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Noise Exposure and Its Effect on the Labyrinth, Part I

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Abstract: According to the author, the assumption is made that in Ménière's disease, compensation should be paid in acoustic trauma cases. Ménière's disease is an aftereffect of noise exposure, even if the time lapse exceeds 10 years. A historical review of existing literature (from 1872 to 1958) shows no convincing evidence of this matter. Ten patients were chosen at random. All were exposed to noise and presented with vestibular dysfunction at a certain time.

Key Words: acoustic trauma; compensation; inner ear vertigo; Ménière's disease; paroxysmal benign positional nystagmus; secondary endolymphatic hydrops

In 1999, we were involved in two compensation court cases brought by patients with noise-induced hearing loss. These patients were asking for compensation after receiving diagnoses of Ménière's disease (MD). The compensation court questioned whether the patient's balance disorder could be related to the existence of a noise-induced hearing loss.

That noise can be the cause of an MD-type syndrome has not been recognized or encountered in South Africa thus far. With these two cases in hand, we required more information concerning this condition, because we were asked by the court whether this were a recognized entity after noise exposure and whether we had seen any such cases in the past and, possibly not having recognized them as such, had simply labeled them as MD.

HISTORY AND LITERATURE REVIEW

In *Blast Injuries to the Ear*, Pahor [1] said that in Boston in 1872, Green mentioned vertigo as a result of an explosion. In 1883 in Vienna, Politzer [2] discussed various types of perforations of the tympanic membrane from blast injuries. He recommended no initial treatment, as traumatic perforations usually heal spontaneously, but advised the application of electricity in cases of concussion of the labyrinth. He expressed the idea that rupture of the tympanic membrane protects the labyrinth from the concussive effect of the blast.

In 1890, Habermann [3] reported for the first time a vestibular dysfunction in boilermakers and profession-induced hearing loss. Milligan and Wingrove [4] advised that to relieve tinnitus and to stimulate the auditory nerve after blast injury in cases accompanied by labyrinthine concussion, the daily employment of a continuous current is useful.

In 1938, Tullio [5] described vestibular stimulation with intense sound.

McCabe [6] stated in a 1958 article that the damaging effects of intense sound on the labyrinth are restricted to the pars inferior (saccule), whereas the pars superior (i.e., the utricle and semicircular duct apparatus) entirely escapes traumatization.

In 1988, Ylikoski [7] provided histological evidence of damage to the vestibular neuroepithelium due to intense sound. He said that the risk of MD-type symptoms appears to be higher among professional soldiers with impulse noise exposure than in the normal population. He added that vestibular symptoms, with or without degeneration of hearing, sometimes do not develop until several years after the exposure. These symptoms should be linked to the assumed preexisting vestibular pathology of impulse noise origin rather than regarded as symptoms of a separate idiopathic disease, such as MD. Ylikoski [8] also proposed that the type of noise can play a role in noise-induced hearing loss and balance disturbance.

Similar findings were reported by Evangelismo and Georgoulopoulos [9] in 1989 in an article entitled "Noise Exposure as a Cause of Vestibular Dysfunction."

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Georgoulopoulos concluded that inner ear lesions due to professional exposure to gunfire are more severe than are those due to industrial noise. They are attributed to dysfunction of the maculae and cupulae of the posterosuperior labyrinth.

In 1970, using electronystagmography (ENG), Oosterveld [10] examined KLM airline personnel who were employed at a noisy airbase and who had suffered noise-induced hearing losses. He concluded that acoustic stimulation affects not only the cochlea but the vestibular organ.

In contrast, Secretan [11] mentioned in a 1945 study that no case of posttraumatic MD could be encountered in the literature. Indeed, the documented cases in the literature even today remain rare. However, in contrast to this, in 1972 Pulec [12] mentioned a few of these cases, as did Clark and Rees [13] in 1977.

METHODS

We elected to study ENGs of people with a history of noise exposure and high-frequency hearing loss who were not necessarily complaining of dizziness or balance disturbance. Ten cases were selected.

When we examine a patient suffering from dizziness, the most important part of the diagnostic workup is the case history. This history serves to differentiate between MD and other diseases of the brain or labyrinth, giving us the opportunity to search for causal factors. In other words, we can differentiate between MD and Ménière's syndrome (MS).

MD is described as classic, with episodic vertigo, fluctuating and progressive hearing loss, aural pressure, tinnitus, and loudness intolerance due to idiopathic endolymphatic hydrops. The characteristic clinical features of MS are the same as those of MD, but they occur in a patient with a predisposing cause. Our research endeavored to study case reports from our clinic, which involved 10 patients with a history of noise exposure and hearing loss, by exploring the history of balance disturbances. We were, therefore, looking for the existence of posttraumatic MS (i.e., balance problems after acoustic trauma, either sudden or chronic).

CASE REPORTS

Patient 1

Age	54 years
Gender	Male
History	No balance problems or tinnitus; high-frequency noise-induced hearing loss and tinnitus (gradual)
ENG findings	
Positional nystagmus	2–3 degrees/sec to the left
Caloric challenge	Left labyrinth pathological ↓ (24%)
Diagnosis	Peripheral vestibular affection

Patient 2

Age	42 years
Gender	Male
History	Bilateral high-frequency hearing loss with tinnitus (mine explosion 16 years previously)
ENG findings	
Positional nystagmus	Positional nystagmus and nystagmus alternans
Caloric challenge	No loss
Frequency butterfly	Central nervous system ischemia
Diagnosis	Central vestibular affection

Patient 3

Age	50 years
Gender	Male
History	Occurrence of minimal balance problems for the last 5 years; unilateral total hearing loss after a dynamite explosion 20 years previously
ENG findings	
Positional nystagmus	Positional nystagmus to the right, 2–5 degrees/sec
Caloric challenge	Right labyrinth ↓ (91%)
Diagnosis	Severe peripheral labyrinth affection

Patient 4

Age	49 years
Gender	Male
History	Slight balance problem for the last 10 years; severe hearing loss after a shooting incident 25 years previously
ENG findings	
Positional nystagmus	Positional nystagmus to the right, 2–7 degrees/sec
Caloric challenge	Left labyrinth pathological ↓ (48%); no central pathology
Diagnosis	Severe peripheral labyrinth affection

Patient 5

Age	32 years
Gender	Male
History	Vertigo for the last 3 years; history of shooting for 11 years (police work); high-frequency sensorineural hearing loss, with a low-frequency conductive component
ENG findings	
Positional nystagmus	Spontaneous and positional nystagmus to the left, 4–7 degrees/sec
Caloric challenge	Both labyrinths equally irritable
Diagnosis	Noise-induced vestibular dysfunction

Patient 6

Age	66 years
Gender	Male
History	Last 3 years, attacks of vertigo, accompanied by nausea and tinnitus (right ear); 34 years in power station; right ear, moderate hearing loss in all frequencies (50 dB); left ear, only high frequencies affected
ENG findings	
Positional nystagmus	Spontaneous and positional nystagmus to the left, 5–10 degrees/sec
Caloric challenge	Right labyrinth ↓ (47%)
Frequency butterfly	Right ↓, peripheral
Diagnosis	Severe loss right labyrinth

Patient 7

Age	31 years
Gender	Male
History	History of vertigo for 3 years and tinnitus; army captain (history of shooting); right-ear sensorineural high-frequency hearing loss
ENG findings	
Positional nystagmus	No nystagmus
Caloric challenge	Left labyrinth pathological ↓ (48%); central tests normal
Diagnosis	Severe dysfunction left labyrinth

Patient 8

Age	27 years
Gender	Male
History	Slight balance problem; army captain (history of shooting and explosion 6 weeks previously); sensorineural hearing loss and tinnitus in left ear
ENG findings	
Positional nystagmus	Spontaneous and positional nystagmus to the right, 2–10 degrees/sec
Caloric challenge	Both labyrinths equally irritable; pathology: directional preponderance (23%) to the right; central tests normal
Diagnosis	Acute noise deafness with dysfunction of the left labyrinth

Patient 9

Age	40 years
Gender	Male
History	Vertigo for the last 6 years with nausea; severe hearing loss and tinnitus in the right ear after mortar explosion 20 years previously
ENG findings	
Positional nystagmus	Spontaneous and positional nystagmus to the left, 5–10 degrees/sec
Caloric challenge	Right labyrinth pathological ↓ (40%); pathology: directional preponderance (60%) to the left; central tests normal
Diagnosis	Severe dysfunction of the right labyrinth

Patient 10

Age	65 years
Gender	Male
History	Severe attacks of vertigo for 6 months; shooting as a hobby for 20 years (without protection); in right ear, severe sensorineural hearing loss in all frequencies; in left ear, only high-frequency sensorineural hearing loss
ENG findings	
Positional nystagmus	Spontaneous and positional nystagmus, paroxysmal benign positional nystagmus type
Caloric challenge	Left labyrinth ↓ (33%); pathology: no directional preponderance; vestibular recruitment left
Diagnosis	Ménière's syndrome bilateral

DISCUSSION

The aim of our study was to answer the question, "Can noise exposure be the cause of a balance disorder." If the answer is yes, compensation for this disability should be paid. We found positive answers in the literature from as early as 1872. As for our own investigation, we studied the ENG results of 10 patients complaining of dizziness, tinnitus, and hearing loss after noise exposure. On the basis of our observations and findings, we noticed dysfunction of the labyrinth. The results led us to diagnose MS in all our subjects.

In South Africa, compensation for hearing loss in cases of noise exposure is usually granted but is not awarded for balance disorders. We believe that compensation for patients with balance disorders after noise exposure and for those with hearing loss should not differ. The degree of compensation should depend on the eventual percentage of labyrinth function loss.

CONCLUSION

The evaluation of patients with noise exposure and hearing loss should be conducted with vestibular testing. Our study should be extended to the study of patients with noise exposure and hearing loss who have no specific complaints of dizziness. If a vestibular dysfunction is found, compensation for it should be awarded as well.

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