CHAPTER IV

4. RESULTS

4.1 Baseline Data

The baseline characteristics of patients are shown in Table 4.1 in forms of mean and SD. The mean age of 300 post menopausal women was 57.91 years old, mean BMI in this population is 23.90 kg/m^2, and mean BMD of left femoral neck is 0.6902 g/cm^2.

Table 4.1. Baseline characteristics in mean and SD (n=300)

Characteristics	X (SD)	Max	Min	Range
Age (year)	57.91(8.76)	85	38	47
BW (kilograms)	57.49(9.12)	173	132	41
Height (centimeters)	154.99(6.05)	95	31	64
Age of last period (year)	46.78(5.69)	34.89	15.94	18.95
BMI (weight/height^2)	23.90(3.39)	1.045	0.37	0.674
BMD (gram/centimeter^2)	0.6902(0.12)	1.045	0.37	0.674
Duration of postmenopausal period (year)	11.13(8.8)	41	1	46

4.2 Osteoporosis and its associations

300 study subjects were measured BMD by using DXA as a gold standard and by QUS measurement as a new diagnostic test. Osteoporosis subjects were classed as positive cases, while those found to have normal BMD were classed as negative cases.

4.2.1 The Prevalence of osteoporosis: By using DXA measurement as the gold standard, the prevalence of osteoporosis was 107 (35.67%). False positive rate is 8.3%, and false negative rate is 60.74%.

Table 4.2. The Number of patients in osteoporosis and normal categories.

QUS (Test)	DXA (Gold standard)		Total
	Yes	No	
Yes	42	16	58
No	65	177	242
Total	107	193	300

4.2.2 The variables associated with osteoporosis

Table 4.3. Variables associated with having osteoporosis (n= 300).

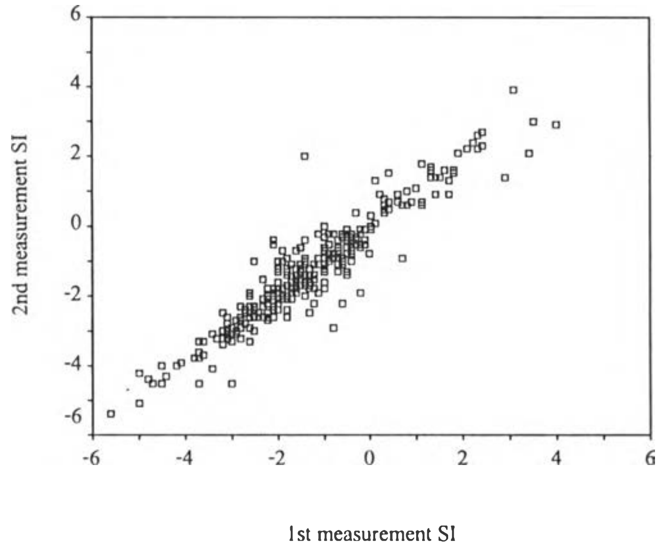
Variables	n (%)	p-value
Age(year)		
< 49	13 (26.5%)	x^2 = 32.435
50-54	17 (22.4%)	df = 5
55-59	17 (28.3%)	p < .001
60-64	21 (42%)	
65-69	17 (47.2%)	
>70	29 (75.9%)	
Age of last period(year)		
≤44	21 (28.4%)	x^2 = 2.345
45-49	47 (38.8%)	df = 2
≥50	39 (37.1%)	p = .310
Duration of postmenopausal period(year)		
≤3	21 (31.3%)	x^2 = 18.987
4-8	18 (22.2%)	df = 3
9-15	22 (33.3%)	p < .001
≥16	46 (53.5%)	
BMI(kg/m^2)		
Normal	74 (41.3%)	x^2 = 15.237
Low	8 (66.7%)	df = 2
High	25 (22.9%)	p < .001

From table 4.3, by univariate analysis indicates that age, age of last period, duration of postmenopause and BMI were significantly associated with having osteoporosis.

4.2.3 The Consistency of the test.

4.2.3.1 The Reliability (Test-retest) Coefficient was determined by using intraclass correlation (ICC) and the correlation graph is shown in Figure 4.1.

Figure4.1. Correlation between the measurement of calcaneous ultrasound of the first and second measurement.



The Reliability Coefficient ranges between 0.00 and 1.00, with values closer to 1.00, represents stronger reliability. In our study, we found that the ICC is 0.976 which indicates that the measurements of QUS had high reliability.

4.2.4 The Accuracy of the test.

4.2.4.1 The diagnostic performance

Table 4.4. The characteristics of diagnostic performance taking QUS-Stiffness Index & DXA-BMD as dichotomous variable and 2 x 2 table.

Characteristics	Percentage	95% confidence interval
Sensitivity	39.25	30.34 to 48.74
Specificity	91.71	87.16 to 95.01
Positive predictive value	72.41	59.90 to 82.73
Negative predictive value	73.14	67.29 to 78.44
LR+	4.73	2.80 to 8.00
LR-	0.66	0.57 to 0.78

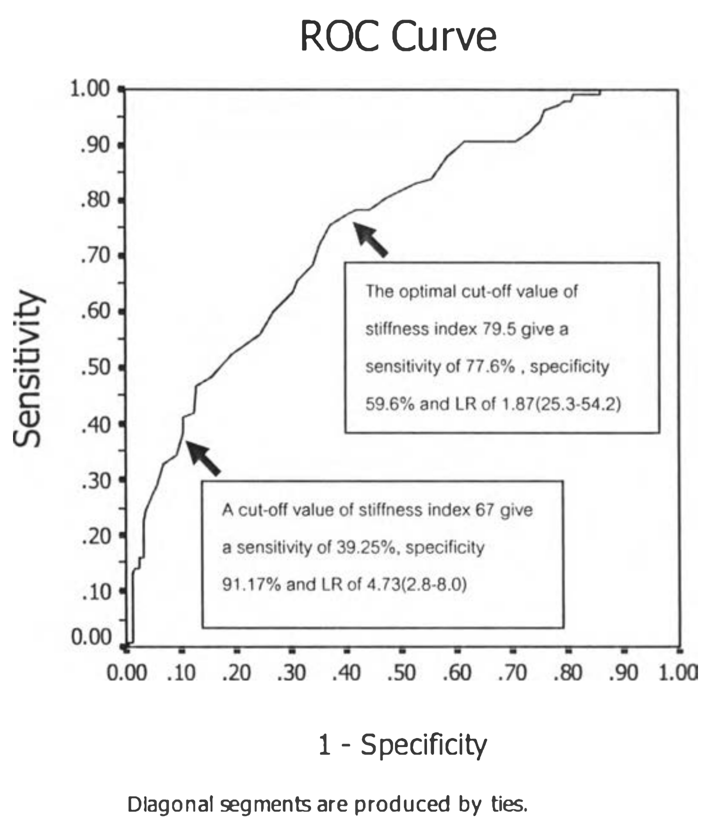
QUS (Test)	DXA (Gold standard)		Total
	Yes	No	
Yes	42	16	58
No	65	177	242
Total	107	193	300

The sensitivity of QUS using DXA as the gold standard was very low (39.25%) but had high specificity (91.71%). The probability that the subjects with a positive test result would have the osteoporosis (positive predictive value) was 72.41% and the probability that an individual with a negative test result would not have the osteoporosis (negative predictive value) was 73.14%. The chance of test positive if the subject has disease (LR+) is 4 times to the chance of a positive result if the subject does not have disease. A high likelihood ratio for a positive result indicates that the test provides useful information, as does a likelihood ratio which is close to zero for negative result.

4.2.4.2 The Receiver operator characteristic (ROC) analysis

The Receiver operator characteristic (ROC) indicates the results from two possible cut-off values, the optimal one and that used in the diagnostic test. (Figure 4.2.)

Figure 4.2. ROC curve and multiple cut-off values.



Using the ROC analysis, we can determine the cut-off value that should be used to give optimal agreement with QUS and DXA. From table 4.4, when using DXA as a gold standard, the cut-off value of stiffness index for QUS at 67 had low sensitivity (39.25%) and high specificity (91.71%). A good diagnostic test should have high sensitivity and high specificity. In this study, the optimal cut-off value at stiffness index = 79.5, we got sensitivity and specificity = 77.6% and 59.6% respectively (Table4.5.).

4.2.4.3 The multiple cut-off values

The optimal cut-off value for diagnosis of osteoporosis which has high sensitivity and high specificity was stiffness index = 79.5. At this point, we found sensitivity was 77.6% and specificity was 59.6% comparing to the low sensitivity (39.25%) when using cut-off values from WHO criteria (Table4.5.)

Table 4.5. Coordinates of the Curve : Test Result Variable(s): Stiffness index

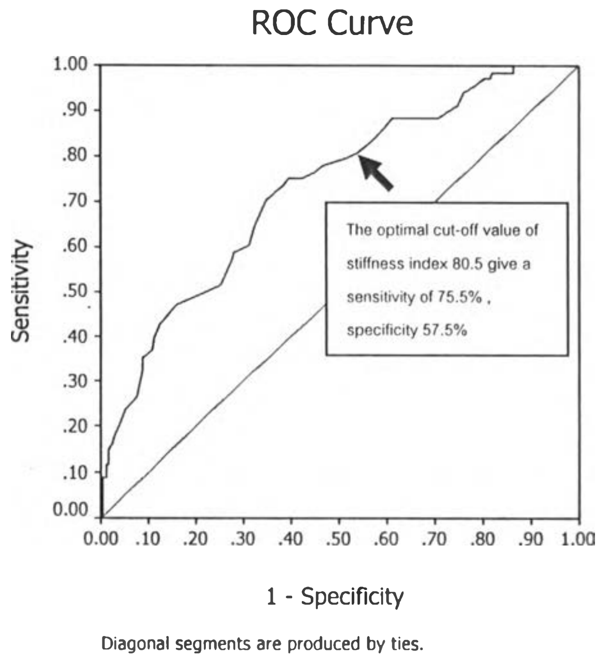
Positive if Less Than or Equal To	Sensitivity	1 - Specificity
64.5000	.327	.067
65.5000	.346	.093
66.5000	.383	.104
67.5000	.411	.104
68.5000	.421	.124
69.5000	.467	.130
70.5000	.486	.155
71.5000	.523	.192
72.5000	.561	.244
73.5000	.598	.269
74.5000	.636	.306
75.5000	.654	.311
76.5000	.682	.342
77.5000	.720	.352
78.5000	.757	.373
79.5000	.776	.404
80.5000	.785	.420
81.5000	.785	.446
82.5000	.804	.472
83.5000	.813	.487
84.5000	.832	.528
85.5000	.841	.554
86.5000	.879	.585
87.5000	.907	.617
88.5000	.907	.637
89.5000	.907	.674
90.5000	.907	.710
91.5000	.925	.731

Because age is associated with having osteoporosis, I decided to use univariate analysis for age categorized into 5 levels to determine how many level would be most appropriate and meaningful. As a result, it is found that age can only be categorized in 2 levels that are < 65 and $\geq$ 65 years in order to increase the power of analysis (See appendix). The optimal cut-off value and sensitivity, specificity of each categorized age are showed in 4.2.4.4 and 4.2.4.5.

4.2.4.4 The ROC analysis (categorized by aged <65)

The Receiver operator characteristic (ROC) indicates the optimal cut-off value of categorized age < 65 to find the (Figure 4.3.)

Figure 4.3. ROC Curve of population age < 65.



4.2.4.5 The cut-off values from coordinates of the ROC curve (age < 65).

The optimal cut-off value for the diagnosis of osteoporosis which has high sensitivity and high specificity was at stiffness index of 80.5. When we found that sensitivity was 75.5% and specificity was 57.5%.

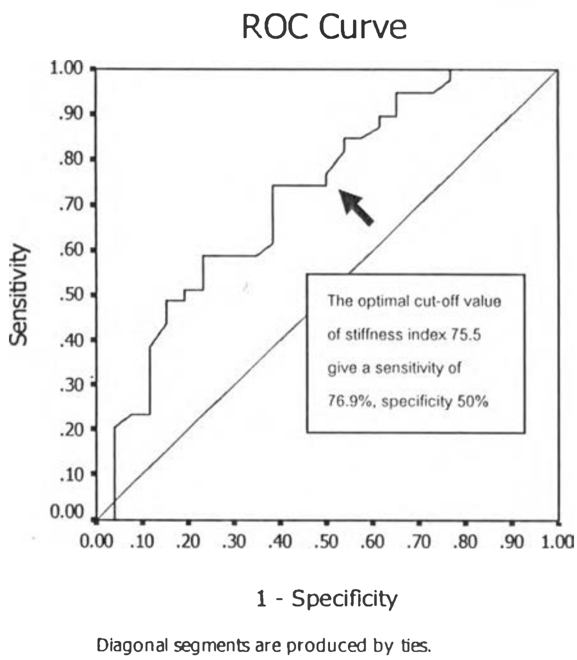
Table 4.6. Coordinates of the Curve: Stiffness index: Test population age < 65

Positive if Less Than or Equal To	Sensitivity	1 - Specificity
77.5000	.647	.323
78.5000	.706	.347
79.5000	.735	.383
80.5000	.750	.395
81.5000	.750	.425
82.5000	.765	.449
83.5000	.779	.467
84.5000	.794	.515
85.5000	.809	.539
86.5000	.838	.575

4.2.4.6 The ROC analysis (divided by aged ≥65)

The Receiver operator characteristic (ROC) indicates the optimal cut-off value of the categorized age ≥ 65 (Figure 4.4.)

Figure 4.4. ROC Curve of population age ≥ 65.



4.2.4.7 The cut-off values from coordinates of the ROC curve (age ≥ 65).

The optimal cut-off value for the diagnosis of osteoporosis which has high sensitivity and high specificity was at stiffness index of 75.5. When we found that sensitivity was 76.9% and specificity was 50% (Table 4.7.).

Table 4.7. Coordinates of the Curve: Stiffness index: Test population age ≥ 65

Positive if Less Than or Equal To	Sensitivity	1 - Specificity
69.5000	.590	.231
70.5000	.590	.346
71.5000	.615	.385
72.5000	.667	.385
73.5000	.744	.385
74.5000	.744	.500
75.5000	.769	.500
76.5000	.821	.538
78.5000	.846	.538
81.0000	.846	.577