Polymer clay as an alternative to lead gonadal shield

Student Researchers: Tristan Daryl S. Cabitac, Joen Mae B. Campeciñ, Mart Bensen M. Abrigo, Rossinni Ross A. Atienza, Christian Emerson R. Alcaraz&Reymart L. San Antonio

Faculty Researchers: Noel A. Flores& Ruben G. Talag

***Abstract* -** Gonadal shielding or lead shield or reproductive organs is probably the single most important factor to obtain the minimum absorption of radiation to the gonads or reproductive organs. It is the most effective way to reduce radiation dose to a patient's reproductive organ and thus lessen the risk of genetic effects as ionizing radiation may interrupt spermatogenesis of male gonads during radiation exposure. Lead is the most common shield against x – rays because of its high stopping power against radiation, ease of installation and low cost. This study determined if clay can be used as an alternative gonadal shield using various thickness of clay versus lead shield with a standard thickness of .05 mm. Results indicate that there is no significant difference on the shielding property of .05 mm lead and varying thickness of clay with a p – value of 0.052 (.05 level of difference).Furthermore, thickness of clay has no effect on its ability to block radiation exposure based on the density of exposed films.

Keywords - radiation, protection, lead, clay, density

INTRODUCTION

One of the most important inventions in the field of medicine is the use of x- ray which is considered as one of the fast growing medical sciences. It is used in diagnostic and therapeutic imaging. (Bushong, 1997)

For most people, radiographs account for the largest proportion of radiation received during their lifetime from artificial sources. Doses must, be kept as low as reasonably achievable (the ALARA principle) Good radiographic technique is essential to ensure that the gonads are protected using lead shields, particularly when they fall within the range of the primary beam as during radiography. (CEC – Council of European Communities 1984; ICRP – International Commission on Radiological Protection, 1990; (McCarty et al., 2001,).So far, various methods and technologies for dose reduction have been assessed, including modulation of the tube current, automated exposure control, and shielding of organs (Greess et al., 2000; Hopper 2002; (Hoh; et al., 2005; Perisinakis et al., 2007; Grobe et., 2008; Hietschold et al., 2008)

In order for the radiologic technologist to clearly define and provide better analysis, there must be very important reasons applied as basic obtaining such excellent radiograph. This includes the accessory devices such as protective device used during radiography. Positioning the lead to shield the gonads is performed by using the collimator light and placing the shadow over the testicles (Hernandez et al., 1978; Sanghvi et al., 2007).

Due to the fact that the testicles are in close proximity to the prostate, a negative influence on sperm count and quality appears obvious. Regarding the testicular tissue, the spermatogonial stem cells represent the main target concerning fertility, as these cells are known to be among the most radiosensitive cells in the human body (Gasinska et al., 1988; Jacobsen et al., 1997, Hacker-Klom et al., Moreno et al., 2001; Cordelli et al., 2003; Boehmer et al., 2004). Gonadal shielding or lead shield for reproductive organs is probably the single most important factor to obtain the minimum absorption of radiation to the gonads or reproductive organs. Gonadal shields must be confined to the area of interest thus; only tissues of diagnostic interest will be –irradiated (Bushong, 1997). It is an effective protective device with protects patients from the risk of permanent infertility and impairment of hormonal function (Boehmer et al., 2004).

Lead is a shiny blue white soft metal its surface is fresh. The chemical symbol of lead is Pb from Latin word plumbum and has an atomic number of 82, a soft malleable material that is used in radiology. Lead is also used in building construction, lead acid batteries, bullet and shots, and has as a radiation shield (Charles et al., 1966; Angier 2007). Lead is the most common shield against X-rays because of its high density, stopping power, ease of installation and low cost. The maximum range of a high – energy photon such as an X-ray in matter is infinite; at every point in the matter traversed by the photon, there is a probability of interaction (Kasai et al., 2005).

Clay is an inexpensive oil-based clay material that can easily be formed into various shapes and sizes. Available in multiple colors, clay can be used to provide contrast at different locations of interest. (Green, 1951; Eckerson et al., 2008).

This study wants to introduce an innovation in conventional radiography by way of using clay as an alternative to lead gonadal shield as a protective device. The use of clay would provide the possibility of having the same protective effect with that of the conventional protective materials. Given the fact that clay has low cost and easily obtained, it will be a significant innovation to the practice of radiology.

MATERIAL AND METHODS

The researcher use 0.5 mm lead gonadal shiled, 10mm, 20mm,40mm BEST BUY clay distributed by: triple stationery; exclusively available at National Bookstore, 8x10 Kodak x-ray film. RMI densitometer x-rite in corporated.

The researchers molded the clay in a circular and square shape with 10mm, 20mm, and 40mm thickness and were measured by a Standard English ruler. The materials were exposed to x-ray using a 40kVp with 5.2 mAs and 40" distance under an 8x10 Kodak x-ray film.

After the exposure, the exposed films were brought to the Department of Health – Bureau of Health Devices and Technology (DOH - BHDT). A Medical Physicist of the DOH – BHDT measured the density of the exposed films with lead using a densitometer.

Statistical Treatment

The statistical instruments used are density; the reading of film density, mean density; it shows the dividend of the 1st and 2nd density. One sample t-test; is used to determine the difference in density of film using clay with value (with lead). One way ANOVA; shows the comparison on the density of film measured with clay suing various thickness

RESULTS

Table 1: Reading of density of film using a densitometer

Thickness of Lead	Density Reading
0.05 mm	0.073 mR

Table 1, reading of film covered with 0.05 mm lead. The density reading was 0.073 mR using a densitometer.

Table 2: ***Computation of the Mean Density from the data gathered from the density reading done in DOH – BHDT.***

Thickness of Clay	1ST reading of density	2ND reading of density	Mean Density
10 mm	0.77mR	0.78mR	0.7750
20mm	0.75mR	0.76mR	0.7550
30mm	0.74mR	0.75mR	0.7450

10mm: $\frac{0.77+.078}{2} = .7750$

20mm: $\frac{0.75 + .076}{2} = .7550$

40mm: $\frac{0.74 + .075}{2} = .7450$

In **Table 2**, it shows the highest reading of the densitometer was from the clay with a thickness of 10mm with a density of 0.77mR, followed by 20mm with a density of 0.75mR and 40mm with a density of 0.74mR. In the second reading of density, the highest reading of the densitometer was from the clay with a thickness of 10mm with a density of 0.78mR, followed by 20mm with a density of 0.76mR and 40mm with a density of 0.75mR. The table also shows the computation and result of mean density of the film using clay with regards to the thickness of the clay. The mean density was calculated using the formula $\frac{d1+d2}{2}$ where in *d1* is the first density reading and *d2* is the second density reading.

Table 3: Difference between the density of film with clay and with lead

Test Value = .73mR

Thickness Of clay	T	Df	P - Value	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
10mm	9.000	1	.070	.0450	-.0185	.1085
20mm	5.000	1	.126	.0250	-.0385	.0885
40mm	3.000	1	.205	.0150	-.0485	.0785

Table 3, shows the thickness differential of 10mm, the results shows that the density of the film using clay is not far from the results as compared to the density of the film using the standard material which is lead, that has a density of 0.73mR, since all the p-values were all higher than 0.05 level of significance, then the computed t-ratios (using t-test for population vs. sample test) were all found to be no difference. This could also mean that the density of film with clay have the same density with lead using 10mm, 20mm and 20mm thickness of clay.

Table 4: Comparison on the density of film measured with clay using various thickness, one – way analysis of variance.

	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	.001	2	.000	9.333	0.52
Within Groups	.000	3	.000		
Total	.001	5			

Table 4, presents the data gathered by the researchers which shows that the p- value was higher than 0.05 level of significant. Therefore, even using 10mm clay, the results will be close to or the same as to lead gonadal shielding. Since the p- value of .052 is higher than .050 level of significant, this indicates non- significant difference on the density of film with clay at different thickness 910mm, 20mm and 40mm).

DISCUSSION

The present study has proven that the clay with the thickness of 10mm, 20mm, and 40mm has no significance or difference with a 0.05 mm. lead gonadal shield. It is found that clay with a thickness of 10mm has the same effectiveness of a 0.05 mm. lead gonadal shield

CONCLUSION

In summary, it is concluded that clay provides the same effect as to lead. There is no significant difference on the density of film using clay at different thickness as compared to lead. Therefore, clay can be used as an alternative gonadal shield.

RECOMMENDATION

Clay can be used as substitute even 10mm thickness. The material is easy to find and much cheaper than a lead gonadal shield. Further study using clay as a gonadal shield in actual patients is recommended.

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