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An unusual case of sudden sensorineural hearing loss after cycling class

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ABSTRACT

In this case report, our patient developed sudden sensorineural hearing loss (SSNHL) after loud noise exposure during a popular cardiovascular group exercise cycling class. To increase awareness among all healthcare professionals of the effects of these modern-day group fitness classes on hearing loss, we describe this case and review the current literature on SSNHL and its management. A 35-year old man developed SSNHL in the setting of loud noise exposure during a high intensity aerobic exercise class. After a short course of oral steroids with no improvement, intratympanic steroids were administered weekly for three weeks. The patient showed minimal improvement; thus, hyperbaric oxygen therapy was conducted. Serial audiograms continued to show severe to profound mixed hearing loss in the right ear. In conclusion, individuals who participate in loud, high-intensity aerobic group-exercise classes should be careful of the potential for noise-induced hearing loss. Aerobic exercise may make these individuals more susceptible to noise-induced hearing loss. Early intervention is critical for any chance of recovery.

1. Introduction

There is a growing popularity of classes in the group-exercise world which integrate high-decibel music into high-intensity cardiovascular work outs, including cycling classes [1]. Numerous men and women attend one or more of these classes a week [2]. According to their websites, the classes often promise to burn up to 800 cal, mirroring the loud, fast-paced music [3]. In theory, the loud music combined with the dim lighting is thought to mimic a club-like atmosphere, which distracts participants from the difficult exercises, and possibly induces the euphoric endorphins of a nightclub.

However, data suggests that risk of noise-induced hearing damage in these classes may mimic that of a nightclub [4]. Sudden loud noise exposure is known to cause acoustic trauma that can induce sensorineural hearing loss [5]. Prolonged exposure to loud noises can pose a similar risk of noise-induced hearing loss [6]. A typical fitness class with music ranges from 40 to 60 min with an average noise level of 101 dB and a maximum noise level up to 116 dB [7]. Although this noise level is below the instantaneous exposure guideline of the National Institute for Occupational Safety and Health (NIOSH) of 140 dB, it does exceed the 15-min exposure or less guideline of 100 dB per day [8,9]. In addition, hearing loss risk can be exacerbated by concurrent high intensity aerobic activity [10]. Previous studies hypothesize that aerobic exercise predisposes the body to hearing loss by inducing a global state of ischemia that can depress stapedius muscle reflexes [10]. We present a case of sudden sensorineural hearing loss (SSNHL) following cycling class and a review of the literature.

2. Case presentation

A 35-year-old male with no significant past medical history contributory to hearing loss presented three days after attending a total of two, 60-minute-high-intensity, high-volume music, group-cycling classes on two consecutive days. Immediately after the second class, he noticed constant, non-pulsatile, subjective tinnitus in his right ear, as well as some unspecified vertigo and numbness around the ear. After several hours, he developed right-sided hearing loss, which did not improve over the next two days. He was seen by an otolaryngologist three days after symptom onset and was found to have a normal ear exam (including pneumatic otoscopy) combined with an abnormal tuning fork exam (512 Hz) in which the Weber test lateralized to the left ear. An urgent audiogram confirmed right-sided SSNHL, as well as a mild conductive loss. He received high dose oral corticosteroids, prednisone [60 mg] for seven days followed by a one-week taper of prednisone [15 mg] for seven days. He was seen by a neurotologist on day 6 following symptom-onset and a repeat behavioral audiogram demonstrated continued unilateral profound right-sided SNHL and mild conductive component. Tests of middle ear function (immitance) were

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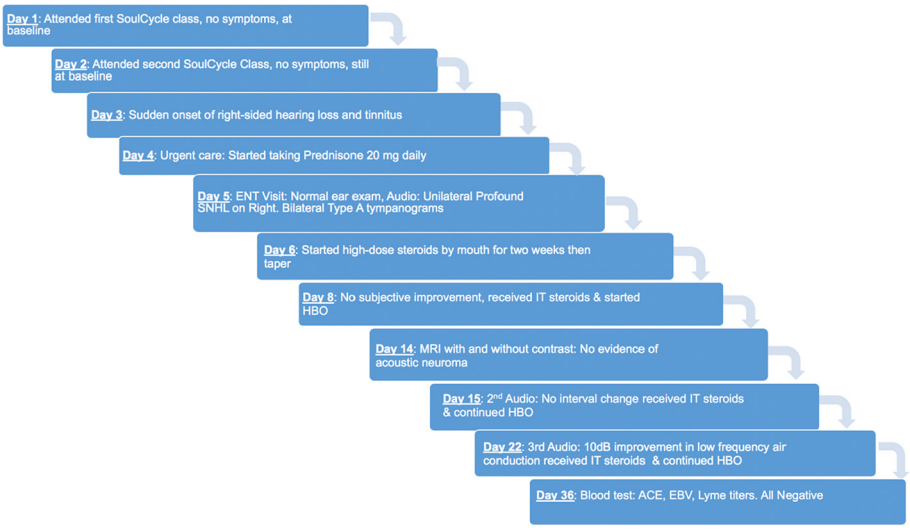

Fig. 1. Timeline of the patient's disease course and treatment.

normal with bilateral type A tympanograms. Speech understanding was (as assessed by word recognition score (WRS)) 0% on the right ear and normal on the left. At this time, he received the first of three intratympanic (IT) steroid injections [1 mL of 10 mg/mL of dexamethasone]. An audiogram was performed one week after each IT injection to assess improvement and no change was demonstrated on any of the audiograms. A total of three injections were performed over three weeks with intermittent hearing tests confirming lack of hearing improvement. He also received concurrent, adjuvant hyperbaric oxygen therapy in an attempt to increase in oxygenation to the middle and inner ear. Magnetic resonance imaging (MRI) with and without contrast of internal auditory canal and cerebellopontine angle (CPA) was performed to evaluate for intracranial or retro-cochlear pathology, none of which was found. Serology for Lyme disease and auto-immune etiology of hearing loss were also negative. The patient was counseled on noise-protection and available amplification (hearing aid) options. The patient's disease timeline and treatment course are outlined in Fig. 1.

3. Discussion

While SSNHL has a variety of etiologies, exercise has not been elucidated as a common cause. The causes of which are idiopathic, vestibular schwannoma, stroke and malignancy [11]. The majority, 90%, is thought to be idiopathic caused by vascular, viral or a combination of causes [11]. The incidence ranges from 5 to 20 out of 100,000 people per year [12]. Interestingly, most of the reported risk factors on SSNHL are related to cardiovascular alterations affecting the labyrinthine artery [12]. In fact, healthy weight and cardiovascular fitness have been linked to otoprotective effects. Marron et al. noted among 115 subjects aged 18 to 84 years old, a healthy waist-to-hip ratio was a significant predictor of better hearing [13]. In a study on over 700 patients older than 70 years old, Gispen et al. found those who have moderate or greater hearing impairment were associated with less physical activity regardless of cardiovascular risk factors [14]. The converse was also found to be true: in a cross-sectional study of over 5000 patients, Tan et al. found that having cardiovascular risk factors is associated with an increased risk of hearing loss [15]. Risk factors can include diabetes, hypertension and hyperlipidemia, while having cardiovascular disease is associated with low-frequency hearing loss [16]. Conversely, Kolkhorst et al. noted that cardiovascular fitness reduces the noise-induced temporary threshold shift (TTS), the temporary change in hearing sensitivity before and after noise exposure [17]. A cohort of subjects followed an eight-month training program with increased cardiovascular fitness showed less TTS and recovered from hearing loss faster than the untrained group [18]. Another study found that individuals with higher-fitness levels had even less TTS than lower fitness individuals [19].

Currently the mechanism for TTS is not fully understood. When the auditory system is over-stimulated with high-intensity noise, there can be a temporary, decreased hearing sensitivity which then returns to normal. One current proposed theory is that the outer hair cells (OHC) in the organ of Corti have temporarily diminished activity either through decreased current or reduced action potentials in the OHC [17]. While there is evidence of altered blood flow in the stria vascularis manifesting in hearing loss, there is no evidence in the literature that vasospasm may cause a TTS [16]. In summary, there is no consensus on how the cardiovascular system affects hearing in the short or long-term. While continued research is conducted on the relationship between cardiovascular health and hearing, loud-noise exposure is widely-accepted as detrimental to hearing.

The patient in our case report experienced SSNHL, as defined by the clinical practice guidelines as sensorineural hearing loss meeting audiometric criteria ≥ 30 dB in at least 3 consecutive frequencies [11]. SSNHL must have a rapid onset occurring over or < 72 h in one or both ears. While the spontaneous recovery rate can be variable 32–65%, there is limited success in treatment options. Patients are often offered oral steroids, intra-tympanic steroid injections, antiviral medications, diuretics, HBO, middle-ear surgical exploration, or conservative management with observation [11]. Our patient received the standard of care with oral and intratympanic steroids as well as a course of HBO, but did not improve in hearing. This could be perhaps due to confounding factors, such as a sub-clinical viral illness or latent herpes simplex virus, contributing to his hearing loss.

Noise induced hearing loss is defined as unwanted sound adversely affecting one's hearing from exposure to intermittent or continuous loud noise [20]. Sinha et al. used the SoundMeter Pro application on iPhone and iPod devices to measure the noise level in different group fitness cycling classes. They found that the average high maximum sound levels reached 113 dB where the majority of the class was spent > 100 dB [7]. According to the NIOSH guidelines, the participants would exceed the recommended daily noise exposure by greater than eight times after attending one 45-minute class [8,9]. This was not exclusive to the cycling classes our patient took. Yaremchuk and Kaczor reviewed 125 group fitness classes of all types at five American health clubs and found that the majority had an average noise level > 90 dB, and 50% of the participants self-reported decreased hearing and tinnitus [21]. Group fitness classes ranged from group yoga to cycling. Among all the group fitness classes, cycling tended to be the loudest,

with an average sound level of 94 dB [22]. Cyclists in these loud group classes may arguably have less noise exposure if they performed the sport in nature. Seidman et al. looked at the noise-induced trauma from wind on cyclists. By using a simulation wind-tunnel, a single cyclist was asked to pedal while tilting their head at varying degrees relative to oncoming differing wind speeds [23]. They found that the noise level reached a maximum of 120.3 dB when the ear was 90 degrees away from the wind traveling at 60 miles per hour [23]. Natural environments may not always be a safe alternative for acoustic safety during exercise.

The present case supports prior reports of SSNHL following high volume, high-intensity exercise classes. It is possible that overall improved fitness may be otoprotective, concurrent, high-decibel sound exposure during exercise may, confer additional hearing loss risk. Compared to noise exposure alone, combined noise exposure during physical activity has been shown to induce a greater TTS [24]. The definitive mechanism of which is unknown, but the cochlea can have vascular changes from noise and exercise [25]. The inner ear is an end-organ with a potentially tenuous vascular supply; the cochlea is supplied by the terminating spiral modiolar artery, a branch of the anterior inferior cerebellar artery [26]. There has been abundant research proving that sympathetic stimulation of the cochlear vessels through the stellate ganglion, does decrease blood flow in the cochlea [27,28]. Interestingly, it appears that noise can induce a sympathetic response similar to that of exercise. Noise as a stressor can elevate heart rate and blood pressure [29,30]. Noise exposure also reduces the red blood cell velocity in cochlear microcirculation [31]. Additionally, Axelsson et al. shows that noise exposure in guinea pigs lead to vasoconstriction in the stria vascularis of the cochlear duct [32]. Hawkins et al. observed this finding on a molecular level, showing that there was vascular damage in the cochlea. Twelve guinea pigs were exposed to 118–120 dB for 8–110 h. Histological sectioning of their cochlear showed microscopic changes of inhibited blood flow and oxygen delivery [33]. This level of noise used in these guinea pig models is similar to the level which participants at group cycling classes experience [7]. Together, the exercise-induced vasoconstriction and noise-induced vasoconstriction of the cochlea could lead to a damaging, hypoxic state, potentially increasing the risk of permanent SNHL.

This case report and other emerging data supports a need for increased awareness of hearing loss risk among participants in high-intensity, high decibel exercise classes. Since outcomes have been linked to timing of treatment, individuals should be encouraged to seek medical attention for any sudden-onset hearing loss, especially after repeated exercise and noise exposure. Even with prompt attention and multi-modality treatment, such as oral and IT steroids and HBO in this case, hearing loss may be refractory to treatment. According to the Occupational Safety and Health Administration (OSHA) guideline a noise level of 85 dB or higher is considered “action” level, and requires employees exposed to this level of noise to wear hearing protection and undergo annual audiograms [34]. Hearing protection should also be offered to all participants exposed to high-decibel music during exercise classes. Ear plugs are offered at certain boutique cardiovascular group workout classes, but not promoted on their websites [3]. Participants should be encouraged to participate in wearing ear plugs. Perhaps these classes can also provide an option to modify the noise exposure during class. This could be another way to temporize the noise-induced environment and promote acoustic safety.

Additional research is needed on the effects of noise and exercise on hearing loss. Specifically, the relationship between high-decibel music and how it affects individuals during high-intensity cardiovascular group fitness classes. More research on the cellular and molecular changes which occur during a global state of exercise in combination with loud have not been fully elucidated. Further information on the temporal relationship of the loud music and its effects on short and long-term hearing is also needed. This is imperative because it can shape the way people currently work out and maintain their own hearing health from a young age. Perhaps wearing protective equipment for acoustic safety during exercise is adequate, but at this time, further research on hearing and this popular new way to exercise is needed.

4. Conclusions

This case describes permanent SSNHL after high-intensity noise aerobic cycling class, despite appropriate and prompt multi-modality treatment. With the ever-growing trend of group exercise studios, participants as well as instructors must be made aware of the otologic harm these classes may have. In cases where patients experience sudden sensorineural hearing loss, early intervention is critical to recovering any potential of hearing.

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Conflicts of interest

The authors declare no conflict of interest.

Author contributions

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