

Design of a Model of Knee Joint for Educational Purposes

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Abstract
Uses ofmodels play an important role by simulating the bone, obviating the need to experiment on humans or animals.The aim of the present study was to access local materials as gypsum and wax is to be tested for performing a knee model matching bone in the density also to explore how students can come to understand function through a modelbaseddesign task.The basic element of the model structure was gypsum powder, water for mixing and as a solvent to change the powder form into a liquid then solid after its dryness, the materials used in imaging also includes commercial silicon which represent muscle tissue and wax.Conclusions: The presented model not only has lower cost and complexity, which make it suitable for educational purposes, but also is capable of providing good images of knee joint for quality control and training purposeswill improve the learning experience, and reduces the time on task for students and the material costs as well.The produced new, simple, and low-cost modelmight beused for training purpose for student radiographers.
Keywords: Knee Joint, Educational Purposes,Wax,Silicon.

1. Introduction

Phantoms used for studying radiographic anatomy are commercially available and for therapy by radiation, radiology and nuclear medicine procedures. These phantoms are used for adjusting different radiographic techniques, exposure factors manipulation, accessory equipment uses and its effect on patient dose and in the training programs in the use of new equipment; they provide a valuable tool for radiographers,radiologic technologistsand students**(Alphons et al.1995).** Commercial features of the Phantom include matching of skeletal and soft tissues with atomically correct position **(Miles 2005 and Berrington de González et al. 2009).** The new technology was used in educational delivery methods in the radiologic sciences for undergraduate students. They changed students from passive listeners to problem solvers and lifelong learners **(Della Corte et al.2005).**Mechanical manipulator arm for surveying radioactive materials from a safe distance and began ofphantoms producing - real human bones in addition to rubber, plastic to simulate organs and flesh for use in radiation and space research. They are still used to calibrate medical devices such as X-ray machines **(Ohgushi et al 1992).** The Company also manufacture phantom Radiation-Equivalent Man for Calibration and heads for dental training**(Alphons et al. 1995).**

This model extended, so the aim of the present study was to design of knee joint model to cover educational aspect so that student radiographers can easily imagine the different posture during imaging of knee joint.

2. Materials and Methods

The basic element of the model structure was gypsum in its powder form as well as water for mixing and as a solvent to change the powder form into a liquid then solid after its dryness, the materials used in imaging also includes commercial silicon which represent muscle tissue and wax. The wax in a candle of 12cm in diameter and 30cm long cylindrical shape is used to test CT number in a soft tissue and intentionally holes are made in the surface of the cylindrical shape and filled with gypsum representing different densities and organs.Scanning factors were seen in table.1

Scan area	From distal femur to proximal tibia
Scan length	25.6cm
Scan direction	Cranio-caudal
KV	130KV
Effective mAs	50mAs
Rotation time	1s
Slice collimation	2 x 1 mm
Slice width	1.25 mm
Table feed/rotation	2 mm
Pitch	2
Reconstruction increment	0.6 mm
Kernel	B80

2.1 Model design stages:
Gypsum is used as the material to produce the knee model in actual size obtained from a plastic knee model normally used for demonstration purposes as shown in **Fig.1**
Table1: Scanning Factors

2.2 Silicon A cast is made of silicon to perform temporary housing for the gypsum mixture until it's dry as shown in the figures below. Before putting the gypsum mixture, the silicon must be rubbed in with grease i.e. Vaselineto easily remove the gypsum from the silicon cast**(Figs. 2,3,4).**

2.3 Knee joint
A.Knee is produced at the standard dimensions of knee in humans as shown in **Fig. 5**
B. After the model is in the solid form i.e. completely dry its removed from the housing slowly with extra care for small parts so it's not broken then it is treated with clean water and carefully remove extra shapes not found in the original anatomy model used by the use of sandpaper**(Fig.6).**

C-Fill the superficial holes that is existed from air diffused in gypsum while mixing with water and put it in normal order of knee joint**(Fig.7).**Placed the knee model on the table and using a radiolucent sponge to support it as shown in **Fig.8**

3. Results
C.T helical or finding and criteria of the Knee models and different materials used for construction of this model usingspiral CT were seen in **Figs.9-17.**The CT images demonstrate clearly the possibility of the designed model to discriminate between bones and soft tissues according to the CT numbers obtained. Additionally, it is possible to achieve diagnostic information of the knee anatomy.

4. Discussions
Criteria for the selection of suitable objects comprised similarity between the obtained image and the corresponding tissues in the human body. In addition to quantitative analysis obtained from image processing, a blind qualitative study was done by a radiologist.Some studies have recommended other Tissue Mimic materials. These materials should mimic the normal density of the tissue and approximate the radiographic appearance of the tissue. Unfortunately, the cost of phantoms is a major limiting problem for imaging centers**(Bude and Adler 1995).Lawless and Pellegrino (2007)**declare the benefit of changing studentsfrom passive learners to active users. Many instructional models focus on the value of model in training and other delivery methods to improve the educational process and gaining more experience(**Edmund and Chao 2003).**

This X-Ray part model gives the chance to make x-ray images of single body parts again and again.The model is perfect for educationbut also for medical technicians since the same bones can be X-rayed again and again in different settings without the danger of harming a patient similar recommendations were advised by**Kumar(2012).**

The key to using modelsas new educational delivery methods lies in incorporating these instructional strategies and learning goals through technological features and benefits**(Lawless and Pellegrino 2007 and Tam 2010).**CT used for imaging the present model in the axial or transverse plane, perpendicular to the long axis of the body. Although most common in medicine. Usage of CT has increased dramatically over the last two decades in many countries.Diagnostic use of CT became increasingly apparent has been increased dramatically in the past 20 years owing to their effectiveness and safe employment as well as their importance in the noninvasive imaging of the human body, especially in orthopedic and abdominal studies. Evaluation of the accuracy and performance of CT and other type of radiography systems usually needs tissue-mimicking (TM) phantoms .These materials should mimic the density of the tissue **(Othman et al.2011).**

The present model providing information about kneejoint on the presence of defects and the actual conditions of it. The use of appropriate models knee joint radiographyof fracturetechniques, have an important impact on the reliability and efficiency of modern fracture diagnosis methods.Similar recommendations were mentioned by **Tillack (1999)**.

5.Conclusions: The presented model not only has lower cost and complexity, which make it suitable for educational purposes, but also is capable of providing good images of knee joint for quality control and training purposes will improve the learning experience, and reduces the time on task for students and the material costs as well. The produced new, simple, and low-cost model might be used for training purpose for student radiographers.

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Figures:

Fig.1: Gypsum is used as the material to produce the knee model in actual size obtained from a plastic knee**.**

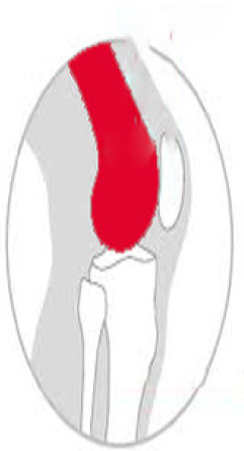
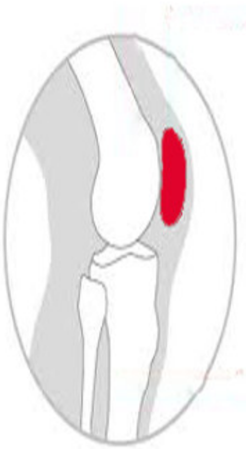


Fig.2.

Thigh bone



Kneecap(patella

Fig.3:

Fig.4

Shin bone

Fig.5. A. Knee is produced at the standard dimensions of knee in humans.

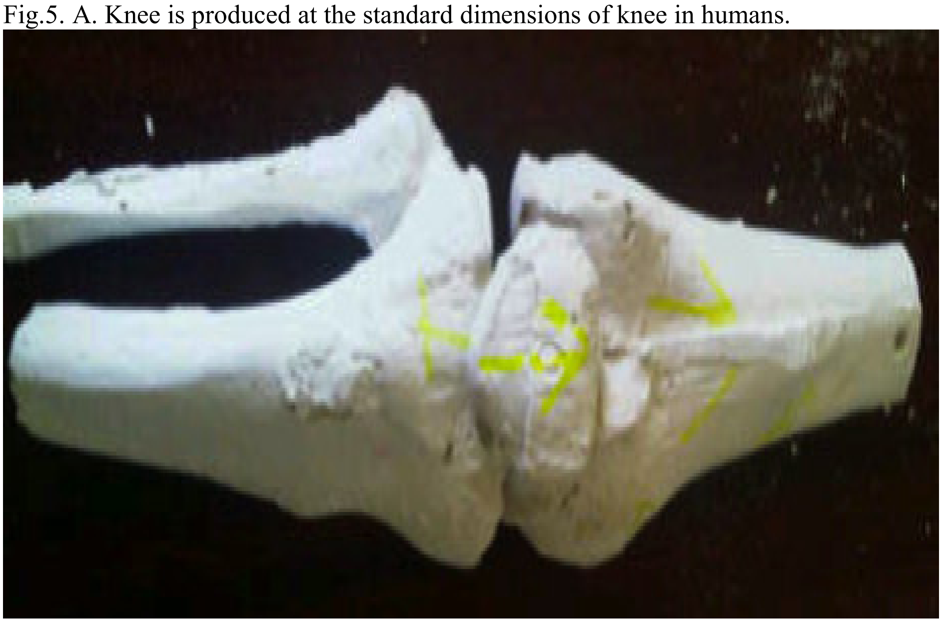


Fig.6:After the model is in the solid, it is treated with clean water and carefully removes extra shapes not found in the original anatomy model used by the use of sandpaper.

Fig.7: Filling of the superficial holes that is existed from air diffused in gypsum while mixing with water and put it in normal order of knee joint.

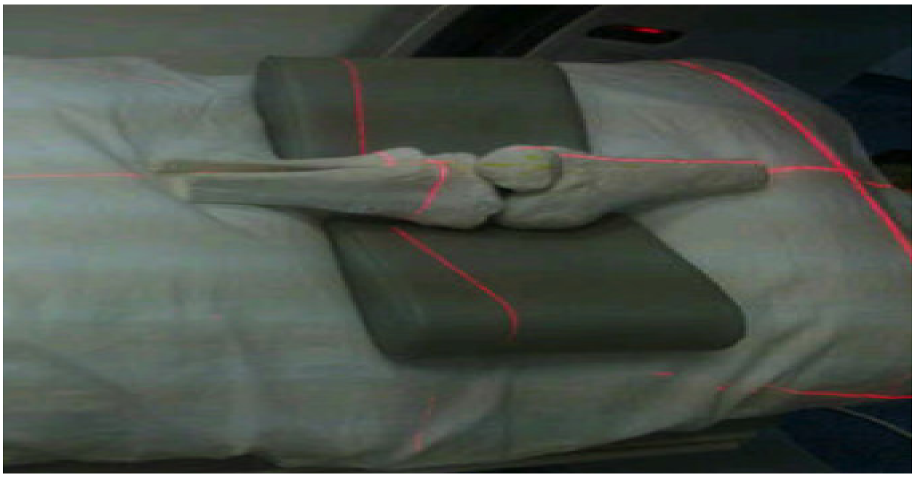


Fig. 8: Knee model on the table and using a radiolucent sponge to support it.

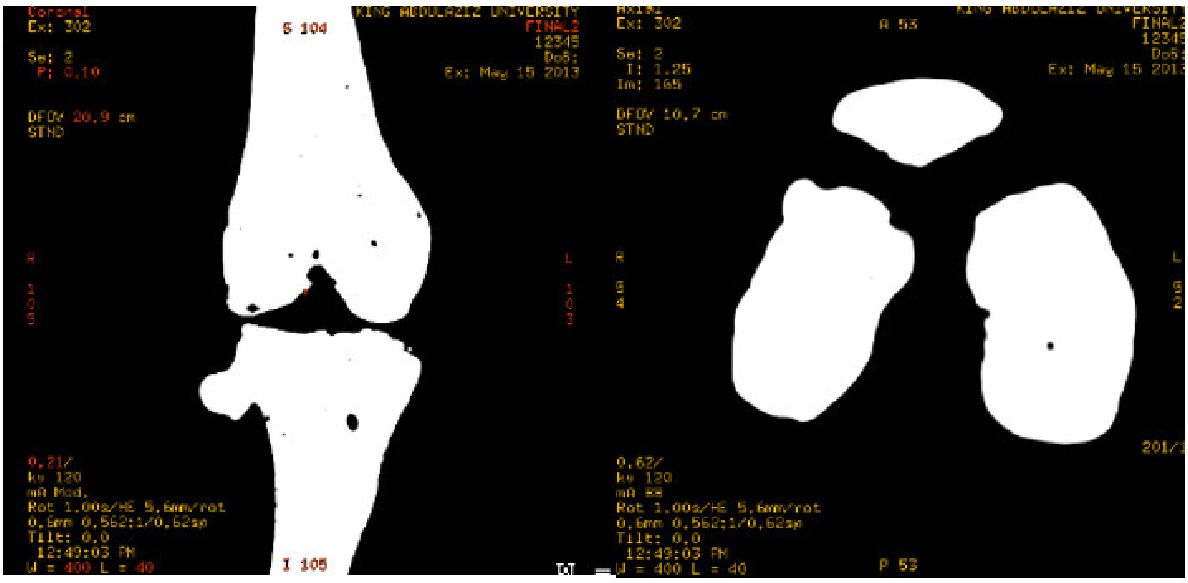
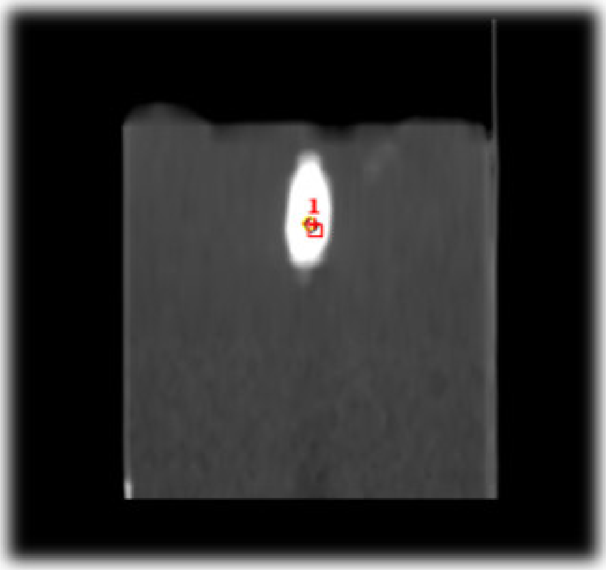


Fig. 9:CT of the Knee Model.

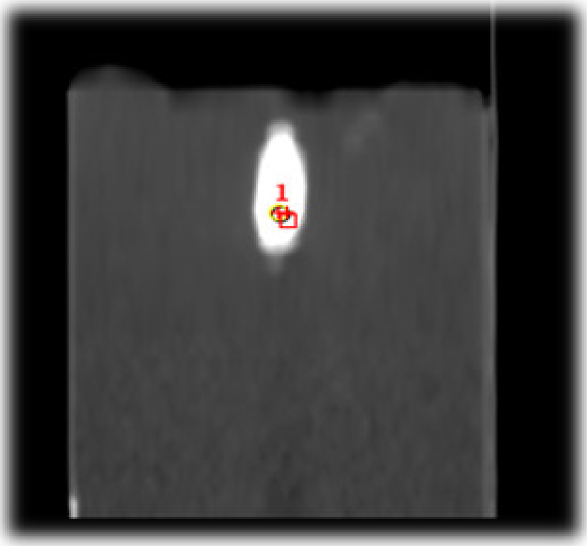


Max=1135.0

Av=119.3

Sd=15.4

Fig. 10: Gypsum

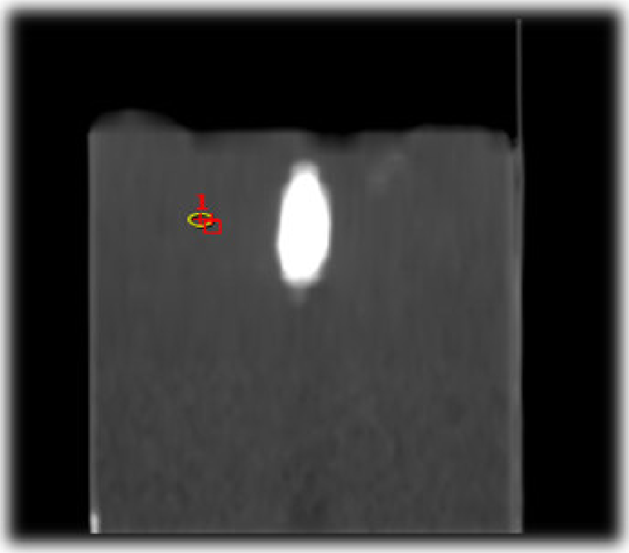


Max=1133.0

Av=1113.8

Sd=10.8

Fig. 11: Gypsum

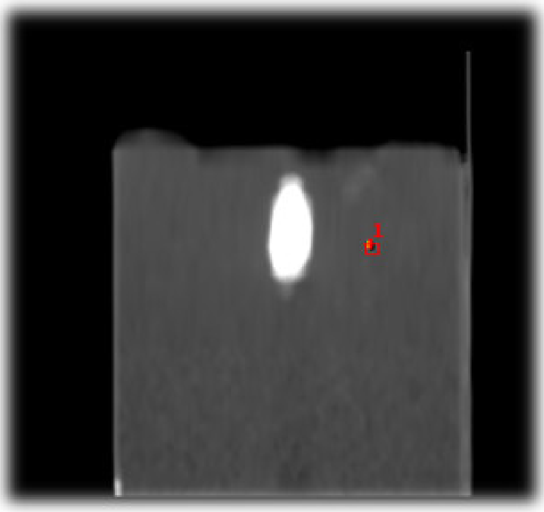


Max=191.0

Av=205.9

Sd=9.1

Fig.12: Wax

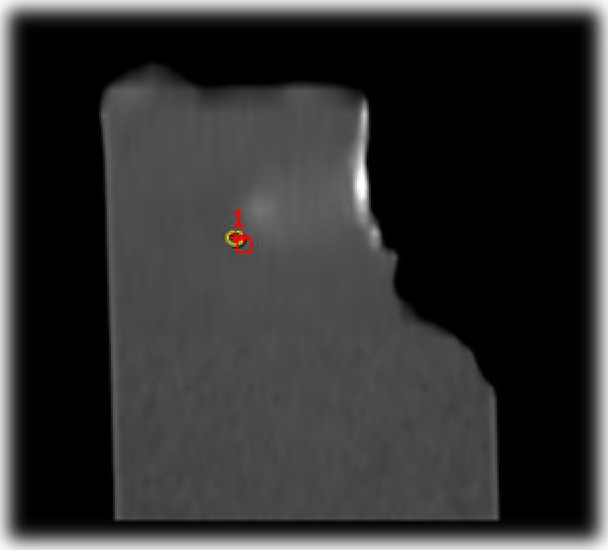


Max=199.0

Av=203.1

Sd=3.7

Fig.13: Wax



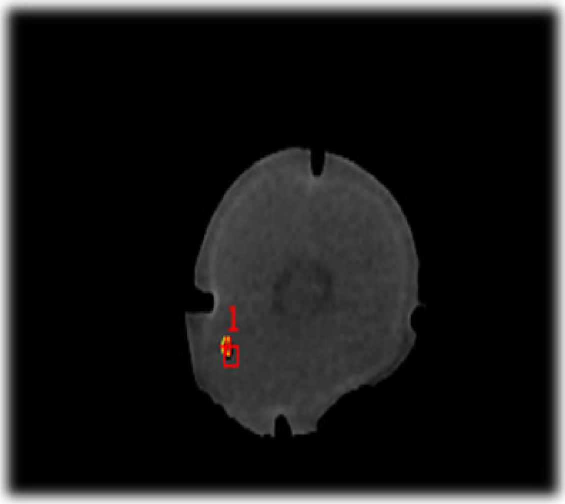
Max=199.0

Av=207.5

Sd=5.9

Fig.14 : Wax

Figs.15, 16, 17 (Silicon).

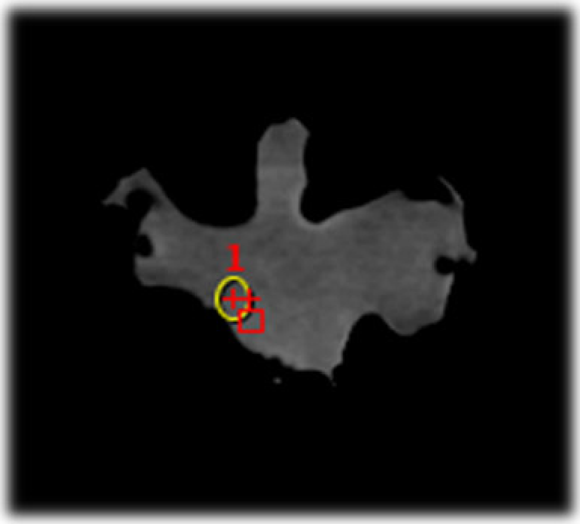


Max=6·0

Av=3·2

Sd=1·4

Fig.15: Silicon

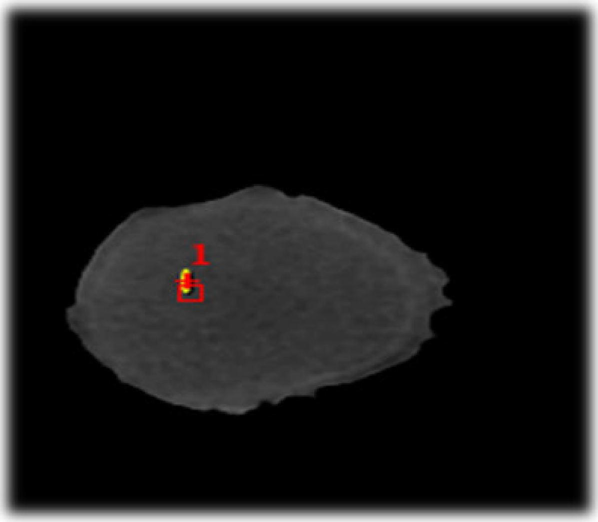


Max=4·2

Av=3·6

Sd=3·3

Fig.16: Silicon.



Max=5·0

Av=3·0

Sd=0·9

Fig.17: Silicon