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Normative Broadband Ultrasound Attenuation and Speed of Sound Data and Correlation Between T-Scores of Quantitative Ultrasound and Dual Energy X-Ray Absorptiometry Among Females of Manipur

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ABSTRACT

Background: *Osteoporosis is the most common metabolic bone disease with a wide distribution among the elderly all over the world. Low bone mass as assessed by bone mineral density (BMD) is the major characteristic of osteoporosis. Ultrasound techniques have been proposed as diagnostic tools for assessing both skeletal mass and other qualitative characteristics of bone.* ***Objective:*** *The objective of this study was to generate a normative broadband ultrasound attenuation (BUA) and speed of sound (SOS) data for Manipuri women and to determine the correlation between t-scores of QUS and DXA among females of 3 districts of Manipur.* ***Methods:*** *A cross-sectional study was conducted among 2700 women with intact ovaries in the range of 21 to 70 years in three districts of Manipur namely Imphal West, Thoubal and Churachandpur districts. The bone mineral density of heel was measured by using Sahara clinical bone sonometer (Hologic INC, USA) measuring the speed of sound (SOS) and broadband ultrasound attenuation (BUA). BMD measurement was done using GE Lunar Prodigy DXA machine.* ***Results:*** *The study estimated normative data of Manipuri women for BUA as 37.6-112.9 dB/MHz and SOS as 1482.1-1616.5 m/s respectively and that there was a statistically significant correlation between t-scores of quantitative ultrasound and DXA scan among the three districts (r=0.455, p<0.000).* ***Conclusion:*** *T-scores of quantitative ultrasound significantly correlate with t-score of DXA scan in osteoporotic females in Manipur. Therefore, where the facility of DXA scan is not available, the bone mineral density measured by quantitative ultrasound can be used as a relatively inexpensive alternative.*

Keywords: Osteoporosis, Bone mineral density, Quantitative ultrasound, Dual-energy X-ray absorptiometry

INTRODUCTION

Osteoporosis is the most common metabolic bone disease with a wide distribution among the elderly all over the world. It is defined as “a skeletal disease, characterized by low bone mass and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture” [1].

Osteoporosis can be classified into two basic forms: primary and secondary. Primary osteoporosis is also known as postmenopausal osteoporosis in women and senile osteoporosis in men. Secondary osteoporosis can result from various medical conditions or diseases, or from the use of certain medications that adversely affect skeletal health [2].

Osteoporosis is estimated to affect 200 million women worldwide, approximately one-tenth of women aged 60, one-fifth of women aged 70, two-fifths of women aged 80 and two-thirds of women aged 90 [3]. In a study among Indian women aged 30-60 years from low income groups, bone mineral density (BMD) at all the skeletal sites were much lower than values reported from developed countries, with a high prevalence of osteopenia (52%) and osteoporosis (29%) thought to be due to inadequate nutrition [4].

Low bone mass as assessed by bone mineral density (BMD) is the major characteristic of osteoporosis. The strong inverse relationship is present between BMD and risk of fracture. While fracture is the single most important manifestation of osteoporosis, but because of lack of warning signs before fractures, it continues to be under-recognized. Chronic pain, depression, disability, and mortality can occur as its complications. It can create significant social and economic burdens, making early diagnosis essential for timely treatment and for identifying patients who are at risk for fractures. Optimal treatment and prevention programs should focus on strategies to minimize bone resorption and maximize bone formation, as well as strategies to reduce falls.

Diagnostic imaging of osteoporosis has two principal aims: (a) to identify the presence of osteoporosis and (b) to quantify bone mass with use of semi-quantitative (conventional radiography) or quantitative (densitometry) methods. Osteoporosis is still most commonly diagnosed at conventional radiography. However, radiography detects osteoporosis only when a substantial of bone loss (approximately 30%) occurs. Dual-energy X-ray absorptiometry (DXA) measurements are currently the standard of reference for the clinical diagnosis of osteoporosis with bone densitometry. Quantitative ultrasound (QUS) is used to measure quantitative parameters and assess tissue properties.

Ultrasound techniques have been proposed as diagnostic tools for assessing both skeletal mass and other qualitative characteristics of bone [5]. Speed of sound (SOS) and broadband ultrasound attenuation (BUA) through the bone are ultrasound properties currently measured. Many studies have shown that SOS and BUA reflect both bone density and other properties of bone such as elasticity and bone microarchitecture [6]. Ultrasound parameters are most frequently measured in calcaneal bone because it is a weight-bearing bone and is composed almost entirely of trabecular bone. Therefore, measurements at this site provide a good estimation of structural properties of axial skeleton [7].

The objective of the present study is to generate a normative broadband ultrasound attenuation (BUA) and speed of sound (SOS) data for Manipuri women and to determine the correlation between t-scores of QUS and DXA among females of 3 districts of Manipur.

PATIENTS AND METHODS

A cross-sectional study was conducted among 2700 pre and post-menopausal women with intact ovaries in the range of 21 to 70 years in three districts of Manipur namely Imphal West, Thoubal and Churachandpur districts representing urban, rural and hill regions based on the population census of the year 2001. From the electoral list, the wards were selected randomly to meet the required sample so as to have 550 women from 21 to 45 years age group and 350 women from the 46 to 70 years age group. Selection of the individual from the selected wards was done in a systematic random fashion.

Pregnant women, lactating women, on steroid or other hormone replacement therapy, chronic endocrine disorders like thyroid diseases, parathyroid diseases, adrenal diseases etc, women on active medication for osteoporosis within 6 months, on calcium channel blocker and with severe systemic disease were excluded from the study.

Study variables included age, district, quantitative ultrasound index (broadband ultrasound attenuation, the speed of sound) and bone mineral density (t-scores of quantitative ultrasound and DXA).

Bone mineral density was measured by using Sahara clinical bone sonometer (Hologic INC, USA). This system incorporates two ultrasound transducers positioned opposite to each other. The heel was placed in between the two transducers. It measured the speed of sound (SOS), broadband ultrasound attenuation (BUA) in dB/MHz of an ultrasound beam passed in between the two transducers. The quantitative ultrasound index (QUI), bone mineral density (BMD), t-score and z-score were estimated from the above data by the system's software. BMD measurement was done using GE Lunar Prodigy DXA machine.

Statistical analysis was done using ANOVA and post-hoc tests and a p-value of less than 0.05 was considered significant.

RESULTS

Table 1 and 2 highlights that the normative data of Manipuri women for BUA is 37.6-112.9 dB/MHz and SOS is 1482.1-1616.5 m/s respectively.

Table 1 Normative value of BUA based on age groups in the 3 districts

Age groups in years	Normative value BUA (dB/MHz)			
	Imphal	Thoubal	Churachandpur	All combine
<25	45.10-112.47	51.63-114.39	49.14-125.86	-
25-39	43.92-115.64	46.63-118.19	49.16-114.81	-
40-59	37.30-109.72	42.91-114.62	40.80-116.49	-
>60	28.52-91.72	28.87-99.82	30.64-104.37	-
Combine	35.70-110.70	40.30-114.70	37.60-114.60	37.6-112.9

Table 2 Normative value of SOS based on age groups in the 3 districts

Age groups in years	Normative value SOS (m/s)			
	Imphal	Thoubal	Churachandpur	All combine
<25	1511.77-1615.54	1526.93-1626.13	1521.09-1638.06	-
25-39	1482.73-1618.26	1489.48-1623.19	1502.61-1616.82	-
40-59	1479.62-1601.92	1495.40-1626.66	1478.67-1620.14	-
>60	1466.48-1573.79	1473.03-1591.03	1464.96-1600.47	-
Combine	1477.30-1609.71	1487.67-1618.55	1479.48-1619.68	1482.06-1616.46

Both BUA and SOS showed a comparatively lower value in the age group above 60 years which corresponds to a reduction of bone mineral density in this older age group. In the normative data of BUA, there was a significant difference between Imphal and Thoubal districts ($p \leq 0.004$) and Thoubal and Churachandpur districts ($p \leq 0.030$), but not between Imphal and Churachandpur districts. Significant differences were noted between Imphal and other districts ($p \leq 0.000$) in the normative data of SOS, but not between Thoubal and Churachandpur districts which may be due to a similar lifestyle and involvement in outdoor activities.

In the age group <25 years, there were statistically significant differences among the 3 districts for BUA ($p \leq 0.03$). Post-hoc analysis showed that difference was between Churachandpur and Imphal districts for BUA ($p \leq 0.002$), but not between Imphal and Thoubal districts. For SOS, there were no significant differences among districts.

In the age group 25-39 years, there were statistically significant differences among the 3 districts for SOS ($p \leq 0.000$), not for BUA. There was a significant difference between Churachandpur and Imphal districts for BUA ($p \leq 0.002$), but not between Imphal and Thoubal districts. For SOS, there were no significant differences between the districts.

In the age group 40-59 years, there were statistically significant differences in the hill and valley districts for BUA ($p \leq 0.001$) and SOS ($p \leq 0.000$). Post-hoc analysis showed a significant difference between Imphal and Thoubal districts for BUA ($p \leq 0.000$) and SOS ($p \leq 0.000$), but not between Churachandpur and the other 2 valley districts.

Statistically significant differences were found among the 3 districts in the age group >60 years for BUA ($p \leq 0.031$) and SOS ($p \leq 0.013$). There was a significant difference between Imphal and Thoubal districts for BUA ($p \leq 0.032$) and SOS ($p \leq 0.009$), but not between Churachandpur and other 2 districts.

Table 3 showed a statistically significant correlation between T-scores of Quantitative Ultrasound and DXA scan among the three districts ($r=0.455$, $p<0.000$).

Table 3 Correlation between t-scores of quantitative ultrasound and DXA

T-scores of DXA vs QUS							
Imphal		Thoubal		Churachandpur		All Districts	
r=0.438	p=0.00	r=0.425	p=0.00	r=0.497	p=0.00	r=0.455	p=0.00
P<0.05 is considered significant							

Again, all the 3 districts separately also showed statistically significant correlations between t-scores of quantitative ultrasound and DXA scan (Imphal ($r=0.438$, $p \leq 0.000$, Thoubal $r=0.425$, $p \leq 0.000$ and Churachandpur $r=0.497$, $p \leq 0.000$)).

This finding showed a high correlation between t-scores measured by the Quantitative Ultrasound and DXA scan in all the age groups understudy for all the districts. Therefore, where the facility of DXA scan is not available, the bone mineral density measured by the quantitative ultrasound can still be used as an alternative.

DISCUSSION

Osteoporosis is responsible for approximately 2 million fractures annually including hip, vertebral, wrist, and other fractures. Osteoporosis-related complications lead to diminished quality of life, disability, and even death. As the elderly population is increasing, annual healthcare costs from osteoporosis will increase exponentially in future. But with appropriate screening, healthcare workers can implement effective preventive strategies for complications and ultimately improve quality of life and also curb healthcare expenditure. Hence screening for osteoporosis has become important and subsequently cheaper and accurate screening and diagnostic modalities have become the need of time. Bone density evaluation for diagnosing osteoporosis can be performed by various methods including bone ultrasound, bone densitometry, tomography, and radiologic study.

The results showed a strong and positive correlation between t-scores measured by QUS and DEXA. Previous studies in literature conducted by Hans, et al., [8], Pearson, et al., [9] and Trimpou, et al., [10] showed similar results of strong compatibility of results of the two methods. In the study conducted by Hans, et al., [8], it was suggested that QUS method could be used to identify individuals with risk factors for osteoporosis and that DXA could be used as a definite test for follow up in therapy.

In a similar study by Pearson, et al., [9], it was found that results obtained from QUS were very similar to those obtained by DXA measurements when both spine and hip were evaluated for osteoporosis. In the study conducted by Trimpou, et al., [10] conducted with a very long follow up period of 7 years, they suggested that QUS has a high sensitivity despite low specificity when compared to DXA and proposed that treatment of osteoporosis may be started with QUS results.

However, the common deduction from all these studies including present study is that single QUS measurement is not as reliable as DEXA which is the gold standard to confirm osteoporosis. But still, QUS has many advantages over DEXA scan. QUS is radiation free, relatively inexpensive, easy to operate and portable. Moreover, QUS technique is fast easy to use for sedentary or non-cooperative patients. In certain specific conditions like ankylosing spondylitis which primarily involves axial, it joints may give false positive results with DEXA and in these conditions, QUS gives the more reliable result.

In developing nations like India, where the facility of DEXA scan is not available everywhere, the bone mineral density measured by the quantitative ultrasound can still be used as an alternative. The normative data for broadband ultrasound attenuation and speed of sound for Manipuri women may be used as a baseline database for further research. The present study may pave way for using QUS as an effective alternate diagnostic modality for osteoporosis and helps in the efficient utilization of resources.

CONCLUSION

T-scores of quantitative ultrasound significantly correlates with t-score of DXA scan in osteoporotic females in Manipur. Therefore, where the facility of DXA scan is not available, the bone mineral density measured by quantitative ultrasound can be used as a relatively inexpensive alternative.

DECLARATIONS

Acknowledgement

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Conflict of Interest

The authors have disclosed no conflict of interest.

REFERENCES

[1] World Health Organization, WHO Scientific Group on the Prevention and Management of Osteoporosis. *Prevention and management of osteoporosis: report of a WHO scientific group*, 2003, http://apps.who.int/iris/handle/10665/42841.

[2] Albright, Fuller. “Osteoporosis.” *Annals of Internal Medicine*, Vol. 27, No. 6, 1947, pp. 861-82.

[3] Kanis, John A. on behalf of the World Health Organization Scientific Group, World Health Organization Collaborating Centre for Metabolic Bone Diseases. *Assessment of osteoporosis at the primary health-care level. Technical Report*. University of Sheffield, UK. 2007: Printed by the University of Sheffield.

[4] Shatrugna, Veena, et al. "Bone status of Indian women from a low-income group and its relationship to the nutritional status." *Osteoporosis International*, Vol. 16, No. 12, 2005, pp. 1827-35.

[5] Canhão, Helena, et al. "Normative data for quantitative ultrasound measurement of the calcaneus in a Portuguese population [Article in Portuguese]." *Acta Reumatológica Portuguesa*, Vol. 31, No. 1, 2006, pp. 65-73.

[6] Gudmundsdottir, Sigridur L., et al. "Age-related decline in bone mass measured by dual-energy x-ray absorptiometry and quantitative ultrasound in a population-based sample of both sexes: identification of useful ultrasound thresholds for osteoporosis screening." *Journal of Clinical Densitometry*, Vol. 8, No. 1, 2005, pp. 80-86.

[7] Rossman, P., et al. "Comparison of speed of sound and ultrasound attenuation in the Os calcis to bone density of the radius, femur and lumbar spine." *Clinical Physics and Physiological Measurement*, Vol. 10, No. 4, 1989, p. 353.

[8] Hans, Didier and Marc-Antoine Krieg. "Quantitative ultrasound for the detection and management of osteoporosis." *Salud Pública de México*, Vol. 51, S1, 2009, pp. S25-S37.

[9] Pearson, Derek, et al. "A Comparison of Calcaneal Dual-Energy X-Ray Absorptiometry and Calcaneal Ultrasound for Predicting the Diagnosis of Osteoporosis from Hip and Spine Bone Densitometry." *Journal of Clinical Densitometry*, Vol. 6, No. 4, 2003, pp. 345-51.

[10] Trimpou, Penelope, et al. "High correlation between quantitative ultrasound and DXA during 7 years of follow up." *European Journal of Radiology*, Vol. 73, No. 2, 2010, pp. 360-64.