Correlation of Bone Mineral Density among Various Measurement Sites

NIMIT TAECHAKRAICHANA, M.D.*, KOBCHITT LIMPAPHAYOM, M.D.*,
PIYAWAT ANGKAWANICH, M.D.*, MAKUMKRONG POSHYACHINDA, M.D.**

Abstract

Bone mineral density (BMD) of the lumbar spine and hip was studied in 1,047 women visiting the menopause clinic, to assess the correlation of BMD among various measurement sites. Bone mass measurement was performed utilizing dual energy X-ray absorptiometer (DEXA), Hologic QDR 2000. The results revealed a significantly high correlation of BMD of total hip and spine. ($r=0.7021$, $P<0.001$) Nevertheless, BMD of the spine was mostly correlated with BMD of trochanteric site ($r=0.7235$, $P<0.001$) and least correlated with BMD of intertrochanteric region. ($r=0.2426$, $P<0.001$) In conclusion, BMD of spine and hip is highly correlated. However, there was some heterogeneity of correlation in different specific measurement sites.

Osteoporosis occurs worldwide in every population and geographic area[1]. Since the major clinical consequence of osteoporosis is fracture, it has become a major public health problem, and postmenopausal osteoporosis constitutes a major part of the problem.

Regarding pathophysiology of fracture, there are two main causes i.e. falls and a reduction in bone mass which leads to increased bone fragility[2]. Measurement of bone mass and several other skeletal characteristics that can effectively identify women at high risk of fractures, are now widely available, and other clinical data, so far, cannot provide equivalent information[3].

At present, bone mass measurement of lumbar spines, hip is frequently practiced in some menopause clinics in Bangkok. Some studies reported that measurement of bone mass at any site is a competent predictor of fracture at all sites[1,4]. Hence, the aim of this study was to assess the correlation of bone mineral density of lumbar spines and hips in women attending the menopause clinic, Chulalongkorn Hospital.

MATERIAL AND METHOD

One thousand and forty seven women, visiting the menopause clinic, Chulalongkorn Hospital from January 1992 to December 1995 were

* Department of Obstetrics and Gynecology,
** Department of Radiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

recruited for the analysis. Bone mass measurement was performed utilizing dual energy X-ray absorptiometer, Hologic QDR 2000. Long term precision was 1.5 per cent. A standard region of measurement, including lumbar spines (LS : L1-4) was scanned. Patients with severe osteoarthritic changes or compression of the vertebrae were excluded from the study. Bone mineral density (BMD) of hip, comprising of BMD of femoral neck, trochanter, intertrochanter, Ward's triangle and total hip, was measured at the nondominant side. Results are expressed in grams of ashed bone per unit area of bone scanned (gram per square centimeter, g/cm^2). The correlation of BMD among various measurement sites was analysed using linear regression analysis.

Table 1. Population characteristics (N = 1,047).

Characters	Mean±SD/Percentage
1. Age (year)	50.51±5.70
2. BMI	23.78±3.35
3. Parity	1.94±1.64
4. Educational background	
University/college	45.9%
Below	49.3%
Above	4.8%
5. Income (Baht)	
20,000-50,000	38.6%
<20,000	47.3%
>50,000	14.1%

BMI = Body mass index

RESULTS

Of all 1,047 women who participated in this study, 34.4 per cent were premenopausal and 65.6 per cent were postmenopausal. Postmenopause was defined as having no vaginal bleeding during the last 6 months and measurements of serum gonadotropin and estradiol levels were in the menopausal range. In the latter group, the mean time since menopause was 4.78±4.16 years. The population characteristics and correlation of BMD among various measurement sites are shown in Table 1, 2.

DISCUSSION

Low bone mass is a major determinant of osteoporotic fracture, and its measurement is a predictor of subsequent fracture[5]. Bone mass measurement can be measured safely, accurately, and precisely by bone densitometry, particularly dual energy X-ray absorptiometer[4,6,7]. It is necessary for the accurate measurement of axial sites (spines and hip), where there are greater and more widely varying quantities of soft tissue[4]. Many studies have suggested that measurement of bone mass at any site is a competent predictor of fracture of all sites[4,8-10]. Hence, the aim of this study was to assess the correlation among various measurement sites.

Most of the studied population was perimenopausal or early postmenopausal. The mean body mass index was rather average. The results revealed positively, high correlation between total BMD of lumbar spines and hip (r=0.7021, P <0.001) eventhough the former was most corre-

Table 2. Correlation of BMD among various measurement sites.

Measurement sites	Spine	Neck	Troch	Inter	Ward	Hip
Spine	1.0000	0.6909**	0.7235**	0.2426**	0.7121**	0.7021**
Neck	0.6909**	1.0000	0.8446**	0.3449**	0.8654**	0.8899*
Troch	0.7235**	0.8446**	1.0000	0.3612**	0.8227**	0.9237**
Inter	0.2426**	0.3449**	0.3612**	1.0000	0.3296**	0.4221**
Ward	0.7121**	0.8654**	0.8227**	0.3296**	1.0000	0.8358**
Hip	0.7021**	0.8899*	0.9237**	0.4221**	0.8358**	1.0000

Neck = femoral neck
Troch = Trochanter
Inter = Intertrochanter
Ward = Ward's triangle
Hip = Total BMD of all the above
**P<0.001

lated with the trochanteric site. (r=0.7235, P <0.001). Nevertheless, there was positively, low correlation between the spines and intertrochanteric region. (r=0.2426, P<0.001).

Since osteoporosis is a systemic disorder in most individuals, bone mass measured distant to the fracture site should reflect a deficit comparable to measurements at the fracture site[11]. However, some studies have suggested some heterogeneity, particularly in regard to postmenopausal bone loss[11,12].

According to the data collected from January 1992 to December 1994 in the Department of Orthopedics, Chulalongkorn Hospital, there were 16 intertrochanteric fractures and 15 femoral neck fractures[13]. In this case, bone mass measurement of the spine which was also highly correlated with those of the femoral neck (r=0.6909, P<0.001) should predict the risk of hip fracture, particularly the femoral neck. However, it did not have a strong association with bone mass in the intertrochanteric region. The reasons for heterogeneity in this subset require further investigation, but possibilities include differential bone loss,[14] localized disease effects, differential bone growth,[15,16] sports involving preferential parts of the body[17] and differential errors in measuring bone mass[11].

SUMMARY

This study was conducted to assess the correlation of BMD among various measurement sites in 1,047 women visiting the menopause clinic, Chulalongkorn Hospital, Bangkok, Thailand. The results revealed a significantly high correlation of BMD of total hip and spine. However, BMD of spine was most correlated with BMD of trochanteric site and least correlated with BMD of intertrochanteric region. The heterogeneity of correlation in different specific measurement sites is possibly due to differential bone loss, localized disease effects, differential bone growth, sports involving preferential part of the body and differential errors in measuring bone loss.

ACKNOWLEDGEMENT

The authors wish to thank Assist. Prof. Yapa Onthaum for her assistance with the statistical analysis.

(Received for publication on May 17, 1996)

REFERENCES

1. Consensus Development Conference : Diagnosis, prophylaxis and treatment of osteoporosis, Hong Kong, 2 April 1993.
2. Meunier PJ. Prevention of hip fractures. Am J Med 1993; 95 (Suppl 5A): 75S-8S.
3. Slemenda CW, Hui SL, Longcope C, et al. Predictors of bone mass in perimenopausal women. A prospective study of clinical data using photon absorptiometry. Ann Intern Med 1990; 112: 96-101.
4. Johnston CC Jr, Slemenda CW, Melton LJ. Clinical use of bone densitometry. N Eng J Med 1991; 324: 1105-9.
5. Johnston CC, Slemenda CW. Risk assessment : Theoretical considerations. Am J Med 1993; 95 (Suppl 5A): 2S-5S.
6. Sartoris DJ, Resnick D. Current and innovative methods for noninvasive bone densitometry. Radiol Clin North Am 1990; 28: 257-78.
7. Gluer CC, Steiger P, Selvidge R, et al. Comparative assessment of dual-photon absorptiometry and dual-energy radiography. Radiology 1990; 174: 233-8.
8. Hui SL, Slemenda CW, Johnston CC Jr. Age and bone mass as predictors of fracture in a prospective study. J Clin Invest 1988; 81: 1804-9.
9. Smith DM, Khairi MRA, Johnston CC Jr. The loss of bone mineral with aging and its relationship to risk of fracture. J Clin Invest 1975; 56: 311-8.
10. Hui SL, Slemenda CW, Johnston CC Jr. Baseline measurement of bone mass predicts fracture in white women. Ann Int Med 1989; 111: 355-61.
11. Wasnich R. Bone mass measurement : Prediction of risk. Am J Med 1993; 95 (Suppl 5A) : 6S-10S.
12. Riggs BL, Wahner HW, Melton III JL, et al. Rates of bone loss in the appendicular and axial skeletons of women. Evidence of substantial vertebral bone loss before menopause. J Clin Invest 1986; 77: 1487-91.
13. Yuktanandana P, Ngarmkos C, Parkpain V, et al. BMD fracture threshold for hip fracture. Chula Med J (in press).

14. Riis B, Thomsen K, Christiansen C. Does calcium supplementation prevent postmenopausal bone loss? A double-blind, controlled clinical study. N Eng J Med 1987; 316: 173-7.
15. Drinkwater BL, Nelson KL, Chestnut CS, et al. Bone mineral content of amenorrheic and eumenorrheic athletes. N Eng J Med 1984; 311: 277-81.
16. Nelson ME, Fisher EC, Catsos PD, Meredith CN, Turksoy RN, Evans WJ. Diet and bone status in amenorrheic runners. Am J Clin Nutr 1986; 43: 910-7.
17. Huddleson AL, Rockwell D, Dulund DN. Bone mass in lifetime tennis athletes. JAMA 1980; 244: 1107-9.

ความสัมพันธ์ของความหนาแน่นของกระดูกในแต่ละตำแหน่งที่ตรวจวัด

นิมิต เตชไกรชนะ, พ.บ., กอบจิตต์ ลิมปพยอม, พ.บ.*,*
ปิยะวัฒน์ อังควณิช, พ.บ., มาคุ้มครอง โปษยะจินดา, พ.บ.***

ได้ตรวจวัดความหนาแน่นของกระดูกสันหลังและกระดูกสะโพก ในสตรีที่มารับการตรวจรักษาที่คลินิกวัยหมดระดู จำนวน 1,047 ราย เพื่อศึกษาหาความสัมพันธ์ระหว่างความหนาแน่นของกระดูกในส่วนต่าง ๆ โดยใช้เครื่อง Dual energy X-ray absorptiometer, Hologic QDR 2000 ผลการศึกษาพบว่า ความหนาแน่นของกระดูกสันหลังและกระดูกสะโพกโดยรวม มีความสัมพันธ์กันในระดับสูง ($r=0.7021$, $P<0.001$) อย่างไรก็ตาม ความหนาแน่นของกระดูกสันหลังมีความสัมพันธ์สูงสุดกับความหนาแน่นของกระดูกสะโพกส่วน trochanter ($r=0.7235$, $P<0.001$) แต่มีความสัมพันธ์น้อยที่สุดกับกระดูกสะโพกส่วน Intertrochanter ($r=0.2426$, $P<0.001$) กล่าวโดยสรุป ความหนาแน่นของกระดูกสันหลังและกระดูกสะโพกมีความสัมพันธ์กันในระดับสูง อย่างไรก็ตาม เมื่อพิจารณาละเอียดลงไปถึงส่วนต่าง ๆ ของกระดูกสะโพก พบว่ามีความแตกต่างกันในระดับของความสัมพันธ์ดังกล่าว

* ภาควิชาสูติศาสตร์-นรีเวชวิทยา,
** ภาควิชารังสีวิทยา, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพมหานคร 10330