

Novel Mixture of Materials Produces Bone- and Soft Tissue-Like Imaging Density

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Abstract

The objective of the present study was to access to imaging material density close to or identical density imaging of bone and soft tissue, from raw materials of nature to be used in different model applications and to provide comprehensive evaluation of the imaging system and techniques under realistic conditions in radiology departments for educational purposes. The palm tree of abundance in Saudi Arabia was chosen to study the date's seeds and palm leaves in terms of photographic density. The results achieved were referring to the lack of imaging density of dates seeds and palm leaves compared to bone density. Thus, it was necessary to use two additional materials: Salt and eggshells in order to find the highest density and graphic approach to bone density. The present preliminary study indicated that the permanent and stable model can be achieved by palm leaves, salt & eggshell powder with imaging material density close to the imaging density of the bone and soft tissue for achieving more clinical skills and medical education.

Keywords

Bone Density, Palm Tree Seeds, Image Density

1. Introduction

Several objects considered as tissue-equivalent material, and their images obtained at different times. Criteria for the selection of suitable objects comprised similarity between the obtained image and the corresponding tissues in the human body, minimal shrinkage, and change in brightness level at different times. The palm tree of abundance in Saudi Arabia was chosen to study the date's seeds and palm leaves in terms of photographic density. Given the results achieved was referring to the lack of imaging density of dates seeds and palm leaves compared to bone density. Thus, it was necessary

to use two additional materials such as salt and egg shells in order to find the highest density and graphic approach to bone density. In addition to quantitative analysis obtained from image processing, a blind qualitative study also performed by radiologists [1].

Radiographic Anatomical Phantoms (RAP) is commercially available for radiation therapy, radiology and nuclear medicine procedures. Radiographic Anatomical model provide a valuable tool for radiologic technologists, radiographers and students. RAP maybe used for adjusting radiographic techniques, manipulation of exposure factors use of accessory equipment and its effect on patient dose and in training in the use of new equipment [2] [3].

The Objective of the present study was to access to imaging material density close to or identical density imaging of bone and soft tissue, from raw materials of nature to be used in different model applications and to provide comprehensive evaluation of the imaging system and techniques under realistic conditions in radiology departments for educational purposes.

2. Methodology

1) Preparing the Materials for Imaging

- Palm: The palm, used in the experiment, has been determined. Both the palm leaves and dates seeds were taken from the palm. The palm leaves was prepared in powder form. This achieved by drying the palm leaves for 2 weeks to facilitate the process of preparing the powder dried from the water. The mill then used to grind the leaves and turning them into powder. The powder kept in a glass for using them in the imaging process later. The second method of preparing the powder from the dates seeds (frankincense) by putting the dates in the freezer in order to be easily broken and gathering them as soon as possible. Grinding them by either breaking the date's seeds into small pieces using the grinder or grinding the small seeds pieces into powder by the home's grinder. Gathering the seeds powder in sealed glass cases for using them in the imaging process.
- Eggshell: Collect the eggshells from boiled eggs in water bath; put them in the grinder to grind it. Gathering the eggshells in sealed glass cases in preparation for using them in the imaging process later.
- Salt: The method of preparing the salt powder done by using a saltpack and grinding it, thus it turned it into powder.
- Imaging Modality: General X-ray machine used for imaging the samples.

2) Experiments using water: The water basin put on the vertical Bucky in the horizontal position, Preparing 4 plastic cups with thickness 3 cm and filling them with the four materials *i.e.* palm leaves, dates seeds, eggshells and salt with a soft compression; to make sure there is no spaces in the powder. Putting the filled plastic cup on one of the Petri dish halves in the water basin. The reason of using the water basin in the experiment, because that the imaging density of water is close to the imaging density of the soft tissue. A forearm phantom put besides the water basin for the imaging comparison.

Preparing the exposure factor from the device and choosing the same existing factors automatically for the (forearm part). Imaging the materials one after another (palm leaves, dates seeds, eggshells and salt.

3) Experiments using sponge: Sponge with palm leaves powder. A hollow sponge brought with about 7 cm in thickness. The cavities inside the sponge filled with the palm leaves powder. The powder then compressed inside the sponge to be very sure that there are no spaces. Exposure factor used with different materials that was tested seen in **Table 1**.

3. Results

The using the palm leaves and seeds (frankincense) resulted in a lesser Imaging density than bones, the uses of two additional materials to the experiment (eggshell and salts) resulting in an imaging density close to the imaging density of bones. Film density of Homogenous color *i.e.* low contrast between the water and the palm leaves powder as shown in (**Figure 1**).

The samples must be carefully prepared, any alteration causing inhomogeneous composition of the materials may affect the film density. The following example shown in (**Figure 2**) demonstrate the case were no similarity with body organ density obtained from the image. Thus, there is a problem related to imaging or preparing of the sample. Even the negative is confusing as shown in.

In the small circle eggshell in about 3 cm showed very good concentration “film density” as skull bone. But the bigger circle is for the Petri dish on top of the water “PVC” of 1 cm showed good representation of liver tissue “solid organ” very good concentration “film density” as skull bone. It is the densest material of the experiment (**Figure 3** and **Figure 4**).

Negative in the sample shown in (**Figure 5**). Same negative compared with the forearm model showed clearly the bone simulated with the eggshell as shown in (**Figure 6**).

7 cm depth of palm leaves powder (Foam wood) showed good representation of a lung organ of about the same thickness (**Figure 7**).

Table 1. Exposure factor used in different materials.

MATERIAL	X-RAY MACHINE SETTINGS			
	EXAM	kVp	mAs	IMAGE TYPE
Palm leaves	Hand	50	2.62	Positive
Date seeds	Hand	50	2.43	Positive
Eggshell	Hand	50	2.81	Positive
Salt	Hand	50	2.54	positive
Eggshell	Hand	50	2.81	Negative
Eggshell with forearm	Forearm	55	5.00	Negative
Foam wood	Hummers	70	0.26	Positive
Silicon + palm leaves	Hand	40	3.96	Positive



Figure 1. Film density of homogenous color (low contrast between the water and the palm leaves powder).



Figure 2. This sample did not show similarity with body organ. So, there may be a problem related to imaging or preparing of the sample.

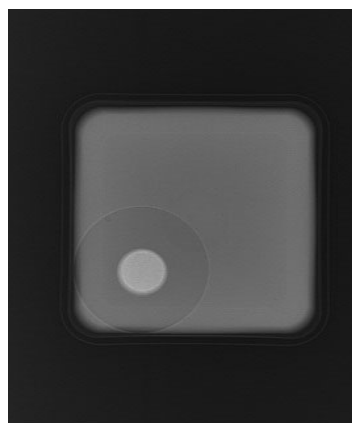


Figure 3. The small circle is eggshell about 3 cm in diameter, showed very good concentration “film density” as skull bone. But the bigger circle is for the Petri dish on top of the water “PVC” of 1 cm showed good representation of liver tissue “solid organ”.

As can see in the image, upper part denser “brighter” of thickness 10 cm can represent heart muscle. Silicon + palm leaves: the silicon of 10 cm same represent to soft tissue but, the palm leaves powder could not be used to simulate bone tissue (Figure 8).



Figure 4. Petri dish on top of the water “PVC” of 1 cm showed very good concentration “film density” as skull bone. It is the densest material of the experiment.



Figure 5. Negative: To confirm result observed in the sample.

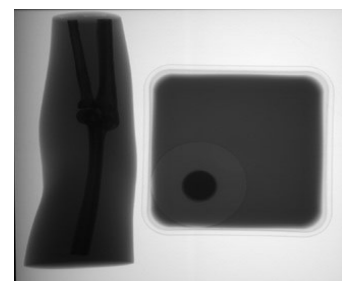


Figure 6. Same negative: Compared with the forearm phantom showed clearly the bone simulated with the eggshell.

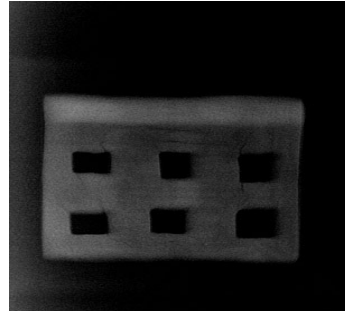


Figure 7. Foam wood: 7 cm depth of palm leaves powder showed good representation of a lung organ of about the same thickness.

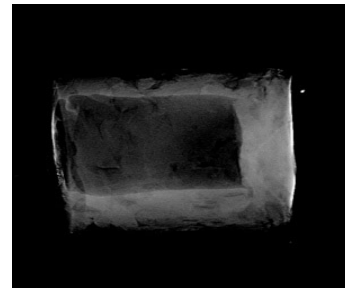


Figure 8. Silicon and palm leaves: the silicon of 10 cm same represent to soft tissue but the palm leaves powder cannot be used as bone tissue.

4. Discussion

The images that obtained showed that the dates seeds and palm leaves has an imaging density closer or lower to the density of tissue. The results achieved were referring to the lack of imaging density of dates seeds and palm leaves compared to bone density. The present results also declare that the uses of two additional materials “salt and eggshells resulted in a good imaging density to bone density. Homogenous color” film density between the water and the palm leaves powder. From image, no similarity with body organ observed. Opposite to the expectation, there may be a problem related to imaging or preparing of the sample. Even the negative is confusing. Due to the findings, when using the palm leaves and seeds (frankincense) which resulted in a lesser Imaging density than bones. Thus, it was necessary to add additional materials to the seeds powder *i.e.* eggshell and food salt to get closer to the desired imaging density of bones where spiral CT used for evaluation of these materials [4]. Kim *et al.* (2001) used kinematic simulation of fracture and bone deformity correction under external fixation [5].

Given the experiences I have had and images that I obtained, show us that the dates seeds and palm leaves has a imaging density closer or lower to the density of tissue. The results achieved were referring to the lack of imaging density of dates seeds and palm leaves compared to bone density. I use two additional materials, salts and eggshells. The images of two materials, salt and eggshells resulted in a good imaging density to bone density. 5% and 2% change in image pixel intensity (brightness) after 2 months, respec-

tively. Delp *et al.* (1993) recommended the uses of an interactive graphics-based model of the lower extremity to study orthopedic surgical procedures [6].

The obtained result show that is possible to produce abnormal forearm model produced from several local material such as gypsum, which give us a brighter bone density. To decrease the bone density and make good appearance of bone marrow, a powder of eggshells mixed with gypsum so the bone marrow is better to visualize in mixture of gypsum with eggshells. Other abnormality also made such as foreign body. As in example the model design with air bubbles that represented Osteoporosis disease. The uses of simulation and animation of musculoskeletal joint system were performed by Chao *et al.* (1993) [7], and for knee joint rehabilitation using computer graphic based mode performed by Chao *et al.* (1994) [8].

The eggshell can represent bone tissue as with 6 cm thickness. According to this work, the water could represent soft tissue, adding salt can increase density of water leading to thicker skin tissue. The permanent and stable phantom materials can be achieved by palm leaves, salt & eggshell powder. Date's seeds with added salt, which is promising due to easy handing cheap materials. Palmtree, which are locally available and very useful in bone simulation as proven by the results.

If the eggshells powder increased, darker bone density obtained that is similar to an adult patient's bones in terms of density. The author believes it is similar to x-ray image which show where the bone and the lungs. The scientific explanation can be due to the closer to the image receptor "water, plastic, egg shell" and with very close look at the image, a circular shape clearly observed in the middle where the container tagged. As can be seen in the image, upper part is denser "brighter" of thickness 10 cm e.g. can represent a heart muscle. Kauczor *et al.* (2010) advised the uses of three-dimensional printing based on imaging data: review of medical applications [9].

The silicon of 10 cm same represent to soft tissue but, the palm leaves powder can't be used as bone tissue. Unless treated by mixing salt and/or eggshell powder which reasonable. Because it has high Z number, as show in previous result. According to the findings in this work, using the palm leaves and seeds (frankincense) resulted in a lesser imaging density than bones, so adding other materials to the experiment (eggshell and food salt) was necessary to a try to get an imaging density close to the Imaging density of bones. Harry *et al.* (2009) found that there is cross-calibration between patient and phantom [2], while Boutiche 2011, detect the defects in weld radiographic images by using chan-vesemodel and level set formulation [3].

5. Conclusion

The present preliminary study indicated that the permanent and stable model can be achieved by palm leaves, salt & eggshell powder with imaging material density close to the imaging density of the bone and soft tissue for achieving more clinical skills and medical education.

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