

Relevance of lead apron in medical imaging profession



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Introduction

Lead aprons are available in the healthcare facilities to provide protection from unnecessary exposure of X-radiation to the patients and workers during radiology procedures usually done for diagnostic purposes. Body is shielded by the protective garment called lead apron from the harmful radiation during the medical imaging. Lead apron is found to be effective in protecting from radiation exposure only when it is worn properly. It is used in a safe and properly inspected environment (Lead Apron Policy, 2012). Protective aprons of 0.25mm lead are worn, while performing fluoroscopy whose body is exposed to 5mR/hr or more. Individuals expected to wear lead aprons or similar radiation protection instruments must inspect these instruments visually for any signs of damage before using them (Lead Apron Policy; California code of regulations, 2012).

Principles of Lead Apron

Advantages of lead apron

It is observed to be effective and appropriate in protecting 95 percent of 80 kVp X-rays. As lead apron causes pain and stress to the back muscles back strain is avoided by wearing a skirt apron around the abdomen. In performing fluoroscopic procedures, wearing lead apron of lead equivalence 0.25mm to 0.5mm is found to decrease scattered X-rays by 95 percent. A thyroid collar is used along with lead apron and it is not required in the case of imaging patients. Every occupation worker exposed to fluoroscopic units higher than 5mrem/hr should wear lead apron. The dose rates that are

higher than 5mrem/hr are measured within six feet of the table and it includes the place occupied by fluoroscopist (Lead Apron Policy, 2012).

Disadvantages of lead apron

Lead apron is not sufficient for protecting ^{111}In or ^{131}I . No shielding is provided for the patients by the lead apron for ^{137}Cs or ^{131}I therapy. In these patients, heavy portable shields are available. Shields are provided for brachytherapy patients in the radiation oncology department. Shields for radioactive iodine therapy patients are provided by health physics department (Lead Apron Policy, 2012).

Inventory policy and lead apron inspection

According to the joint commission standards, annual inspections have to be performed on the medical equipment by the healthcare organizations. Lead apron inspection and inventory are performed by Stanford hospital & Clinics, Lucile Packard Children's hospital and VA Palo Alto Healthcare system. Some of the recommendations in the apron inspection policy are looking for sagging and deformities or any visible damage, performing annual tactile and visual inspection and holes and cracks are identified by radiography and fluoroscopy. It is important to use manual settings and low technique factors during fluoroscopic examination. It is not recommended to use automatic brightness control as it will drive up the high voltage and tube current, which might result in exposure of unnecessary radiation to the operator and the wear (Lead Apron Policy, 2012).

Lead apron is discarded, if the inspection reveals that there is a defect larger than 15 sq. mm on the apron parts shielding an organ or if there is any defect larger than 670 sq. mm along the seam or in the back of the apron and in thyroid shields with defects larger than 11 sq. mm (Lead Apron Policy, 2012).

How can the affected technical personnel be protected from the radiation?

It is not necessary for the technical personnel to stay closer to the patient in the case of radiography, general computerized tomography and mammography. Staying distant from the patient will prevent the personnel to receive the scattered X-rays from the patient. Structural shielding can also be placed in between the patient and the personnel to avoid the X-rays reaching the personnel. When the personnel are closer to the patient in fluoroscopic examinations as well as in image guided interventions, distance and structural shield will not be able to stop the scattering of the X-rays. In such cases, protective clothing like aprons, spectacles, table- mounted protective curtains, ceiling suspended protective screens and thyroid shields have to be used by the personnel (JL Heron et al., 2010).

Based on the lead equivalence and X-ray energy, an apron will terminate 90 percent or more of the incident scattered radiation. The protective aprons are available in various thicknesses and shapes starting from front-only apron to a full coat. The front-only apron will be effective, if the person wearing it is facing the source of the scattered radiation (JL Heron et al., 2010).

Radiological workloads differ for various specialities. The concerned protective tools required by a particular department are specified by a radiation protection expert or a medical physicist. The person with high workload in the cardiac laboratory must utilize all the protective tools, while a person in the orthopedic suite might require a front-only apron. If the person is working closer to the patient during imaging and wears an apron, a dosimeter that is fixed under the apron will estimate exposure of rays to the shielded portion and will not properly estimate the exposure of organs and tissues present outside the apron. Two dosimeters fixed inside and outside of the apron will give a good estimate of the effective dose to be used (JL Heron et al., 2010).

How far are the lead aprons protective against ionizing radiation?

Research studies were done to analyze the qualitative and quantitative aspects of lead aprons with the help of various methods. Eighty five lead aprons were collected from various departments in the hospital and from the district polyclinics where radiation exposure was present. They were collected and brought to the radiology clinic of the hospital to assess their protective nature. Aprons were identified based on the number of years they were used by the personnel, the units from where they have been obtained, number of personnel by whom they were worn, the model, the material by which they are made of and the thickness of lead in the apron (O Oyar and A Kislalioglu, 2012).

X-rays were delivered such that 35X35 cm wide area of the lead apron is exposed to the radiation. There was 110cm distance between tube focus and

lead apron. The images on the plates exposed on the back of the apron are transferred to films and these films are later evaluated with the help of scratches, cracks, rips and defects that might be present on the lead aprons (O Oyar and A Kislalioglu, 2012). As per the standard method, holes greater than 2mm diameter and cracks longer than 4mm were considered as destruction criteria. The aprons exposed with the same criteria were allotted for dosimeter testing by the ratio of ray absorption. The absorption features were assessed using two tests such as scattering X-rays on the apron directly and indirectly. In both direct and indirect methods, same parameters were used for estimating the radiation by fixing the dosimeters in the front as well as at the back of apron. The doses were evaluated and the absorptions were calculated.

The base for apron measurements, ten protective aprons with radiation permeability and various lead thicknesses, Turkish standards institution documents approved quality and durability were chosen. Aprons that were not used before were used as controls. The analyzed aprons were measured individually and the results were noted down (O Oyar and A Kislalioglu, 2012).

The results have shown that lead is the material used for radiation protection. Among double-sided lead aprons, skirt-vest lead aprons and frontal protection lead aprons, the frontal protection apron is mostly used. Evaluating the cleanliness of the aprons, 23 were clean and the remaining were either little or too dirty. No significant association was observed between the apron destruction criteria and apron cleaning methods.

Evaluating the overall condition of the apron, 45 aprons were in good
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condition and the remaining was either slightly or extremely worn out (O Oyar and A Kislalioglu, 2012).

Highest radiation permeability was observed in extremely worn out aprons and in aprons that were in decent condition. The apron that was worn out very little is least permeable compared to the extremely worn out and those in good condition. Among 58 aprons, 26 were destroyed due to cracks, 14 due to tears and holes, and 18 due to tears. In all these aprons, radiation permeability was more than normal. No significant relationship was observed between radiation permeability and internal structural features of protective lead aprons or total number of apron users. Destruction criteria were significantly associated with apron models. Frontal protection lead apron model was destroyed most often (O Oyar and A Kislalioglu, 2012).

The exposure dose was analyzed as 996. 1 micro grays on average. For 0. 25mm lead aprons, the exposure dose was 51. 59 micro grays on average. For 0. 5mm lead aprons, exposure dose was 9. 891 micrograys on average. Among the indirect measurements, scattered radiation value measured at the distance of 50cm was 2. 1 R/h. The indirect radiation measured for 0. 25mm lead equivalent apron was evaluated as 1. 85 micro grays and that for 0. 5mm lead apron was evaluated as 1 microgray (O Oyar and A Kislalioglu, 2012).

Some folds and sags were observed on the protective layers of the aprons. Significant radiation permeability difference was not observed between folded aprons and non-folded aprons. The protected dose was measured as 60. 20+/-22. 96 micro grays for unfolded 0. 5mm lead equivalent aprons.

The protected dose was 50.36 +/- 22.96 micro grays for folded 0.5mm aprons, 50.36 +/- 22.96 micro grays for 0.25mm lead equivalent aprons. For folded 0.25mm aprons, the dose was evaluated as 46 +/- 19.05 micrograys (O Oyar and A Kislalioglu, 2012).

Discussion

The aprons that were used for protecting against scattered ionizing radiation are made using lead embedded in rubber fabric, which is the mixture of lead-rubber or lead-vinyl. These aprons possess the thickness of 0.25mm to 0.5mm. They are costly and are of great importance when used and stored properly. It is an expert view that these aprons are not often preserved and taken care of, and they are folded carelessly, which could be reasons for them to lose protective ability. The research study first done in Turkey by Oyar and Kislalioglu in a quality certified hospital with a control standard and the measurements were taken for quantitative and qualitative radiation exposure values from the protective lead aprons (O Oyar and A Kislalioglu, 2012).

It is estimated that 0.5mm thick lead aprons will be able to absorb higher than 90 percent of irradiation at the dose of 150kVp. The similar apron must be able to absorb higher than 99 percent of the irradiation dose at 70kVp (Radiation issue notes, 2008). In some of the studies on absorption ratio of protective aprons, research has revealed that either indirect or direct X-ray absorption ratio of aprons must be measured separately (Christodoulou EG, 2003; Muir S, 2005).

Though the actual purpose of lead apron is to protect against indirect X-radiation, in the study done by Oyar and Kislalioglu, the results from direct radiation exposure measurements might be more beneficial in the evaluations due to wider spectrum width. Direct measurements were accepted to provide better results from the evaluations of ray absorption by the lead aprons.

If lead aprons are not stored properly, they will lose the protecting quality and radiation protection ability is reduced for that apron gradually. The storage racks for lead aprons are available in various styles and configurations to fulfill the necessities of the medical facility (Universal medical, 2014).

Medical professionals interested to wear lead aprons or other radiation protection instruments must have their protective garments checked well for any damages like rips and tears, cracks in the lead lining and sagging lead before their use. Proper lead apron storage will extend the apron life by preventing the lead lining damage and the external fabric damage. Lead aprons have to be hung by the apron hangers instead of folding them. Damages can result even if the apron storage is incorrect. Organizing the aprons properly will make the tracking process and the State or Joint commission inspection easier. Inspection of aprons will improve their organization (Universal medical, 2014).

Usually, it is a common practice to place half apron at the back of the patient during the erect chest radiograph to protect the patient from radiation dose from tube leakage and room scatter. Most of the back scatter from the

patient is a part of the internal scatter that might affect gonads and other tissues. Half apron will have least effect from patient dose and they make the patients to realize that precautions taken will protect them from unnecessary exposure (Lead garments (Felmlee JP et al., 1991).

Use of lead shield is made mandatory for gonadal protection in most of the X-ray departments. If the gonads are present nearer the primary X-ray beam, gonadal shielding is very much necessary. Even if the X-ray field is not near the gonads, gonadal shield is given as the deterrent for the pediatric patients. According to the national recommendations associated with shielding of patients from radiation exposure during imaging, lead aprons were not significantly reducing radiation dose. Dental radiation policies indicate that implementing all the routine precautions will not demand the use of lead aprons on the patient. Later, lead aprons were considered as reducing the radiation dose, from several diagnostic X-ray procedures, to the reproductive organs. Radiation can cause germ cell mutations which might be carried to the next generations. Lead aprons have a precautionary role in reducing the radiation dose (Felmlee JP et al., 1991).

The protective clothing worn by the radiographers consists of lead and other metals like tungsten, barium, tin and antimony. The clothing will help in shielding the personnel from radiation. The metals in the radiation protective clothing are equivalently mixed with polyvinyl chloride or synthetic rubber. Sheets of nylon fabric coated with urethane are placed against the side of lead impregnated rubber in between the two and five sheets of metal-impregnated rubber or PVC. These materials are cut as a pattern and sewn to create a protective garment. The manufacturers of these garments alter <https://assignbuster.com/relevance-of-lead-apron-in-medical-imaging-profession/>

the sheet number, metal percentage, rubber or PVC grade and the metal mixture affecting the durability, weight, flexibility and radiation absorption efficiency (Felmlee JP et al., 1991).

Normally, lead apron is not used for the patients undergoing medical procedures associated with radiation as the area of interest will not be protected. Lead aprons are mostly recommended for those who are exposed to the radiation by being in their occupation. If the apron is worn between the direct X-ray beam and the patient, then 90 percent of the rays are prevented from entering the patient's body. Therefore, it is not practical for putting apron on the body part that is of interest to the physician (Felmlee JP et al., 1991).

As per the standards put forward by the Joint Commission, healthcare organizations have to perform inspections on the medical instrumentation along with the lead aprons. Health department of State also should have a regulation for inspecting the lead aprons. Titanium is used as the shielding material in the titanium aprons. Other materials used in the aprons are barium and bismuth. The shielding properties of the material can be assessed by their mass coefficient and linear attenuation coefficient. Mass attenuation coefficient for the elements is found by physical reference data website of National institute of standards and technology (Felmlee JP et al., 1991).

Conclusion

As the X-ray imaging is being used continuously all through the world, this technology has created new challenges for occupational protection for the <https://assignbuster.com/relevance-of-lead-apron-in-medical-imaging-profession/>

medical staff from radiation. In many of the X-ray procedures, it is necessary for the medical staff to stay closer to the patients, while performing the imaging. Therefore, there is potential for the staff to get exposed to the radiation and it has become extremely important for them to implement certain restrictions to prevent themselves from radiation exposure.

Lead aprons decrease the radiation dose to the gonads from various diagnostic X-ray procedures. Radiation can cause mutations in the reproductive cells, which might be transferred to the future generations. Protective clothing worn by the radiographers consists of lead and other metals, like tungsten, barium, tin and antimony. These metals are mixed with polyvinylchloride to create a protective garment. The number of sheets, metal percentage, rubber grade and metal mixture in different ratios will show impact on the flexibility, durability, radiation absorption, weight and efficiency of the protection sheets.

Lead aprons are highly effective in absorbing diagnostic X-rays to the body parts shielded by the apron. The effectiveness is energy dependent and averages to about 90 to 95 percent. Irrespective of whether the radiation personnel have worn the lead apron or not, the exposure allowed on the body is ruled by exposure limits. Apart from the lead aprons, mobile shielding is also helpful in protecting the body from radiation.

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