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Relation between Grip Strength and Hand Bone Mineral Density in Healthy Women Aged 30-70

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ABSTRACT

Aim of Study: To determine the site-specific relationship between grip strength and hand bone mineral density (BMD) measured with dual energy x-ray absorptiometry (DXA) in healthy women. The correlation of hand BMD and BMD at axial sites has also been assessed.

Method: Twenty-nine healthy housewives, aged 30-70, were included in the study. Women were grouped according to their menopausal status (12 premenopausal and 17 postmenopausal). Grip strength of the dominant hand was measured using a Jamar dynamometer. BMD of the antero-posterior spine, femoral neck, trochanter, and Ward's triangle were measured with DXA. For the hand BMD measurements, the analysis software, which was modified from the software of small animals and developed for hand BMD measurements, was used.

Results: Hand BMD moderately correlated with grip strength in postmenopausal women. There was no significant correlation between grip strength and hand BMD in premenopausal women. Significant positive correlations were determined between the hand BMD and BMD at axial sites.

Conclusion: Grip strength may be an independent indicator of hand BMD in postmenopausal women, and also a site-specific relationship. Hand BMD measurements may indirectly reflect the BMD of axial sites especially in postmenopausal women.

Keywords: hand, bone mineral density, grip strength

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INTRODUCTION

Most previous literature on muscle strength and bone density examined the association between specific muscle groups and adjacent bones. The association of grip strength with bone density at distant sites, such as the spine and hip, as well as at the wrist and radius has been examined[1-6]. While determining this site-specific relationship of bone density and muscle strength, measurements of radial bone mineral density (BMD) and grip strength have been used[3-6]. Recently, BMD measurements of the hand by dual-energy x-ray absorptiometry (DXA) with modified software have been described in patients with rheumatoid arthritis (RA)[7,8]. The measurement of hand BMD in healthy subjects by using DXA and also the correlation with grip strength have not been studied yet.

In this study, the evaluation of the site-specific relationship between grip strength and hand BMD has been proposed. The correlation of hand BMD and BMD at axial sides has been also assessed in premenopausal and postmenopausal women.

METHODS

The subjects were 29 women who willingly participated in the study. These sedentary subjects, defined as those expending less than 10% of their daily energy in the performance of moderate- and high-intensity activities (such as walking, climbing stairs, gardening etc.), had to meet the following criteria: (1) no history of renal, cardiac, endocrine, or rheumatological disorders; (2) no evidence of compression fracture(s), degenerative arthritis or other metabolic bone diseases on the roentgenogram of the spine and hands; (3) no history of oestrogens or prolonged steroid use (4) ambulatory and independent in daily living.

Women were grouped according to their menopausal status. Twelve women were premenopausal and 17 women were postmenopausal. All had normal results of electrocardiograph and urinalysis. Fasting blood chemistry tests, including biochemical bone markers, were performed. All were informed of the procedures to be used and signed informed consent forms.

Handgrip strength was assessed with a JAMAR® dynamometer in the dominant hand that was right side for all subjects. With the women standing and the arms held straight at their sides, the dynamometer was gripped as hard as possible for 3 seconds without pressing the instrument against the body and without any flexion of the elbow. Three measurements, repeated with two minutes of interval between measures, were recorded and the mean values were calculated in kilograms.

BMD of the antero-posterior (AP) spine, femoral neck, trochanter, and Ward's triangle (on the dominant right side) was measured with DXA by using Lunar® DPX bone densitometer. We have used a DXA methodology for the measurement of hand BMD using the same device with an analysis package which was originally developed for the measurement of bone mass of small animals and modified for hand BMD measurements.

There are special features of this software, which are essential to the successful measurement of BMD of the hand. Firstly a lower current (150μA) is employed. Secondly, both a 0.84 mm collimator and a higher number of scan pixels (1.2 X 2.4 mm) are chosen.

Women sat at the end of the scanning table and placed their dominant hand flat (extended and palmar face downwards) on the forearm plate and along the longitudinal centre line of the scan field. The origin of the carpal bones was palpated and marked with the laser pointer at start. Scanning was performed in slow-detail mode.

Spearman's rank correlation coefficients were used for assessment of possible associations between parameters. Two-tailed p values at levels of 0.05 or less were considered to be of statistical significance.

RESULTS

Characteristics of the two groups and the results of BMD and grip strength measurements are demonstrated in Table I. BMD of the measured sites were expressed in g/cm^2. Blood chemistry results and radiographs were within normal limits. There was moderate correlation of Hand BMD with grip strength in the group of postmenopausal women (r:0.70, p=0.002). There was no significant correlation between grip strength and hand BMD in the group of premenopausal women (r:0.14, p=0.65). Significant positive correlations were determined between the hand BMD and BMD at axial sites (Table II).

Table I. Subject characteristics

Variables	Premenopausal Women n=12 Mean±SD	range	Postmenopausal Women n=17 Mean±SD	range
Age (years)	45.7±11.1	30-53	56.6±5.0	51-70
Height (cm)	156.9±4.7	153-170	153.6±3.5	148-160
Weight (kg)	68±10.2	53-83	66.3±9.1	53-80
Grip strength (kg)	28.9±7.8	17-45	24.1±4.0	19-33
Total hand BMD (g/cm^2)	0.448±0.04	0.381-0.511	0.389±0.04	0.312-0.484
AP spine (L2-L4) BMD (g/cm^2)	1.104±0.17	0.774-1.409	0.963±0.14	0.776-1.355
Femoral neck BMD (g/cm^2)	0.945±0.13	0.652-1.118	0.797±0.11	0.641-0.980
Trochanter BMD (g/cm^2)	0.773±0.11	0.579-0.912	0.669±0.09	0.529-0.821
Ward's Triangle BMD (g/cm^2)	0.798±0.16	0.484-1.057	0.631±0.10	0.474-0815

Table II. Relationship between hand and axial BMD (g/cm^2) in premenopausal and postmenopausal women.

	AP spine (L2-L4) BMD	Femoral neck BMD	Trochanter BMD	Ward's Triangle BMD
Total hand BMD (g/cm^2)	r	r	r	r
Premenopausal n=12	0.62*	0.47	0.64*	0.54*
Postmenopausal n=17	0.76**	0.54*	0.54*	0.51*

r = correlation coefficient *p<0.05 ** p<0.0001

DISCUSSION

DXA is the most precise, accurate and widely accepted technique for measurement of skeletal integrity for the diagnosis of osteoporosis and fracture risk[9]. Although relationship between grip strength and hand BMD has been examined by using modified software in patients with RA[7,8], this relationship has not been investigated on healthy subjects.

This newly developed software makes it possible to obtain BMD or bone mineral content of total hand or any region of interest marked during the analysis. However the lack of the reference population prevents obtaining the results in Z and T scores.

Significant positive correlations exist between muscle strength and BMD in postmenopausal women[1-4]. Site-specific relations between BMD and muscle strength previously have been demonstrated in grip strength and forearm density in postmenopausal women[3,4,6]. The measurement of hand BMD may be considered to be more specific than forearm density while examining the relationship between grip strength and site-specific bone density.

Our focus in this cross-sectional study was to determine the relationships between BMD and grip strength not only in postmenopausal women but also in premenopausal women. Previous studies have not fully evaluated premenopausal women.

Contrary to findings in older women, no significant correlation between grip strength and hand BMD has been found in our study group of premenopausal women. Although a site-specific correlation have been found between grip strength and radial BMD, Sinaki et al. suggested that in premenopausal women with normal levels of oestrogens the role of muscle strength might be less significant on bone mass[10].

In our study, highly significant correlation among hand and axial sites BMD has been obtained. This may be considered as hand BMD measurements to be a predictive method for detecting bone structure. Similar relationships have been found between hand BMD, measured by DXA with modified software and BMD at other sites in patients with RA[7,8].

In conclusion, grip strength may be an independent indicator of hand bone mineral density in postmenopausal women and considered as a site-specific relationship. On the basis of significant correlation between hand BMD and BMD at axial sites, it may also be considered that one measurement reflects each other, especially in postmenopausal women.

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