Acta Med. Okayama, 2012
Vol. 66, No. 1, pp. 17-21

Acta Medica Okayama
http://escholarship.lib.okayama-u.ac.jp/amo/

Original Article

Measurements and Evaluation of Proximal Femoral Bone Mineral Density with Dual Energy X-ray Absorptiometry

Keiichi Hayashida[a,b]*, Yoshihiro Takeda[b], Toshizo Katsuda[c], Kenyu Yamamoto[d], Yasuhide Suesada[a], Moeko Shibata[a], and Masami Azuma[e]

[a]Department of Radiology, Meiwa Hospital, Nishinomiya, Hyogo 663-8186, Japan,
[b]Department of Radiological Technology, Graduate School of Health Sciences, Okayama University, Okayama 700-8550, Japan,
[c]Seikeikai 2-Gakuin, Sakai, Osaka 590-0026, Japan, [d]Osaka Cancer Prevention and Detection Center, Osaka 536-8588, Japan, and [e]Osaka Kyoiku University, Kashiwara, Osaka 582-8582, Japan

Proximal femoral bone mineral density (BMD) can be measured by dual energy X-ray absorptiometry method in the neck, trochanter, intertrochanter, total and Ward's triangle area. Ward's triangle area of the proximal femur is a smaller area to measure than the others, and the position varies, depending on the status of inner rotation of the target leg. In this study, the measurements of the proximal femoral BMD in women were carried out on the neck, trochanter, intertrochanter, total and Ward's triangle area with the, subjects' legs turned 15 degrees toward the inside. The Ward's BMD were measured using Ward's cognitive method, in which the measured BMD were compared among age groups of 50-59, 60-69, 70-79 and 80-89 to determine whether this process could reveal decreased femoral BMD in elderly women. The correlation between BMD and age was tested using the Pearson correlation coefficient. In all measured parts, the BMD of women age 50-59 were significantly higher than those of women age 80-89. The correlations between BMD and age were negative in all measured parts, and the most negative correlation was between age and Ward's BMD. The study using Ward's cognitive method showed an inverse correlation between Ward's BMD and age in women.

Key words: proximal femoral BMD, dual energy X-ray absorptiometry, Ward's BMD, Ward's cognitive method

Dual energy X-ray absorptiometry (DXA) is mainly used for the measurement of bone mineral density (BMD). This method detects bone via high-energy and low-energy X-ray. DXA can be used for the measurement of BMD of all bones of the body, and is used especially often to measure the BMD of the lumbar vertebrae, proximal femur and radius. The incident number of proximal femoral fractures has been increasing recently [1, 2], and the appropriate evaluation of proximal femoral BMD via accurate measurements is considered necessary for the prevention of these fractures [3]. The BMD of the neck, trochanter, intertrochanter, total and Ward's triangle area of the proximal femur can be measured with DXA. The dual energy X-ray permeates Ward's triangle area the most [4, 5], as it is an offal part of the bone, and Ward's BMD is the lowest of the proximal femoral BMD. The range of region of interest (ROI) in Ward's is narrower than those of other parts of the proximal femur, which causes a reproduction problem.

Received June 15, 2011; accepted September 15, 2011.
*Corresponding author. Phone:+81-798-47-1767; Fax:+81-798-47-7613
E-mail:hayashida922000@yahoo.co.jp (K. Hayashida)

In this study, we used the Discovery W (Hologic Company) version of Ward's cognitive method to determine the ROI in the proximal femur.

Strictly speaking, Ward's triangle area refers to the crossing of the neck, trochanter and intertrochanter, and it changes slightly depending on the position of the inside-turned leg. A previous report [6] showed that better measurement could be obtained if a subject's leg was turned inside 15 degrees for the measurement of proximal femoral BMD. Therefore, in this study the position of subjects' legs was fixed to be turned inside 15 degrees for every measurement. Because osteoporosis is more common in women than men currently, we studied middle-aged and elderly women who may suffer from osteoporosis. Our goal was to examine whether Ward's triangle area is a suitable part of the proximal femur to find decreasing BMD in elderly women.

Materials and Methods

Subjects. The subjects were all middle-aged and elderly women who visited Meiwa Hospital to have medical examinations from January to June in 2009. They were 288 women (50-59 years: 42, 60-69 years: 100, 70-79 years: 113, 80-89 years: 33) without deformity in the proximal femur, and their proximal femoral BMD was measured in the Hospital. The permission to undertake this study was given by the Ethical Committee of Meiwa Hospital.

Measurements and evaluation of BMD. The method using DXA (Discovery W, produced by Hologic Company) was applied to the measurements of proximal femoral BMD. Each subject lay on her back on the examining table with the leg turned inside 15 degrees, and proximal femoral BMD was measured in the neck, trochanter, intertrochanter, total and Ward's triangle area. These parts are shown in Fig. 1. Ward's BMD was measured using Ward's cognitive method. The part of Ward's examined by this method is shown in Fig. 2. We established the ROI to cover a wide area that would be likely to include Ward's triangle area. With a 1 cm × 1 cm stabilized area of ROI the Ward's triangle area could automatically be regarded as the area having the lowest BMD within the ROI. The measured BMD were compared among 4 age groups of 50-59, 60-69, 70-79 and 80-89.

Statistical analyses. The Pearson correlation coefficient was used for the test of correlations between ages and BMD. Differences with $p < 0.05$ were regarded as significant. Statistical analyses were performed using SPSS Japan, Inc, Tokyo, Japan.

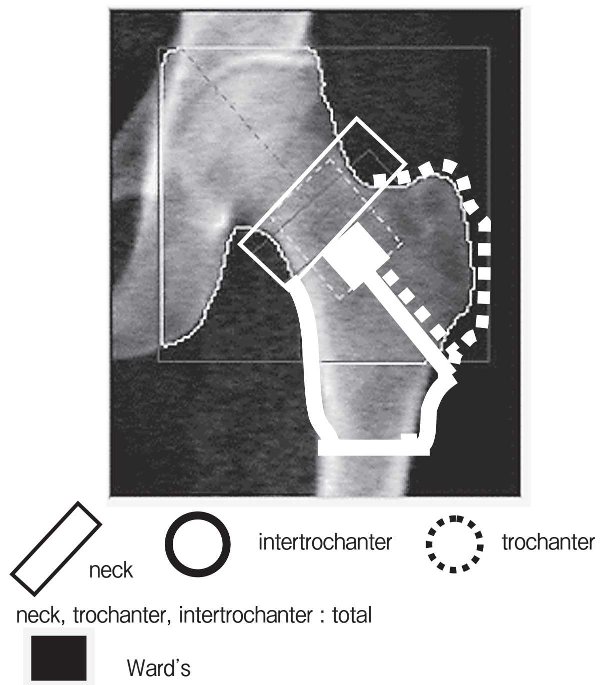

Fig. 1 The parts of the proximal femur for BMD measurements.

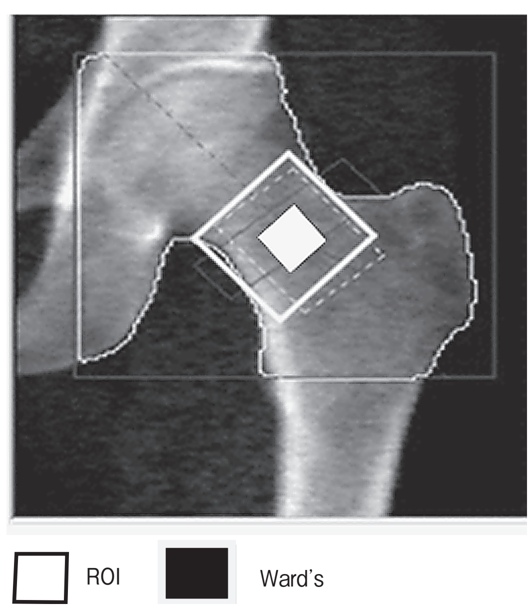

Fig. 2 The Ward's triangle area determined by Ward's cognitive method.

Results

Table 1 shows measured values (means ± SD) of BMD on 5 areas of the proximal femur in subjects separated into age groups. All values of measured BMD for age 50–59 are significantly higher than those for age 80–89. The inverse correlations between BMD and age are shown in Fig. 3 for the neck, in Fig. 4 for the trochanter, in Fig. 5 for the intertrochanter, in Fig. 6 for the total and in Fig. 7 for Ward's triangle area. The correlation coefficients were −0.444 for the neck, −0.405 for the trochanter, −0.344 for the intertrochanter, −0.381 for the total and −0.501 for the Ward's triangle area. The coefficient for the Ward's triangle area had the greatest inverse relationship among the coefficients.

Fig. 5 The correlation between intertrochanter BMD and age.

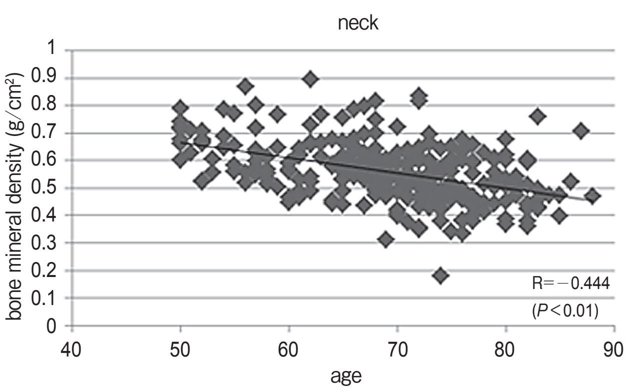

Fig. 3 The correlation between neck BMD and age.

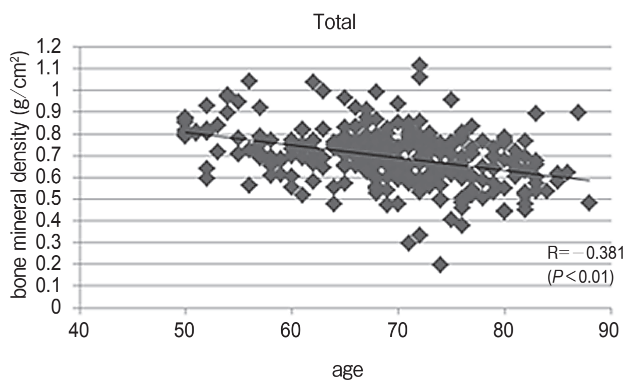

Fig. 6 The correlation between total BMD and age.

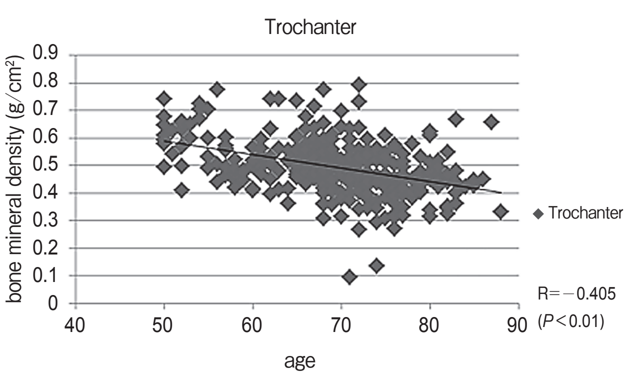

Fig. 4 The correlation between trochanter BMD and age.

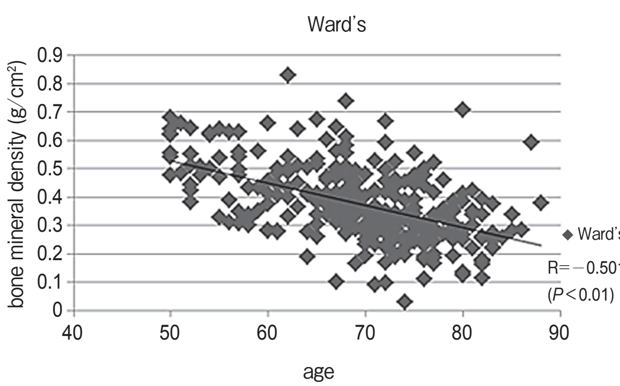

Fig. 7 The correlation between Ward's BMD and age.

Table 1 Measured BMD on 5 parts of the proximal femur

part╲age	50-59	60-69	70-79	80-89
neck	0.931 ± 0.138	0.876 ± 0.139	0.805 ± 0.175	0.762 ± 0.156
trochanter	0.566 ± 0.095	0.518 ± 0.087	0.462 ± 0.103	0.450 ± 0.093
intertrochanter	0.931 ± 0.138	0.876 ± 0.139	0.805 ± 0.175	0.762 ± 0.156
total	0.777 ± 0.112	0.722 ± 0.108	0.661 ± 0.137	0.629 ± 0.121
Ward's	0.492 ± 0.116	0.414 ± 0.117	0.325 ± 0.110	0.295 ± 0.124

(mean ± SD)

Discussion

To prevent proximal femoral fracture, it is necessary to find the point where proximal femoral BMD begins to decrease initially with aging. In this study, the correlation coefficient between Ward's BMD and age was more inverse than those between BMD of other parts of the proximal femur and age. We believe that Ward's BMD decreases with aging earliest in the proximal femoral BMD in women and that Ward's triangle area is a suitable part to measure decreasing BMD with aging.

Previous reports revealed that Ward's BMD decreased remarkably with aging [4, 5, 7], that the correlation between Ward's BMD and age was negative similar to that between neck BMD and age [8], and that the values of Ward's BMD were close to those measured with quantitative computed tomography (QCT) [9]. Other reports indicated that Ward's BMD was more suitable then neck BMD for the evaluation of proximal femoral fracture [10] and that exercise for 6 months prior to measurement had little effect on Ward's BMD [11]. As cortical bone has a lower metabolic rate than cancellous bone [12], it can be concluded that Ward's BMD covers an area containing many cancellous bones.

Other papers showed that Ward's BMD decreased with aging more than did the neck, trochanter, intertrochanter or total BMD [7, 13], and that there was no difference in neck BMD but any difference in trochanter and Ward's BMD between the cases of proximal femoral fracture and no fracture [14]. The coefficient of variation (CV) of Ward's BMD was higher than those of the neck, trochanter, intertrochanter and total BMD [15, 16]. For the measurement of proximal femoral BMD, the leg of the subject should be turned inside to expose the proximal femur. However, the Ward's triangle area changes depending on the leg status. We avoided this problem in the present study by using a fixed position with the leg turned inside 15 degrees, and by using Ward's cognitive method. However, more detailed and longitudinal studies using Wards' cognitive method are necessary to improve the CV of Ward's BMD, especially because it is sometimes difficult to fix the leg of an elderly person due to proximal femoral deformation.

In conclusion, the study using Ward's cognitive method showed a fairly large inverse correlation between Ward's BMD and age in women. The measurement of Ward's BMD will contribute to the formation of an index of proximal femoral fracture in advanced age.

References

1. Hagino H, Furukawa K, Fujiwara S, Okano, Katagiri H, Yamamoto K and Teshima R: Recent trends in the incidence and lifetime risk of hip fracture in Tottori, Japan. Osteoporos Int (2009) 20: 543-548.
2. Hagino H, Katagiri H, Okano T, Yamamoto K and Teshima R: Increasing incidence of hip fracture in Tottori Prefecture, Japan: Trend from 1986 to 2001. Osteoporos Int (2005) 16: 1963-1968.
3. Marshall D, Johnell O and Wedel H: Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. BMJ (1996) 1254-1259.
4. Greenspan SL, Maitland-Ramsey L and Myers E: Classification of Osteoporosis in the Elderly is Dependent on Site-Specific Analysis. Calcif Tissue Int (1996) 58: 409-414.
5. Aoki TT, Grecu EO, Prescott P, Benbarka M and Arangeli MM: Prevalence of osteoporosis in Women: Variation with skeletal site of measurement of bone mineral density. Endocr Pract (2000) 6: 127-131.
6. Goh JC, Low SL and Bose K: Effect of Femoral Rotation on Bone Mineral Density Measurements with Dual Energy X-Ray Absorptiometry. Calcif Tissue Int (1995) 57: 340-343.
7. Steiger P, Cummings SR, Black DM, Spencer NE and Genant HK:

Age-Related Decrements in Bone Mineral Density in Women over 65. J Bone Miner Res (1992) 7: 625-632.
8. Lofman O, Larsson L, Ross I, Toss G and Berglund K: Bone Mineral Density in Normal Swedish Women: Bone (1997) 20: 167-174.
9. Yoshihashi AK, Drake AJ 3rd and Shakir KM: Ward's Triangle Bone Mineral Density Determined by Dual-Energy X-ray Absorptiometry is a Sensitive Indicator of Osteoporosis. Endocrine Practice (1998) 4: 69-72.
10. Di Monaco M, Di Monaco R, Mautino F and Cavanna A: Femur bone mineral density, age and fracture type in 300 hip-fractured women. Aging Clin Exp Res (2002) 14: 47-51.
11. Sakai A, Oshige T, Zenke Y, Yamanaka Y, Nagaishi H and Nakamura T: Unipedal standing exercise and hip bone mineral density in postmenopausal women: a randomized controlled trial. J Bone Miner Metab (2010) 28: 42-48.
12. Parfitt AM: Morphologic Basis of Bone Mineral Measurements: Transient and Steady State Effect of Treatment in Osteoporosis. Mineral Electroly Metab (1980) 4: 273-287.
13. Cui LH, Choi JS, Shin MH, Kweon SS, Park KS, Lee YH, Nam HS Jeong SK and Im JS: Prevalence of osteoporosis and reference date for lumbar spine and hip bone mineral density in a Korean population. J bone Miner Metab (2008) 26: 609-617.
14. Karlsson KM, Sernbo I, Obrant KJ, Redlund-Johnell I and Johnell O: Femoral Neck Geometry and Radiographic Signs of Osteoporosis as Predictors of Hip Fracture. Bone (1996) 4: 327-330.
15. Svendsen OL, Marslew U, Hassager C and Christiansen C: Measurements of bone mineral density of the proximal femur by two commercially available dual energy X-ray absorptiometric systems. Eur J Nucl (1992) 19: 41-46.
16. Haddaway MJ, Davie MW and McCall IW: Bone mineral density in healthy normal women and reproducibility of measurements in spine and hip using dual-energy X-ray absorptiometry. Br J Radiol (1992) 65: 213-221.