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Prevalence and management outcomes of tonic tensor tympani syndrome in an ENT audiology tinnitus clinic in Singapore

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Main Article

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Abstract

Objective. Tonic tensor tympani syndrome is found in a subset of tinnitus patients who experience intra-aural and peri-aural symptoms, in addition to their tinnitus, in the absence of clinically detectable pathology. As the syndrome has not been widely reported, this study aims to determine its prevalence and evaluate the effectiveness of current management.
Methods. The tinnitus management clinic records of patients over the past six years were assessed to identify tonic tensor tympani syndrome patients and track their progress based on patient-reported Tinnitus Handicap Index scores. Patients with reversible ear pathology and temporomandibular joint disorder were excluded.
Results. It was found that 13 per cent of the tinnitus management patients fulfilled the criteria for tonic tensor tympani syndrome and 94 per cent of those who returned for follow up showed an improvement in their Tinnitus Handicap Index grades.
Conclusion. This study suggests that tonic tensor tympani syndrome is a significant problem among tinnitus patients and current tinnitus management strategies contribute effectively to helping such patients habituate to their symptoms.

Introduction

Tinnitus, associated aural symptoms and temporomandibular joint disorder

Tinnitus is a perception of sound in the absence of an external source.[1,2] It is very common but often difficult to quantify. Sufferers describe a variety of auditory experiences, including ringing, buzzing, whistling and whooshing sounds. Like pain, tinnitus affects different individuals in different ways and is often difficult to treat. It follows a complex cascade of neural responses, usually initiated by damage in the auditory system. Traditionally, this has been associated with inner-ear pathology causing sensorineural hearing loss, but it is now recognised that conductive pathology can also result in tinnitus. The sensation of tinnitus is generated not in the ear but by changes that take place in central auditory pathways when the brain is disengaged from sound because of hearing loss. Epidemiological studies suggest that tinnitus affects 20 per cent of people worldwide and 2–4 per cent are almost always bothered by it.[3]

Tinnitus may be accompanied by other aural symptoms, such as sharp pain or dull ache in the ear, a sensation of aural fullness or 'blockage', tympanic flutter, sensitivity to loud sounds (hyperacusis), muffled hearing, temporomandibular joint (TMJ) pain, numbness along the side of the neck, vertigo, nausea and even headache. These symptoms worsen the aversive experience for sufferers.

The correlation between TMJ disorder and tinnitus has been previously explored. Gelb *et al.*[4] found that 42 per cent of patients with TMJ disorder reported tinnitus, with earaches and headaches reported frequently in addition to masticatory muscle tenderness. However, the reason behind this association is still not fully understood. Ramirez *et al.*[5] investigated the possible anatomical and physiological connections between TMJ disorder and secondary aural symptoms such as tinnitus and earache. Their research placed strong emphasis on the tensor tympani muscle in the middle ear, which passes between the muscle coat of the Eustachian tube and inserts onto the medial aspect of the malleus. They hypothesised that in TMJ disorder, the auriculotemporal branch of the trigeminal nerve, which innervates this muscle, is compressed and abnormally stimulated because of the disposition of the mandibular condyle, resulting in hyperactivity in the tensor tympani muscle.

Acoustic shock injury and tonic tensor tympani syndrome

Tonic tensor tympani syndrome was first described by Klockhoff and Westerberg.[6] It is postulated to be due to reduced thresholds for tensor tympani muscle activation, leading to aural symptoms that result from tympanic membrane tension, alterations in middle-ear

ventilation and increased irritability of the trigeminal nerve. Tympanic membrane tension manifests as tinnitus, pain, hyperacusis, clicks and tympanic membrane flutter. Middle-ear ventilation alterations cause a sensation of blocked ear or fullness and muffled hearing. Trigeminal nerve irritability results in ear- and headaches, pain and TMJ disorder.

Acoustic shock disorder was described by Westcott[7] to encompass a cluster of symptoms, including a shock reaction, pain in the ear, TMJ pain, tinnitus, hyperacusis and vertigo. These symptoms were first reported by call-centre employees, who are vulnerable to sudden unexpected loud sounds transmitted via telephone lines: the initial acoustic incident. Subsequent to their acoustic trauma, apart from experiencing the more anticipated symptoms of tinnitus and hyperacusis, these individuals also felt symptoms of TMJ disorder without discernible TMJ pathology.

A study by Milhinch of acoustic shock disorder symptoms in audiological clinics from 103 call-centre operators exposed to 123 acoustic incidents found that ear, neck and/or TMJ pain was the most frequent symptom, reported by 95 per cent of patients.[8] Tinnitus was reported by 50 per cent of patients and loss of balance by 48 per cent. The most distressing and durable symptom tended to be hyperacusis, reported by 32 per cent of patients. Other symptoms reported included headaches (32 per cent), facial numbness (9 per cent), a burning feeling in the ear or face (5 per cent), tingling (3 per cent), a feeling of pressure or fullness in the ear (11 per cent), an echo or hollow feeling in the ear (18.4 per cent) and muffled/distorted hearing (18.4 per cent). Some cases had all symptoms resolve within days, whereas other patients had symptoms that persisted for months or even indefinitely. In the long term, 10 per cent of patients developed a range of emotional reactions, including anxiety, depression, hypervigilance, anger and feelings of vulnerability.

Westcott subsequently proposed that the underlying cause for acoustic shock disorder could indeed be tonic tensor tympani syndrome. Unlike the stapedius muscle in the middle ear, the tensor tympani muscle is not normally activated by sound. Instead, it contracts as part of the startle reaction, which can be triggered by a loud sound that is perceived as threatening. As a result of such trauma, the reaction to which can be exacerbated by anxiety, the tensor tympani muscle is hypothesised to continually and rhythmically contract and relax. This appears to initiate a cascade of physiological reactions in and around the ear, including an abnormal stimulation of the trigeminal nerve innervating the tensor tympani muscle, leading to frequent neuralgic pain and sensations of numbness and burning. Central sensitisation develops from the resultant chronic pain, leading to an expansion of the perceived peripheral pain and the typical symptoms of TMJ disorder.

As there is no internationally recognised consensus definition for tonic tensor tympani syndrome, accurate recruitment of study subjects poses a challenge for researchers. Nevertheless, a multiclinic study was conducted by Westcott *et al.* simultaneously in eight clinics to investigate the prevalence of tonic tensor tympani syndrome symptoms in tinnitus patients.[9] Five clinics in Australia and New Zealand, two clinics in Brazil and one clinic in Spain were involved. The study included consecutive patients with tinnitus and/or hyperacusis seen at the clinics. Data collected included symptoms consistent with tonic tensor tympani syndrome, onset and exacerbating factors, and severity of tinnitus and hyperacusis. Symptoms considered consistent with tonic tensor tympani syndrome were pain, ache or burning in or around the ear, blocked ear in the absence of middle-ear pathology, hearing perturbations without a change in audiometric testing, imbalance and pain around the jaw or head. Patients with known underlying pathologies that could cause these symptoms were excluded.

The researchers found a 40.6 per cent prevalence of at least one symptom consistent with tonic tensor tympani syndrome in patients with tinnitus, and an even higher prevalence of 81.1 per cent in those with hyperacusis. These results support a central relationship between tinnitus, hyperacusis and tonic tensor tympani syndrome as well as an explanation for the aural pain reported by tinnitus patients.

More recently, in 2022, Fournier *et al.* conducted a small study on 11 patients to investigate the possible mechanisms behind tonic tensor tympani syndrome.[10] They used admittancemetry and measurement of air pressure in the sealed external auditory canal to measure middle-ear stiffness and tympanic membrane displacement, respectively. They found that middle-ear muscle contraction could be evoked by acoustic stimulation ($n = 3$), somatic manoeuvres such as jaw contraction ($n = 3$) or pressure changes in the ear canal ($n = 3$). Spontaneous tensor tympani muscle contraction was noted in one patient and voluntary contraction in five patients. Tonic contraction of the tensor tympani muscle was not observed, calling into question the nomenclature behind the term tonic tensor tympani syndrome.

Management of patients with tinnitus and hyperacusis

In 2000, Jastreboff and Jastreboff proposed a comprehensive model of tinnitus that addressed three clinically prominent features, namely, the tinnitus sensation itself, the ability of the tinnitus sensation to command attention and the patient's disturbing emotional reaction to the tinnitus percept.[11] Jastreboff suggested that although elimination of the tinnitus sensation was in most cases not practical, the latter two features of tinnitus were likely modifiable and if treated would benefit the tinnitus patient. Management options for tinnitus include education, counselling, psychology-based techniques such as behavioural and cognitive therapy, hearing aids and sound therapy.

Education in the form of tinnitus retraining therapy was devised to reduce attentional and emotional responses by presenting low-level tinnitus-like external sounds that could be filtered out along with the tinnitus by perceptual mechanisms. Studies of tinnitus retraining therapy have confirmed that emotional responses diminish with time for most tinnitus sufferers.[12,13] Cognitive behavioural therapy is useful in combination to teach patients cognitive distraction strategies, reduce hypervigilance and help reframe irrational thought processes.[14]

Sound therapy includes environmental sound enrichment strategies, which are used to promote hyperacusis desensitisation using music players that provide a wide choice of stable, neutral environmental sounds. Hearing aids with sound enrichment programmes, such as zentones and white noise, can also help patients habituate to their tinnitus.

Aim of study

The aims of this study were to determine the prevalence of symptoms consistent with tonic tensor tympani syndrome amongst patients who attended tinnitus clinic at a general hospital in Singapore, as well to evaluate the effectiveness of our

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current treatment for patients with tonic tensor tympani syndrome. Some of the strategies employed regularly in our clinic include tinnitus counselling based on the tinnitus retraining therapy model, sound therapy and, where appropriate, the use of hearing aids. In addition, our tonic tensor tympani syndrome patients are given a detailed explanation of the middle-ear anatomy using diagrams that depict the position of the tensor tympani muscle. The function of the muscle as a protective mechanism is explained, as is its heightened contraction in tonic tensor tympani syndrome sufferers. This is done to help patients understand the physiology behind and possible psychological influences on their symptoms. When necessary, patients are also referred to relevant specialties, for example psychiatry, for further management in the form of cognitive behavioural therapy and/or medication.

Materials and methods

After obtaining approval from the Institutional and Domain Specific Review Boards (Study number 2022/00167), audiological records of patients seen in the tinnitus clinic from January 2016 to January 2022 were reviewed to identify patients with symptoms consistent with tonic tensor tympani syndrome, in particular pain, burning, numbness and ache around the ear, aural fullness, muffled hearing, giddiness, headache and exacerbation of symptoms with sound exposure. As there is no consensus definition, a broad definition of tonic tensor tympani syndrome was used to include all possible tonic tensor tympani syndrome patients. The demographic data, tinnitus history, accompanying otological symptoms, otological examination and hearing assessment results of these patients were collated and anonymised. The audiological test results recorded included pure tone audiometry, tympanometry and tinnitus matching.

Patients with reversible external, middle- and inner-ear pathology were excluded, until treated, as were patients who were found to have retrocochlear pathology. Patients with diagnosed TMJ disorder were also excluded. Because of the possibility of another underlying pathology, those patients whose only symptoms were headache, imbalance or vertigo, nausea, or muffled or distorted hearing were not considered to have symptoms consistent with tonic tensor tympani syndrome and their symptom data were excluded.

The outcomes of tinnitus management were evaluated based on the patients' Tinnitus Handicap Index scores before and after tinnitus counselling. The Tinnitus Handicap Index is a patient-reported measurement of tinnitus severity and its impact on the patient's quality of life.[15] It encompasses a list of 25 statements to which patients respond 'yes' (4 points), 'sometimes' (2 points) or 'no' (0 points). The overall score ranges from 0 to 100 and is categorised into 5 grades of tinnitus severity, with 0–16 being slight or no handicap to 78–100 being catastrophic. It is routine in our practice that all patients fill out these questionnaires during their tinnitus management sessions. It was also recorded if patients underwent sound therapy and whether they received any psychological or psychiatric input in tandem with tinnitus management. The data were analysed using Microsoft Excel and sent to the Research Office Central Trusted Third Party (National University Health System, Singapore) for de-identification.

Data analysis

The effect size, Cohen's *d*, was initially calculated as the mean difference between pre- and post-treatment scores divided by the standard deviation of the difference.[16] Because the analyses were based on within-subject comparisons and because overall scores can vary markedly across patients, the effect size values determined in this way are likely to be larger than those obtained in between-subject studies, that is, studies that assess differences between treatment and control groups. To make the effect size values comparable to those obtained in between-subject studies, we used Equation 8 of Morris and DeShon[17] to obtain a corrected effect size value. For controlled studies, effect size values above 0.2 are considered small, those above 0.5 are considered medium and those above 0.8 are considered large.[18]

To calculate the minimum sample size required for power analysis, we used the effect size and standard deviation of the pre- and post-treatment scores of routine tinnitus patients who were seen during the period from January 2016 to January 2022 to achieve a power of 80 per cent and a level of significance of 5 per cent.[19]

Results and analysis

Prevalence

Of the 364 patients who attended the tinnitus management clinic from January 2016 to January 2022, 47 were identified as having symptoms consistent with tonic tensor tympani syndrome. This represents 13 per cent of patients who were seen for tinnitus management. One patient did not complete the Tinnitus Handicap Index questionnaire as they could not understand the questions, hence this patient was excluded from the study. The median age of the remaining 46 patients was 42 years, which was significantly younger ($p = 0.002$) than the median age of 56 years for all patients who attend our tinnitus management clinic, based on our previous analysis. Further demographics are described in Table 1.

The 4-frequency average based on pure tone audiometry was 19 dB HL for tonic tensor tympani syndrome patients, which is significantly lower ($p = 0.000$) than the 27 dB HL value obtained for all tinnitus management clinic patients. In addition, the pre-treatment Tinnitus Handicap Index score of tonic tensor tympani syndrome patients was 44, compared with 32 ($p = 0.06$) for all tinnitus management clinic patients.

Although the complete history was not always available for review, there appeared to be a trend that the majority of tonic tensor tympani syndrome patients experienced a prior acoustic insult. This ranged from a loud sound during a phone call to exposure to live firing. Most patients described their tinnitus as a ringing sound, often high pitched. Some also heard crickets, crackling or hissing sounds. In keeping with the definition of tonic tensor tympani syndrome, all patients had associated aural symptoms, the most common being aural fullness, earache or ear pain, and headaches. It was found that 28 per cent of patients had hypersensitivity to sounds, with sounds like shouting or children crying being triggers. In addition, 61 per cent of patients had personal stressors that are likely to have exacerbated symptoms, as compared with 43 per cent of patients in the non-tonic tensor tympani syndrome tinnitus population, and 43 per cent (*vs* 41 per cent) had sleep issues because of their tinnitus.

Tinnitus management and counselling

Of the 46 tonic tensor tympani syndrome patients, 59 per cent had tinnitus severity grades of 3 to 5 based on their Tinnitus

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Table 1. Demographics of 46 tonic tensor tympani syndrome patients

Characteristic	Value
Gender (*n* (%))	
– Male	26 (57)
– Female	20 (43)
Age (years)	
– Median	42
– Range	19–81
Ethnicity (*n* (%))	
– Chinese	37 (80)
– Malay	5 (11)
– Indian	2 (4)
– Others	2 (4)
Hearing assessment, based on four-frequency average (*n* (%))	
– Normal hearing in both ears	29 (63)
– Abnormal hearing in at least one ear	17 (37)
Localisation of tinnitus (*n* (%))	
– Monaural (left or right ear)	29 (63)
– Both ears or in the head	17 (37)
Tinnitus severity grade (*n* (%))	
– Slight (grade 1)	7 (15)
– Mild (grade 2)	12 (26)
– Moderate (grade 3)	11 (24)
– Severe (grade 4)	7 (15)
– Catastrophic (grade 5)	9 (20)

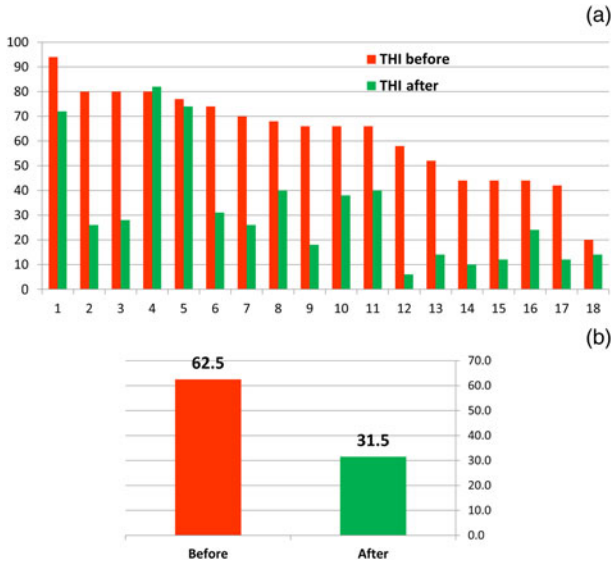

Figure 1. THI scores before and after treatment. THI = Tinnitus Handicap Index

Handicap Index scores, suggesting moderate to catastrophic handicap. In addition, 41 per cent of patients had slight or mild tinnitus severity grades. Tinnitus counselling was carried out for all 46 tonic tensor tympani syndrome patients. Tinnitus matching was performed for 24 per cent of patients, hearing aids and/or sound generators were fitted for 13 per cent, and 13 per cent of patients received input from psychiatrists in the form of therapy as well as medication.

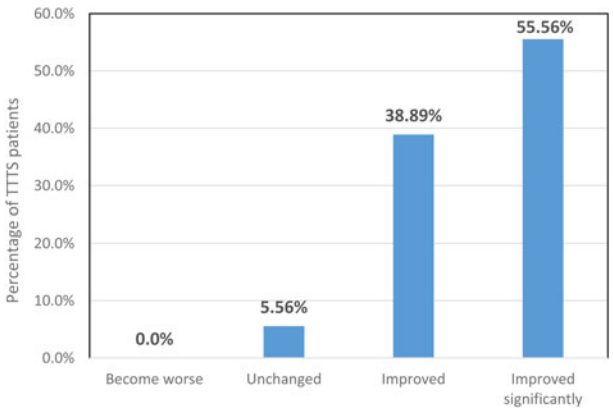

Figure 2. Change in Tinnitus Handicap Index grade after three months of tinnitus management. TTTS = tonic tensor tympani syndrome

Table 2. Tinnitus Handicap Index grades before and after tinnitus management

Tinnitus Handicap Index score	Tinnitus severity grade	Before counselling (*n* (%))*	After counselling at 3 months (*n* (%))*
0–16	1 (slight or no handicap)	0 (0)	6 (33)
18–36	2 (mild)	1 (5)	6 (33)
38–56	3 (moderate)	5 (28)	3 (17)
58–76	4 (severe)	7 (39)	2 (11)
78–100	5 (catastrophic)	5 (28)	1 (6)

*$n = 18$

Table 3. Paired *t*-test between the before and after Tinnitus Handicap Index scores for tonic tensor tympani syndrome patients: paired samples statistics

Pair 1	Mean	*n*	Standard deviation	Standard error of the mean
VAR00002	62.5000	18	18.40796	4.33880
VAR00003	31.5000	18	22.98401	5.41738

Out of the 46 patients, 18 returned for a second tinnitus management session. Before tinnitus counselling, 17 (95 per cent) of these patients exhibited tinnitus severity grade 3 to 5 (moderate to catastrophic). After undergoing counselling, the number of patients exhibiting tinnitus severity grade 3 to 5 (moderate to catastrophic) decreased to 6 (33 per cent). The mean Tinnitus Handicap Index score for the 18 patients before counselling was 62.5 (moderate). Three months after counselling, the mean Tinnitus Handicap Index score decreased by half to 31.5 (mild) (Figure 1). Furthermore, 17 patients (94.5 per cent) had tinnitus severity grade improvements, reflecting an improvement in their Tinnitus Handicap Index scores: 55.56 per cent of patients improved by 2 grades and 38.89 per cent by 1 grade, while 1 patient (5.56 per cent) had no change to the tinnitus severity grade (Figure 2). Table 2 details the change in Tinnitus Handicap Index for each tinnitus severity grade.

Paired *t*-test calculations (Tables 3–7) indicated a significant difference between the median Tinnitus Handicap Index scores before and after tinnitus counselling: $t\ (17) = 7.8$, $p < 0.001$. Based on Dhand and Khatkar's sample size

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Table 4. Paired *t*-test between the before and after THI scores for tonic tensor tympani syndrome patients: paired samples test – paired differences

	Paired differences							
				95% confidence interval of the difference				
	Mean	Standard deviation	Standard error of the mean	Lower	Upper	*t*	df	Significance (two-tailed)
THI before – THI after	31.00000	16.83134	3.96719	22.62997	39.37003	7.814	17	.000

THI = Tinnitus Handicap Index

calculator of comparing two paired means, the required sample size to achieve a power of 80 per cent and level of significance of 5 per cent is 10 pairs, which our numbers, albeit small, do fulfil.

A corrected effect size value of 1.84 (95 per cent confidence interval 1.22, 2.39) was obtained by application of Equation 8 of Morris and DeShon to Cohen's *d*.[17] As this is greater than 0.8, it is considered large, indicating that the magnitude of change between pre- and post-counselling Tinnitus Handicap Index scores is significantly large. As a comparison, a similar calculation was carried out for the non-tonic tensor tympani syndrome patients who were seen in the tinnitus clinic during this time, with a resultant corrected effect size value of 1.14.

Table 5. Paired *t*-test between the before and after Tinnitus Handicap Index scores for non-tonic tensor tympani syndrome patients: paired samples correlations

Pair 1	*n*	Correlation	Significance
VAR00004 and VAR00005	79	.574	.000

Table 6. Paired *t*-test between the before and after Tinnitus Handicap Index scores for non-tonic tensor tympani syndrome patients: paired samples statistics

Pair 1	Mean	*n*	Standard deviation	Standard error of the mean
VAR00004	46.2278	79	22.39045	2.51912
VAR00005	24.2785	79	18.98646	2.13614

Discussion

Tonic tensor tympani syndrome is not widely recognised and has not, to our knowledge, been studied in an Asian population. Given that symptoms more commonly occur in younger patients with normal hearing to mild hearing loss, these patients may often be missed on routine consultation and not referred on to tinnitus counselling. This could mean that the prevalence is actually higher than the 13 per cent reflected in this study, which is a seemingly small prevalence in comparison with the 40.6 per cent noted in Westcott's multicentre study.

Tonic tensor tympani syndrome patients tend to have higher Tinnitus Handicap Index scores, reflecting a greater impact of symptoms on their quality of life despite often having near-normal hearing. This creates additional stress for these individuals, who often are already more anxious or have environmental stressors to deal with. The causal relation between stress and/or anxiety and tonic tensor tympani syndrome is as yet unclear. It may be that patients who are more prone to stress and anxiety are also more prone to developing tonic tensor tympani syndrome and perpetuating its symptoms. At the same time, it is likely that tonic tensor tympani syndrome compounds the stress and anxiety these individuals face, creating a hypothetical vicious cycle. Furthermore, a significant proportion of patients report difficulties with their sleep and there appears to be a trend towards tonic tensor tympani syndrome patients more frequently requiring additional input from psychological services. It is therefore important for clinicians to not just be aware of the condition but also maintain a higher index of suspicion for tonic tensor tympani syndrome, especially when patients complain of hyperacusis and increased sound sensitivity.

Currently, the diagnosis of acoustic shock is made purely by clinical history and audiological investigations. Tonic (fixed) contractions of the tensor tympani are not easily detected, making it difficult to prove definitively that this is the cause of tonic tensor tympani syndrome patients' symptoms of otalgia, fullness of the ear and TMJ disorder pain. Aron *et al* ., using human subjects who could voluntarily move their eardrums, as well as manually tensed cadaveric temporal bones, showed that tensor tympani contraction produces distinctive tympanometric findings, supporting the hypothesis that abnormal tensor tympanic contraction occurs in ears producing symptoms compatible with tonic tensor tympani syndrome.[20] Fournier *et al.* suggest that the tensor tympani contractions may not be tonic, but measuring changes in the pressure of a sealed external auditory canal could be a reproducible means of testing for middle-ear muscle hyperactivity.[10] The measurement of changing ear pressure in a sealed external auditory canal was not carried out in our retrospective cohort but would be worth exploring in future studies.

- Tonic tensor tympani syndrome is a subset of tinnitus that is seen in more than 10 per cent of tinnitus sufferers
- A central limbic system reaction is involved in the perpetuation of tonic tensor tympani syndrome symptoms
- Some studies have investigated the prevalence of tonic tensor tympani syndrome, but to date there have been none evaluating the effectiveness of tinnitus management for the syndrome
- Current tinnitus management strategies contribute to the alleviation of the symptoms experienced by tonic tensor tympani syndrome patients
- Additional explanation of tensor tympani muscle function appears to help patients understand the physiology behind and possible psychological influences on their symptoms
- It is important to keep a lookout for symptoms of tonic tensor tympani syndrome in tinnitus patients so that treatment can be initiated quickly and expediently

In the course of our study, we also discovered an interesting novel observation of a fluctuating acoustic reflex threshold on decay testing of one of our patients, in the presence of normal tympanograms. This finding may also be worth further

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Table 7. Paired *t*-test between the before and after Tinnitus Handicap Index scores for non-tonic tensor tympani syndrome patients: paired samples test

	Paired differences							
				95% confidence interval of the difference				
Pair 1	Mean	Standard deviation	Standard error of the mean	Lower	Upper	*t*	df	Significance (two-tailed)
VAR00004 and VAR00005	21.94937	19.32973	2.17476	17.61974	26.27899	10.093	78	.000

investigation as this would be feasible to test in routine clinical practice.

Our study is the first that we know of that looks at outcomes of management for tonic tensor tympani syndrome. Reassuringly, tinnitus management strategies employed for the generic tinnitus population do appear to benefit tonic tensor tympani syndrome patients as well. The additional explanation of middle-ear anatomy and the physiology of tonic tensor tympani syndrome is likely to play a role in our patients' understanding of their illness, allowing them to comprehend and be on board with the treatment strategies. This is because the unpleasant sensations experienced by patients lead them to believe that certain sounds are intolerable, or even harmful to them. Fear of future exposure leads to hypervigilance and avoidance, perpetuating and escalating their hyperacusis. For some patients, even the anticipation or thinking of such sounds can lead to symptoms, without any actual exposure to the sound. Furthermore, investigations are likely to be normal or near normal, precluding a tangible explanation for their symptoms, with resultant bewilderment that can lead to further stress and anxiety. This suggests some of the symptoms tonic tensor tympani syndrome patients experience may be mediated by the limbic system and that addressing their fears may play an important role in their rehabilitation.

The limitations of our study include the fact that this was a retrospective study in which only 39 per cent of the tonic tensor tympani syndrome patients in this study returned for follow up and there was no control group for comparison. While we did conduct statistical analysis on our outcomes, we are cognisant that this remains a benchmark and that this analysis does not overcome the limitation of our study design related to the lack of a control group, as uncontrolled effect size values are usually larger than those obtained in controlled studies. We are thus unable to exclude other contributing factors to treatment success based on this study alone. Future controlled studies that include tinnitus management patients nationally would be useful to determine this. It would also be useful to have longer follow-up periods to assess if the benefits of tinnitus management are sustained.

Conclusion

The pathology and mechanisms behind tonic tensor tympani syndrome remain relatively unexplored in comparison with better understood hearing loss pathologies, such as noise-induced hearing loss. The relationship between acoustic shock disorder and tonic tensor tympani syndrome has also not been clearly established.

Our study provides some reassurance that the use of prevailing tinnitus management strategies, in combination with an explanation of the action of the tensor tympani, contributes to the successful management of patients with tonic tensor tympani syndrome symptoms, with 94 per cent of patients showing improvement in their Tinnitus Handicap Index grade after receiving intervention. It is our hope that our research will increase awareness of tonic tensor tympani syndrome as a significant problem seen in our tinnitus patients to allow for more expeditious diagnosis and timely management of their illness, with the aim of alleviating their symptoms and improving their quality of life. We also hope to provide a stepping stone to future research and the development of guidelines for the management of this condition.

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