นิพนธ์ต้นฉบับ • Original Article

ความสัมพันธ์ของค่าความหนาแน่นของกระดูกระหว่าง กระดูกสันหลังส่วนบั้นเอวกระดูกบริเวณข้อสะโพกและกระดูกท่อนแขนส่วนปลาย

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The Correlation of Bone Mineral Densities among the Lumbar Spines, Proximal Femur and Distal Forearm

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Purpose: To determine the correlation of bone mineral density (BMD) among the lumbar spines, proximal femur, and distal forearm in women.

Design: Retrospective, descriptive study

Materials and Methods: We reviewed the results of bone mineral density performed at Srinagarind Hospital from May 1997 to June 1999. Dual energy X-ray absorptiometry (DEXA) technique was used to determine the bone mineral densities (BMDs) at the lumbar spines, proximal femur, and distal forearm in 230 women of age range from 31 to 87 years (mean age = 53.5 years). Most cases were healthy, with only 10 cases being osteoporotic.

Results: A significant correlation (p<0.001) was found among the three parts of the skeleton examined. The correlation coefficient (r) was approximately 0.7 between the lumbar spines (average BMD of L2 to L4) and various parts of the proximal femur, was 0.6 between the lumbar spines and various parts of the distal forearm, and was 0.5-0.6 between various parts of the proximal femur and various parts of the distal forearm.

We subdivided the data into two groups, Group 1 with 88 cases aged < 50 years, this group represented premenopausal group. Group 2 with 142 cases older than 50 years of age, this group represented postmenopausal group.

The correlation coefficient at p<0.001, in Group 1 was approximately 0.6 between the lumbar spines (average BMD of L2 to L4) and various parts of the proximal femur, was 0.5 between the lumbar spines and various parts of the distal forearm, and was 0.4-0.6 between various parts of the proximal femur and various

วัตถุประสงค์ : เพื่อหาความสัมพันธ์ระหว่างค่าความหนาแน่นของแร่ธาตุในกระดูก (BMD) ของกระดูกสันหลัง กระดูกบริเวณข้อสะโพก และกระดูกบริเวณท่อนแขนส่วนปลายของสตรี

รูปแบบการศึกษา : เป็นการศึกษาย้อนหลังเชิงพรรณา

วิธีการ : คณะผู้ศึกษาได้ทำการศึกษาย้อนหลังค่า BMD ของผู้ป่วยที่มารับการตรวจความหนาแน่นของแร่ธาตุในกระดูก ณ โรงพยาบาลศรีนครินทร์ ตั้งแต่ เดือนพฤษภาคม 2540 ถึง เดือนมิถุนายน 2542 โดยใช้เครื่อง Dual Energy X-ray Absorptiometry (DEXA) วัดใน 3 ตำแหน่งคือ ที่กระดูกสันหลังส่วนบั้นเอว กระดูกบริเวณข้อสะโพก และกระดูกท่อนแขนส่วนปลาย จำนวน 230 ราย ช่วงอายุตั้งแต่ 31-87 ปี (อายุเฉลี่ย 53.5 ปี) ส่วนใหญ่มีสุขภาพแข็งแรง ยกเว้น 10 รายที่เป็นโรคกระดูกพรุน

ผลการศึกษา: ค่า BMD ที่ทุกตำแหน่งมีความสัมพันธ์กันอย่างมีนัยสำคัญทางสถิติ (p<0.001) โดยพบว่าค่าสัมประสิทธิ์แห่งความสัมพันธ์ (r) ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกบริเวณข้อสะโพกประมาณ 0.7 ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกท่อนแขนส่วนปลายประมาณ 0.6 และประมาณ 0.5-0.6 สำหรับความสัมพันธ์ระหว่างกระดูกบริเวณข้อสะโพกและกระดูกท่อนแขนส่วนปลาย

หลังจากนั้นได้ทำการแบ่งกลุ่มผู้ป่วยออกเป็น 2 กลุ่มโดยกลุ่มแรกมีจำนวน 88 รายอยู่ในช่วงอายุตั้งแต่ 50 ปีลงไป กลุ่มนี้ถือเป็นตัวแทนของกลุ่มสตรีที่ยังไม่หมดประจำเดือน ขณะที่กลุ่มสองมีจำนวน 142 รายอายุมากกว่า 50 ปีขึ้นไป ซึ่งกลุ่มนี้ถือเป็นตัวแทนของกลุ่มสตรีภายหลังหมดประจำเดือน

ในกลุ่มแรกพบค่า BMD ที่ทุกตำแหน่งมีความสัมพันธ์กันอย่างมีนัยสำคัญทางสถิติ (p<0.001) โดยพบว่าค่าสัมประสิทธิ์แห่งความสัมพันธ์ (r) ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูก

parts of the distal forearm.

The correlation coefficient at p<0.001 in Group 2 was approximately 0.7 between the lumbar spines (average BMD of L2 to L4) and various parts of the proximal femur, was 0.5-0.6 between the lumbar spines and various parts of the distal forearm, and was 0.5-0.7 between the varous parts of the proximal femur and various parts of the distal forearm.

Conclusions: The BMD of all three parts of the skeleton investigated had significant linear correlation with each other, with mild to moderate degree of correlation. However, the degree of correlation between the lumbar spines and various parts of the proximal femur was higher than that between the distal forearm and the other parts.

Key words: Correlation, BMD, DEXA

บริเวณข้อสะโพกประมาณ 0.6, ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกท่อนแขนส่วนปลายประมาณ 0.5 และประมาณ 0.4-0.6 สำหรับความสัมพันธ์ระหว่างกระดูกบริเวณข้อสะโพกและกระดูกท่อนแขนส่วนปลาย

ในกลุ่มที่สองพบค่า BMD ที่ทุกตำแหน่งมีความสัมพันธ์กันอย่างมีนัยสำคัญทางสถิติ (p<0.001) โดยพบว่าค่าสัมประสิทธิ์แห่งความสัมพันธ์ (r) ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกบริเวณข้อสะโพกประมาณ 0.7, ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกท่อนแขนส่วนปลายประมาณ 0.5-0.6 และประมาณ 0.5-0.7 สำหรับความสัมพันธ์ระหว่างกระดูกบริเวณข้อสะโพกและกระดูกท่อนแขนส่วนปลาย

สรุป: ค่าความหนาแน่นของแร่ธาตุในกระดูกทั้งสามตำแหน่งพบมีความสัมพันธ์กันในเชิงเส้นตรงอย่างมีนัยสำคัญทางสถิติ โดยมีค่าความสัมพันธ์อยู่ในระดับต่ำถึงปานกลาง แต่ระดับความสัมพันธ์ระหว่างกระดูกสันหลังส่วนบั้นเอวและกระดูกบริเวณข้อสะโพกมีสูงกว่าความสัมพันธ์ระหว่างกระดูกท่อนแขนส่วนปลายกับบริเวณอื่น

ศรีนครินทร์เวชสาร 2542; 14(4), 245-250 • Srinagarind Med J 1999; 14(4), 245-250

Introduction

" Osteoporosis is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility, and susceptibility to fracture." [sic][1] There are two important parameters used to determine osteo-porosis, bone mass and bone structures.

Bone structure is determined by invasive histomor phometric techniques whereas measurement of bone mass can be performed by non-invasive techniques and effectively identifies the risk of fracture[2-4]. So it is the suitable measure to determine evidence of osteoporosis.

There are several methods of measuring bone mass in which one of the most recently developed and widely used is dual energy X-ray absorptiometry (DEXA). This method uses higher beam intensity and therefore provides faster scan (less than 5 minutes compared to 20 minutes needed for the lumbar spines scanning by the dual photon absorptiometry (DPA) method[5], better precision (expected precision error = 0.01-0.03 g/cm^2 depending on the sites measured)[6], and low radiation dose (effective radiating dose from fan-beamed DEXA scan of the lumbar spines = 1.0 μSv, whereas effective dose of simple chest radiography is 60 μSv)[7]. However, the cost of this method remains high so it is limited in measurement of all sites including lumbar spines, hip, and forearm. Many studies showed mild to moderate correlation among the BMDs at these three skeletal sites[8-12]. Most of these studies used DEXA, DPA or quantitative computed bomography (QCT) methods in measuring the BMDs of the lumbar spines and hip, and single energy X-ray absoptiometry (SEXA) or single photon absorptiometry (SPA) methods in measuring BMD of the forearm. In this study, we used only DEXA technique in measurement of BMDs at these three sites with the aim to re-assess the correlation among these parts.

Materials and Methods

We reviewed the results of 230 bone mineral densitometric studies performed at Srinagarind Hospital from May 1997 to June 1999. All cases were female with age range from 31 to 87 years (mean age = 53.5 years). Most of them were healthy, with only 10 cases being osteoporotic. The lumbar spines, proximal femur, and distal forearm BMDs were measured using DEXA technique with the Lunar EXPERT-XL system.

The lumbar spine BMDs were measured from L1 to L4 in the anteroposterior (AP) projection. Each vertebra was identified and measured. The bone masses of L1, L2, L3, L4 and the average BMD of L2-L4 were recorded in g/cm^2, and T- and Z-scores were presented.

Femoral BMDs were measured at the neck, Wards ' region, trochanteric region, shaft, and total proximal femoral part. The bone masses of all these parts were recorded in g/cm^2, and T-and Z-scores were presented.

Forearm BMDs were measured at ultra-distal radius (radius UD), ultra-distal ulna (ulna UD), 33% region of the distal radius (radius 33%), 33% region of the ulna (ulna 33%), ultra-distal region of both bones (both UD), 33% region of both bones (both 33%), the total radius (rad total), the total ulna (ulna Total), and total both bones (both Total). The bone masses of all parts were recorded in g/cm^2, but T- and Z-scores were presented only for radius UD, radius 33%, and rad Total.

Statistical analysis: We collected all data in dBase III Plus software and derived the correlation coefficient (r) using SPSS software version 7.5 for Windows. The correlation described was between the average BMD of L2-L4 and BMD of each part of the proximal femur (neck, Wards ' region, trochanteric region, shaft, and total proximal femur), between the average BMD of L2-L4 and each part of the radius (radius UD, radius 33%, and rad Total), and between each part of the proximal femur and each part of the radius by using Pearson 's product-moment correlation.

Results

The average BMD of L2-L4 and BMDs of various parts of the proximal femur were highly correlated (p value<0.001) with the correlation coefficient ranged from 0.68-0.74 as shown in Table 1.

The correlation coefficients of BMDs between the lumbar spines and various parts of the distal forearm ranged from 0.57-0.63 (p value <0.001). The correlation coefficients of BMDs between various parts of the proximal femur and various parts of the distal forearm ranged from 0.51-0.69 (p value<0.001) as shown in Table 2.

Table 1. The correlation coefficients of BMDs between the lumbar spines and each part of the proximal femur.

CORRELATION COFFEICIENT	NECK	TROCHANTER	WARDS '	SHAFT	TOTAL
AVERAGE BMD OF L2-L4	0.7212	0.6961	0.7363	0.6761	0.7115

All correlation coefficients are significant at p value < 0.001.

Table 2. The correlation coefficients of BMDs between each part of the radius, and the lumbar spines, and each part of the proximal femur.

CORRELATION COEFFICIENT	RADIUSUD	RADIUS33%	RADTOTAL
AVERAGE BMD OF L2-L4	0.5740	0.6235	0.6350
NECK	0.5459	0.6771	0.6257
TROCHANTER	0.5968	0.6647	0.6453
WARDS '	0.5706	0.6751	0.6330
SHAFT	0.5150	0.6402	0.5969
TOTAL	0.5453	0.6864	0.6293

All correlation coefficients are significant at p value < 0.001.

We subdivided all the patient data into two groups: 88 cases in group 1 being 50 years old or younger, this group represented premenopausal group. And 142 cases in group 2 being older than 50 years old which represented post-menopausal group. Then we evaluated the correlation between the three skeletal sites in both groups.

In group 1, the correlation coefficients of BMDs between the lumbar spines and various parts of the proximal femur were approximately 0.6 (p value < 0.001) as shown in Table 3. The correlation coefficients of BMDs between the lumbar spines and various parts of the distal forearm were approximately 0.5-0.6 (p value < 0.001). The correlation Coefficients of BMDs between various parts of the proximal femur and various parts of the distal forearm were approximately 0.4-0.7 (p value <0.001) as shown in Table 4.

Table 3. The correlation coefficients of BMDs between the lumbar spines and each part of the proximal femur in group 1.

CORRELATION COFFEICIENT	NECK	TROCHANTER	WARDS '	SHAFT	TOTAL
AVERAGE BMD OF L2-L4	0.627	0.622	0.599	0.608	0.652

All correlation coefficients are significant at p value < 0.001.

Table 4. The correlation coefficients of BMDs between each part of the radius, and the lumbar spines, and each part of the proximal femur in group 1.

CORRELATION COEFFICIENT	RADIUSUD	RADIUS33%	RADTOTAL
AVERAGE BMD OF L2-L4	0.5994	0.4786	0.5059
NECK	0.6700	0.5322	0.5363
TROCHANTER	0.6758	0.4723	0.4851
WARDS '	0.6232	0.4864	0.4911
SHAFT	0.6125	0.4003	0.4282
TOTAL	0.6974	0.4908	0.5161

All correlation coefficients are significant at p value < 0.001.

In group 2, the correlation coefficients of BMDs between the lumbar spines and various parts of the proximal femur were approximately 0.7 (p value <0.001). The correlation coefficients of BMDs between various parts of the proximal femur and various parts of the distal forearm were approximately 0.5-0.7 (p value < 0.001) as shown in Table 6.

Table 5. The correlation coefficients of BMDs between the lumbar spines and each part of the proximal femur in group 2.

CORRELATION COFFEICIENT	NECK	TROCHANTER	WARDS '	SHAFT	TOTAL
AVERAGE BMD OF L2-L4	0.7239	0.7048	0.7722	0.6863	0.7109

All correlation coefficients are significant at p value < 0.001.

Table 6. The correlation coefficient of BMDs between each part of the radius, the lumbar spines, and each part of the proximal femur in group 2.

CORRELATION COEFFICIENT	RADIUSUD	RADIUS33%	RADTOTAL
AVERAGE BMD OF L2-L4	0.5272	0.6232	0.6303
NECK	0.4759	0.6824	0.6124
TROCHANTER	0.5543	0.7007	0.6724
WARDS '	0.5195	0.7271	0.6583
SHAFT	0.4663	0.6915	0.6282
TOTAL	0.4756	0.7153	0.6344

All correlation coefficients are significant at p value < 0.001.

We found that the correlation of BMDs between the lumbar spines and varous parts of the proximal femur in the older patients (group 2) was higher than that of the younger age group (group 1) with the correlation coefficients approximately 0.7 and 0.6, respectively (Tables 3 and 5).

The correlation of BMDs between the lumbar spines and each part of the distal forearm was similar to the correlation between the lumbar spines and proximal femur, with higher correlation found in the older age group compared to the younger age group (correlation coefficients approximately 0.5-0.6 and 0.5, respectively).

The spinal BMD of those older than 50 years had slightly better correlation with BMD of the proximal femur and the distal forearm than in the younger patients.

Discussion

In previous studies[8-14], bone mass was measured at the lumbar spines and proximal femur by DPA, DEXA or QCT methods, and at the forearm by SPA or SEXA methods. The correlation between bone mass of the proximal femur and the lumbar spines was higher than that between the lumbar spines and the forearm[3,10,13]. In our study, we used only DEXA densitometric technique (Lunar Expert-SL system) in measuring BMDs of the lumbar spines, proximal femur and distal forearm. We found comparable correlation compared with previous studies. The correlation of BMD between the lumbar spines and any part of the proximal femur was approximately 0.7 whereas the correlations between the lumbar spines and the forearm or between the proximal femur and the forearm were approximately 0.5-0.6.

Riggs BL et al. in 1981 and 1986[15,16] found a diminution of BMD at the spines in the linear correlation pattern from the pre-menopausal period continuing to the postmenopausal period with the same rate. By contrast, there was no decrease in BMD at the forearm until the age of 50. The decrease in BMD was accelerated from the age of 51 to 65 in linear correlation pattern and then decelerated some what after the age of 65. The pattern of diminution of BMD at the forearm was best fit by the cubic equation or the curvilinear correlation. Accordingly the pattern of bone diminution between the lumbar spines and forearm was heterogeneous in pre-menopausal women and homogenous in post-menopausal women. We found that the correlation between BMD of the lumbar spines and the distal forearm in patients younger than 50 years was less than that in patients over 50 years (r = 0.48 in the age younger than 50 years and 0.62 in the age older 50 years).

The bone mass of the ultra-distal radius in this study was measured at the so-called " 10% " location. In fact, this site is 12-15% of the radius length and percentage of trabecular bone at this region is less than 25%[11] whereas percentage of trabecular bone at the lumbar spines is about 66%[17]. The correlations, according to the percentage difference of trabecular bone between these two sites, were mild to moderate (r approximately 0.53 in the age group over 50 years and 0.6 in the age group younger than 50 years). Nilas L et al. (1985)[9] scanned the ultra-distal radius at the site in which the radius-ulna gap was 8 mm, whereas Grubb (1984)[11] scanned at 5 mm radius-ulna gap. From these points, four scans were made at 2-mm increments distally. The percentages of trabecular bone at these two sites were approximately 60%-70%[11]. They found a correlation between the ultra-distal redius and lumbar spines of approximately 0.5-0.6 which is not greater than the correlation between the usual ultra-distal measurement and the lumbar spines. Therefore, higher percentage of trabecular bone in the ultra-distal radius provides no significant improvement in the correlation of BMD with the lumbar spines.

Conclusions

The correlations of BMDs between the central skeletal regions (lumbar spines and proximal femur) are higher than those between the central and peripheral skeleton in both pre-menopausal and postmenopausal women. The correlation of BMD between the lumbar spines and the distal radius (radius 33%) in postmenopausal women is higher than that in pre-menopausal women. The correlation of BMD between the lumbar spines and ultra-distal radius (radiusUD) is not greater than that between the lumbar spines and distal radius (radius 33%).

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