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HAND-MADE BODY LEAD APRON

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ABSTRACT

A hand-made body lead apron was successfully done by using the lead sheets in the used dental films. The x-ray protections was perfect. The total cost was much cheaper than the commercial one. However, its weight was higher due to the thickerness of the total lead used. The process in making this apron was simple and should be promoted to be used in our country.

INTRODUCTION

Radiation protection to the patients and the personnels working in the department of Radiology is very important. Ignoring the radiation protection would bring hazard to both the patients and the personnels. In the old days when x-ray was used in the medicine in the year 1922, many involved personnels were dead from cancer[1,2], leukemia[3] and some had short lifespan, decreased length of stay for 6 years[1,4,5]. They might be infertile within one year if they received the x-ray dose up to 250 rems (2.5 Sv)[6]. Owing to these hazards, the international commission on radiological protection (ICRP)[7] proposed the following general principles: (a) No practice involving exposures to radiation should be adopted unless it produces sufficient benefit to the exposed individuals or to society to offset the radiation detriment it causes (b). In relation to any particular source within a practice, the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposures where these are not certain to be received should all be kept as low as reasonably achievable, economic and social factors being taken into account. This procedure should be constrained by restrictions on the doses to individuals, so as to limit the inequality likely to result from the inherent economic and social judgements (c). The exposure of individuals resulting from the combination of all the relevant practices should be subject to dose limits, or to some control of risk in the case of potential exposures. These are aimed at ensuring that no individual is exposed to radiation risks that are judged to be unacceptable from these practices in any normal circumstances. Not all sources are susceptible to control by action at the source and it is necessary to specify the sources to be included as relevant before selecting a dose limit.

For the optimisation of protection (principle c), the involved personnels wear the lead apron to protect the internal body organs. Since the manufac-tured lead aprons are all imported and are expensive, an attempt to make our own lead apron was done.

MATERIAL AND METHODS

The industrial made body lead aprons were made from the mixture of lead and rubber which are expensive (6500 - 10000 Baht per unit). In order to balance the budget of the division, we consider using the throw-away material for the x-ray protection. The lead sheet for scattering-ray protection in the dental films were collected after the films had been exposed. The dental films were composed of the jacket, two pieces of x-ray films

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with paper covering and the lead sheet. We used the lead sheets, size 3.1 X 4.1 cm. in the periapical films which were the most frequently used size. Each piece of the lead sheet was 0.07 mm thick (Fig.1).

There were several rows of tiny projections on each end of the lead sheets. They were made flat by hand, using bottles or cans. The thickness of one body lead apron was equal to the thickness of 9 pieces of lead sheets. There were three sets of lead sheets, each set was composed of three sheets of lead covered by a piece of thin cloth. The purpose of making the apron this way was to seal the holes caused by the sewed-needles. The size of the apron was 62 X 100 cm. The total lead sheets used were 5435 sheets (Fig. 2). Finally, the apron was covered by the artificial leather as in figure 3., ready for use (Fig. 4). The total cost for the material used for this apron was about 2000 Bahts. The weight of our apron was 6.0 kilograms. Total thickness of lead is 0.63 mm.

RESULTS

Six pieces of the Kodak ultraspeed periapical dental x-ray films were attached to the innerside of the front part of the lead apron. The lead apron was routinely used in the fluoroscopic DSI unit for 6 weeks. The attached films were detached from the apron one film per one week.

Then the lead apron was hung 1 meter away from the x-ray tube, in the general unit. Six similar dental x-ray films were attached to the innerside and six films to the outerside of the front part of the lead apron. Exposure was allowed for 6 weeks; for each week, one film from the innerside and one film from the outerside part of the apron was removed. The identical performance was applied to the manufactured lead apron routinely used in that room.

The processed films that were previously attached to the lead aprons were measured for densities by the densitometer. The results were

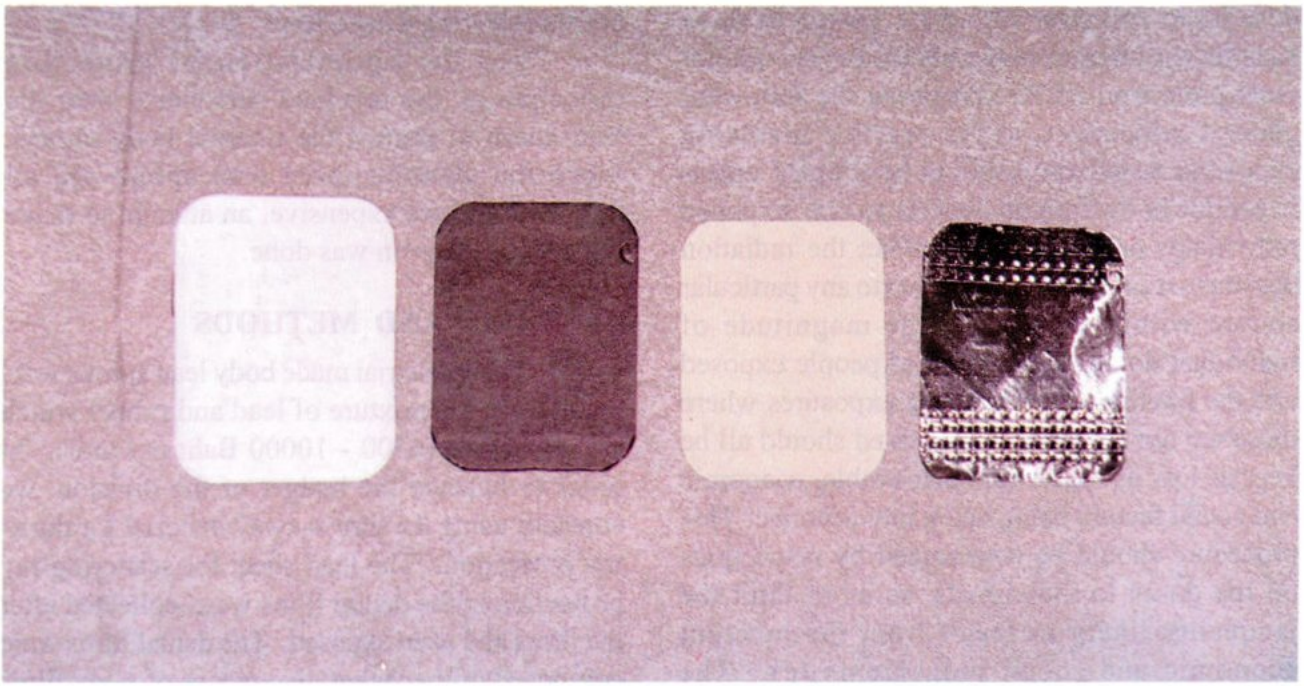

Fig. 1 Components of the dental films: jacket, film, film and lead sheet

shown by the graphic drawing (Fig.5). From this experiment, the study proved that this hand-made lead apron could protect the scattered radiation as safe as the manufactured one.

Fig. 2 Lead sheets sewed on the thin piece of cloth

DISCUSSION

There are several items that provide protection for associated personnel during a fluoroscopic/radiographic imaging procedure. The first and foremost is the lead apron worn by all individuals who must work in the room when the x-ray tube is operated. Lead equivalent thicknesses from 0.25 mm to 0.5 mm are typical. Often, the lead is in the form of a rubber material to provide flexibility and handling ease. Aprons protect the torso of the body and are available in fronto or wrap-around fitting designs, the latter being important when the back is exposed to the scattered radiation a considerable portion of the time. Greater than 90% of the incident scattered radiation is attenuated by the 0.25 mm thickness at standard x-ray energies (less than 100 keV). Thickness of 0.35 and 0.50 mm lead in an apron give greater protection (up to 95-99% attenuation), but weigh 50 to 100% more than the minimal 0.25 mm thickness. For long fluoroscopic procedures, the weight of the apron often becomes a limiting

Fig. 3 The appeared lead apron after being covered with the imitated leather

Fig. 4 The hand-made body lead apron on the real technician.

factor in the ability of the radiologist and the attending staff to complete the case without substititions. The areas not covered by the apron include the arms, lower legs, the head and neck, and the back (except for wrap-around type aprons).

The body areas not protected by the apron include the thyroid and the eyes. Accordingly, there are thyroid shields and leaded glasses that can be worn by the personnel in the room. The thyroid shield wraps around the neck to provide similar shielding as the lead apron does. Leaded glasses attenuate the incident x-rays to a lesser extent, typically 30-70 %, depending on the content (weight) of the lead. Normal eye glasses provide limited protection, typically much less than 20% attenuation. Whenever the hands must be in the primary beam, leaded gloves made of 0.5 mm thick lead (or greater) should be worn.

The lead aprons utilized in diagnostic radiology are of limited value in nuclear medicine because, in contrast to their effectiveness in reducing exposure from low enegy scattered x-rays, they do not attenuate enough of the medium energy photons emitted by Tc-99m (140 keV) to be practical.[8]

Film are optically and x-ray sensitive. The film densitometer measures the optical density of a selected film area by comparing the light intensity without the film in place to the light intensity with the film in place, and taking of the log of the ratio. The optical density (OD) of film is measured at a given point and describes the amount of light that gets through the film base and developed emulsion. If the film transmits a certain fraction (T1, the transmittance) of the light shone upon it, then the OD will be: OD = -Log (T) = Log (1/T). A densitometer is used to measure OD. A characteristic curve for the screen-film system can also be produced by exposing the film in a cassette with screens by

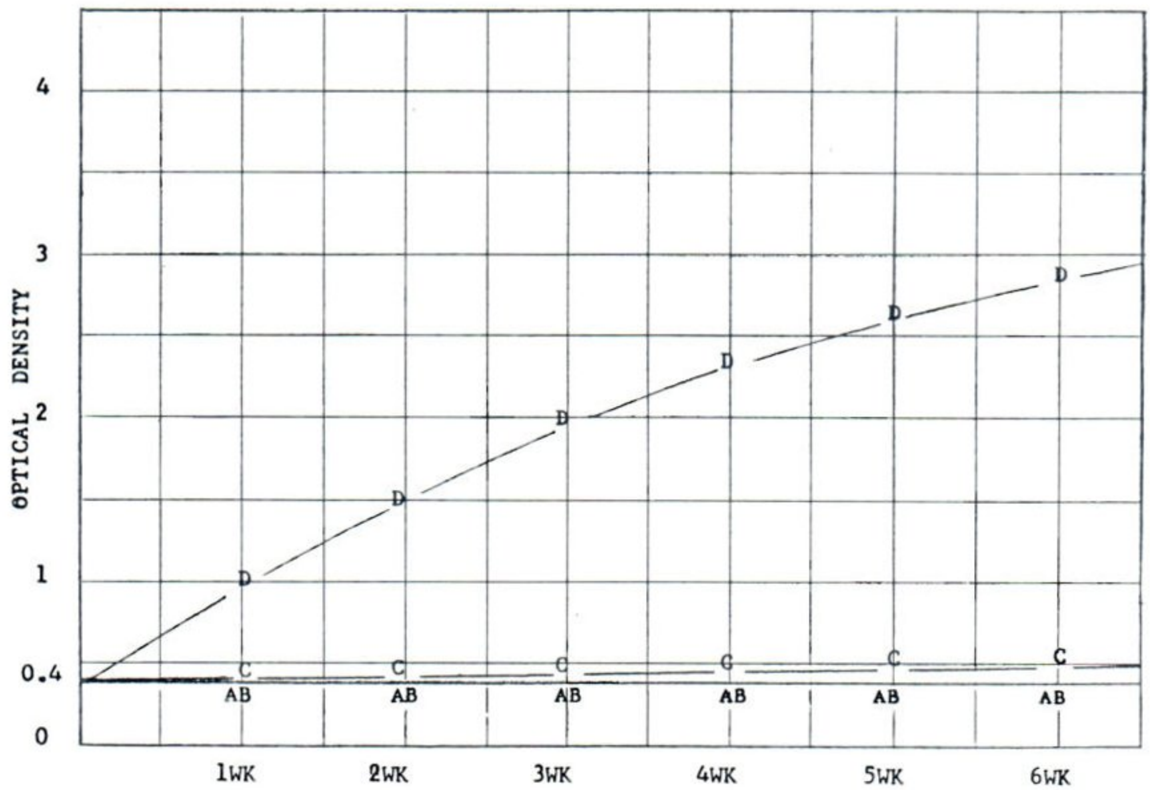

Fig. 5 Optical density of the films attached to the lead aprons
A = control
B = films that were attached at the innerside of the hand-made lead apron in the fluoroscopic and general rooms
C = films that were attached at the manufactured lead apron (0.5 mm thick) in general room
D = films that were attached in front of the aprons in general room

using x-ray radiation. In principle, the charactristic curves for light exposure will be quite similar. X-ray film typically used in radiology has a slight tint to the mylar base, so that unexposed film has an OD of about 0.13 after having been developed. Heavily exposed film can yield OD of about 3.0 to 3.5 in radiography[9].

The weight of our lead apron is heavier than the manufactured apron of the same design which weigh 3.2 - 5.5 kg. However, the thickness of our apron is more than 0.5 mm. An experiment will be performed in making another apron to reduce the weight by reducing the thickness of the lead sheets previously used but still effective for x-ray protection.

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