Hearing threshold in geriatric osteoporosis: Is osteoporosis a risk factor for hearing loss?

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Abstract

Aim: The aim of this study was to evaluate hearing loss in geriatric osteoporosis patients in
Methods: This study included 60 female patients in postmenaupausal period. Cases were evaluated for osteoporosis using dual-energy x-ray absorptiometry. This study was performed on 30 geriatric osteoporosis female patients and 30 normal patients (the control group). The patients' pure tone audiometry and tympanometry values between 250-8000 Hertz frequencies were analysed.
Results: In our study, statistical significance was found between high frequency (8,000 Hertz) sensorineural hearing loss and osteoporosis (P=0.04). There was no statistical significance between other frequencies. We found no statistically significant difference in conductive type hearing loss.
Conclusion: Osteoporosis is a risk factor for hearing loss in geriatric patients who are likely to develop presbycusis. In osteoporotic patients, hearing loss is related to an increased risk of falls and bone fractures. Patients with the initial diagnosis of osteoporosis should have their hearing levels measured in terms of quality of life. Pre-treatment audiometry should be measured in terms of medico-legal importance. This is due to the possible ototoxic effects of osteoporosis treatment agents such as bisphosphonates.

Keywords: hearing loss, health service research, sensorineural hearing.

Introduction

Osteoporosis is a bone metabolism disorder involving the progressive thinning of bone tissue. With the anticipated increase in life expectancy, this disease is a major public health problem. According to several studies, the overall prevalence of osteoporosis is estimated at 5% (1). These patients are, for the rest of their lives, at risk of bone fractures due to trauma.

Over time, hearing loss may occur in patients with osteoporosis. Conductive and sensorineural hearing loss and the relationship of osteoporosis have been defined in various studies. Hearing loss increases the risk of vulnerability and, therefore, increases the risk of fractures in the population. At the same time, bisphosphonates used in the treatment of osteoporosis can have ototoxic side effects (2).

Presbycusis is defined as age-related hearing loss (3). It is the most common cause of hearing loss in the geriatric population. In a previous study, the rate of admission to a doctor with hearing loss was found to be 33% for patients in the 65-74 age range. In the 75-84 age range, it was 45% and in the over 85 age range, it was 62% (4). Hearing loss reduces the quality of life in geriatric patients.

In our study, we investigated the prevalence of hearing loss and the type of hearing loss in patients with osteoporosis.

Methods

A total of 60 female patients who had been referred to routine controls for postmenopausal period were included in this study. The patients were all female. Cases were evaluated for osteoporosis using dual-energy x-ray absorptiometry, searching for bone mineral density (BMD). In this study, 30 patients had been diagnosed with osteoporosis due to BMD. The remaining 30 patients had a normal BMD and constituted the control group.

Patients using ototoxic drugs, hormone replacement therapy for menopause and bisphosphonates for osteoporosis were excluded from this study. Furthermore, patients with chronic diseases, diabetes mellitus, hypertension, renal and thyroid diseases, acute otitis media, secretory otitis media, cerumen in the way of the external ear, tympanic membrane perforation, myringosclerosis or tympanosclerosis in the eardrum and with chronic otitis were excluded from the study. The patients were asked how many years they had been in menopause.

Bone mineral density (BMD) was measured using DXA (dual-energy x-ray) technology on the lumbar spine from 1-4. The World Health Organization working group defined osteoporosis as a t-score of -2.5 or lower. A t-score between -1 and -2.5 is classified as low BMD or osteopenia. A t-score lower than -1 is classified as normal.

In this study, we performed audiometric and tympanometric examinations on both groups of patients. The Impedance Audiometer (AZ26, Interacoustics, Assens, Denmark) was used during measurement. Patients' hearing thresholds were measured in the frequency of 250-500-1000-2000-4000-8000 Hertz (Hz). Frequencies of 250-500 Hz were considered low frequencies, 1000-2000 Hz frequencies were considered medium frequencies and 4000-8000 were considered high frequencies. Patients with hearing loss were classified as 0-25 Decibel (db) normal, 26-40 db mild, 41-55 db moderate, and 56-70 db moderate to severe, 71-90 severe hearing loss. Additionally, we examined all of the acoustic reflexes.

Following a detailed explanation of the objectives and protocol of this study, we obtained written informed consent from each subject. This study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the Institutional Ethics Committee.

We conducted a statistical analysis using computer software (SPSS version 15.0, SPSS Inc. Chicago, USA). Hearing thresholds were calculated per frequency. We also performed a post-hoc Tukey test in order to determine the relationship between osteoporosis and hearing thresholds. Additionally, an independent-samples t-test was performed to determine the relationship between osteoporosis and

tympanometric thresholds. Data were expressed as means (standard deviations; SD) and ≤0.05 was considered statistically significant.

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Results

In the osteoporosis group, the mean age of the 30 female patients was 69.3±4.3 years (range: 65-80 years). T-scores of the cases were monitored in the range from -2.5 to 4.3 (mean value: -3±0.4). Cases were in the postmenopausal period in 16.4±1.9 (13-21) years. Acoustic reflex values were assessed as normal in the study group.

In the control group, the mean age of the 30 female patients was 70.4±4.6 years (range: 65-80 years). T-scores of the cases were monitored in the range from -0.9 to -0.2 (mean value: -0.5±0.2). The control group was in the postmenopausal period in 16.2±2.9 (13-21) years. Acoustic reflex values were assessed as normal in the control group.

Pure tone audiometry and tympanometry values between 250-8000 Hz frequencies were analysed. In our study, statistical significance was found between high frequency (8000 Hertz) senso-rineural hearing loss and osteoporosis (P=0.04). There was no statistical significance between other frequencies. There was no tympanometric statistical difference between osteoporosis and control group (Table 1).

Table 1. Tympanometric values and statistical analysis in both groups

		Pressure	Min-Max	P-value
Osteoporosis	Right	14.6±38.4 dPA	-40-90 dPA	0.855
	Left	22±34.8 dPA	-50-90 dPA	0.855
Control	Right	13±31.3 dPA	-40-90 dPA	0.419
	Left	14.6±36.9 dPA	-40-70 dPA	0.419

We found sensorineural hearing loss rather than conductive type hearing loss. The bone and air hearing thresholds are presented in Table 2 and Table 3.

Table 2. Hearing thresholds and statistical analysis of right ear in both groups

	Study group	Control group	Skewness	P-value
R 250 Hertz (Db) **Air**	22.3±11.3	19.6±10.9	0.87/0.9	0.59
Bone	20.3±9.9	18.3±9.1	1/0.9	0.1
R 500 Hertz (Db) **Air**	23.3±11.5	20.6±12.8	0.58/1.1	0.75
Bone	21±10.2	19.3±11.1	0.8/1.4	0.4
R 1000 Hertz (Db) **Air**	25.6±11.9	23.3±13.7	0.67/1.1	0.98
Bone	23±10.2	21.6±14.4	0.58/1.4	0.4
R 2000 Hertz (Db) **Air**	28±10.9	27±11.7	0.42/1	0.87
Bone	26.6±11.2	26±11	0.33/1.2	0.6
R 4000 Hertz (Db) **Air**	30.5±11.6	28±12.6	0.55/1.1	0.18
Bone	28.5±11.2	27±12.2	0.26/1.2	0.7
R 8000 Hertz (Db) **Air**	38±17.4	32.3±14.5	0.99/0.5	**0.04**
Bone	35±16.7	31.6±14	0.87/0.6	**0.04**

Table 3. Hearing thresholds and statistical analysis of left ear in both groups

	Study Group	Control Group	Skewness	P-value
L 250 Hertz (Db) **Air**	25±19.4	23.3±20.3	1.6/1.6	0.49
Bone	22.3±15.9	20.3±15.6	1.5/1.7	0.15
L 500 Hertz (Db) **Air**	25.6±18.3	24±20.1	1.1/1.1	0.77
Bone	23±16	21±16.4	1.4/1.6	0.24
L 1000 Hertz (Db) **Air**	27.6±18.5	26.3±21	1.5/1.4	0.98
Bone	25±16.1	23.6±17.5	1.5/1.5	0.34
L 2000 Hertz (Db) **Air**	31.3±20	32±22.9	1.7/1.4	0.9
Bone	28.6±16.9	29±18.2	1.4/1.5	0.69
L 4000 Hertz (Db**) Air**	38.6±20.8	38.6±21.7	1.7/1.3	0.44
Bone	32.2±18.8	33.7±18.6	0.8/0.7	0.78
L 8000 Hertz (Db) **Air**	45±23.5	42.6±23.3	0.9/0.8	0.3
Bone	39±19.8	38±18.2	0.7/0.5	0.5

Normal hearing levels at all levels were found in eight patients of the osteoporosis group. Low/medium/high levels of hearing loss were found in 22 patients.

Hearing loss at low frequencies was found in 10 patients of the study group. Three of these patients had mild hearing loss and seven had moderate hearing loss.

Hearing loss at medium frequencies was found in 14 patients in the study group. Six of these patients had mild losses and eight had severe losses.

Hearing loss at high frequencies was found in 22 patients in the study group. Twelve of these patients had mild loss, five had moderate hearing loss and a further five had severe losses.

Normal hearing levels at all levels were found in 10 patients in the osteoporosis group. Low/medium/high levels of hearing loss were found in 20 patients.

Hearing loss at low frequencies was found in 11 patients in the control group. Five of these patients had mild losses, four had moderate losses and two had severe losses.

Hearing loss at medium frequencies was found in 14 patients in the control group. Five of these patients had mild losses, six had moderate losses and three had severe losses.

Hearing loss at high frequencies was found in 20 patients in the control group. Ten of these patients had mild losses, seven had moderate losses and eight had severe losses.

Discussion

Osteoporosis is a progressive bone disease that can cause mortality and morbidity, particularly in the geriatric population (1). With osteoporosis, bone mineral density is reduced in all of the bones in the body. These include the temporal bone, temporomandibular joint, cochlear capsule, internal auditory channel, mandible and middle ear bony structures (5,6). Middle ear bony structures and cochlear capsules can be investigated using computerized tomography (7).

Bones consist of cortex and spongoid tissue. Both of these parts can be influenced by osteoporosis. Early stages of the disease can impact the spongoid parts of the spina or femur. The spina and the head of the femur have spongy textured bones (8). The cortical bone can be affected by the late stages of osteoporosis. The middle ear bony structures are mostly made up of cortical bone rather than spongoid bone. Hearing loss may occur in the process of osteoporosis. Hearing levels can be corrupted in diseases of bone metabolism disorders such as Paget's disease and Osteogenesis Imperfecta (9). Demineralization of cochlear capsule may reveal both sensorineural and conductive hearing loss.

Epidemiological studies have revealed that, in all age groups up to menopause, women have better hearing potential than men (10). Oestrogen levels begin to decrease in menopause. Oestrogen reduces the rate of bone loss by inhibiting osteoclastic activity. Furthermore, oestrogen leads to the release of prolactin. Prolactin activates an osteoclastic enzyme called Osteoprotoger (OPG). OPG is reported to have a high concentration in cochlea (11). Over time, oestrogen-containing oral contraceptives and hormone replacement therapy may reveal otosclerosis and hearing loss (12). In pigs, long-term oestrogen hormone replacement therapy has revealed to cause dysmorphology of the otic capsule (13).

Presbycusis is defined as age-related hearing loss. Reduction of hearing levels may occur with increasing age. In a previously conducted study, the rate of admission to a doctor with hearing loss in the 65-74 age range was 33%. In the 75-84 age range, it was 45% and in the over 85 age range, it was 62% (4). The hearing loss observed in presbycusis is symmetrical and bilateral, holding high frequencies at the beginning rather than radiating all frequencies.

Written studies report the relationship between menopause and hearing loss (13). With the decrease of oestrogen in the blood, electrolyte imbalances in the transport may occur, as well as neuronal deterioration in the transmission between cells (14). In the Turner Syndrome, cochlear hearing may deteriorate. This is due to the endogenous reduction of oestrogen levels (15). Hormone replacement therapy, including oestrogen, has two effects on hearing. Some scholars defend hormone replacement therapy, arguing that patients have better hearing levels compared to those who are not using hormone replacement therapy (14). On the other hand, these treatments can lead to the demineralization of the otic capsule (16). This can result in hearing loss. For our study, we selected subjects who were not undergoing treatment involving oestrogen.

In previous studies, both sensorineural and conductive type hearing loss have been reported in osteoporosis patients (17,18). Otosclerosis can be associated with osteoporosis. COL1A1 gene mutation is present in both osteoporosis and otosclerosis (19). Sensorineural hearing loss is responsible for cochlear dysfunction (20).

In our study, the geriatric population is a potential risk group in terms of hearing loss. Factors, such as haemodialysis, uraemia, HT and DM, are also risk factors for the hearing of these patients. Bisphosphonate agents used in the treatment of osteoporosis have ototoxic effects (20-22). For this study, we selected patients with initia with initial osteoporosis diagnosis who had not used these agents.

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Informed Consent: Written informed consent has been obtained from all participants.

Conflicts of interest: None declared.

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