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Evaluation of Bone Density Using Computed Tomography

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Abstract **Original Research Article**

Introduction: A bone density test is used mainly to diagnose osteopenia and osteoporosis. It is also used to determine your future fracture risk. Evaluation of bone density is important to help healthcare providers spot bone loss in people who might otherwise have no symptoms. The accurate diagnosis of bone density is a matter of considerable importance as it is a useful guide for arriving at a diagnosis of the bone diseases such as osteopenia and osteoporosis. It is therefore of utmost importance to resort to a mechanism that will give us an accurate estimation of the density of the bone. ***Objectives:*** this work was to evaluate bone density in normal Sudanese by using computed tomography. ***Methods:*** 100 CT scans of consecutive adult patients (52 male and 48 female) aged between 21 - 60 years, having no bone disorder, The patient's body weight and height were recorded at the time of the Computed tomography (CT) examination. The density of bone was calculated using a Hounsfield unit. ***Results:*** The average of compact and spongy bone of the lumber spine for all populations was 547.1 ± 84 HU and 209.9± 57 HU. The average of compact and spongy bone in males was 536.5 ± 93 HU and 229.9±51 HU. Moreover, the average of compact and spongy bone in females was 533.4 ± 108 HU and 213.9±53 HU. ***Conclusions:*** These results provide normative data for evaluating the bone density of the Sudanese population.

Keywords: Compact Bone, Spongy Bone, Density, Osteopenia, Osteoporosis.

INTRODUCTION

The matrix of bone is made of calcium salts and collagen and is strong, hard, and not flexible. The function of bone tissue is related to the strength of the bone matrix [1]. Moreover, the skeleton supports the body and some bones protect internal organs from mechanical injury [2].

The four general categories of bones are long bones, short bones, flat bones, and irregular bones. Long bones include the clavicles, humeri, radii, ulnae, metacarpals, femurs, tibiae, fibulae, metatarsals, and phalanges. Short bones include the carpal and tarsal bones, patellae, and Sesamoid bones. Flat bones include the skull, mandible, scapulae, sternum, and ribs. Irregular bones include the vertebrae, sacrum, coccyx, and hyoid bone. Flat bones form by membranous bone formation, whereas long bones are formed by a combination of endochondral and membranous bone formation [3].

Since bone, strength is proportional to bone mass, measurement of bone mass, or, what is commonly called, bone density, provides the means to diagnose osteoporosis and estimate an individual's future fracture risk. Quantitative measurements of the bone density of the lumbar spine, hip, forearm, and heel have proven to be as effective at predicting fracture risk as high blood pressure or high cholesterol levels in the blood are at predicting the risk of stroke or heart disease [4].

Dual-energy X-ray absorptiometry (DXA) is a method developed originally for the measurement of bone density and mass. DXA can also be used to measure soft tissue composition. DXA can measure total and regional fat, bone mineral, and bone mineral-free lean components [5] .

Moreover, it provides information about bone strength or fragility and the risk of fractures or broken bones, the higher the density, generally, the lower the risk of fracture [5].

Quantitative computed tomography or QCT Densitometry is all names used to describe a method of measuring bone density. It is the most accurate method in the evaluation of osteoporosis.

The principle underlying CT BMD is that normal calcified bone will absorb more x-rays than surrounding tissue so that the CT density measurement can be used to measure total bone mass within a sample of tissue [6].

MATERIAL AND METHODS

Population and Sampling of the Study

The data used in this study were collected from subjects admitted to various hospitals in Khartoum state (Ebnsina Hospital and Modern Medical Center) during the period from august 2016 to august 2022, with 100 CT scans of consecutive adult patients (261 male and 239 female) with aged ranged from 18 to 90 years, having no brain disorders. All patients with bone metabolic disorders were excluded.

CT Lumber Spine Procedure

Both 16-slice spiral CT unit GE optima were used to examine patients for lumber spine scans.

The patient lies supine in the middle of the table, with their arms above their head. A pillow or similar item can be used for supporting the head. Use pads and bands to support the arms. If the patient is unable to sustain this position for the duration of the scan, the arms may be folded high across the chest. The patient usually goes foot first into the scanner.

Data Acquisition and Measurement Protocol

Volumetric acquisition parameters were kV settings 120 kV, 350 mAs; 1.5-3 mm slice thickness, 250 mm field of view, and Effective pitch of 0.85, lumber images were reconstructed with a thickness of sequential 5 mm, soft tissue window, and bone window.

Data Analysis and Collection

Data were collected by using a data collection sheet for all subjects to maintain consistency with the information from the display. The data sheet was designed to obtain the patient's age, gender, weight, highest, BMI, sponge, and compact bone density. Data will be entered as a code using the statistical package for the Social Sciences (SPSS) version 20 (IBM Corp., Armonk, NY, USA).

RESULTS

Table 1: Demonstrate the distribution of gender in this study

Gender	Frequency	Percent
Male	52	52%
Female	48	48%

Table 2: Demonstrate the distribution of participants regarding age groups in this study

Age /Year	Frequency	Percent
< 21	3	3%
21 - 40	45	45%
41 - 60	31	31%
> 60	21	21%
Total	**100**	**100%**

Table 3: Demonstrate the Body mass index

BMI	Frequency	Percent
Underweight	27	27%
Healthy weight	46	46%
Overweight	19	19%
Obese	8	8%
Total	**100**	**100%**

Table 4: Correlate bone densities with gender

	Gender	N	Mean	Std. Deviation	P value
Compact Bone	Male	52	536.5577	93.29111	.878
	Female	48	533.4375	108.71687	
sponge Bone	Male	52	229.9423	51.99056	.134
	Female	48	213.9236	53.86461	

Table 5: Show group statistics of L1, L3, and L5 (mean, median, mode, std. deviation)

Level		Compact Bone	Sponge Bone
L1	Mean	535.0600	222.2533
	Std. Deviation	100.48457	53.24085
L3	Mean	553.1900	203.8700
	Std. Deviation	74.21273	58.82069
L5	Mean	553.1900	203.87
	Std. Deviation	74.21273	58.82069
Total	Mean	547.1467	209.9978
	Std. Deviation	84.04533	57.48954

DISCUSSION

As our hurry life rhythm, there aren't care about health as general and inconsiderable especially about, bone health till there is an urgent problem such as sudden bone trauma which continues to occur during daily life that we take care of and start to research the main cause of this problem and then return to the origin of this problem it related to body nutrition which affects directly n bone dense positively or negatively and that reflected on body and bone resistance to face the daily problem.

This study was performed in random samples in EbnSina hospital and modern medical center to attempt to have real readings and reach the number of it 100 cases with different age variables from (15-88) years old (Table 1).

The largest group of the age of measure vertebra came for scanning age between (21-40) years was 45 patients which were 54%, (41-60) years was 31 patients which were 31%, (more than 60) years was 21 patients which was 21% and less than 21 years 3 patient which was 3% (Table 2).

The BMI according to the majority of patients was healthy weight by a percentage of 46%, Underweight by a percentage of 27%, Overweight by a percentage of 19%, and obese by 8% the compact bone was denser than the spongy bone in both females and male (Table 3).

This study is in line with the finding of Abdul-Aziz Khalid *et al*., 2015 [7], as they mentioned that the mean of compact and spongy related in female cases record 337.11 for cortical and140.72 for spongy bone with SD of 69.513 for cortical bone and 31.398 for spongy bone, and the study of (Hiba Osman Mohamed at 2010) as she mentioned that female bone dense average is(267-173.42) This reading for an average of compact and spongy (Table 4).

This study is in line with the finding of Abdul-Aziz Khalid [7], as they mentioned that the mean of compact &spongy related in male cases, which recorded 387.30 for cortical bone and 149.5 for spongy bone with SD of 82.996 for cortical bone and 28.578 for spongy bone and the study of (Hiba Osman Mohamed 2010) as she mentioned that increase in the average of compact and spongy bone is (301.571- 187.55) This reading is for compact and spongy (Table 4).

Table (5) shows the mean SD in L1 cases, an average of compact and spongy, which record for compact 94.17037 for spongy with SD 64.93598 for first. In addition, the mean average of compact and spongy which was recorded for compact 550.2300 for spongy is 237.94. Which shows high values of compact rather than spongy.

Table (5) shows the mean SD in L3 cases, an average of compact & spongy which record for compact 74.21273. For spongy with SD 58.82069 for first.

Moreover, the mean average of compact and spongy which is a record for a compact is 553.1900for spongy is 203.8700. Which shows high values of compact rather than spongy.

Table (5) shows the mean SD in L5 cases, an average of compact & spongy which record for compact 74.21273. For spongy with SD 58.82069 for first. In addition, the mean average of compact and spongy which was recorded for a compact is 553.1900 for spongy is 203.8700. Which shows high values of compact rather than spongy.

Moreover, the total average L1, L3, and L5 average of compact & spongy records for a compact are 84.04533. For spongy with SD 57.48954 and the mean average of compact and spongy which record for a compact is 547.1467 for spongy is 209.9978.

CONCLUSION

In summary, The result of the study concluded that the commonest age group was (21-40) with a percentage of 54% and the least group was (less than 21 years) with a percentage of 3%, according to BMI, the majority of patients was in healthy weight by a percentage of 46% and the compact bone was denser than the spongy bone in both female and male.

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