BONE MINERAL DENSITY IN PHYSIOTHERAPISTS: The association of osteoporosis with occupational exposure to non-ionizing radiation modalities

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SUMMARY

The aim of this study was to determine whether bone mineral density of physiotherapists (PT) is lower than expected, and to investigate the association with the duration of exposure to non-ionizing radiation modalities.

Forty PTs who have been operating physical modalities for at least one year and forty control subjects who had no history of exposure to non-ionizing radiation modalities were included the study.

Risk factors of osteoporosis were assessed by a detailed questionnaire. Duration of exposure to non-ionizing radiation modalities (shortwave or microwave diathermy, ultrasound, infrared, ultraviolet lamps and laser) was recorded. Stiffness index and z-scores were measured using a Lunar Achiles Expres ultrasound densitometer.

In PTs, stiffness was 11% and z-score was 22% lower than the control group, however, the difference was not statistically significant (p>0.05). The average duration of exposure to non-ionizing radiation modalities was 12.4 ± 6.8 years. The relationship between bone density and the duration to radiation modalities was not statistically significant (p>0.05).

In conclusion physiotherapists are unlikely to have an extra risk for osteoporosis after being exposed to non-ionizing radiation.

Key Words: *Osteoporosis, bone density, physiotherapists, occupational exposure.*

ÖZET

FİZYOTERAPİSTLERDE KEMİK MİNERAL YOĞUNLUĞU: İyonize olmayan radyasyon modalitelerine mesleki maruziyet ile osteoporoz ilişkisi

Bu çalışmada fizyoterapistelerde kemik mineral yoğunluğunda beklenenin altında bir düşüklük olup olmadığının araştırılması ve iyonize olmayan radyasyon modalitelerine mesleki maruziyetin süresi ile ilişkisinin araştırılması amaçlandı.

En az bir yıldır iyonize olmayan radyasyon modalitesi kullanım öyküsü olan 40 fizyoterapist ve böyle bir öyküsü olmayan 40 normal birey

Tüm denekler kapsamlı bir form ile osteoporoz gelişiminde suçlanan risk faktörleri açısından sorgulandılar. İyonize olmayan radyasyon modalitelerine (kısa veya mikrodalga diyatermi, ultrason, infraruj, ultraviolet lambaları ve lazer) maruziyet süresi kayıt edildi. Kemik sertlik indeksi ve z skorları "Lunar Achiles Expres Ultrasound Densitometer" cihazı kullanılarak hesaplandı.

Fizyoterapistelerin kemik sertlik indekleri normalden %11, z-skorları ise %22 daha düşük bulundu, ancak fark istatistiksel olarak anlamlı değildi (p>0.05). İyonize olmayan radyasyon modalitelerine mesleki maruziyetin süresi ortalaması 12.4 ± 6.8 yıldı. İyonize olmayan radyasyon modalitelerine mesleki maruziyetin süresi ile kemik sertlik indeksi arasında anlamlı bir ilişki bulunmadı (p>0.05).

Sonuç olarak bu çalışma ile, iyonize olmayan radyasyon modalitelerine mesleki maruziyetin fizyoterapistlerde osteoporoz gelişimi açısından ek bir risk yarattığı gösterilememiştir.

Anahtar Kelimeler: *Osteoporoz, kemik mineral yoğunluğu, fizyoterapist, mesleki maruziyet.*

INTRODUCTION

Physiotherapists (PT) are exposed to radio- and microwave-frequency electromagnetic radiation by operating shortwave and microwave units. Recent studies suggest that use of shortwave diathermy

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was associated with an excess risk of birth defects, perinatal deaths, and late spontaneous abortions among the offspring of exposed female therapists (1). Another study showed the association between heart disease and exposure to shortwave radiation for male PTs (2). Tuschl et al. investigated the influence of chronic exposure to electric and magnetic fields (shortwave, decimeter wave and microwave units) on the immune system of PTs (3). However, they did not find a statistically significant difference between the control and exposed persons. Exposure to ultrasound and shortwaves showed about threefold odds ratios for spontaneous abortions occurring after the 10th week of gestation but in analysis where potential confounding variables were controlled, neither reached statistical significance. Deep heat therapies together, and shortwaves alone, were associated significantly with congenital malformations, but the increase was found in the lower exposure category only.

Shortwave diathermy devices used in physical therapy situations have been found by the Food and Drug Administration's (FDA) Bureau of Radiological Health (BRH), to produce relatively high levels of unintended exposures (sometimes exceeding present U.S. exposure standards) to device operators and to the non-prescribed tissues of the patients (4).

Osteoporosis is the most common metabolic disease of bone, defined by reduced bone mass and density, with increased structural fragility and fracture risk (5). Decreasing quality of life and increasing morbidity and mortality, osteoporosis is a very important public health problem worldwide. Epidemiological studies revealed that besides genetic factors, there are some other environmental, life style and medical factors influencing approximately 20% of the bone mass (6). In terms of occupational exposure, ionizing radiation and cadmium are shown to be associated with an increased risk of osteoporosis (7,8). To our knowledge, the association of osteoporosis and non-ionizing radiation modalities has not been investigated before.

The purpose of that study was to assess the impact of occupational use of non-ionizing radiation modalities such as, shortwave or microwave diathermy, ultrasound, infrared, ultraviolet lamps and laser on bone mineral density of PTs.

MATERIAL AND METHOD

A total of 40 PTs who have been operating physical modalities (shortwave or microwave diathermy, ultrasound, infrared, ultraviolet lamps and laser for at least one year) in two university based physical medicine and rehabilitation clinics and 40 control subjects who have no history of exposure to radiation modalities were enrolled into the study. Informed consent was given to all participants. Risk factors for osteoporosis were assessed by a detailed questionnaire including demographic, social, reproductive and relevant life style, environmental and medical factors (5,6,9,10). None of the participants had a history of a disease or treatment which may influence bone metabolism. All of the female participants were in their premenopausal period.

Achilles Express Ultrasonometer (Lunar Corp., Madison, WI, USA) was used to investigate the bone loss in the os calcis. Ultrasound variables Speed of Sound (SOS) and Broadband Ultrasound Attenuation (BUA) were measured from right calcaneous and combined by the machine to produce the Index Stiffnes (where Stiffness = 0.67*BUA + 0.28*SOS - 420) for the right os calsis (11). Z score [Stiffness value in patient-age-related mean/standard deviation] was calculated, based on the Lunar reference data for males and females (12).

Data analysis was done using SPSS for Windows version 9.0[a]. Student's t test and chi-square were used for comparisons between the groups. Correlation was carried out using Pearson rank correlation. Precision was measured, in vivo by repeating the scan, with repositioning, on 15 volunteers, on the same foot, and in vitro, by 15 repeat measurements on the Achilles phantom, provided with the densitometer. Calculation of precision is by the root mean square (rms) value of the coefficient of variation (%) (13). Precision in-vivo for Stiffness, was 1.2%. For the manufacturer's phantom, precision was 1.22%.

RESULTS

The sociodemographic and clinical characteristics of the participants were presented in Table I. The difference between the groups in terms of assessed risk factors for osteoporosis was not significant, except daily calcium intake. Physiotherapists had a lower daily calcium intake than the control subjects and the difference was statistically significant. The mean ± SD Stiffness index of the os calcis was 89.2 (19.6) in PTs and 99.0 (18.5) in control group. The mean ± SD z-score in PTs was –0.21 (1.5) and 0.37 (1.4) in the control group. In PTs, stiffness was 11% and z-score was 22% lower than the control group, however, the difference was not statistically significant ($p>0.05$). The average duration of exposure to radiation modalities was 12.4 ± 6.8 years (with a minimum of 1 and maximum of 26 years). The relationship between bone density and the duration to radiation modalities was not statistically significant ($p>0.05$). Number of patients whose t-score is under –2.5 and z-score under –1.5 (which is the criteria for the diagnosis of osteoporosis (14)) was 2 and 1 for PTs and control subjects, respectively.

[a] Statistical Package for the Social Sciences (SPSS) for Windows, Version 9.0; SPSS Inc., 444 N. Michigan Avenue, Chicago, IL.

DISCUSSION

This study investigated whether occupational exposure to radiation modalities in PTs is associated with lower bone density. Although the bone density of PTs was found 11% lower than the control subjects, the difference was not statistically significant. Osteoporosis was observed in 2 PTs aged 34 and 43 years, with a duration of 11 and 20 years of exposure. They were smoking for over 5 years and had a positive family osteoporosis history. One subject in the control group who had osteoporosis was 47 years old, was smoking, and her mother had a history of osteoporosis-related fracture. Genetic factors are named as the main determinants of bone mass and women whose mother had an osteoporosis-related fracture are at high risk for osteoporosis (15).

In terms of previously known risk factors for osteoporosis, no significant difference was observed between the groups, except daily calcium intake. Physiotherapists had a lower daily calcium intake than the control subjects and the difference was statistically significant. Low calcium intake cannot explain the difference in bone mineral density, itself. There are different reports in the literature about the relationship between calcium intake and bone mass. Kröger et al. showed that low calcium intake increased the risk for decreased bone mineral density (10), however, Ooms et al. suggested that calcium intake was not a risk factor for osteoporosis (5). If we had found a significant relationship between bone density and the duration of exposure to radiation modalities, we could have talked about the effects of radiation modalities on bone density.

In conclusion, the results in this study indicate that physiotherapists are unlikely to have an extra risk for osteoporosis after being exposed to non-ionizing radiation.

Table 1: The sociodemographic and clinical characteristics of the participants (values are mean ± SD for age, body mass index, calcium=daily calcium intake, duration=duration of exposure to non-ionizing radiation modalities, age at menarche, number of pregnancy, stiffness index and z-score; percentages for education, disease history for secondary osteoporosis, fracture, family history of osteoporosis, alcohol, caffeine consumption and smoking)

		Physiotherapists	Control subjects	P value
Age		35.4 ± 7.1	34.4 ± 7.5	0.441
Gender	Female	78%	83%	
	Male	22%	17%	
Body mass index		18.7 ± 3.6	16.3 ± 4.0	0.403
Calcium	mg/day	448.3 ± 262.7	613.7 ± 255.9	0.018*
Duration	years	12.4 ± 6.8	–	
Age at menarche		13.5 ± 1.9	13.2 ± 1.1	0.52
Number of pregnancy		0.95 ± 0.87	0.82 ± 1.1	0.139
Alcohol consumption		7%	5%	0.389
Caffeine consumption		8%	7%	0.497
Smoking		38%	35%	0.785
Family history of osteoporosis		13%	17%	0.132
Disease history for secondary osteoporosis		6%	3%	0.552
Stiffness index		89.2 ± 19.6	99.0 ± 18.5	0.056
z-score		-0.21 ± 1.5	0.37 ± 1.4	0.145

* Statistically significant

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