



Clocking tinnitus: An audiology symptom of migraine

Wei-Hsi Chen^a, Yi-Lang Hsu^b, Yun-Si Chen^c, Hsin-Ling Yin^{d,*}

^a Department of Neurology, Kaohsiung Chang Gung Memorial Hospital, and College of Medicine, Chang Gung University, Kaohsiung City, Taiwan

^b Department of Surgery, Chien-Yau Hospital, Kaohsiung City, Taiwan

^c Department of Psychology, College of Social Sciences and Management, Fo Guang University, Yilan County, Taiwan

^d Department of Clinical Forensic Medicine, Kaohsiung Medical University Hospital, and College of Medicine, Kaohsiung Medical University, Kaohsiung City, Taiwan

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ABSTRACT

Objectives: In contrast to previous concept that tinnitus is confined to an otologic disorder, current evidence supports it as a phantom sensory phenomenon of vestibulocochlear damage with cortical reorganization. It is a common problem worldwide, but the treatment response is always unsatisfactory.

Patients and Methods: In this study, we report 10 patients who described their staccato tinnitus as simulating the ticking sound of a pendulum or quartz clock (or termed clocking tinnitus). The tinnitus characteristics, laboratory tests, and treatment response were recorded.

Results: Clocking tinnitus was unilateral in three patients, bilateral in one patient, and at midline in another six patients. It usually subsided within 15 min. Neither patient experienced vertigo, hemifacial spasm, focal neurological deficit or otic disorder in association with tinnitus. Pre-existing migraine was present in seven patients. During tinnitus attack, a few migraine symptoms concurrently occurred in six patients. Pure-tone audiometry showed symmetric sloping pattern of hearing impairment in half patients whereas brainstem auditory evoked potentials revealed a prolonged wave I-III latency in 30% of patients. The p300 and electroencephalogram were normal in all of them. Neuroimaging study did not disclose structural change. All patients responded poorly to conventional treatments but favorably to flunarizine or topiramate.

Conclusion: Clocking tinnitus may be an audiology manifestation of migraine in some individuals. Antimigraine treatment can be considered in this specific group of staccato tinnitus. Audiogenic classification of tinnitus may provide diagnostic and treatment clues in tinnitus patients.

1. Introduction

Tinnitus, a subjective and/or objective sound heard inside the ear or brain (cephalotinnitus), is a global clinical disorder regardless of ethnicity, gender, and territory. Its prevalence ranges from 11.9% to 30.3% in adults [1] with the same definition of tinnitus. Although tinnitus does not disturb physical activity, it is associated with a high frequency of neuropsychological disorders such as anxiety, depression, and insomnia [2] that cause poor quality of life, functional disability, and high economic loss. Unfortunately, there is still no standard treatment strategy, except for a positive recommendation for cognitive behavioral therapy [3].

Tinnitus is a multifactorial disorder encompassing a variety of primary and secondary triggers. To elucidate and promote treatment response, tinnitus can be approached by grouping specific patterns of tinnitus, such as vascular anomaly for pulsatile tinnitus [4] and metallic

scraping sound for poststroke tinnitus [5]. Paroxysmal, non-pulsatile tinnitus, also described as “typewriter”, “Morse code”, “machine gun”, “coin in a can”, or “crackling” tinnitus, is a relatively uncommon condition. Recently, a group of typewriter tinnitus, which is characterized by a concomitant paroxysmal vertiginous spells, hemifacial spasms, and a favorable response to carbamazepine, predicts for ipsilateral microvascular compression of the cochlear nerve (NVC-C). Therefore, the sound property of tinnitus, in addition to associated symptoms, may provide diagnostic clue in clinical setting.

In this study, we report a group of patients who described their staccato tinnitus simulating clocking sound and to show favorable response to antimigraine treatment. During tinnitus attack, these patients did not have concomitant neurological deficits compatible with NVC-C or significant vertigo/dizziness as vestibular migraine. However, some of them showed a few migraine symptoms, such as yawning or mild motion sickness, during attacks. Therefore, clocking tinnitus may be a

* Corresponding author at: Department of Clinical Forensic Medicine, Kaohsiung Medical University Hospital, 100 Shih Chuan 1st Road, San-Min District 807, Kaohsiung City, Taiwan.

E-mail address: schoolyin@cc.kmu.edu.tw (H.-L. Yin).

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relatively uncommon but specific auditory manifestation of migraine or vestibular migraine, and antimigraine treatment can be considered in the case of treatment failure.

2. Patients and methods

Between 2012 and 2016 year, a total of 10 patients complaining of clocking tinnitus were encountered. Clocking tinnitus, stated by patients, was a subjective, paroxysmal, intermittent, rhythmic, consistent ticking sound identical to a pendulum or quartz clock inside the ear or brain. The ticking sound and radial pulse were not matched. Each patient was requested to count the frequency of ticking sound three times during different attacks after the initial outpatient visit. Patient history (head trauma, medications, and comorbidities), characteristics of tinnitus (localization, relationship to environment and head posture, triggering), neuroimaging study (computer tomography or magnetic resonance imaging), pure-tone audiometry (mean hearing level was calculated as the average hearing threshold at 0.5 kHz and 1 kHz, and also at 2 kHz and 3 kHz), vestibular function study (caloric test and optokinetic test), brainstem auditory-evoked potential, p300, electroencephalogram, transcranial color doppler, and treatment response to flunarizine or topiramate, which was initially prescribed for migraine prophylaxis, were reviewed. The Tinnitus Handicap Inventory was completed before and 6 months after index treatment. The diagnosis of migraine with aura, migraine without aura, or vestibular migraine was adapted to the diagnostic criteria of the International Classification of Headache Disorders 3–beta edition [6]. This study has been approved by the Chang Gung Medical Foundation Institutional Review Board (approval number: 201701606B0).

3. Results

These 10 patients were 6 men and 4 women. Their age ranged from 39 to 81 years, with the average being 66.1 years. The mean age of onset was 64.3 years (Table 1). The frequency of sound ranged from 45 to 57 ticks per minute with the average being 50 ticks per minute.

3.1. History

Two patients had previous minor head trauma: one as a child and another at 5 years before clocking tinnitus occurred. No patient acknowledged having antecedent family violence or otic disorder. Non-migraine comorbidities were present in 7 patients, including cardiovascular disease, cancer, stroke, depression, seizure, and illicit drug use. In one patient, non-pulsatile tinnitus had been present at the contralateral ear for more than 15 years. Migraine was present in 7 patients, namely, vestibular migraine in 5 patients, migraine without aura in 1 patient, and migraine with aura in 1 patient, respectively.

3.2. Characteristics of tinnitus

The ticking sound was located at the midline deep in the brain in 5 patients, right ear in 4 patients, and bilateral ears in 1 patient, respectively. The duration of tinnitus was less than 3 min in 1 patient, within 15 min in 7 patients, within 1 h in 1 patient, and variably between 1 h and 1 day in another 1 patient, respectively. The ticking sound occurred at both day and night, and did not change in the silent environment, under postural change (non-somatic change), or during hot or cold weather. Two patients stated that the ticking sound was mildly masked by external noise.

During tinnitus occurrence, two migraineurs and one migraine-free patient occasionally had transient symptoms, including yawning, nausea, sensation of motion sickness, or ocular heaviness, which were similar to their migraine attack. These discomforts usually terminated before their tinnitus subsided.

In two patients, clocking tinnitus could occur during their migraine

Table 1
The clinical and laboratory data of ten clocking tinnitus patients.

Case No.	Sex/Age	Side	Duration of history (months)	Vertigo, otalgia	Hearing loss, MHL (dB HL)	Brainstem sign	Imaging findings	ABR, p300, EEG	Migraine features during attack
1	F/77	ML	10	-	-	-	Old right striatal infarct	NI	-
2	F/66	R	9	-	-3/-16	-	NI	Bil. I-III delay	-
3	F/77	ML	18	-	-	-	NI	NI	Head heaviness feeling, yawning
4	M/84	ML	43	-	-7/-26	-	NI	Bil. I-III delay	Fatigue, tightness of headache
5	F/68	R	8	-	-6/-26	-	Old small infarcts at right corona radiata	EEG showed focal slow wave	-
6	M/35	R	8	-	-	-	Left brain atrophy	NI	Nausea
7	F/50	ML	16	-	-	-	NI	NI	Yawning, eye fullness
8	F/75	ML	30	-	-13/-33	-	Old left thalamic hemorrhage with resolution	NI	-
9	M/67	R	7	-	-11/-23	-	NI	NI	Motion sickness feeling
10	F/62	B	16	-	-	-	NI	NI	Head heaviness feeling, fatigue, yawning

Abbreviation: Bilateral; Ffemale; MMale; MHLmean hearing level; MLMid-line; NINormal; Right. Brainstem sign: hemifacial spasm, trigeminal syndrome or symptom of brainstem involvement. Mean hearing level: average hearing threshold change (from 26 dB) at 0.5/1 kHz and 2/3 kHz.

attack.

All patients did not experience vertigo, headache, otalgia, hemifacial spasm, trigeminal pain, photophobia, phonophobia, or nausea/vomiting shortly before, during or after clocking tinnitus occurred.

3.3. Laboratory tests

An abnormal result of pure-tone audiometry, brainstem auditory evoked potential, and p300 was found in 5 patients, 2 patients, and 0 patients, respectively. Hearing loss was mixed type and symmetric at both ears with gradually sloping down pattern, suggesting a probable aging change. Abnormal brainstem auditory evoked potential was a prolongation of wave I-III latency at both sides. The amplitude of wave I, II and III was however normal. Except for focal slowing found in 1 epileptic patient, the electroencephalogram did not reveal abnormal findings in the other 9 patients. The p300 was normal in all of them. Vestibular function studies, including caloric test and optokinetic test, were completed and shown normal response in 2 patients (Case 6 and Case 7). However, they were incompletely studied in another 2 patients (due to vertigo and vomiting) and refused by another 6 patients. The neuroimaging study (cranial computerized tomography in 6 patients and head magnetic resonance imaging in another 4 patients) did not disclose focal lesion at the auditory pathway or brainstem. Transcranial color doppler disclosed intracranial atherosclerosis without apparent stenosis in 4 patients.

3.4. Treatment response

All patients had received previous multiple treatments for their tinnitus, including cognitive behavioral therapy. After inform, eight patients received treatment for migraine or dizziness: flunarizine (5 mg/day) was administered to 7 patients and topiramate (25 mg/day) to 1 patient. Another two patients turned to herbal treatment. At 6-month follow-up, the total score on the Tinnitus Handicap Inventory showed a 65.8% (ranging from 40.0% to 87.5%) reduction after antimigraine treatment. The average scores on the functional, emotional, and catastrophic domain decreased to 66.7%, 68.5%, and 60.8%, respectively. Migraine attack also simultaneously decreased.

4. Discussion

In our patients, the tinnitus of “clocking” sound is a subjective description themselves and may be categorized into typewriter tinnitus or its analogy by others elsewhere. Factually, patients can always differentiate the sounds of their tinnitus, such as phone ringing, ocean wave, running machine, and so on that are primarily stored in their auditory memory. Till now, tinnitus of staccato or typewriter sound offers little diagnostic value, except NVC-C at the internal acoustic canal or cerebellopontine angle. Clocking tinnitus in our series differs from the staccato tinnitus of NVC-C by an absence of vertigo, otalgia, hemifacial spasm or other brainstem symptom, a lower frequency of abnormal brainstem auditory evoked potential and hearing impairment, and a less frequency of lateralized tinnitus. Moreover, their clocking tinnitus does not show postural change. Therefore, clocking tinnitus is a distinct non-somatic staccato tinnitus with diagnostic value. Our findings suggest that tinnitus can be approached through different patterns, such as sound nature, in order to elucidate and improve treatment response.

In our series, two lines of evidence support clocking tinnitus as an audiology symptom of migraine. First, clocking tinnitus was occasionally accompanied by migraine symptoms in migraineurs. In the migraine-free patients, one also suffered migraine symptom during tinnitus attack. Second, clocking tinnitus occasionally occurred in two migraine patients during migraine attack. Generally, tinnitus occurs in 12% of patients with migraine [7], 45% of patients with migraine with brainstem aura [8], and 46%–55% of vestibular migraine patients. It is pulsatile in 28.3% of migraine patients, whereas non-pulsatile in 71.7%

of them [7]. The nature of non-pulsatile sound is unfortunately not mentioned further in the literature. Moreover, vestibular migraine and other migraines is prevalent for clocking tinnitus patients. Accordingly, a rhythmic, non-pulsatile, staccato clocking tinnitus suggests an audiology manifestation of migraine, and its presence should differentiate the possibility of migraine if no other reasonable explanation as migraine is amenable for treatment and prophylaxis.

Flunarizine and topiramate are two of the first-line prophylactic drugs for migraine [9] and also improve the clocking tinnitus in our patients. In a prior study, Hulshof and Vermeij [10] compared the effect of flunarizine for tinnitus in 25 patients and placebo in another 25 patients. They showed that treatment with flunarizine resulted in a non-significant reduction of tinnitus in 44% of patients as compared with 24% of the placebo subjects and a reduction in annoyance of tinnitus in 16% as compared with 20% of the placebo subjects. Importantly, more patients with dizziness responded favorably to flunarizine than those without dizziness. Whether responders are vestibular migraineurs is uncertain. Recently, Weinreich and Carey [7] disclosed a 69% improvement of pulsatile tinnitus in 19 migraineurs under antimigraine treatment, including topiramate. Although these results, including ours, are limited by a small number of patient enrollment, they still suggest that migraine-related tinnitus is amenable to antimigraine treatment, as found in our series. Therefore, antimigraine treatment can be considered for migraine-related tinnitus, such as clocking type, if there are no contraindications.

Currently, classical tinnitus is proposed as a phantom sensory phenomenon of cortical reorganization in reaction to vestibuloauditory pathway damage [11]. Some tinnitus is exceptional. For example, pulsatile tinnitus may occasionally result from secondary vascular cause, such as vascular anomaly [4] or drug-associated vasodilatation. In contrast to a high prevalence of abnormal audiometry in classic tinnitus patients, vestibulocochlear impairment, auditory cortical damage, or vascular compromise was not consistently documented in our series. In fact, audiometry is usually within the reference range in migraine patients with tinnitus. These findings reflect a different pathomechanism between classical tinnitus and migraine-related tinnitus.

In conclusion, we report a group of patients with clocking tinnitus in whom a high frequency of migraine was found. Antimigraine treatment by flunarizine or topiramate significantly reduced their tinnitus as well as migraine attack. Abnormal audiometry and brainstem auditory evoked potential is not common. Vertigo and hemifacial spasm are absent. Therefore, clocking tinnitus may be an audiology symptom of migraine and is amenable to treatment.

Conflict of interest

All the authors hereby declare to have no conflicts of interest including, consulting fees, paid expert testimony, employment, grants, honoraria, patents, royalties, stocks, or other financial or material gain, that may involve the subject matter of the this manuscript.

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