Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/10297
DOI URL: http://dx.doi.org/10.21474/IJAR01/10297

RESEARCH ARTICLE

PHANTOM RADIOLOGY CHARACTERISTICS OF $CACO_3$ - BASED USING CT - SCAN

Manumpan Sihombing[1], Syahrul Humaidi[1], Kerista Tarigan[1], Muhammad Zaini Afdlan[1], Ali Napiah[3], Yolanda Sitompul[2] and Zaher Piavani[2]

1. Mathematic and Science Faculty, Universitas Sumatera Utara, Jl. Biotechnology 1 USU Campus, Medan 20155, Indonesia.
2. Royal Prima Hospital, Medan Petisah , North Sumatera, Medan 20118 Indonesia.
3. Fakultas Kedokteran Universitas Prima Indonesia Medan Petisah , North Sumatera, Medan 20118 Indonesia.

Manuscript Info

Manuscript History
Received: 23 November 2019
Final Accepted: 25 December 2019
Published: January 2020

Key words:-
CT-SCAN, Hounsfield Unit, Phantom, $CaCO_3$

Abstract

Phantom replacement of femur based on human $CaCO_3$, CaCl, NaCl, KOH + white cement successfully made. Phantom replacement of the femur in humans is made with 3 variants of composition (x = 0.3 and y = 0.67, x = 0.34 and y = 0.63, and x = 0.4 and y = 0.57) namely x is $CaCO_3$ and y is white cement. Thigh replacement phantom was tested using the GE / Optima 660 brand CT-SCAN with 3 potential different variations namely 80 kV, 100 kV, and 120 kV to see Hounsfield units (HU) in the test sample. Through CT-SCAN test, the highest HU is 2016, which is found in substitute phantom x = 0.3 and y = 0.67 with a potential difference of 80 kV and the lowest HU is 904 found in the replacement phantom variation x = 0.4 and y = 0.57 with 120 kV potential difference, while HU bone in general is +/- 1000.

Introduction:-

Radiology is medical science to see parts of the human body by using emission or radiation waves, both electromagnetic waves and mechanical waves. This makes the human body an important object that must be present in the process of photographing using x-rays, scanning with CT-Scan, MRI, ultrasound, and nuclear medicine (1). CT-Scan (Computed Tomography Scanner) is a modern development of radiology using the working principle of tomography, and the X-ray machine in the form of a ring (gantry) rotates around a patient who is sleeping on his back (2).

Bone is a living structure composed of proteins and minerals. Bone contributes to the body's mineral homeostasis and has recently been found to participate in endocrine regulation of energy metabolism (3). Bone tissue has the ability to store minerals, especially calcium and is almost mostly in the form of hydroxyapatite crystals. This material distinguishes bones from other connective tissue, including cartilage (4). The femur or femur is the largest body part and the strongest bone in the human body. It connects the hip and knee. Adult femur lengths averaged 505 mm, diameters from 40 mm to 60 mm, with thicknesses of 3 mm to 4 mm (5).

X-rays are electromagnetic waves that have very short wavelengths with very large energy and have very high penetrability. X-rays can damage body cells which can increase the potential risk of cancer. To avoid and minimize the danger of radiation effects, it requires a substitute object in the form of phantom radiology so that students do not need to get X-ray exposure during the learning process and practicum (6).

Corresponding Author:- Syahrul Humaidi
Address:- Mathematic and Science Faculty, Universitas Sumatera Utara, Jl. Biotechnology 1 USU Campus, Medan 20155, Indonesia.

In this research a radiology phantom will be made based on $CaCO_3$, CaCl, NaCl, and KOH with variations in composition x = 0.3 and y = 0.67, x = 0.34 and y = 0.63, and x = 0.4 and y = 0.57 where x is $CaCO_3$ and y is white cement. This research was conducted to facilitate students in the learning process, due to the high price of phantom in the market and must be imported. This phantom must have the same imaging and structure as bone in humans, which is a Hounsfield Unit value of +/- 1000 (7).

Methods:-

Procedure:-

First prepare each material to be used to make a phantom radiology replacement based on $CaCO_3$ including $CaCO_3$, CaCl, NaCl, KOH, and white cement. Then weigh the analytical balance until the mass of each material is reached.

Mix CaCl2, NaCl, and white cement, crushed until completely even, then dissolved with enough water. Then the material that has been crushed and dissolved in water is formed in the mold that has been provided. Next the material is dried at room temperature for 36 hours.

Next CT.Scan is performed on the material that has been formed, the image that appears on CT.Scan computer is reformed to display axial, coronal, and sagittal pieces. After that the Hounsfield Unit (HU) was measured at each image display.

Results and Discussion:-

Characterization of CT-SCAN at 80 kV, 100 kV, dan 120 kV:-

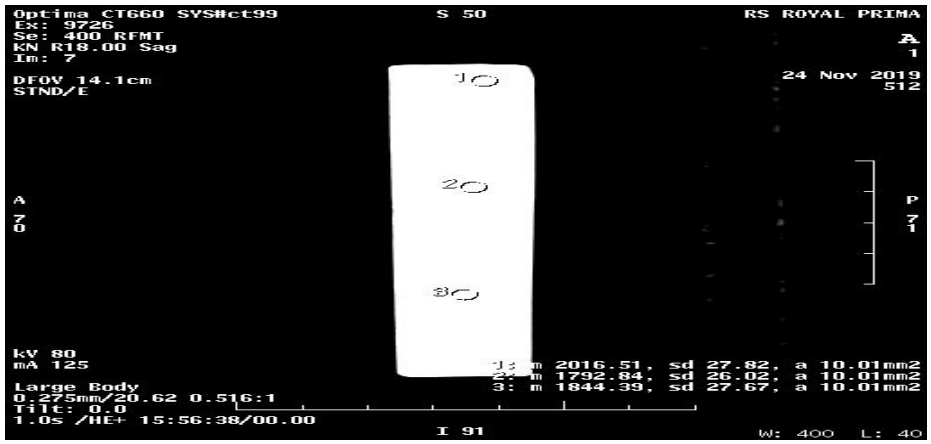
Hounsfield unit (HU) identification of test samples a, b, and c using GE / Optima 660 CT-SCAN was carried out to see the density of units in the test sample. Through this test Hounsfield units were obtained from test samples with composition variations (x = 0.3 and y = 0.67, x = 0.34 and y = 0.63, and x = 0.4 and y = 0.57). The data obtained were analyzed using the standard Hounsfield bone unit in the human body which is +/- 1000.

A. Characterization of CT-SCAN (x = 0.3 dan y = 0.67):-

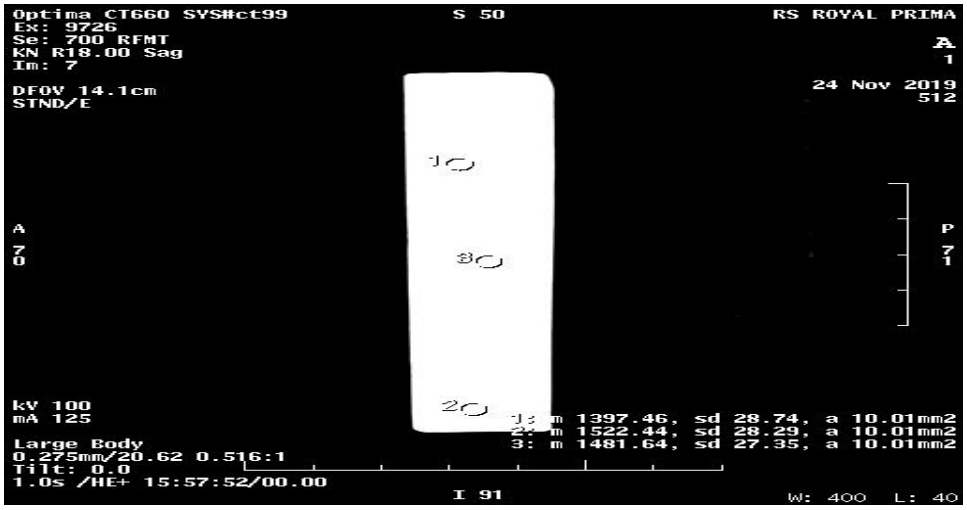
Samples of $CaCO_3$, CaCl, NaCl, KOH, and White Cement (x = 0.3 and y = 0.67) were tested using CT-SCAN to determine the value of Hounsfield units. Samples were tested with variations in potential difference of 80 kV, 100 kV, and 120 kV. The results of Hounsfield unit testing through CT-SCAN on $CaCO_3$, CaCl, NaCl, KOH, and White Cement Samples (x = 0.3 and y = 0.67) can be seen in Table 1 and Figure 1.

No	Name	Potential Difference (kV)	Hounsfield Unit	
			Min	Max
1	Sample A (x=0.3 and y=0.67)	80	1792	2016
2		100	1390	1520
3		120	1189	1402

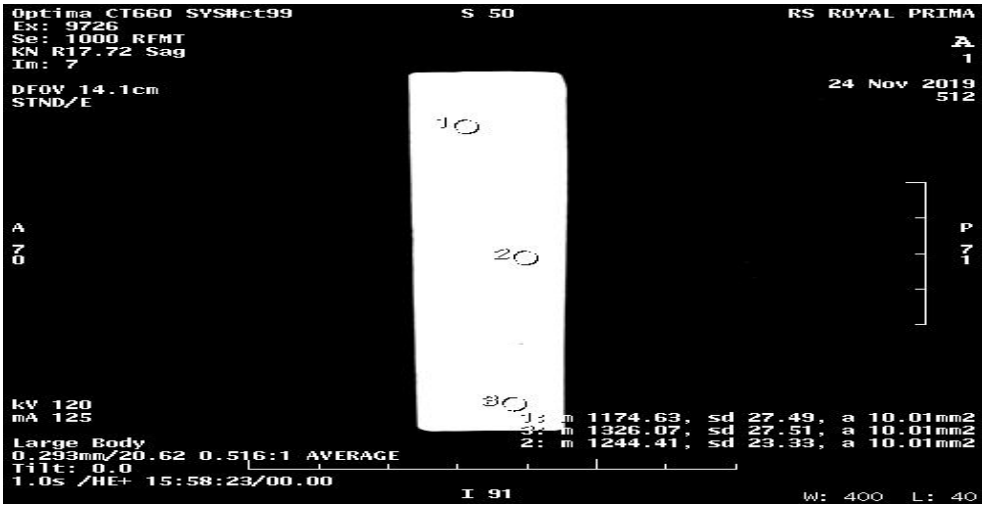
Table 1:-Hounsfield Unit Value in sample A.



A. 80 kV



B. 100 kV



C. 120 kV

Figure 1:-CT-SCAN Test Results for sample A with a potential difference of 80 kV, 100 kV, and 120 kV.

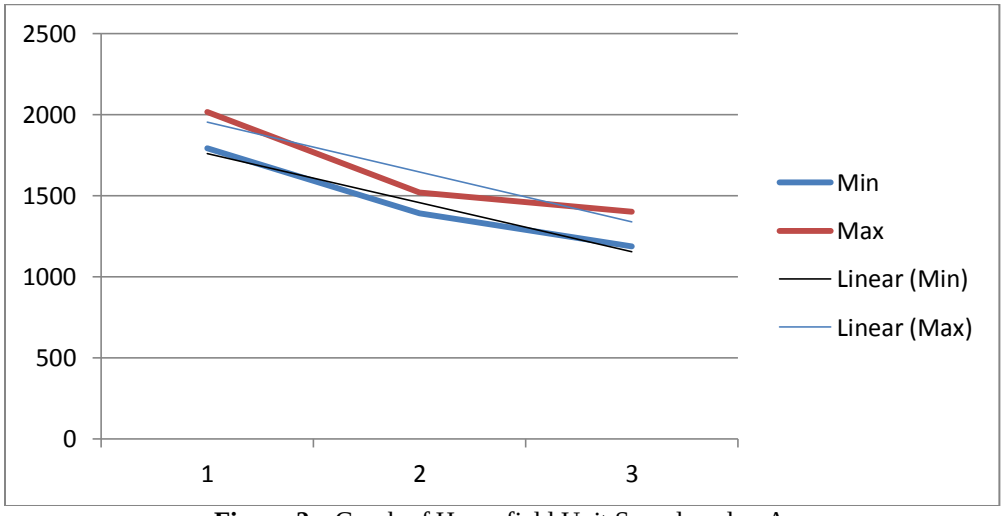


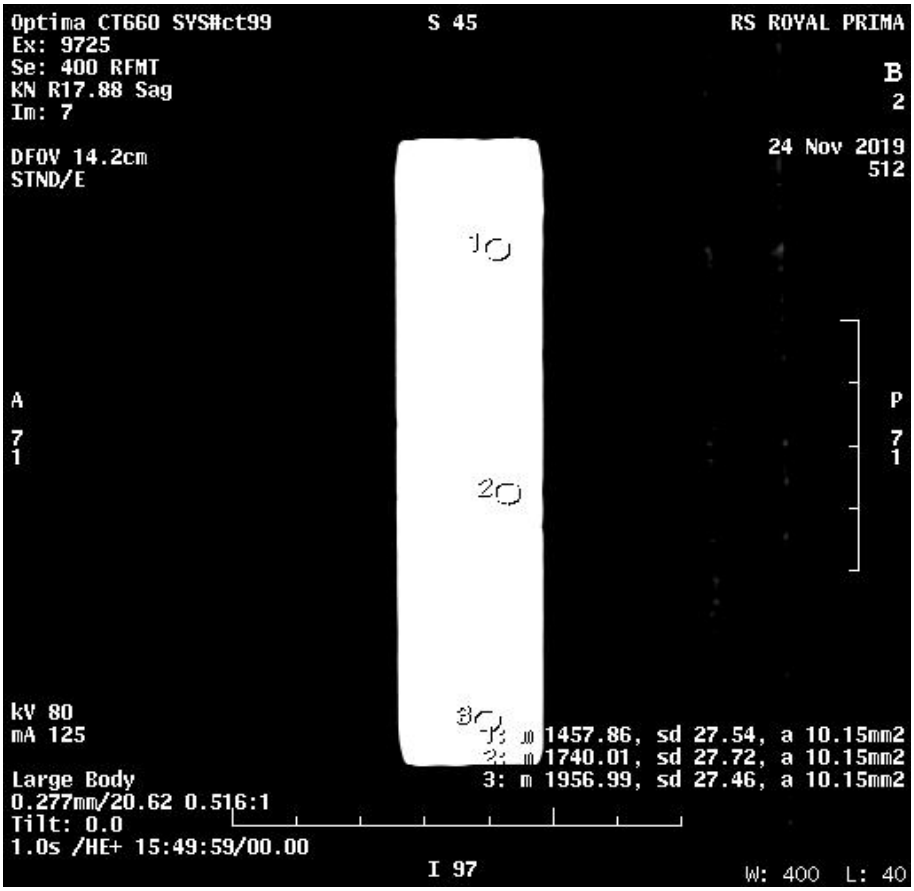
Figure 2:- Graph of Hounsfield Unit Sample value A.

Figure 2 Shows the value of Hounsfield unit sample A obtained is linear through the CT-SCAN test with a potential difference of 80 kV, 100 kV, and 120 kV.

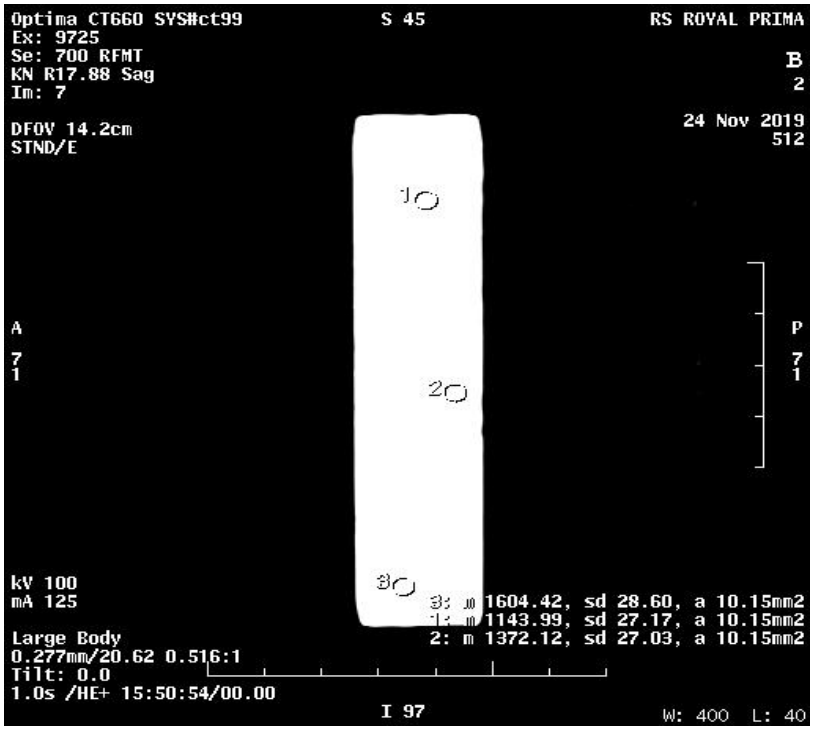
Characterization of CT-SCAN (x = 0.34 dan y = 0.63):
Samples of $CaCO_3$, CaCl, NaCl, KOH, and White Cement (x = 0.34 and y = 0.63) were tested using CT-SCAN to determine the value of Hounsfield units. Samples were tested with variations in potential difference of 80 kV, 100 kV, and 120 kV. The results of Hounsfield unit testing through CT-SCAN on $CaCO_3$, CaCl, NaCl, KOH, and White Cement Samples (x = 0.34 and y = 0.63) can be seen in Table 2 and Figure 3.

No	Name	Potential Difference (kV)	Hounsfield Unit	
			Min	Max
1	Sample B (x=0.34 and y=0.63)	80	1477	1947
2		100	1158	1617
3		120	983	1374

Tabel 2:-Hounsfield Unit Value in sample B.

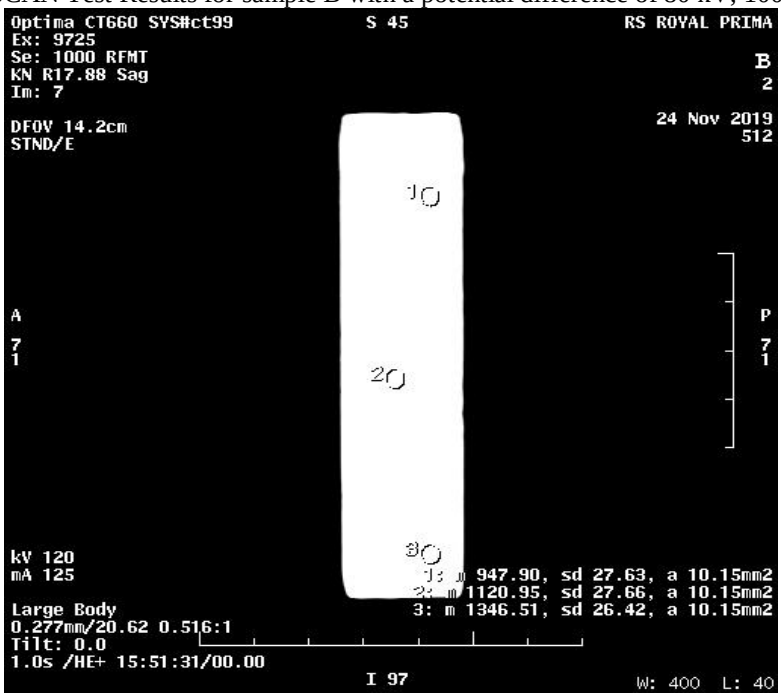


A. 80 kV



B. 100 kV

Figure 3:- CT-SCAN Test Results for sample B with a potential difference of 80 kV, 100 kV, and 120 kV.



C. 120 kV

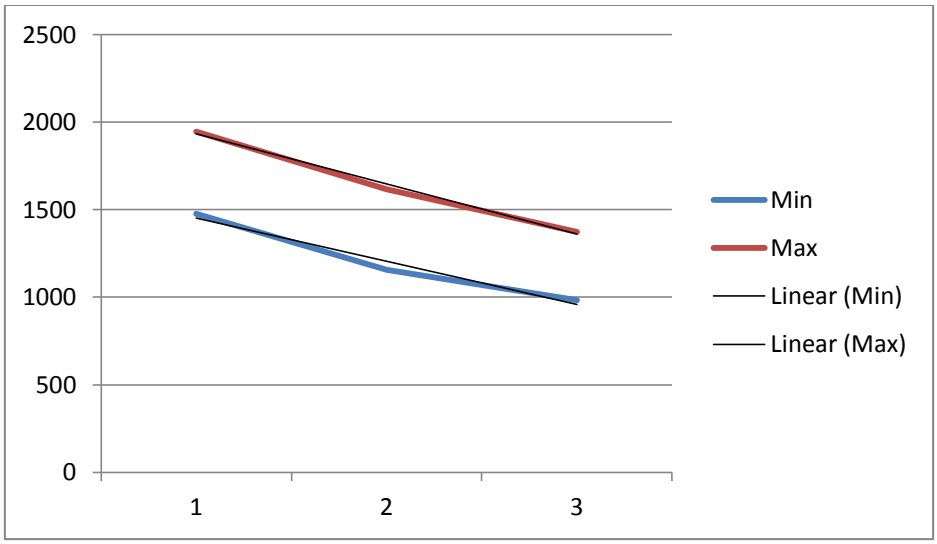


Figure 4:- Graph of Hounsfield Unit Sample value B.

.

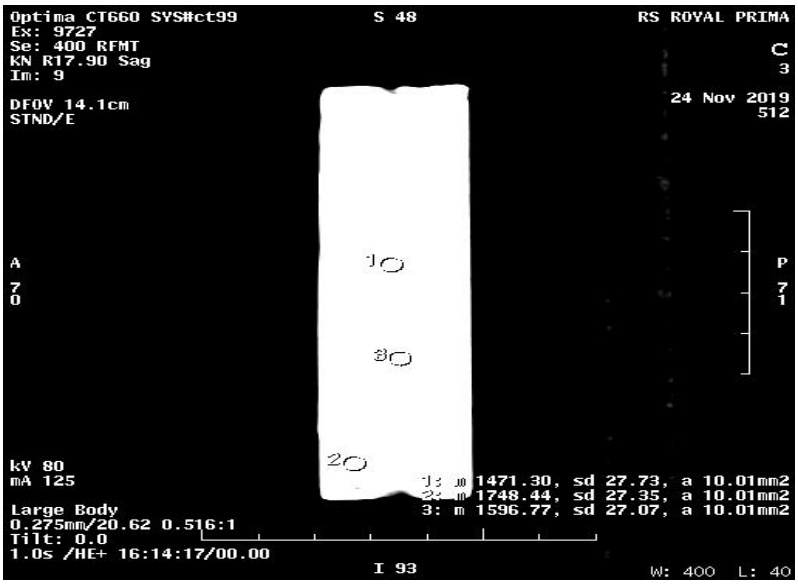
Figure 4 shows the value of Hounsfield unit sample B obtained is linear through the CT-SCAN test with a potential difference of 80 kV, 100 kV, and 120 kV.

Characterization of CT-SCAN (x = 0.4 dan y = 0.57):-

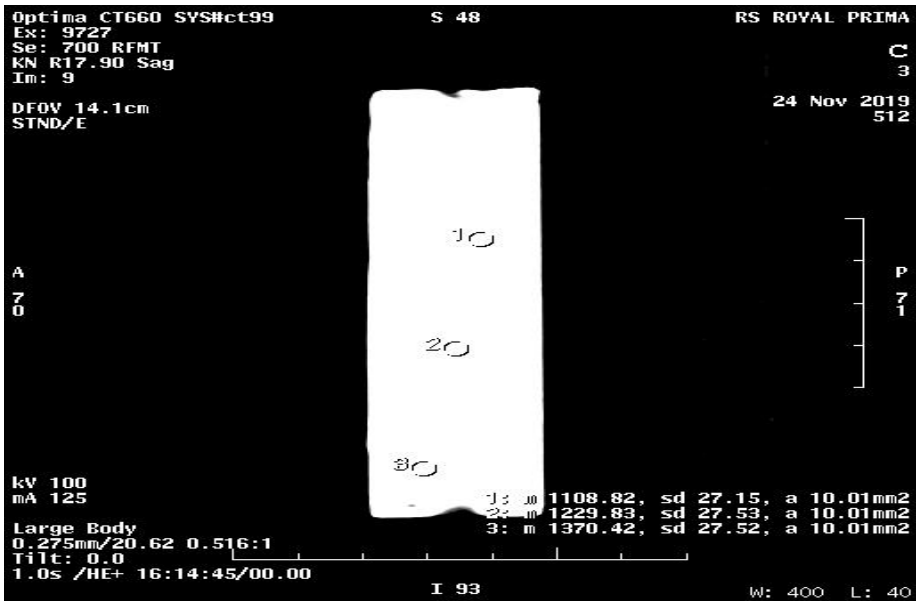
Samples of $CaCO_3$, CaCl, NaCl, KOH, and White Cement (x = 0.4 and y = 0.57) were tested using CT-SCAN to determine the value of Hounsfield units. Samples were tested with variations in potential difference of 80 kV, 100 kV, and 120 kV. The results of Hounsfield unit testing through CT-SCAN on $CaCO_3$, CaCl, NaCl, KOH, and White Cement Samples (x = 0.4 and y = 0.57) can be seen in Table 3 and Figure 5.

No	Name	Potential Difference (kV)	Hounsfield Unit	
			Min	Max
1	Sample C (x=0.4 and y=0.57)	80	1471	1748
2		100	1108	1370
3		120	904	1152

Tabel 3:- Hounsfield Unit Value in sample C.

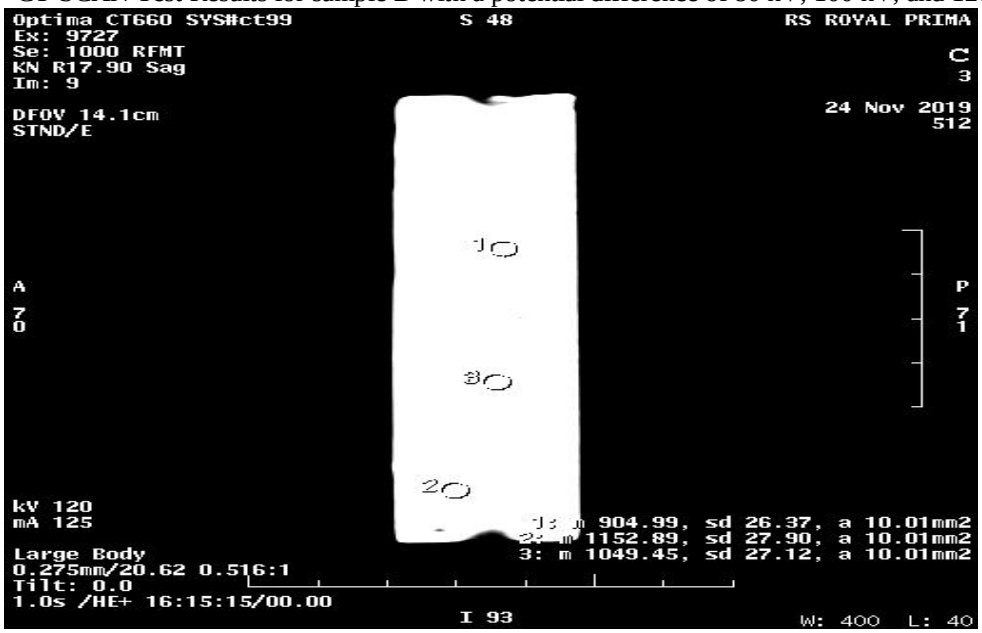


A. 80 kV



B. 100 kV

Figure 6:- CT-SCAN Test Results for sample B with a potential difference of 80 kV, 100 kV, and 120 kV.



C. 120 kV

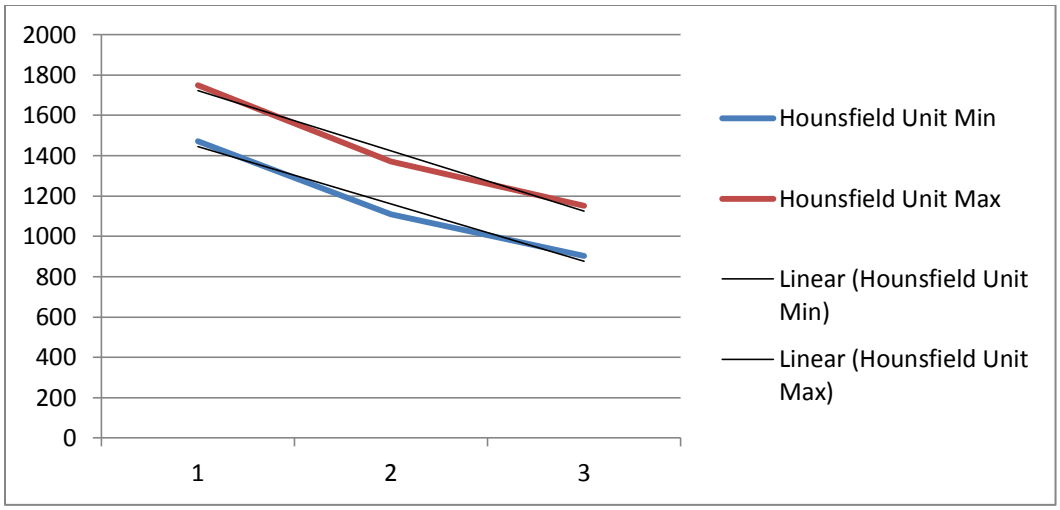


Figure 7:- Graph of Hounsfield Unit Sample value C.

Figure 7 shows the value of Hounsfield unit sample A obtained is linear through the CT-SCAN test with a potential difference of 80 kV, 100 kV, and 120 kV.

Conclusion:-

From the test results of measurement of the value of Hounsfield Unit (HU) conducted on samples A, B, and C it can be concluded that the greater the content of Calcium Carbonate (CaCO3) the value of Hounsfield Unit (HU) is lower and closer to the average value of the Hounsfield Unit (HU) in human bones so that under certain conditions otherwise can be used.

Acknowledgement:-

We would like to thanks Department of Radiology Royal Prima Hospital for the facilities and Medical Faculty Of Universitas Prima Indonesia member and staff.

References:-

1. Bontrager, Kenneth L dan John P. Lampignano. 2014. Textbook of Radiographic Positioning and Related Anatomy. St Louis: Elsevier Mosby.
2. Wibisono, N. I., 2011, Koreksi Geometri Pengukuran Dosis Pada Phantom Menggunakan Metode CTDI, Skripsi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Indonesia, Depok.
3. Samuelson DA. 2007. Text Book of Veterinary Histology. China: Elsevier. Page 109-126.
4. Koval KJ, Zuckerman JD. Handbook Of Fracture.3rdedition.Lippincott Williams & Willkins;2006.Hlm.25,29.
5. Rasad, Sjahriar. 2013. Radiologi Diagnostik. Balai Penerbit Fakultas Kedokteran Universitas Indonesia: Jakarta.
6. Rasad, Sjahrir. 2011. Radiologi Diagnostik. Edisi 2. Jakarta: Balai Penerbit FKUI.