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# COMPARISON BETWEEN PERIPHERAL DEXA AND QUANTITATIVE ULTRASOUND (QUS) FOR DETECTION OF OSTEOPOROSIS IN ELDERLY POPULATION

**Orthopaedics**

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## ABSTRACT

Background: Osteoporosis is a major health problem that affects millions of women worldwide. Quantitative Ultrasound can serve as a screening test for the elderly population, for confirmation by DEXA and early management. Objective: To evaluate the efficacy of QUS in diagnosing osteopenia and osteoporosis in comparison to peripheral DEXA (pDEXA). Methods: 110 elderly participants were investigated for t-scores by pDEXA and QUS measurement. Results: QUS T-score of -2.0 was selected as a cut-off point, for an optimal use of calcaneal QUS as a first-step screening tool that could identify the majority of subjects with pDEXA T-score ≤-2.5. Conclusion: Our study shows that QUS can be used for stratifying the population into risk groups for osteoporosis and that elderly with QUS T-score ≤-2.0 are candidates for referral for DEXA measurements.

## KEYWORDS

osteoporosis, DEXA, QUS, densitometry

## Introduction

Osteoporosis is defined as "a skeletal disorder characterized by compromised bone strength predisposing to an increased risk of fracture; bone strength reflects the integration of two main features: bone density and bone quality".[1] According to the World Health Organization (WHO) criteria the diagnosis of osteoporosis is based on bone mineral density (BMD) 2.5 standard deviation (SD) or more below the young adult mean (a *T*-score < 2.5 SD).[2] A *T*-score within the normal range is −1.0 SD or above, while a *T*-score between −1.0 and −2.5 SD characterizes low bone mass, referred to as osteopenia. Despite osteoporosis-related fractures be a major health issue, osteoporosis remains underdiagnosed.[3-5] This is especially more true in India, due to illiteracy and ignorance.

Bone mineral density (BMD) measured by dual energy X-ray absorptiometry (DEXA) is the best predictor of fracture risk, and over the past decade, DEXA has emerged as the gold standard to evaluate patients at risk for fragility fractures.[6-8] However, DEXA is not an optimal tool for population screening because of cost constraints and limited availability.[9] Also, DEXA provides information on mineralization status but does not sheds no light on bone quality.

Low-cost screening methods in order to select high-risk individuals who are more likely to benefit from DEXA testing are needed. Today, QUS is accepted as an attractive reality as it possibly provides early detection of people at high risk of fracture.[10] This technique is widely available, radiation-free, portable, relatively inexpensive and more time-saving than DEXA[11], and these properties make it suitable for mass screening in primary care. Many studies have reported that QUS parameters may reflect not only bone density but also quality properties of bone (elasticity, structure, micro-architecture) that are strictly related to bone strength.[12]

QUS parameters include broadband ultrasound attenuation (BUA), a measure of frequency dependent ultrasound attenuation, and speed of ultrasound (SOS) passing through soft tissue and bone tissue.[13] Nevertheless it is not completely known which parameter and in which extent is sensitive to the bone structure.[13,14] It is hypothesized that BUA has an explanatory power for the mechanical property measurements, while SOS is a possible way of measuring bone elasticity.[12] Several studies, both longitudinal and cross-sectional have demonstrated that for the assessment of the risk of fracture QUS is as suitable as bone densitometry, irrespective of the bone mass.[15-17]

The purpose of our study is to evaluate the efficacy of QUS in diagnosing osteopenia and osteoporosis in comparison to peripheral DEXA (pDEXA).

## Materials and Methods

***Study population***

One hundred forty four participants (age more than 50 years) were included in this study. These were the patients who attended the orthopaedic BMD camp in our outpatient setup at Gwalior. Exclusion criteria were rheumatoid arthritis, other metabolic bone disease, and current or previous usage of bisphosphonates or hormone replacement therapy. Informed consent was obtained from each participant after the general aim of the study was explained. Finally, a total of 110 participants were included in the study. Demographic data was collected by trained personnel. Height and weight was recorded, and BMI was calculated.

***Quantitative ultrasound (QUS) measurement:***

was carried out using Achilles express ultrasound device at the left calcaneum. Subjects were classified as normal, osteopenic and osteoporotic based on QUS t-scores. All measurements were carried out by same technician.

***Peripheral DEXA (pDEXA) measurement:*** Bone density was measured using peripheral DEXA at left calcaneum by trained and certified technicians.

***Statistical Analysis***

Data were analyzed using the Statistical Package for the Social Sciences program (SPSS 13.0). Receiver operating characteristic (ROC) analysis was carried out to determine the best sensitivity and specificity for QUS T-scores to compare to the gold standard and to find the best cut-off values that would give the highest sensitivity. Statistical difference was defined as $P < 0.05$.

## Results

The demographic characteristics of the 110 participants are shown in Table 1. According to pDEXA t-scores, 38 subjects (34.5%) were considered as osteoporotic, 47 (33.8%) as osteopenic, and 25 (22.7%) had normal bone mass. According to QUS t-scores, 54 subjects (49%) were in the osteoporotic group and 52 (47.3.1%) presented osteopenia. QUS results were compared with pDEXA results in Table 2.

***ROC Analysis***

Using ROC analysis, we identified the cut-off value that can be used as an optimal agreement between QUS and pDEXA. The cut-off value of QUS T-score was -2.0 with 52.63% sensitivity and 44.44% specificity for osteoporosis. The probability of subjects with a positive test result having osteoporosis, expressed as positive predictive value (PPV), was 33.33%, and probability of subjects with a negative test result not having osteoporosis, expressed as negative predictive value (NPV), was 64%. The chance of a positive test in the women who had osteoporosis, expressed as positive likelihood ratio (+ LR), was 0.95

times the chance of a positive result if the elderly did not have the disease. The sensitivity of QUS for osteopenia was 40.43% and specificity 57.14%, with a cut-off point -1.68. These results are shown in Table 3.

## Discussion

The major aim of this study was to evaluate if QUS could be used as a selective population pre-screen method, in order to maximize the cost effectiveness of referral for DEXA examinations and to limit at the same time the radiation dose to the patients.

Bone fragility shows a high correlation with bone mass, but as much as 25-30% of observed variation in bone strength may be due to qualitative features such as structure and elasticity of bone material[18-21]. Bone densitometry is an established, worldwide-accepted method to measure bone mass and predicts osteoporosis fracture risk.[22] However, none of the densitometric techniques enable a qualitative evaluation of bone tissue.

On the other hand, QUS became more and more accepted as reflecting some qualitative properties of bone. In 1996 it was officially declared that QUS is an alternative diagnostic technique for assessment of osteoporosis.[23] Several studies have shown that ultrasound variables correlate moderately with BMD measured by DEXA at different sites[24], but strongly when measured on the same site.[21] It has been demonstrated that QUS is as suitable as densitometry for the assessment of the risk of fracture, irrespective of the bone mass[15], because QUS provides information on the so-called non-mass characteristics of bones.[15,22,25]

A screening device may be considered as an effective method when it minimizes the number of false negatives while limiting referral to a second level, like DEXA. Therefore, it is indispensable to identify the QUS values below which further referral are necessary[10]. In this regard, ROC analysis was performed and QUS T-score of -2.0 was selected as a cut-off point, for an optimal use of calcaneal QUS as a first-step screening tool that could identify the majority of subjects with pDEXA T-score ≤-2.5, while restricting the number of subjects to be referred for a further DEXA examination. In the same way, a cut-off value of QUS T-score is calculated as -1.68 for identifying osteopenic subjects.

In the present study, QUS identified about 40.43% of subjects with osteopenia (sensitivity) and about 57.14% of subjects without osteopenia (specificity). Only about 41.3% of subjects with a positive QUS test had osteopenia (PPV). Of the subjects with a negative QUS test, about 56.25% had no osteopenia (NPV). QUS is much more useful for screening for elderly with osteopenia who are at risk of developing osteoporosis if no intervention is done. The limitation of this study is the small sample size. Further study with a larger sample size is advisable.

## Conclusion

Our study shows that QUS can be used for stratifying the population into risk groups for osteoporosis and that elderly with QUS T-score ≤-2.0 are candidates for referral for DEXA measurements. QUS can be used in any place of convenience for population screening, such as primary care settings, and its use in developing countries should be encouraged to increase detection of osteoporosis.

**Table 1. Demographic Characteristics**

| Variables | n (%) Total: 110 (100%) |
|---|---|
| Men | 64 (58.2%) |
| Postmenopausal Women | 46 (41.8%) |
| Mean Age, years (Range) | 61.7 (50-83) |
| Height (cm) | 166.1 |
| Weight (kgs) | 62.8 |
| BMI (kg/m$^2$) | 22.7 |

**Table 2. Comparison of pDEXA and QUS results**

| pDEXA | QUS Results | Total | | |
|---|---|---|---|---|
| | Osteoporosis | Osteopenia | Normal | |
| **Osteoporosis** | 20 | 18 | 0 | 38 (34.5%) |
| **Osteopenia** | 25 | 19 | 3 | 47 (33.8%) |
| **Normal** | 09 | 15 | 1 | 25 (22.7%) |
| **Total** | 54 (49%) | 52 (47.3%) | 4 (3.7%) | 110 (100%) |

**Table 3. Use of QUS parameters to predict Osteoporosis or Osteopenia**

| Characteristics | Osteoporosis | Osteopenia |
|---|---|---|
| Sensitivity | 52.63 (26.37 to 55.73) | 40.43 (26.37 to 55.73) |
| Specificity | 44.44 (32.72 to 56.64) | 57.14 (44.05 to 69.54) |
| PPV | 33.33 | 41.30 |
| NPV | 64.00 | 56.25 |
| LR + | 0.95 | 0.94 |
| LR - | 1.07 | 1.04 |
| Accuracy | 47.27% | 50% |

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