BMD-QUS ASSESSMENT RESULT APPROPRIATES TO DIAGNOSE OSTEOPOROSIS

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ABSTRAK

Sebuah peralatan medis dengan teknologi USG-gelombang, yang disebut Quantitative Ultrasound (QUS), sudah tersedia untuk mengukur kepadatan massa tulang / mineral (BMD) sebagai alat dalam mendiagnosis osteoporosis. Peralatan ini mengukur kuantitas USG-gelombang yang melewati tumit-tulang (kalkaneus). Hasil pengukuran disajikan dalam T-score dan Z-score. Karakteristik QUS sederhana, menyimpan, dan murah, tetapi hasil keluaran tidak akurat. WHO "standar emas" untuk pengukuran BMD adalah Dual-energi X-ray Absorbtiometry (DXA). Sampai saat ini, di Indonesia DXA telah tersedia hanya di Jakarta. Tapi biaya penilaian DXA relatif mahal bagi masyarakat Indonesia. Selain itu, QUS dan DXA menggunakan tulang wanita Jepang sebagai referensi. Analisis statistik dari 15 hasil penilaian paralel dari QUS-DXA dilakukan untuk mendapatkan koefisien korelasi dan persamaan matematis antara dua hasil penilaian. T-skor dari QUS berkorelasi untuk gr/cm2 dan T-skor dari DXA dari FN (femoralis leher), LS (lumbar spine-) dan RD (radius). Z-skor dari QUS yang berhubungan dengan Z-skor dari DXA dari FN, LS dan RD. Analisis statistik juga dilakukan untuk 132 QUS Data T-score dari populasi wanita dengan usia puncak massa tulang, untuk mendapatkan populasi T-score nilai rata-rata. Hasil penilaian QUS yang berkorelasi dengan hasil penilaian DXA di tiga lokasi dengan koefisien korelasi rata-rata 0,67. Rerata koefisien korelasi yang didapat dari hasil penilaian DXA di tiga lokasi pengukuran adalah 0,81. Selain itu, hasil penilaian QUS dikombinasikan dan disesuaikan ke dalam persamaan korelasi ini, untuk mendapatkan estimasi data yang DXA. Nilai rata-rata T-score yang dihasilkan oleh analisis data referensi adalah -1 (minus satu). Nilai ini kemudian digunakan sebagai faktor koreksi dari persamaan referensi QUS sebelumnya / aslinya, sehingga kita dapat memiliki persamaan referensi lokal dan kriteria lokal. Persamaan korelasi QUS-DXA adalah jawaban untuk penilaian DXA langka dan mahal. Selanjutnya, persamaan referensi lokal dan kriteria lokal beberapa cara untuk meningkatkan akurasi QUS sebagai alat pengukuran kepadatan massa tulang/mineral. Penelitian ini diharapkan akan meningkatkan optimalitas hasil penilaian QUS selama proses diagnosa. Selanjutnya, keakuratan diagnosis akan meningkatkan efektivitas & efisiensi terapi, dan pada akhirnya akan meningkatkan kualitas pelayanan kesehatan masyarakat. ***(FMI 2013;49:112-115)***

Kata kunci: *massa tulang/densitas mineral, ultrasound kuantitatif, hasil penilaian, analisis statistik, referensi, faktor koreksi, korelasi*

ABSTRACT

A medical equipment with ultrasound-wave technology, which is called Quantitative Ultrasound (QUS), is readily available to measure bone mass/mineral density (BMD) as a tool in diagnosing osteoporosis. This equipment measures the quantity of ultrasound-wave that passes through heel-bone (calcaneus). The measurement results are expressed in T-score and Z-score. The characteristics of QUS are simple, save, and cheap, but the output result is not accurate. WHO's "gold standard" for BMD measurement is Dual-energy X-ray Absorbtiometry (DXA). Up to now, in Indonesia DXA has been available only at Jakarta. But assessment cost of DXA is relatively expensive for Indonesian people. Moreover, QUS and DXA use Japanese woman bone as the reference. Statistical analysis of 15 parallel assessment results from QUS-DXA is done to get correlation coefficient and mathematical equation between two assessment results. T-scores from QUS are correlated to gr/cm^2 *and T-scores from DXA of FN (femoral-neck), LS (lumbar-spine) and RD (radius). Z-scores from QUS are correlated to Z-scores from DXA of FN, LS and RD. Statistical analysis is also done to 132 QUS T-score data from woman population with peak bone mass age, in order to get population T-score mean value. QUS assessment results are correlated to DXA assessment results at three sites with mean correlation coefficient of 0.67. The mean of correlation coefficient got from DXA assessment results at three measurement sites is 0.81. Moreover, QUS assessment result is combined and adjusted into this correlation equation, to get DXA data estimation. The mean value of T-score resulted by the reference data analysis is –1 (minus one). This value is then used as a correction factor of the previous/original QUS reference equation, so that we can have local reference equation and local criterion. QUS-DXA correlation equation is an answer for the rare and expensive DXA assessment. Furthermore, local reference equation and local criterion are several ways to increase QUS accuracy as the bone mass/mineral density measurement tool. Hopefully, this research will increase the optimality of QUS assessment result during the process of diagnosing. Next, the accuracy of diagnosis will increase the effectiveness & efficiency of therapy, and finally it will raise the quality of public health service.* ***(FMI 2013;49:112-115)***

Keywords : *bone mass/mineral density, quantitative ultrasound, assessment result, statistical analysis, reference, correction factor, correlation.*

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INTRODUCTION

In medical world, the method to determine osteoporosis is by measuring bone mass/mineral density (BMD) (Francis 1990). Standard equipment for BMD measurement is DXA/DEXA (*Dual-Energy X-ray Absorptiometry*) (Wahner & Fogelman 1994). Usually, this equipment is used to measure BMD at three sites, those are: spine, hip and arm. Since DXA measurement technique is complex, DXA unit price and operational cost are expensive for common Indonesian people. Therefore, DXA has been available only in big cities of Indonesia. DXA capability in doing direct measuring of axial bone, such like spine and hip that usually suffer from osteoporosis, makes DXA still to be gold standard for BMD measuring. DXA measurement results are expressed in gr/cm2, T-score and Z-score (Z score is a deviation value toward young normal reference and age matched reference) (Fogelman & Blake 2000). But, DXA equipment is big and heavy, so that DXA is not a portable equipment. Another weakness is that DXA measurement uses Japanese people's bone as the reference of measurement. In fact, Japanese people's bone is considered to have higher density than Indonesian people's bone.

Figure 1. DXA Assessment

Recently, there is a new equipment for measuring BMD level, which is called QUS (*Quantitative Ultrasound*). This equipment uses ultrasonic-wave to measure BMD of heels (calcaneus) (Langton & Njeh 2008, National Osteoporosis Society 2001). QUS measurement results are also expressed in T-score and Z-score, but not in gr/cm^2. Moreover, since QUS is small and light, it is appropriate to be a portable equipment. The other advantage of QUS is that it has cheaper unit price and operational cost than DXA (Jenkins 2001). Unfortunately, QUS measurement result is not accurate and easily changed. Consequently, it is difficult to be used as a truthful diagnostic tool. Some physicians use QUS assessment results carefully because sometimes the result are confusing. Consequently, the patients could be over/under diagnosed. Another weakness of QUS is that it uses Japanese people bone as its measurement reference, such like DXA. Since QUS has been available in Indonesia, many people have been judged to suffer osteoporosis.

Figure 2 QUS Assessment

MATERIALS AND METHODS

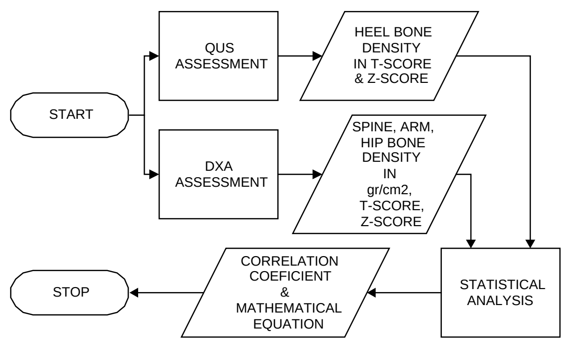

Figure 3. Data Correlation Test Process

By referring to DXA as BMD measurement tool such as being recommended by WHO, the study tries to answer the research question about the validity of QUS in BMD measurement. Validity test is done by collecting DXA & QUS measurement result at the same subject and the same time. The study examines 15 sets of data, and analyze them using statistic computation to find out correlation between them.

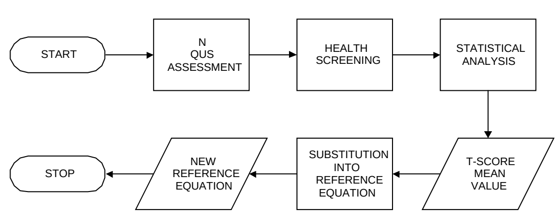

Figure 4. Reference Data Finding Process

Because DXA and QUS references operated in Indonesia uses Japanese reference, the research tries to find reference for Indonesian women's bone mass/mineral density. For the early step, it examines the bone mass density of the women in Bandung (Pramudyo & Wachjudi 2001). The study looks for peak bone mass age reference. About 132 young women, who are at peak bone mass are measured by QUS. The measurement results are used as correction factors for the equipment reference, so that the reference is changed and being a matched reference for woman in Bandung. Next, this research identifies QUS data pattern, by comparing with DXA data, and by getting local reference in Bandung. Hopefully, the result of this research can help medical practitioners to make the best use of QUS measurement result and to make needed adjustment, so that the accuracy of the diagnoses can be increased.

RESULTS

Parallel measurement output is 15 sets of QUS-DXA data. The Pearson correlation analysis (r_{xy}) is used to compare between QUS measurement result of heel (CCN) and DXA measurement result of femur (FN), spine (LS) and forearm (RD) (Supranto 1994).

Table 1. The QUS-DXA Correlation Coefficient

Relation	N	Correlation Coefficient
DXA(FN)-QUS(CCN)	14	0.643
DXA(LS)-QUS(CCN)	15	0.748
DXA(RD)-QUS(CCN)	15	0.617

From 132 data, only 105 of them can pass data analysis, as shown at the Table 6. A new reference equation is developed by adding the T-score mean value into the previous/original QUS reference equation such as below:

$$T = -2 + \frac{1.975}{1 + (\frac{Age}{55.9})^{10.1}} + mean$$

$$T = -3 + \frac{1.975}{1 + (\frac{Age}{55.9})^{10.1}}$$

The original and local overlaid graphics can be seen at Picture 5 below:

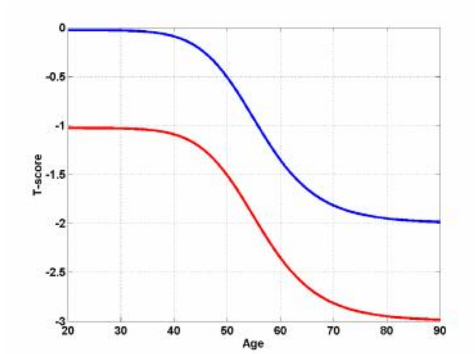

Figure 5. The original and local overlaid graphics

DISCUSSION

There is correlation between the measurement results of DXA dan QUS at three measurement points, those are FN, LS and RD. The mean of the correlation coefficient is 0.67. The DXA measurement at three locations produces 0.81 as the mean of correlation coefficient. By combining the QUS measurement result into the correlation equation, it will produce estimation of DXA data. The estimation can be used to overcome the high-cost and the scarcity of DXA assessment.

The T-score's mean of peak bone mass, which is resulted from reference data analysis is –1 (minus 1). This value can be used to be a correction factor, by putting it into the original/previous QUS reference equation, so that they result local reference and local criteria. So, the accuracy of the QUS measurement results can be increased by taking into account local correction factors. The steps used for measuring BMD in this research can be seen in the Picture 6 below:

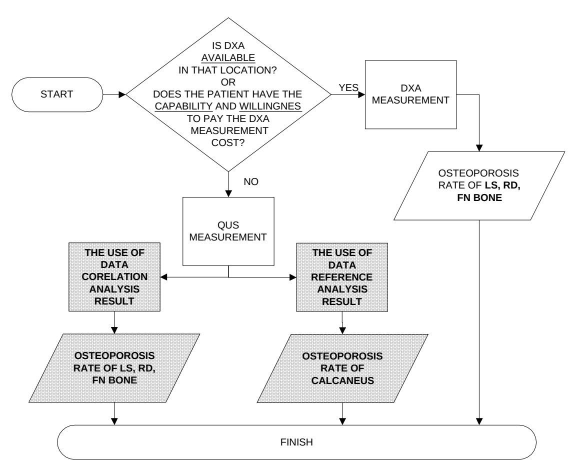

Figure 6. The Steps of BMD Measurement

In order to make a correct osteoporosis diagnosis, medical practitioners should use the new reference equation and the new criteria from QUS reference analysis limitedly and carefully. First, it should be used limitedly because the object of this research is the women in Bandung only. Second, it should be used carefully since from this observation, the inaccuracy of QUS does not only depend on the bias of the reference, but also the factors as follows: patient's foot position changes, patient's foot are too nervous or moving/instable, the administration of gel is not good, and there is a mistake in patient's age input. Medical practitioners can use QUS-DXA Correlation Equation to predict gr/cm^2, T-score and Z-score of hip (FN), spine (LS) and arm (RD) bone by input heel (CCN) bone data. But it also should be done carefully because the QUS-DXA correlation is not as strong as the correlation among DXA's data. Finally, the research recommends several aspects for further study such as Reference data making should be widen to other age group after peak bone mass/mineral density period, so that it can create more complete than reference for BMD of the women in Bandung. The important things to be considered in improving the precision of QUS measurement is sufficient skill and capability of operators and high carefulness and consistency of operators in doing QUS measurement. It is better to use DXA to make the reference of bone mass density, since DXA can result bone mass density measurement in gr/cm^2 (Kanis & Glüer 2000). Obviously, it is expensive, but this is the best way to get an accurate bone mass density reference.

CONCLUSIONS

This research result will help doctors in QUS assessment result management, so that the accuracy of QUS diagnosis can be increased. Therefore, the result of QUS measurement can be used to diagnose osteoporosis with using and considering this research findings. Moreover, the correctness of a diagnosis can raise effectiveness and efficiency of therapy. Later, it can improve the quality of public health service.

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