Original Investigation

Forearm Bone Mineral Density in Healthy Young Adult Mobile Phone Users

Muharrem Cidem[1], Cengiz Bahadir[2], Yunus Karakoc[3], Ilhan Karacan[4]

[1] Department of Physical Medicine and Rehabilitation, Osmaniye State Hospital, Turkey
[2] Department of Physical Medicine and Rehabilitation, Haydarpasa Numune Training and Research Hospital, İstanbul, Turkey
[3] Department of Biophysics, Inonu University Faculty of Medicine, Malatya, Turkey
[4] Department of Physical Medicine and Rehabilitation, Vakif Gureba Training and Research Hospital, İstanbul, Turkey

Abstract

The electromagnetic radiation of mobile phone (MP) can produce a variety of adverse health effects. Bone mineral density (BMD) of rats exposed to radiation emitted by MPs was found to be a statistically non-significant decrease. The aim of the present study was to investigate forearm BMD in healthy young adult MP users. Two hundred and sixty three healthy subjects (86 male MP users, 14 male controls and 97 female MP users, 66 female controls) were included in this study. Ages ranged from 20 to 35 years. Dominant hands were the rightsight in all cases. BMD was measured in the proximal femur and right ultradistal (UD) radius using a dual-energy X-ray absorptiometry. The mean UD radius BMD was statistically significant lower in MP user than non-MP users. Binary logistic regression analysis indicated that a risk for osteopenia was found to be higher in females than males (Odds ratio=6.66 P=0.006), and in MP users than MP non-users (Odds ratio=7.92 P=0.004). In conclusion, MP can cause osteopenia in the forearm of healthy young adult females.

Key words: mobile phone, bone mineral density, electromagnetic field

Corresponding Address: Dr. Ilhan KARACAN, M.D., Zuhuratbaba Mah Tatlınar Sk 8/11 Bakırköy, İstanbul, Turkey
E-mail: ilhankaracan@hotmail.com

Introduction

The system for mobile communication mobile phones (MP) used extensively facilitates communication, but electromagnetic radiation of MP can produce a variety of adverse health effects. Due to close proximity of the MP device to the head, the brain is intensely exposed to the pulsed electromagnetic fields (PEMF) [1,2]. Symptoms of the nervous system such as headaches were the most frequently reported type of effect [3,4]. Another tissue intensely exposed to the PEMF emanating from MP may be bone, especially the skull and hand bones. Yildiz et al showed a statistically non-significant decrease in the bone mineral density (BMD) of rats exposed to radiation emitted by MPs [5]. The aim of the present study was to investigate forearm BMD in healthy young adult MP users.

Materials and Methods

Subjects

Two hundred and sixty three healthy subjects (86 male MP users, 14 male controls and 97 female MP users, 66 female controls) were included in this study. Ages ranged from 20 to 35 years. Dominant hands were the right sight in all cases. No cases engaged in regular sportive activity that required the use of hands and arms. The exclusion criteria were listed in Table 1.

Procedure

BMD was measured in the left proximal femur (femoral neck, trochanter area, and total hip) and right ultradistal (UD) radius using a dual-energy X-ray absorptiometry (DXA, Lunar Corporation, Madison, WI, USA). Coefficient of variation was 1.41% for ultradistal radius and 1.78% for femoral regions. Osteopenia was defined as BMD was -1.0 to -2.5 standard deviations (SD) below the healthy sex-matched young adults reference range; Osteoporosis was defined as BMD < -2.5 SD below the sex-matched young adult reference range.

Statistical Analysis

Means and standard deviations were computed for continuous variables. Frequencies were calculated for categorical variables. The Fisher's Exact test was used to compare the distribution of male subjects with and without osteopenia between MP users and controls. Likelihood ratio test was used to compare the distribution of female subjects with and without osteopenia between MP users and controls. The unpaired t test was used to analyze the statistical difference in the BMD between female MP users and controls. Mann-Whitney U test was used to analyze the statistical difference in the BMD between male MP users and controls.

The binary logistic regression analysis (method: forward stepwise-conditional, change contrast: indicator) was used to identify predictors of the forearm osteopenia. Validity of the final regression model was determined by Hosmer-Lemeshow goodness-of-fit test. A P value of less than 0.05 was considered statistically significant. All analyses were completed with SPSS (version 10.0; SPSS Inc. IL USA) for Windows.

Results

The characteristics of the cases of MP users and controls are presented in Table 2. The mean BMD was statistically significant lower in MP users than controls (Figure 1). Osteopenia in the UD radius was found in 4.7% of male MP users, 7.1% of their controls (p=0.537); in 25.8% of female MP users, 6.1% of their controls (p=0.001).

Binary logistic regression analysis indicated that osteopenia was not associated with age, and BMI. This analysis also indicated that a risk for the forearm osteopenia was found to be higher in females than males (Odds ratio=6.66 P=0.006), and in MP users than MP non-users (Odds ratio=7.92 P=0.004). (Binary logistic regression analysis-Hosmer and Lemeshow test, P=0.003) (Table 3).

Table 1: The exclusion criteria

Generalized low bone mass	Femoral T-score ≤-1
Osteoporosis risk factors	Early menopause, amenorrhea
	Fracture
	Inflammatory disease (rheumatoid arthritis, etc)
	Chronic diarrhea
	Malign tumor
	Surgery (ovariectomy, thyroidectomy, orchiectomy etc)
	Long-standing immobilization
	Endocrine or metabolic disease
	Use of drugs (corticosteroid, heparin, etc)
Living near sources of EMF (less than 50 meters)	MP base-station
	High-voltage power lines
	FM radio/TV transmitter

Table 2: Characteristics of the cases of MP users and non-users (controls)

	Male		Female	
	MP users	**Controls**	**MP users**	**Controls**
Number	86	14	97	66
Age (yrs)	27.8 ± 4.5	31.1 ± 2.6	27.0 ± 4.7	30.7 ± 3.9
BMI (Kg/m^2)	25.0 ± 3.6	25.9 ± 3.8	24.5 ± 5.1	26.9 ± 5.0
Duration of MP use (yrs)	3.8 ± 1.8	0 ± 0	3.0 ± 2.0	0 ± 0

Table 3. The risk factors for osteopenia in right forearm

	B	**Wald**	**P**	**Exp(B)** (Odds Ratio)
Gender	1.897	7.52	0.006	6.665
Ultradistal radius BMD	-12.027	41.73	0.000	0.000
MP usage	2.070	8.43	0.004	7.923

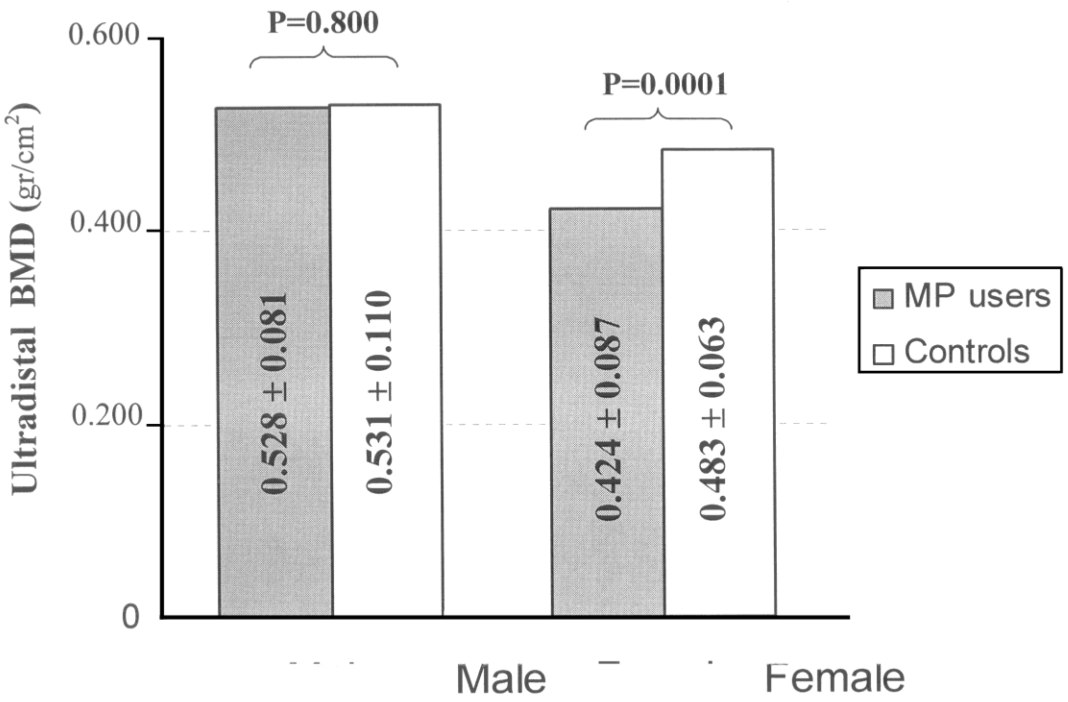

Figure 1: Bone mineral density in the ultradistal radius of right forearm (gr/cm^2)

Discussion

Bone mineral metabolism can be affected by many factors such as environmental factors, old age, menopause, endocrine-metabolic disease, malabsorption etc [6,7]. One of these factors may be electromagnetic fields.

Nowadays, there is a serious environmental electromagnetic pollution. Main sources of this pollution are electrical household appliances such as hair-dryer, electric shaver, personal computer. The frequency of PEMF emanating from these devices is extremely low frequency (ELF) (15-120 Hz) [6,7]. In the previous studies, it was investigated that whether the electromagnetic field influenced on the bone. The ELF PEMF has shown to have stimulatory effects on bone formation or have no negative effects on bone [8, 9-15].

MP operates with radiofrequencies mainly in the 800 GHz to 1800 MHz range. The effects of high frequency PEMF on bone are not clear. Yildiz et al applied a 900 and 1800 MHz PEMF radiation emitted by MPs to rats for 30 min/day for 4 weeks. They showed a statistically non-significant decrease in the BMD [5].

In our observational study, the mean BMD was statistically significant lower in female MP user than non-users. However, there was no statistically significant difference in forearm BMD between MP users and MP non-users in males. It was found that risk of forearm osteopenia was mainly associated with gender and MP usage. A risk of osteopenia in the forearm was 6.66 times higher in female than male, and 7.92 times higher in MP users than non-users.

In conclusion, the current study showed that MP can cause osteopenia in the forearm of healthy young adult females. Osteoporosis is a major public health problem, especially in postmenopausal women [16]. Epidemiological studies are needed for a full delineation of the relation between the MP usage and osteoporosis.

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