantly more subjects in the TMD group reported tinnitus alterations from jaw movement, pain in the ipsilateral ear, fullness in the ipsilateral ear and more than one tinnitus sound. It was speculated that these features may also predict which TMD patients with coexisting tinnitus would obtain tinnitus improvement through TMD therapy.

Rubinstein et al.<sup>20</sup> divided tinnitus patients into TMD and non-TMD groups based on presence or absence of TMD symptoms and reported subjects in the TMD group had gradual tinnitus onset more often than in the non-TMD group. This study suggests gradual tinnitus onset may be another predictor for tinnitus improvement from TMD therapy. Shulman<sup>1</sup> speculated that patients with SIT would also report a history of gradual tinnitus onset.

Clinical tests might further be able to identify TMD patients whose tinnitus would improve through therapy. Shulman<sup>1</sup> speculated if tinnitus patients can intensify their tinnitus by clenching their teeth, TMD is contributing to their tinnitus. Rubinstein et al.<sup>21</sup> observed

audiology clinic patients who reported tinnitus alteration when pressure was applied to the ipsilateral TMJ, load was applied to the ipsilateral TMJ and resistance applied against mouth opening or protruding. Additionally, palpation of the deep masseter, medial pterygoid, lateral pterygoid and sternocleidomastoid muscles have been reported to reproduce or intensify a patient's tinnitus.<sup>22</sup> Since TMD therapy helps resolve TMJ and masticatory muscle tenderness, positive clinical tests that reproduce or intensify a patient's tinnitus might predict patients who would have tinnitus improvement from TMD therapy.

This prospective study assessed TMD patients for tinnitus characteristics, tinnitus associations and clinical test results to determine if any variables would identify TMD patients whose tinnitus would improve or resolve with TMD therapy.

## SUBJECTS AND METHODS

Two hundred and sixty-seven TMD patients referred to a TMD specialty clinic, diagnosed with TMD, were asked if they had ringing or buzzing in their ear or head. One hundred and one patients positively responded to this question. Only 42 rated their tinnitus as moderate or severe and were enrolled in this study. Participants were asked about their tinnitus characteristics and associated questions (Tables II and III). The pitch of their tinnitus was determined by asking the subject to select one of three categories which most accurately identified its range: below, within or above voice range. Subjects also participated in clinical tests (Table IV) to determine whether tests reproduced or intensified their tinnitus. The chosen questions and clinical tests were based upon the suggestions derived from the literature and clinical experience. The tinnitus frequency was rated as constant, daily (occurring every day but not constant), weekly (occurring every week but not every day) or monthly (occurring every month but not every

**Table II:** Characteristics of tinnitus in a TMD patient population with notable tinnitus

	Subjects: Mean age* (SD):	Group 1	Group 2	Group 3
		Tinnitus Resolved n = 21 27.9 (9.2)	Significant Tinnitus Improvement n = 12 30.9 (10.5)	No Tinnitus Improvement n = 7 42.3 (18.2)
<i>Frequency</i>	NS			
Constant		3	3	3
Daily		5	6	1
Weekly		11	3	3
Monthly		2	0	0
<i>Duration</i>	NS			
Constant		3	3	3
Hours		2	5	1
Minutes		12	2	2
Seconds		4	2	1
<i>Severity*</i>	P = 0.032			
Moderate		19	9	3
Severe		2	3	4
<i>Pitch</i>	NS			
Below voice range		3	2	0
Within voice range		5	1	1
Above voice range		13	9	6

\* Significant difference, p < 0.05.

week). Tinnitus duration was similarly rated as constant or lasting for hours, minutes or seconds.

The clinical tests were performed in the following manner:

1. Maximum Voluntary Clenching. Subjects were asked to bite on their posterior teeth as hard as they could for one minute but stop if they developed intolerable pain.
2. Jaw Movements. Subjects were asked to maximally move their mandible to the right, left, and forward and open.

3. Pressure Applied to Ipsilateral TMJ. The ipsilateral TMJ was palpated on the lateral pole and posterior aspect with the mouth wide open, using one pound of force for one to two seconds.
4. Loading of Ipsilateral TMJ. Subjects were asked to open slightly (approximately 3 mm). The palm of one hand exerted cranially directed force on the inferior border of the mandible while the palm of the other hand supported the cranium.
5. Mouth Opening Against Resistance. Subjects were instructed to open while approximately one pound of finger pressure resisted their opening.

**Table III:** Tinnitus - TMD questionnaire

Questions	P-Value	Group 1		Group 2		Group 3	
		Yes	No	Yes	No	Yes	No
1. Is your ipsilateral ear hearing normal?	P = 0.003	15	6	8	4	0	7
2. Do you have pain in your ipsilateral ear?	NS	10	11	8	4	2	5
3. Did your tinnitus begin when your TMD symptoms began?*	P = 0.013	15	6	4	8	1	6
4. Is your tinnitus worse when your TMD symptoms are worse?*	P = 0.001	16	5	4	8	0	7
5. Is your tinnitus related to stress?*	P = 0.003	14	7	2	10	0	7
6. Does your tinnitus change with jaw movement?	NS	5	16	5	7	0	7
7. Does your tinnitus fluctuate in intensity?	NS	8	13	4	8	1	6
8. Is your tinnitus accompanied by fullness in your ipsilateral ear?	NS	13	8	7	5	4	3
9. Does your tinnitus have 2 or more sounds?	NS	2	19	3	9	2	5
10. Did/does your tinnitus come on gradually?	NS	5	16	4	8	3	4
11. Is your tinnitus related to loud noise?*	P = 0.0001	5	16	9	3	7	0

\* Significant difference, p < 0.05; significant tinnitus improvement or resolution when significant TMD symptom improvement is acquired, is based on "yes" to Questions 1, 3, 4, or 5 or "no" to Question 11.

**Table IV: Clinical tests**

	P-Value	Group 1		Group 2		Group 3	
		Yes	No	Yes	No	Yes	No
<i>Is subject's tinnitus reproduced or intensified by:</i>							
Maximum voluntary clenching*	P = 0.003	14	7	3	9	0	7
Jaw movements	NS	1	20	3	9	0	7
Pressure applied to ipsilateral TMJ	NS	4	17	2	10	0	7
Loading of ipsilateral TMJ	NS	8	13	3	9	0	7
Mouth opening against resistance	NS	3	18	0	12	0	7
Mouth protruding against resistance	NS	5	16	0	12	0	7
<i>Is subject's tinnitus reproduced or intensified by palpating:</i>							
Deep masseter muscle	NS	8	13	3	9	0	7
Lateral pterygoid muscle	NS	6	15	0	12	0	7
Medial pterygoid muscle	NS	3	18	1	11	0	7
Sternocleidomastoid muscle	NS	2	19	0	12	0	7
Posterior digastric muscle	NS	8	13	4	8	0	7

\*Significant difference,  $p < 0.05$ ; significant tinnitus improvement or resolution when significant TMD symptom improvement is acquired, is based on a "yes" answer.

6. Mouth Protruding Against Resistance. Subjects were instructed to protrude their mandible while approximately one pound of finger pressure resisted their movement.
7. Muscle Palpation. The most tender areas of the ipsilateral muscles were identified, where possible. The palmar surface of the index finger palpated these areas using one to two pounds of force for one to two seconds. The sternocleidomastoid muscle was palpated between the thumb and index finger along its full length.

The subjects were provided conservative TMD therapy in a manner thought to be most advantageous for their TMD disorder.<sup>23-25</sup> All subjects received TMD self-care instructions.<sup>24</sup> Most received an intraoral orthotic appliance (dental splint) and many attended a six hour class given by a behavioral psychologist who taught strategies for reducing oral habits (i.e., clenching, biting cheeks, etc.), and taught relaxation and coping skills. Some subjects were referred to a physical therapist who provided stretching exercises, posture training and/or physical therapy modalities. Of the 40 patients enrolled, three were prescribed medications. Following successful conservative TMD therapy, subjects were asked if their tinnitus was resolved, significantly improved, unchanged or worse, during the two to six months they were followed.

The data was evaluated to determine which questions and tests were associated with improvement in tinnitus when significant TMD symptom improvement is obtained. Statistical comparisons between the three groups was completed by Analysis of Variance (ANOVA) with Fisher's LSD Multiple Comparison post-hoc test for age. Comparisons between the groups on each ques-

tion was analyzed by Pearson's Chi-square Statistic with Yates Correction and Fisher's Exact Test as appropriate. Alpha was set at 0.05 and power at 0.80 for all procedures.

## RESULTS

Two hundred and sixty-seven TMD patients were evaluated, 101 reported coexisting tinnitus and 42 rated their tinnitus as moderate or severe. The subjects' ages ranged from 18 to 63, with a mean age of 31.3. Two subjects, who did not return for TMD therapy, were dropped from the study. Of the 40 subjects completing this study, 21, 12, 7 and 0 reported their tinnitus was resolved, significantly improved, unchanged and worse, respectively.

The subjects' tinnitus characteristics, tinnitus associations and clinical test results are summarized in Tables II, III and IV with subjects separated into groups according to their tinnitus change. Group 1 reported their tinnitus was resolved, Group 2 had significant tinnitus improvement and Group 3 had no tinnitus improvement in spite of having significant TMD improvement.

ANOVA was used to assess the difference between the groups with regard to age. The analysis revealed there was a significant difference ( $P = 0.024$ ). Fisher's LSD Multiple Comparison post-hoc test revealed the significant difference was between Groups 1 and 3 and between Groups 2 and 3.

Pearson's Chi-square Statistic and the Fisher's Exact Test revealed that there was a significant difference between Groups 1 and 3 for tinnitus severity (Table II); Questions 1,3,4,5 and 11 (Table III); and maximum voluntary clenching (Table IV). The only variables found to

have a significant difference between Groups 1 and 2 were Question 5 and maximum voluntary clenching; between Groups 2 and 3 were Question 4 and maximum voluntary clenching.

## DISCUSSION

Of the 40 subjects completing this study, 52.5 percent reported tinnitus resolution, 30 percent reported significant tinnitus improvement and 17.5 percent reported no tinnitus change.

Only TMD patients who rated their tinnitus as moderate or severe were chosen for this study because it is thought that these patients would be more representative of patients consulting their physician for a tinnitus complaint rather than their dentist with a TMD complaint.

Younger TMD subjects were more likely to report tinnitus improvement than older subjects. Most TMD patients are between the ages of 20 and 40 years old while most tinnitus patients are between 40 and 80 years old.<sup>2,26</sup> It appears the etiology of the tinnitus for our younger patients tended to be from TMD while older patients tended more often to be from another cause.

Tinnitus severity was the only characteristic (Table II) found significantly related to tinnitus outcome. Subjects rating their tinnitus as moderate were significantly more likely to report tinnitus improvement than if they rated it as severe. This corroborates Erlandsson et al.<sup>18</sup> findings which identified low tinnitus severity as a predictor for a subject's tinnitus improving from dental TMD therapies (splint, etc.) and biofeedback therapy. Similarly, Bush<sup>15</sup> found patients rating their tinnitus as severe were less likely to report tinnitus improvement from TMD therapy.

Though not statistically significant ( $P = 0.273$  and  $P = 0.147$ ), the data showed a slight trend for subjects reporting tinnitus occurring less frequently and for shorter duration were more likely to report tinnitus improvement (Table II).

Tinnitus pitch was not found to be significant ( $P = 0.613$ ) nor was a trend noted for a relationship between the selected pitch range and tinnitus improvement through TMD therapy. This corroborates a similar finding by Vernon et al.<sup>19</sup> in which they found no significant difference in tinnitus pitch between their TMD and non-TMD groups of tinnitus patients. The authors speculate pure tone audiometric assessment to identify the frequency spectrum of a patient's tinnitus would not be productive for identifying patients with coexisting TMD and tinnitus, who would obtain tinnitus improvement through TMD therapy.

Five of the eleven tinnitus associated questions (Table III) were significantly related to the subjects' outcome. Subjects reporting "yes" to Questions 1, 3, 4, or

5, or "no" to Question 11 were significantly more likely to report tinnitus improvement.

Similar to our finding that a subject reporting normal hearing in the ipsilateral ear (Question 1) were significantly more likely to report tinnitus improvement, Erlandsson et al.<sup>18</sup> also identified normal hearing or compensated hearing loss as a predictor for a subject's tinnitus improving from dental TMD therapies and biofeedback therapy.

Questions 3, 4, 5 and 11 are thought to suggest the presence or absence of a TMD/tinnitus relationship. Questions 3 and 4 attempt to identify whether the subject had a temporal relationship between tinnitus and TMD. TMD is often exacerbated by stress and Question 5 attempts to identify whether the subject could recall a stress/tinnitus relationship, which may suggest an underlying TMD/tinnitus relationship. Loud noise can sometimes reproduce or intensify tinnitus (Question 11).<sup>17</sup> However, TMD symptoms are generally not exacerbated by loud noise and a noise/tinnitus relationship may suggest the absence of a TMD/tinnitus relationship.

Among the clinical tests evaluated (Table IV), the investigator was only able to reproduce or intensify tinnitus for 22 of the 33 subjects (67%) who reported tinnitus improvement. Interestingly, all subjects who had no change in their tinnitus did not have a positive clinical test.

Maximum voluntary clenching was the only clinical test evaluated found significantly related to tinnitus outcome. It was the test most frequently able to elicit a positive tinnitus response, occurring for 17 of the 33 subjects (52%) who had tinnitus improvement. Practitioners should be aware that maximum voluntary clenching often causes a TMD patient's pain to intensify.<sup>27</sup> Therefore, the subjects in this study were instructed to bite on their posterior teeth as hard as possible for one minute but stop if they developed intolerable pain. Other tests that frequently elicited a positive tinnitus response were palpation of the posterior digastric muscle (36%) and masseter muscle (33%), and loading of the ipsilateral TMJ (33%).

In order to rule out a coexisting TMD problem, the author recommends the practitioner first observe for masticatory muscle or TMJ tenderness signs by applying two pounds of force to the extraoral masticatory muscles and one pound to the TMJs and intraoral muscles.<sup>5</sup> This is a considerable amount of force. It is not uncommon for the author to observe his residents reluctant to apply this amount of force and unable to elicit masticatory muscle or TMJ tenderness in a TMD patient. Conversely, some TMD patients have exquisitely tender masticatory muscles or TMJs. Therefore, the author palpates very lightly at first, gradually increases the force up to these limits but stops as soon as tenderness is noted.

Sometimes even palpating with this force will not reproduce a TMD patient's pain. In this situation, the author will try to elicit the TMD pain by asking the patient to clench on his/her posterior teeth as hard as they can for one minute, but stop if it brings on his/her pain.

A valuable prediction would be if this exam was able to reproduce or intensify the patients' tinnitus, because all subjects reporting a positive tinnitus response to at least one of the clinical tests listed in Table IV, reported tinnitus improvement after TMD therapy. But only 67 percent of the subjects who reported tinnitus improvement had a positive tinnitus response to one of these tests.

The practitioner should be able to identify most TMD patients by observing for TMD signs in this manner and inquiring about TMD symptoms. As previously cited,<sup>4</sup> the two most common descriptors for TMD symptoms were a feeling of pressure and/or dullness. Some patients do not interpret the pressure or dull quality as "pain," but only consider it an uncomfortable feeling that they have become used to having.

Additionally, the previous study<sup>4</sup> reported 42 percent of their TMD patients had ear pain. Sometimes ear pain is the only presenting symptom for a TMD patient. Consequently, the authors recommend practitioners consider TMD in their differential diagnosis for non-otologic otalgia.

Within the limits of this clinical trial, this study suggests:

1. Many TMD patients with coexisting tinnitus find TMD therapy improves or resolves their tinnitus in conjunction with their TMD symptoms.
2. The statistically significant questions identified with tinnitus outcome improvement in this study may help practitioners identify which TMD patients may obtain tinnitus improvement with TMD conservative treatment. These are patients reporting:
  - a. They are younger in age (the range of our population was 18-63 years old);
  - b. Their tinnitus is moderate rather than severe;
  - c. Their hearing is normal;
  - d. Their tinnitus began approximately when their TMD symptoms began;
  - e. Their tinnitus is worse when their TMD symptoms are worse;
  - f. Their tinnitus is stress related;
  - g. Their tinnitus is unrelated to loud noise;
  - h. Their tinnitus was reproduced or intensified from one minute of maximum voluntary clenching on their posterior teeth.

This study observed for a change in tinnitus among patients whose primary complaint was TMD symptoms who had concomitant tinnitus. The authors speculate these findings may be generalizable to patients whose

primary complaint is tinnitus and have coexisting TMD. The authors recommend additional research be conducted evaluating the questions and clinical tests listed above with patients whose primary complaint is tinnitus and have concomitant TMD.

Statistically significant questions and clinical tests were identified which may be helpful for patients with SIT and TMD in determining whether TMD conservative therapy should be considered in the evaluation and treatment or co-treatment of tinnitus.

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