Hearing Function in Osteoporotic Patients

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Abstract: Background: Osteoporosis is as a progressive systemic skeletal disorder characterized by low bone mineral density (BMD), The reduction in BMD is measured using T-score. WHO criteria defines T-score of more than -1 as normal, -1 to -2.5 as osteopenic and less than -2.5 as osteoporotic. Hearing impairment and osteoporosis are two of the most common public health problems, metabolic changes and possible degeneration of middle ear ossicles or the cochlear capsule may cause hearing loss in osteoporotic patients. **The aim:** To evaluate the hearing function in patients with osteoporosis and assessment of type and configuration of hearing loss if present in those patients. **Subjects & method:** This study included 40 osteoporotic patients and 20 control. Participants underwent DEXA scan, full history taking, basic audiological evaluation, DPOAE. **Results:** The percentage of hearing loss in the study group was 22 osteoporotic patients 55% and 18 patients 45% had normal hearing. **Conclusion:** there is a relation between osteoporosis and hearing loss especially SNHL mainly at high frequencies.
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Keyword: Osteoporosis, bone mineral density (BMD), Dual energy x ray absorptiometry (DEXA), Hearing loss, sensor neural hearing loss (SNHL).

1. Introduction:

Osteoporosis is as a progressive systemic skeletal disorder characterized by low bone mineral density (BMD), deterioration of the microarchitecture of bone tissue and susceptibility to fracture. Osteoporosis is major public health problem, which affects millions of people around the world, more common in Egypt, its frequency increases by age, women more affected than men, measurement of BMD by DEXA is the "gold-standard" method for the noninvasive diagnosis of osteoporosis, DEXA is the technique of choice in the assessment of bone mineral density **(Yosria et al., 2014).**

Hearing impairment and osteoporosis are two of the most common public health problems more common in old age, there is a relation between osteoporosis and hearing loss, Osteoporosis may affect auditory system due to its effect on cochlear bone, middle ear ossicles lead to hearing loss. The present study aimed to evaluate the hearing function in patients with osteoporosis and Assessment of type and configuration of hearing loss if present in those patients.

2. Subjects and Method:

1. Subjects:

A total of 60 subjects composed of;

A- Cases:

40 patients diagnosed as osteoporosis by DEXA scan. They were selected from outpatient clinic of Rheumatology and Physical Medicine Department at AL-Hussin University Hospital. They were chosen according to the following criteria: Age: Above 45 years old. Both genders were involved. Patients with current general medical disease or otologic finding known to adversely affect hearing as chronic suppurative otits media were be excluded.

B- Control:

20 healthy control subjects without osteoporosis, and not complaining of otological symptoms. They were selected to match the age range and gender distribution in the study group. The same above exclusion criteria were be applied for the control group be included in the study.

2. Methodology:

A. Method:

They were being subjected to the following:

I- Estimation of bone mineral density (BMD): by Dual energy x-ray absorptiometry (DEXA) scan.

II- Complete History Taking:

Detailed information was obtained about osteoporosis and hearing loss, tinnitus, history of bone fractures, general diseases.

III- Examination:

- Full ENT examination.

IV- Audiological evaluation:

Including:

a- Pure tone audiometry:

- Air conduction hearing threshold level fo frequencies between 250 – 8000 Hz.
- Bone conduction threshold for frequencies between 500-4000 Hz were done.

The threshold was taken as the faintest sound that the patient responds to 50% of the time. Masking was used whenver indicated.

b- Speech audiometry including:

- Speech reception threshold (SRT) using Arabic spondee words.
- Word discrimination scores (WDS) using Arabic phonetically balanced words.

c- Immitancemetry and acoustic reflex.

- Tympanometry done at varying pressure ranging from +200 to – 400 mm H2O, to evaluate the middle ear pressure and its compliance.
- Acoustic reflex thresholds elicited both ipsilaterally and contralaterally using pure tones of 500, 1000, 2000 and 4000Hz.

d- Distortion Product Otoacoustic Emission (DPOAE):

- Stimulus generation:

The stimulus consisted of two pure-tone signals at two different frequencies.

B. Equipment:

1- Two channels Pure Tone Audiometer Interacoustic model AC40.

2- Sound treated room (locally made) according to the international specifications of sound treated room.

3- Immitancemeter: GSI model 39.

4- Cochlear Emission Analyzer model celesta 503.

5- Otoscope model Rister.

Table (1): Age and sex distribution of both study and control groups.

Variable	Osteoporosis N=40	Control N=20	
Age mean±SD	52.1±11.3	49±5.4	0.119
Sex N (%) Female	(80)32	16(80)	1
Sex N (%) Male	8(20)	4(20)	1

C. Statistical methods

Student T test was used for continuous normally distributed data and Mann-whitney U test for none-normally distributed data. Comparing of categorical data was done using chi square test or fisher exact test used whenever appropriate. Analysis of variance (ANOVA) test was used to compare means between more than two groups. Statistical significance was considered when probability (P) value was less than or equal to 0.05.

Results:

Table (1) sex show insignificant association between osteoporotic group and control. Also, age show insignificant difference between both groups.

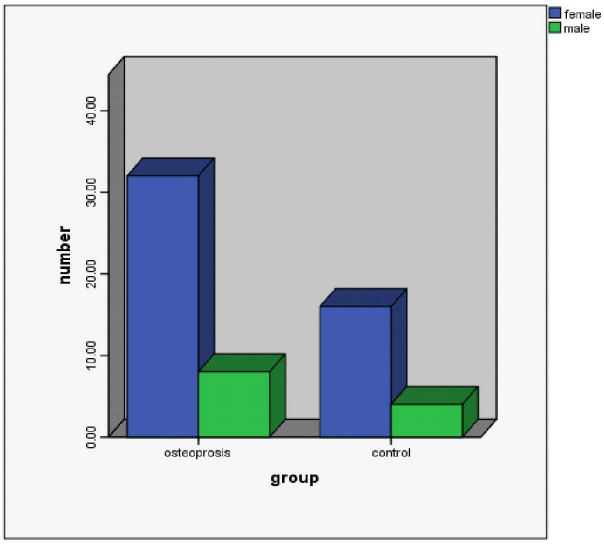

Figure (1): Sex between groups.

Table (2): DEXA between both osteoporotic and control groups.

Variable		Osteoporosis	Control	P
DEXA	Mean	-3.34	0.44	0.001*
	SD	1	0.8	

Table (2) show significant low DEXA in osteoporotic group compared to control group.

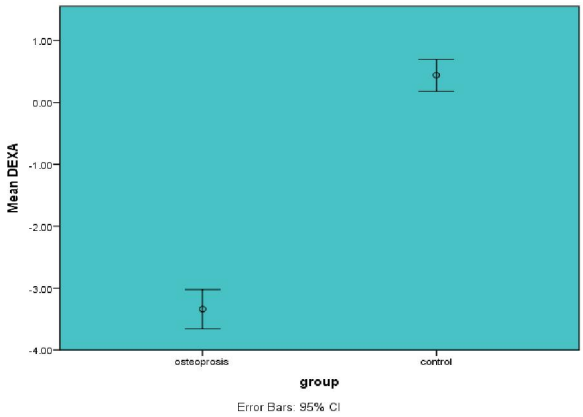

Figure (2): DEXA between osteoporotic and control group.

Table (3): Pure tone audiometry between osteoporotic and control groups.

PTA (Hz)		Osteoporosis		Control		P
		Rt	Lt	Rt	Lt	
250	Mean	15 dBHL	15 dBHL	10 dBHL	10 dBHL	0.764
	SD	8.3	6.9	4.7	4.6	
500	Mean	21 dBHL	20 dBHL	12 dBHL	13 dBHL	0.822
	SD	8.2	8.3	4.7	4.5	
1000	Mean	24.5 dBHL	24.7 dBHL	15 dBHL	15 dBHL	0.71
	SD	7.9	6.5	4.9	4.9	
2000	Mean	26.3 dBHL	26.3 dBHL	16.5 dBHL	17 dBHL	0.74
	SD	12.3	7.7	7.5	7.3	
4000	Mean	26 dBHL	26 dBHL	24.2 dBHL	23 dBHL	0.171
	SD	15.7	15.1	7.1	7.3	
8000	Mean	40 dBHL	40 dBHL	27.2 dBHL	27.2 dBHL	0.012*
	SD	21.8	21.7	7.8	7.1	

Table (3) show significant high pure tone audiometry at 8000 in osteoporotic group while pure tone audiometry at 250, 500, 1000, 2000, 4000 do not show any significant difference between both groups.

Table (4): Post hoc analysis of pure tone audiometry at 8000 Hz.

PTA (8000 Hz)		Osteoporosis	Control	P
Rt	Mean	40	27.2	0.019*
	SD	21.8	7.8	
Lt	Mean	40	27.2	0.023*
	SD	21.7	7.1	

Post hoc analysis show pure tone audiometry 8000 in osteoporotic group on rt and lt ear compared to control group.

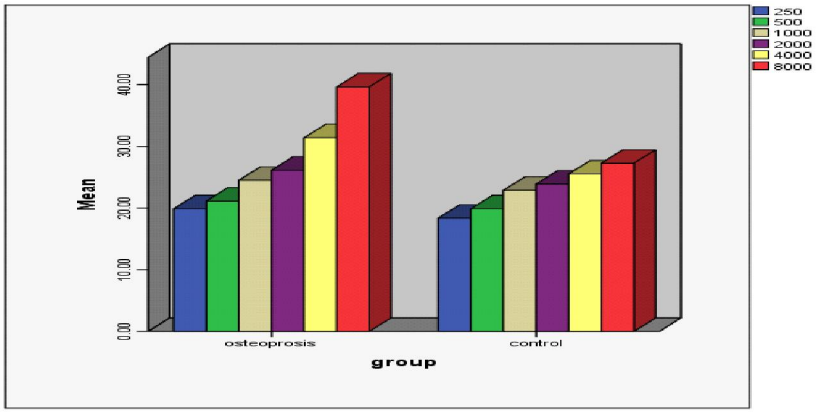

Figure (3): Pure tone audiometry in control and osteoporosis.

Table (5): Bone conduction threshold between both groups.

Bone conduction threshold (Hz)		Osteoporosis		Control		P
		Rt	Lt	Rt	Lt	
500	Mean	15.5	16.1	10	11	0.872
	SD	8.2	8.4	4.5	4.8	
1000	Mean	19.5	19.7	12	12	0.819
	SD	7.9	6.5	4.1	4.8	
2000	Mean	21	21.1	15.1	15.2	0.722
	SD	11.5	8.1	7.3	6.3	
4000	Mean	28.1	28.7	22.2	22	0.474
	SD	14.6	15.1	6.9	5.2	

Table (5) show insignificant difference of bone conduction threshold at 500, 1000, 2000, 4000 Hz between osteoporotic and control groups.

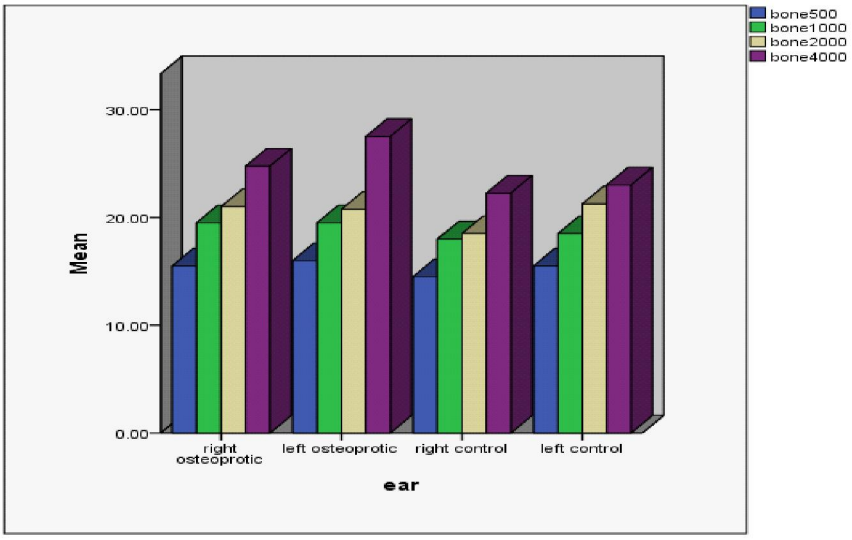

Figure (4): Bone conduction threshold in both groups.

Table (6): Arabic speech audiometry.

Arabic speech audiometry		Osteoporosis		Control		P
		Rt	Lt	Rt	Lt	
SRT	Mean	24.5 dBHL	24.2 dBHL	20.7 dBHL	20.7 Dbhl	0.304
	SD	8.4	7.3	4.9	4.9	
MCL	Mean	64.2 dBHL	64.2 dBHL	60.7 dBHL	60.7 dBHL	0.324
	SD	7.4	7.4	4.9	4.9	
WD%	Mean	98.2	98.3	99.2	99.2	0.347
	SD	6.2	5.5	1.6	1.6	

Table (6) show insignificant difference between both groups in SRT, MCL, WD%.

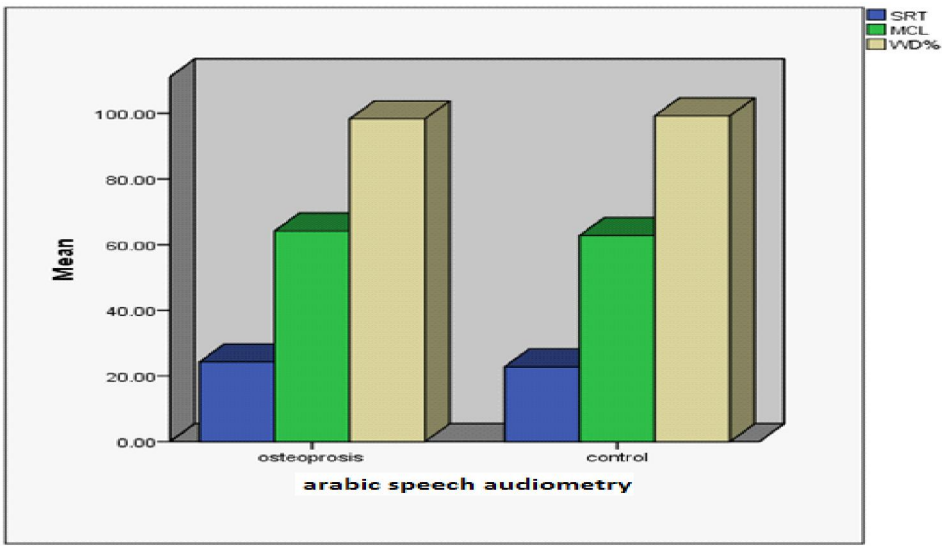

Figure (5): Arabic speech audiometry.

Table (7): Tympanometry and Acoustic reflex.

Tympanometry		Osteoporosis	Control	P
Type A	N	40	20	1
	%	100%	100%	
Acoustic reflex	N	40	20	1
	%	100%	100%	

Table (7) shows insignificant difference between both groups in tympanometry, all bilateral type (A) tympanogram with intact acoustic reflex.

Table (8): Ipsilateral acoustic reflex threshold.

Ipsilateral acoustic reflex		Osteoporosis N=40	Control N=20	P
500	Mean	88.2 dBHL	86.2 dBHL	0.204
	SD	5.8	5.3	
1000	Mean	87.7 dBHL	84.7 dBHL	0.043*
	SD	5.4	4.9	
2000	Mean	89.2 dBHL	84.7 dBHL	0.001*
	SD	4.6	4.7	
4000	Mean	88.7 dBHL	85 dBHL	0.005*
	SD	4.4	5.1	

Table (8) show high ipsilateral acoustic reflex threshold at (1000, 2000, 4000 Hz) in osteoporotic patients than control group, while ipsilateral acoustic reflex threshold at 500 Hz do not show any difference between both groups.

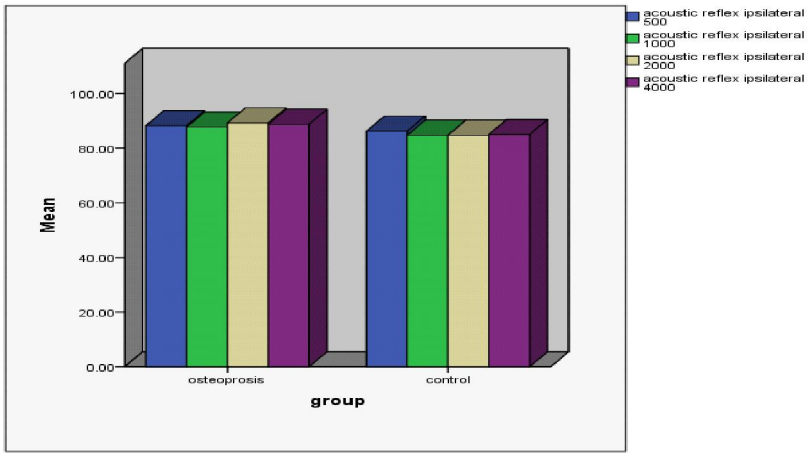

Figure (6): Ipsilateral acoustic reflex between both groups.

Table (9): Contralateral acoustic reflex threshold.

contralateral acoustic reflex		Osteoporosis N=40	Control N=20	P
500	Mean	89.4 dBHL	87 dBHL	0.263
	SD	8.7	5.7	
1000	Mean	91.5 dBHL	85.5 dBHL	0.001*
	SD	4.9	4.8	
2000	Mean	89.7 dBHL	85.7 dBHL	0.002*
	SD	4.1	5.4	
4000	Mean	89.7 dBHL	85.5 dBHL	0.006*
	SD	4.6	5.5	

Table (9) show high contralateral acoustic reflex threshold at (1000, 2000, 4000 Hz) in osteoporotic patients than control group, while contralateral acoustic reflex threshold at 500 Hz do not show any difference between both groups.

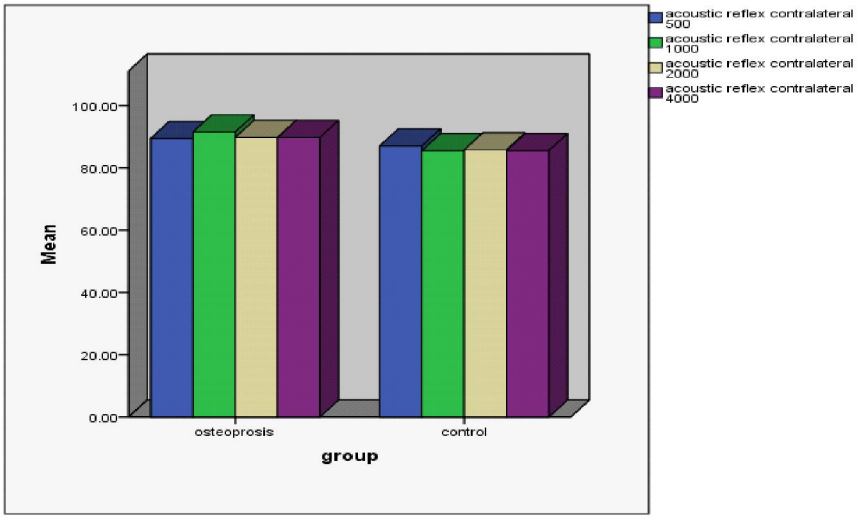

Figure (7): Contralateral acoustic reflex between both groups.

Table (10): DPOAEs between both groups.

DPOAEs (Hz)	Osteoporosis		Control		P
	median	Range	Median	Range	
500	4 SPL	2-7	2.5 SPL	1-10	0.613
1000	4 SPL	1-8	4.2 SPL	1-8	0.472
2000	3 SPL	1-6	3 SPL	2-7	0.685
4000	4.5 SPL	-4- 7	5 SPL	-1-7	0.379
6000	4 SPL	-11-8	3.5 SPL	-2-6	0.027*
8000	2.5 SPL	-12-8	3.5 SPL	-5-7	0.043*

Table (10) show significant differene DPOAEs at 6000, 8000 Hz while 500, 1000, 2000, 4000 Hz do not show significant difference between 2 groups.

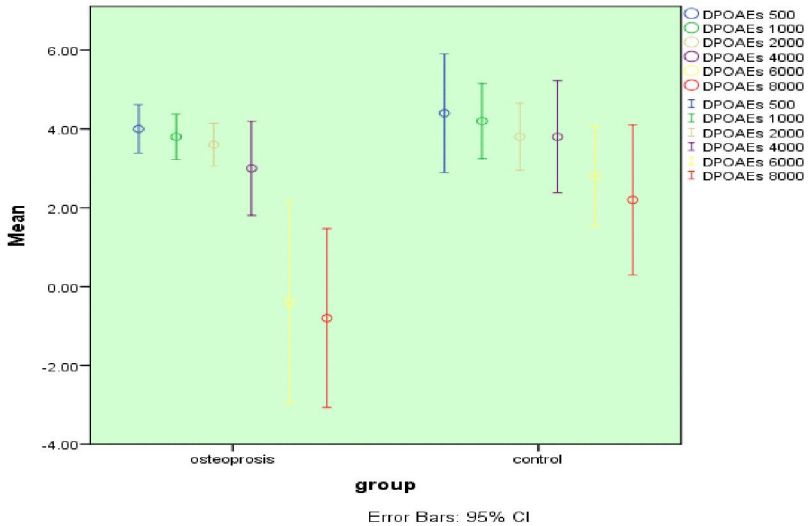

Figure (8): DPOAEs between both groups.

Table (11): Degree of hearing in both osteoporosis and control group.

Degree of Hearing	Osteoporosis N=40		Control N=20	
Normal	N	%	N	%
	18	45	18	90
SNHL	22	55	2	10

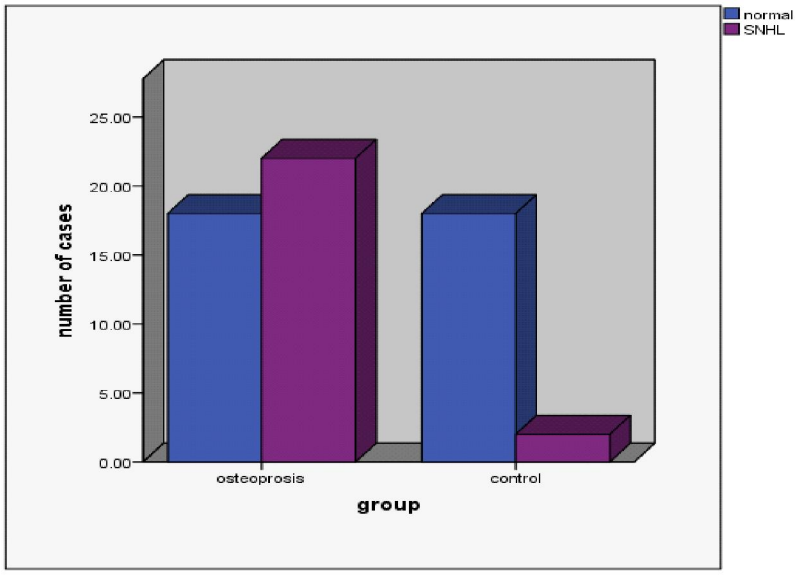

Figure (9): Degree of hearing in both osteoporosis and control group.

Discussion

To achieve this target, we enrolled 60 subjects: 40 patients diagnosed as osteoporosis in this study group, in addition to 20 healthy control subjects without osteoporosis, and not complaining of otological symptoms in the control group, the studied osteoporotic patients with lower BMD had a mean age of 52.1±11.3 years and their age range was 45-60 years, 32 female patients (80%), 8 male patients (20%). Control group with normal BMD had a mean age of 49±5.4 years and their age range was 45-55 years, 18 female control (80%), 2 male control (20%). There was insignificant difference between the study osteoporotic group and healthy control group regarding age and gender ratio indicating that the two groups were compartable.

Both of the 2 groups were subjected to DEXA scan to assess their BMD, also They were subjected to careful history taking, through clinical examination, otoscopic examination, pure tone audiometry, speech audiometry, tympanometry, acoustic reflex and DPOAEs.

PTA results the mean pure tone average threshold of 17.3 dBHL in control group, 25.34 dBHL in osteoporotic group. With significant high pure tone audiometry in high frequencies mainly 8000 Hz. The mean SRT average threshold of 24.35 dBHL in osteoporotic group, 22.7 dBHL in control group. Mean percentage of word discrimination score WDs 98.2% in osteoportic group, 99.2% in control group. Similer results were mentioned in the study done by **Bhavya et al., (2016)** who reported that mean thresholds at all frequencies from 250 Hz to 8 kHz were better for normal women with a mean pure tone average threshold of 16 dBHL for right ear, 16 dBHL for left ear.

Tympanometry, all osteoporotic patients and control groups were type (A) tympanogram, with intact acoustic reflex This reflecting normal middle ear pressure in both osteoporotic and control groups. Similer results were mentioned in the study done by **Bhavya et al., (2016)** reported that normal middle ear status with type (A) tympanogram in almost all of the ear in both groups. Study done by **Ozkiris et al., (2013)** reported that there is no significant difference between normal and osteoporotic group in tympanometric values, reflecting normal middle ear pressure in both osteoporotic and control groups.

DPOAEs results were statistically significant differences in high frequencies 6000, 8000 Hz, significant lower in osteoporotic study group than normal control group while 500, 1000, 2000, 4000 Hz do not show any significant difference between both groups this indicate that the causes of high frequencies sensorineural hearing loss may be due to cochlear dysfunction. In support of the result of our study,

similar study done by **Bhavya et al., (2016)** reported that the reduced DPOAEs was seen predominantly at high frequencies. **Kahveci et al., (2014)** reported that DPOAE results of patients with osteoporosis at (6000 Hz) were significantly lower than those of normal and osteopenic patient, thresholds were also significantly worse at high frequencies, this affection of basal region of the cochlea causes SNHL mainly at high frequencies because the cochlea is organised tonotopically which means that the base end of the cochlea responds to high-frequency sounds while the apical aspect responds to the low frequency sounds. In this study there is a relation between osteoporosis and hearing loss especially SNHL

In our study there were 60 subjects composed of 40 osteoporotic patients and 20 healthy control subjects without osteoporosis. There were 18 osteoporotic patients (45%) had normal hearing without any problem in auditory system and 22 osteoporotic patients (55%) had SNHL. In healthy control subjects without osteoporosis there was 18 subjects (90%) had normal hearing without any problem in auditory system and only (2) subjects (10%) had SNHL. The degree of hearing loss in our result, 12 osteoporotic patients (55%) had mild SNHL and 10 osteoporotic patients (45%) had mild to moderate SNHL. In healthy control subjects without osteoporosis only 2 patients with hearing loss (100%) had mild SNHL. So all cases of hearing loss in both osteoporotic and healthy control groups were SNHL mainly high frequencies SNHL, 55% in osteoporotic group and only 10% in healthy control.

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