Hand Grip Strength; A Determinant of Bone Mineral Density in Turkish Postmenopausal Women

EL KAVRAMA GÜCÜ: TÜRK POSTMENOPOZAL KADINLARDA KEMİK MİNERAL YOĞUNLUĞU BELİRLEYİCİSİ OLARAK

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Summary

Objective: To assess the relationship between bone mineral density and hand grip strength in postmenopausal women.

Methods: Two hundred one (201) postmenopausal women aged 41-83 years on no medical regimen were studied. Hand grip strength (dominant hand) were measured by JAMAR hand-held dynamometer. Bone marker (osteocalcin) was measured in the serum of patients, 24 hour urinary calcium was also measured. Bone mineral density was measured by NORLAND (XR-46) at lumbar, femoral (neck) and distal (1/3) forearm regions.

Results: There was significant positive correlation between hand grip strength and bone mineral density at the femoral (neck), lumbar and radial regions (r=0.218; p=0.002, r=0.210; p=0.003, r=0.395; p=0.000). There was also negative correlation between handgrip strength and age, years since menopause, respectively (r= -0.306, p=0.000, r= -0.231, p=0.004). There was no significant correlation between bone markers and grip strength (r=-0.079; p=0.491, r=0.130; p=0.170) respectively. Grip strength was also correlated with body mass index (r=0.170; p=0.000).

Conclusion: Although it is unclear, the study suggests that handgrip strength as a determinant of bone mineral density can help clinicians to identify subjects on risk.

Key Words: Hand grip strength,
Bone mineral density

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Özet

Amaç: Postmenopozal dönemdeki kadınlarda, el kavrama gücü ile kemik mineral yoğunluğu arasındaki ilişkiyi değerlendirmek .

Metod: İkiyüzbir (201), 41-83 yaş arasındaki tedavi almamış postmenopozal kadın çalışmaya alındı. El kavrama gücü JAMAR el dinamometresi ile ölçüldü. Katılımcıların serumunda, kemik belirleyicisi (marker) (osteocalcin), 24 saatlik idrarda ise kalsiyum ölçüldü. Kemik mineral yoğunluğu (KMY) NORLAND (XR-46) ile lomber, femur boynu ve önkol (distal 1/3 radius) bölgesinde ölçüldü.

Bulgular: El kavrama gücü ile, femur boynu, lomber ve önkol bölgesi KMY arasında pozitif ilişki vardı (r=0.218; p=0.002, r=0.210; p=0.003, r=0.395; p=0.000). El kavrama gücü, yaş ve menopoz süresi arasında ise negatif ilişki vardı (r= -0.306; p=0.000, r= -0.231; p=0.004). El kavrama gücü ile kemik belirleyicileri arasında ilişki yoktu (r=-001; p=0.910, r=0.153; p=0.08). El kavrama gücü ile vücut kitle indeksi (VKI) arasında ise pozitif ilişki vardı (r=0.170;p=0.000).

Sonuç: Bu çalışma, kesin olmamasına rağmen, el kavrama gücünün, KMY luğunun bir belirleyicisi olarak, riskli kişilerin saptanmasında, klinisyene yardımcı olabileceğini göstermektedir.

Anahtar Kelimeler: El kavrama gücü,
Kemik mineral dansitesi

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Muscle strength is an important determinant of bone density. Age related decline in bone density may be related in part to a decline in muscle strength. The aim of the muscle strengthening exercises is to investigate the relationship between muscle strength and bone mineral density for the prevention and treatment of osteoporosis (BMD) (1).

Although some studies have shown significant correlation between muscle strength and BMD, the subject is still unclear. It has been suggested that, skeletal muscle contraction force generates large joint reaction force and has an effect on BMD. Significant relationship between handgrip strength and BMD has also been indicated in some studies (2).

Limited number of studies relating muscle strength to anatomic related BMD have also been reported (2).

The aim of this study is to investigate the correlation between handgrip strength and axial and peripheral BMD in Turkish osteoporotic women, because of differences in genetic, racial, life sytle and nutritional factors.

Methods

The study was performed from September 2000 to September 2001 in out-patient clinic of University hospital. (Mersin-Turkey). Informed consent was obtained from all women for participating to the study.

Exclusion criteria were renal disease, diabetes, liver disease, malignancy, connective tissue diseases, abnormalities of the parathyroid and thyroid glands, gastrectomy, hysterectomy, long term immobilization, alcoholism, history of trauma, drugs that can interfere with bone metabolism. Patients with clinically relevant scoliosis or ectopic calcifications were also excluded. None of them had history of smoking, alcohol abuse and hormone therapy.

Subjects who reported no menstruation for at least a year before the study without any medical reason were classified as natural menopausal. All the women were physically active and non were athletes. All of them had history of breast feeding.

Body mass index (BMI), (weight/height $(m)^2$) was also calculated, as a determinant of obesity.

Muscle strength was measured as grip strength of the dominant hand using JAMAR squeeze handheld dynamometer. The device was new for the study and was factory calibrated. The test was performed in a sitting position with the upper arm parallel to the trunk, the elbow at the 90 degree of flexion and the forearm and hand in zero position. The test was performed 3 times and the mean value was noted (3).

Bone mineral density of right femur (neck), lumbar and distal forearm (Distal 1/3) were measured by NORLAND-XR-46,(Norland Co, Fort Atkinson, WI, USA).

All measurements were done by a trained technician.

Whole venous blood samples were taken from patients. Blood samples were allowed to clot for 30 minutes at room temperature and centrifuged for 10 minutes at 5000 rpm. Then, serum samples were removed and stored at –20 C until used for assay.

The levels of osteocalcin were analyzed with quantitative determination N-MID osteocalcin in serum. The electrochemiluminescence immunoassay (ECLIA) was used for determination of this tests. The levels of PTH was also analyzed with electrohemiluminescence immunoassay method (Roche Electsys 2010 immunoassay analyzer, Mannheim, Germany). The activity of alkaline phosphates was measured according to recommended reference method of the IFCC. The levels of calcium were analyzed with method according to Schwarzenbach with o-cresolphtalein complexion and the concentrations of inorganic phosphate were analyzed with direct phosphomolybdate method according to Daly and Ertingshausen (Cobas Integra 700 analyzer, Roche Diagnostics, Mannheim, Germany). Urine specimens collected in acid –washed bottles. Twenty –four hours specimens collected in containers containing 5 ml 6 mmol/L HCl. Urine specimens mixed well prior analysis. Urinary calcium was determined by calorimetric assay with endpoint determination in Roche diagnostics.

The statistical software package SPSS statistics version 9.0 was used. Correlation analyses were assessed by Pearson′s correlation test. A linear regression analysis was used to study the predictability of BMD using several variables. P values <0.05 were considered statistically significant.

Results

A total of 201 post-menopausal healthy women were studied. The characteristics of patients were shown in (Table 1).

In the present study, there was statistically significant correlation between hand grip strength and BMD of the right femur (neck) (r=0.218;

Table 1. Background data of the participants

	Mean ± SD(n=201)
Age (years)	57.5±8.7
BMI (kg/m^2)	28.5±4.8
Years since menopause	13.4±9.8
Age at menarche (years)	13.4±1.1
Lumbar BMD (g/cm^2)	0.860±0.1
Femur (neck) BMD(g/cm^2)	0.762±0.1
Distal Radius BMD(g/cm^2)	0.285 ±9.5
Urinary Ca (24 hours)(mgr/dl)	152.8±10.2
Osteocalcin (ng/ml)	19.9±19.3

BMD: Bone mineral density

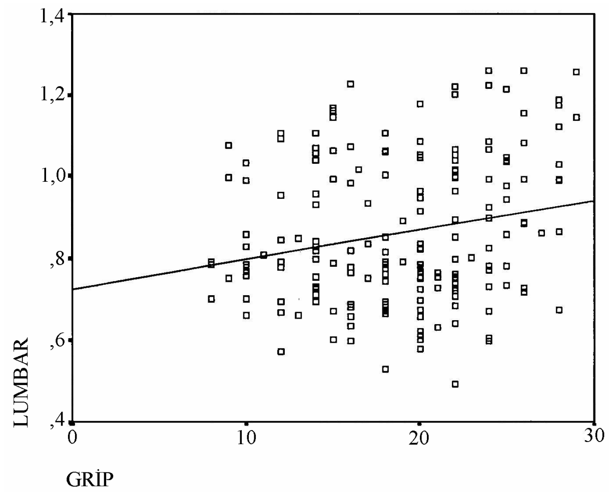

Figure 1. Correlation of lumbar BMD (g/cm^2) with handgrip strength (Kg).

p=0.002), lumbar and distal radial regions (r=0.210; p=0.003, r= 0.395; p=0.000) (Figure 1,2,3).

Age was correlated with grip strength negatively (r= -0.306, p=0.000). The duration of menopause (years since menopause) was also correlated negatively with grip strength (r= -0.231, p=0.000). Years since menopause was also correlated negatively with BMD of the lumbar and femoral neck regions (r= - 0.219; p=0.006, r= -0.369; p=0.000)

BMI was correlated with lumbar and femoral BMD in patients (r=0.352; p=0.000, r=0.173; p=0.01, respectively). BMI was also correlated with grip strength (r=0.170; p=0.000).

There was not correlation between either the osteocalcin level or the urinary calcium level and grip strength (r=-0.079; p=0.491, r=0.130; p=0.170, respectively).

Discussion

Muscle mass is a strong determinant of muscle strength and both of them decline in parallel with bone mineral density, during aging. Aged muscles have fewer fibers, fewer motor units, and reduced metabolic capacity. In response to strength training, BMD increases. Assessing muscle strength may give information about muscle mass and

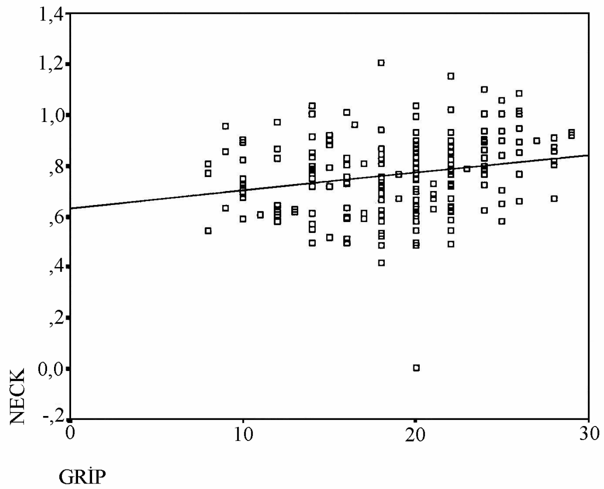

Figure 2. Correlation of femoral neck BMD (g/cm^2) with handgrip strength (Kg).

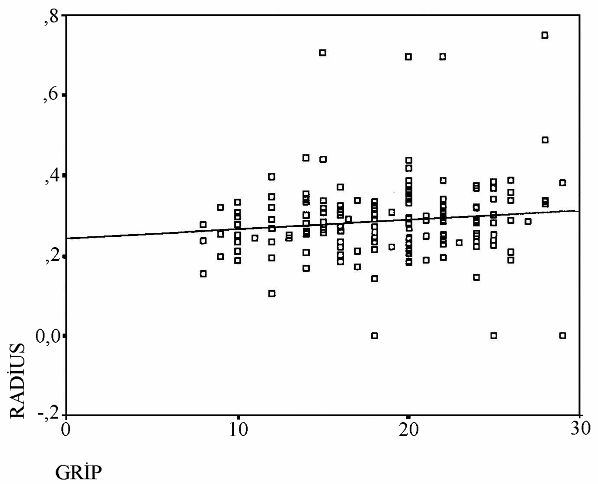

Figure 3. Correlation of distal radius BMD (g/cm^2) with handgrip strength (Kg).

BMD. Since the muscular action provides a stimulus for bone remodeling, the torque the muscle can generate, may be related to BMD which is stressed during weight bearing. The influence of weight loading on BMD is assumed to be very important (1,2).

Pocock et al. showed that biceps strength was a better predictor of both forearm BMD and hip BMD and they also reported that isometric handgrip strength is the predictor of BMD at the lumbar spine and radius sites (4). Muscle mass, in turn, is correlated with physical activity, hand strength and bone mineral density (2,4). Because of its low cost, non-invasive and easy use, handgrip strength test is preferred. It has been suggested that, the postmenopausal women with a strong power grip also have strong back muscles for preventing osteoporotic fractures (2,4). Although the functional mechanism(s) by which a significant relationship between upper extremity muscle strength and BMD could occur have not been described, this may be related to complex biomechanical relationship between muscle strength of different muscle groups in one individual (4).

Kritz-Silverstein and Barrett-Connor reported the relationship between grip strength and BMD of the lumbar spine and proximal femur in 649 postmenopausal women aged 65 years and older (5). Bevier et al. reported the relationship between handgrip strength and BMD of the lumbar spine and forearm in 91 healthy women and men aged 61-84 years (6). In the present study, we found significant relationship between grip strength and BMD at femoral (neck), lumbar and distal radial regions in 201 postmenopausal healthy women and in agreement with other authors, we suggest that handgrip strength may be a determinant of axial and as well as peripheral BMD. However, as a homogenous study, we did not evaluate the BMD of the male subjects.

Foley et al. also found significant relationship between handgrip strength and BMD of the proximal femur in postmenopausal women (7). In addition, body weight also correlated significantly with BMD of the proximal femur and handgrip strength in their study.They suggested that body weight plays an important role (7). In this study, we found that BMI was significantly correlated with lumbar and femoral neck BMD and also with handgrip strength.

Sinaki et al also found significant negative correlation between handgrip strength and age. In this study, we also found significant negative correlation between age and handgrip strength. Di Monaco et al reported that years since menopause was independently related to BMD in 140 postmenopausal women (2). We found not only significant negative correlation between years since menopause and BMD but also negative correlation between years since menopause and handgrip strength.

Although it is unclear, a limited number of studies relating muscle strength to anatomic related BMD have been performed. Zimmerman et al, Halle et al. demonstrated a positive correlation between BMD of the lumbar spine measured by DPA and back extensor strength in postmenopausal women (9,10). Sinaki et al found found positive correlation between BMD of the midradius and grip strength in 63 healthy postmenopausal caucasian women (8). Other studies have shown significant correlation between individual bones and the muscles that insert on them, but have shown similar correlation between the same bones and distant muscle groups (10). Madsen et al. reported significant correlation between BMD of the proximal tibia, and quadriceps strength, but they found that distal forearm BMD was not correlated with quadriceps strength (11). Hyiaman et al reported that, grip strength correlated with metacarpal bone mineral density in 1168 postmenopausal women aged 40-70 years (11). In the present study, ın agreement with other authors, we also found that hand grip strength was significantly correlated with anatomically related (distal forearm) BMD. However, results of this study is not sufficiently strong to allow for prediction of BMD from hangrip muscle strength. It may play a role in the prevention and cessation of the osteoporotic changes that occur.

In conclusion, as a result of importance of muscle mass, muscle strength and its relation with BMD, grip strength may be used to perform BMD measurements for subjects on risk and to decide to the treatment and exercise for prevention and treatment of osteoporotic patients to maintain good balance, physical strength and flexibility, making falls and fractures less likely. But we need further studies with increased number of subjects to predict a cut-off value for clinical desicion making or epidemiologic investigations.

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