Evaluation of the Effectiveness of a Model of a Pediatric Chest Positioning Device with respect to Image Quality

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Abstract— Diagnosis of diseases highly depends on radiological procedures. The application of plain radiography in pediatrics has increased over years. For the successful diagnosis high quality images are important. Immobilization plays a major part in Pediatric Radiography. Aim of this study is to introduce cost effective and time saving immobilization device for chest position of pediatrics and evaluate the effectiveness of the device with respect to image quality. Study was performed in two stages, for the first stage, designed a model according to the requirements with relevant specifications and modifications which is useful in obtaining adequate immobilization with proper positioning. Second stage was to build the device and to evaluate the effectiveness of the device with respect to image quality using a patient simulating dummy. For changing kV and mAs image density values with device and without device were measured and those values were analyzed with SPSS statistical software version 17.Since for changing kV and mAs, image density values for bone(p=0.143,p=0.089), air (p=0.143,p=0.353), water(p=0.353,p=0.436) not followed normal distribution, accorrding to the Mann Whitney U test there is no significant different between image density for changing kV and mAs with device and without device at 95% confidence level. As designed the model was consisted of mechanisms which facilitate the main peditric chest positions and effect of the device on image quality was minimal.

Index Terms: Density, Immobilization, Immobilization Device, Image Quality, Pediatric Radiography, Radiographic Positioning

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1 Introduction

The presentation of diseases and pathology of gy of children is unique and varies with the the age. Effective examination is dependent pendent upon gaining the cooperation of the the child. This is highly dependent on age. Sedation or anesthesia may be required in certain situation. Patient positioning has to be exact even if the patient does not cooperate. So that the beam can be correctly centered, the proper projection and collimation can be obtained. And also the non-examined part of the body is shielded.[1]

Since motion blur the edges of closely spaced objects on image can lead to repeating the radiograph, there are devices and methods that have been used for reducing motion.[5] When performing radiographic studies immobilization devices, such as sponges, Plexiglas or sandbags may be used in the very small infants. It may be useful to take advantage of the period when the infant is calm or asleep after having been feed to perform the radiological examination.[6] Immobilization devices should be easy to use and their application should not be traumatic to the patient (or caregivers). Therefore their uses and benefitssshould be explained to the accompanying caregiver or guardian[1]

But the uses of such devices are limited in Sri Lanka due to high cost and high work load. For radiological procedures optimization of patient dose and maintaining of image quality is crucial.

2. Methadology

After considering the requirements of the device, it was designed by using Computer Aided Design and it was finalized by experienced radiographers. Model was built at Department of Mechanical Engineering, Faculty of Engineering, University of Peradeniya. Testing was done by using patient simulating dummy with changing kV and mAs values. Radiographs were taken with 100mm focus to film distance , 24*30 casset and non bucky technique. Image density values cooresponding to bone,air and water were measured using Densitometer (Unilight D, IBA Dosimetry GmbH) and data analysed were done by spss 17.0 software with p<0.05 indicating the level of significance.

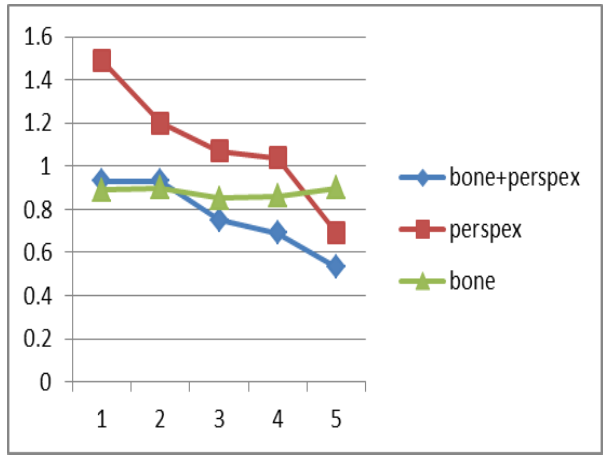

Fig.2. Image density values for several thicknesses of perspex

3. Results

The model is consisted of specific features which facilitate the Erect AP/PA and supine projections of chest without gaining the cooperation of guardian.

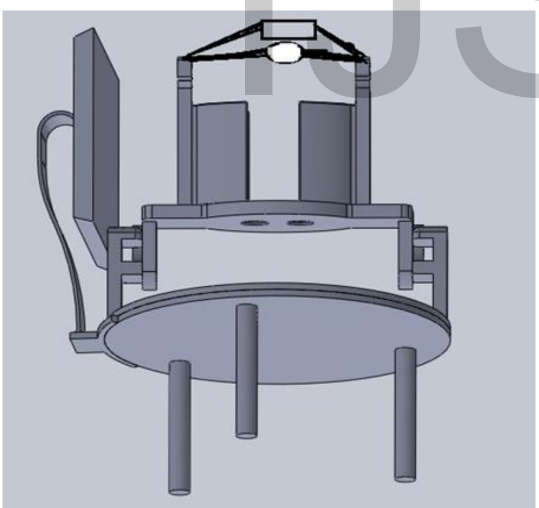

Fig.1.The Final Design

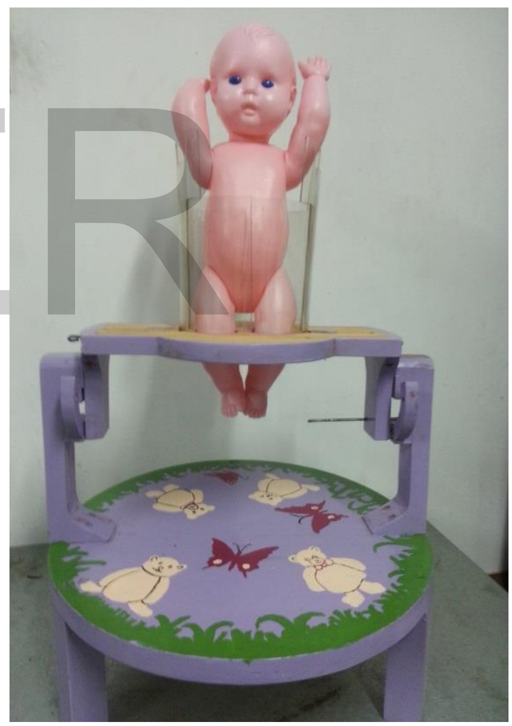

Fig 3. Device on Erect position

Considering image quality, the selection of materials for lateral body support was done after radiation exposures on several thicknesses of perspex. (Fig 2) Image density reduction due to the attenuation of perspex was neglegible at 2mm thickness of perspex.

Fig 4.Device on Supine position

Figure 2 and 3 shows the Basic movements of the model which facilitate the erect and supine projections of chest.

Image quality evaluation was done to asses the effect of the perspex lateral body support to the radiographic images

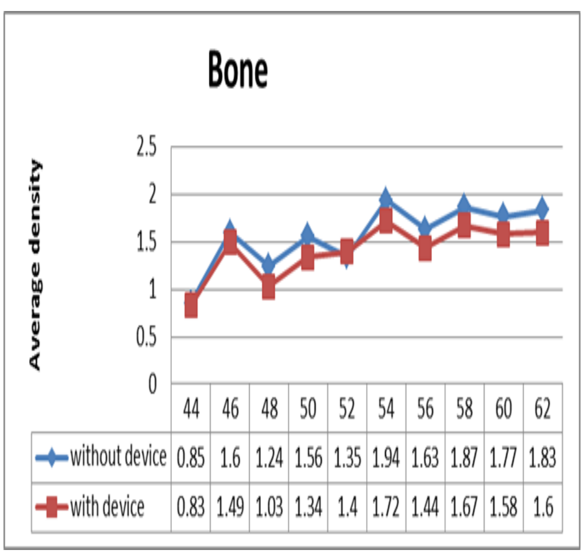

Fig.5 Image density values of bone against kV

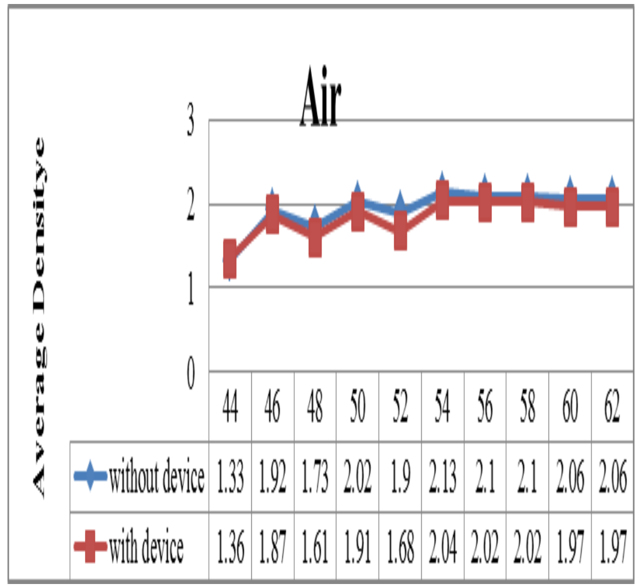

Fig.6. Image density values of Air against kV

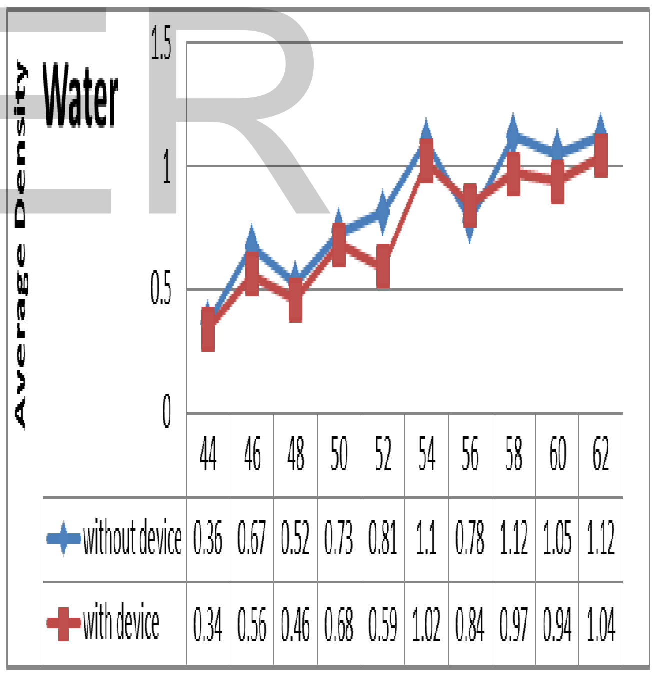

Fig.7. Image density values of water aginst kV

International Journal of Scientific & Engineering Research Volume 8, Issue 5, May-2017
ISSN 2229-5518

Figure 4 , 5 and 6 shows image density values of bone ,air and water for changing kV values with and without device. Since all of the values not follwed normal distribution acco rding to Mann Whitney U test, there was no significant difference between image density values for bone(p=0.143) ,air(p=0.143) and water (p=0.353) at 95% confidence level.

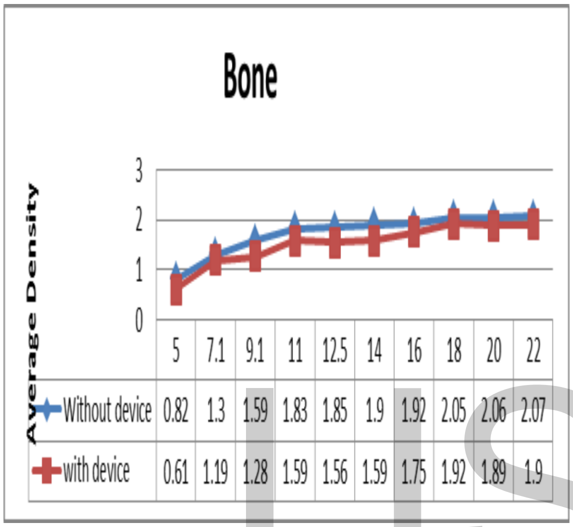

Fig.7. Image density values of bone against mAs

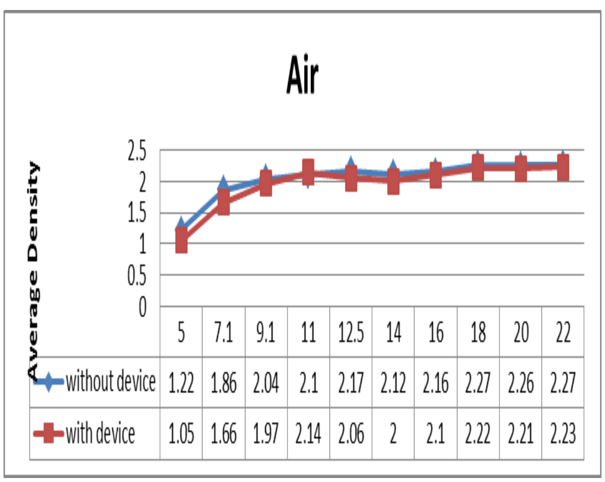

Fig.8.Image density values of air against mAs

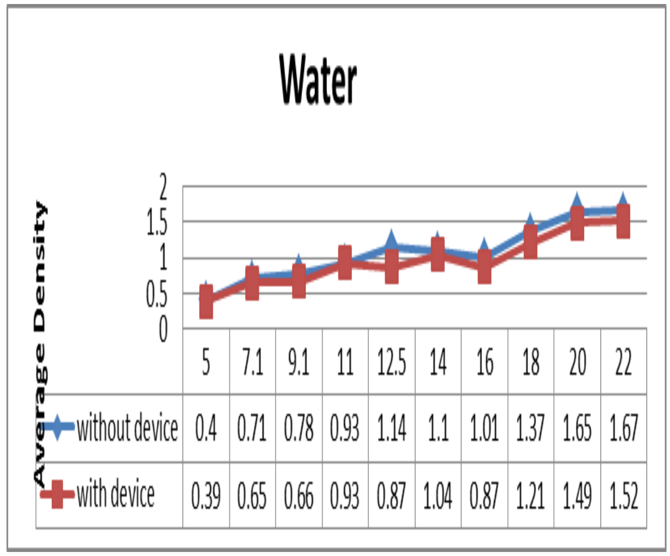

Fig.9.Density values of water against mAs range

Figure 7 , 8 and **9** shows image density values of bone ,air and water for changing mAs values, with and without device. Since all of the values not follwed normal distribution according to Mann Whitney U test, there was no significant difference between image density values for bone(p=0.0.089) ,air(p=0.353) and water (p=0.436) at 95% confidence level.

Slight fluctuations of the results were seen due to processor condition and other image processing conditions.

4. Discussion

Pediatric Radiography is a sub catogery of radiology including imaging procedures of children and young adults. It creates distinct challenges to the department. The use of peadiatric devices minimise the repetition of radiological procedures and unwanted radiation to the guardian also. [1] Most of the avaialble devices are limited to obtain either erct or supine projections only.[6]The use of such devices are limited due to high cost and high work load .As we designed the model is consisted of mechanisms which facilitate both erect and supine projections of chest.

The children are restricted within a new devices by there nature.[5] Thus the model was designed in a way to attract the children.

For any technique that use for imaging ,should not obscure the real image and impact on diagnostic value should be at a accepted level.[5] According to the result it was proved that ther is no significant different between image density values with device and without device at the diagnostic range.

5. Conclusion

Results of the study implies that the excessive density provide by the 2mm thick lateral body support of the device is not significant in case of image quality since it preserve the diagnostic value of the radiograph. The mechanism of the model is to take erect and supine position in single movement. Those mechanisms are in acceptable conditions which facilitate the important features of the model. Furthur adjustments are needed to improve the model to practice as a Paediatric chest positioning device.

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