

Entrance Skin Dose Estimation in X-Ray Lumbar Spine Lateral Procedure: Conventional Vs Digital X-Ray Units: A Pilot Study.

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Abstract: It has been accepted that radiation received by a patient undergoing a diagnostic X-ray procedure should be minimum without any loss of quality for the image. In the present study the aim was to measure the Entrance Skin Dose (ESD) received by patient undergoing lumbar spine lateral X-ray procedure at the beam entry point using a Thermoluminescent Dosimeter (TLD) viz calcium sulphate (CaSO_4): dysposium (Dy) tablet kept on the skin. Dose was measured in a TLD reader. The measurement of ESD was performed in a total of 7 patients in conventional X-ray unit and the same procedure was done in another 7 subjects on a digital X-ray unit. The mean ESD values were calculated in both trials. It was observed that mean ESD value in digital unit was lower than what was observed in conventional unit and the percentage of reduction was noted. The conventional unit was compared with British safety Standard (BSS) values of UK, which is considered as guideline value. The concept of effective radiation dose derived from ESD was discussed as it is more important considering the damaging effect produced by X-ray beam inside the patient in its path in tissues. The advantages involved when a digital X-ray unit is in use are also discussed.

INTRODUCTION

It has been established that the largest contribution of manmade radiation to common man is from medical use of X-ray. It has also been accepted that radiation dose received by a patient undergoing X-ray investigation should be brought into a minimum. For this purpose regulatory controls from competent authorities at national and international levels have been applying pressure from early days itself, continuously reviewing and updating their protection recommendations.

In the United Kingdom for reducing patients dose in X-ray diagnostic procedure, national reference standards and corresponding protocols have been formulated as NRPB guidelines. In India attempts have been made by the National Competent Authority viz Atomic Energy Regulatory Board (AERB) under the authority of Indian Atomic Energy Act of 1962¹ to enforce protection recommendations guided by International Commission on Radiological protection-ICRP 26 and ICRP 60².

It is an established practice to subject newly installed X-ray diagnostic machines to standardized safety operations as per rules before these are commissioned, to ascertain diagnostic quality and to reduce patient dose. Here surface X-ray dose measurement could be made by Thermo Luminescent Dosimeter (TLD) in tablet form is placed on the skin at X-ray beam entry point on the patient kept in position. The same procedure can be followed using a standard phantom in place of the patient. Entrance Surface Dose (ESD) estimated after exposure in a TLD reader is the dose the patient received on the skin surface undergoing the diagnostic procedure.

The Entrance Surface Doses measured using a phantom for various diagnostic procedures are preserved as a standard guideline data, otherwise called Basic safety Standard (BSS) values published. This may include not only common diagnostic procedures but also mammography, CT, fluoroscopy, etc. In U.K. this ESD data are revised every five years. Currently, BSS⁶ is the latest one.

Instead of Entrance surface Dose, the effective dose which is the actual radiation dose received by the patient from the X-ray beam incident when it passes through the patient and other organs in a given procedure is also computed and estimated. The effective dose can also be a guideline value data for different procedures. This data is also used instead of ESD values to ascertain patient safety level.

In the present study an attempt is made to measure the entrance skin dose

at the entrance level of the X-ray beam in a given x-ray procedure i.e. Lumbar spine Lateral, positioning the patients in two types of x-ray units (1) conventional and (2) digital type-seven subjects were studied on each unit along with control TLD tablet.

MATERIALS AND METHODS

ESD measurement is made by using TLD discs obtained from Avanttec Laboratory in Chennai, a company reputed for personnel radiation monitoring services. The disc is 13 mm diameter and 0.8 mm thick. The material is Calcium Sulphate (CaSO_4): Dysposium (Dy) which has high sensitivity with ease in handling and also has tolerable energy dependence (10%) for x-rays in the energy range of 60 KVp to 140 KVp (or details Pradhan A.S. et al)³. Being of small size in any convenient shape with ruggedness it is amicable for inter dose comparison work unlike ionization chamber. Hence TLD has become popular for dose comparison, standardization in different situations when KVp, mAs, FSD, patient build, film screen type etc are changed.

As indicated before ESD is measured when the same procedure is performed on conventional X-ray unit as well as digital X-ray unit in a comparable group of patients. It is well known that in the digital set up conventional screen film combination, image intensifier is replaced by digital receptors. X-ray photons incident on receptors have high probability of interaction. Energy absorbed from X-ray is converted into electrical signal which is then digitized. Hence digital files are stored electronically. So in this technology no films, no chemicals, no cassettes, no film storage facility are needed. It is claimed that in the digital technology image quality is better with lesser radiation dose to the patient⁵.

RESULTS

The entrance Skin Dose for each subject measured with patient data and operating factors adjusted on the X-ray unit are tabulated in both conventional viz non-digital and digital X-ray units shown separately (Table I & 2). The mean ESD with Standard Deviation is shown separately for comparison in the case of Lumbar Spine lateral procedure only as explained before. As per the tabular form in the conventional X-ray unit data the ESD values are between 36.9 and 3.4 mSv with mean value 19.15 and in the digital unit data it is between 22.3 and 4.5 with mean value 11.01. It is true that the ESD and the concerned effective doses are related. As per International definition given by ICRP and published National radiological Protection Board (NRPB) collated national database effective doses are compiled and tabulated as per the tables for Lumbar Spine lateral procedure. The range is found to be 0.1 to 0.6 mSv⁴. The ESD values as guideline values are available with British safety Standard (B.S.S.) values published in International Atomic Agency (IAEA)

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Table 1 : Radiographic Factors & Dosage For Conventional Radiograph Of Lumbar Spine Lateral

S.No.	Name	Exam	KV	MA	Distance in cm	Thickness in cm	Reading in microSv	Net reading	Dose in mSv
1	Control	Conevntional L.S.Spine					457		
2	Test 1	L.Spine Lateral	76	100	100	31	135246	134.996	13.4996
3.	Test 2	L.Spine Lateral	84	150	100	35	369571	369.321	36.9231
4	Test 3	L.Spine Lateral	76	100	100	31	152785	152.535	15.2535
5.	Test 4	L.Spine Lateral	78	125	100	31.5	199824	199.574	19.9574
6.	Test 5	L.Spine Lateral	76	125	100	30	203755	203.505	20.3505
7	Test 6	L.Spine Lateral	78	125	100	30.5	216163	215.913	21.5913
8	Test 7	L.Spine Lateral	76	30	100	24.5	34858	34.608	3.4608

Mean	19.15
± S.D	11.05

Table 2: Radiographic Factors & Dosage For Digital Radiograph Of Lumbar Spine Lateral

S.No.	Name	Exam	KV	MA	Distance in cm	Thickness in cm	Reading in microSv	Net reading	Dose in mSv
1	Control	Digital L.S.Spine					457		
2	Test 1	L.Spine Lateral	85	80	100	28	76012	75.762	7.5762
3.	Test 2	L.Spine Lateral	81	64	100	22	51219	51.041	5.1041
4	Test 3	L.Spine Lateral	90	100	100	34	135799	135.549	13.5549
5.	Test 4	L.Spine Lateral	90	100	100	32	133882	133.632	13.3632
6.	Test 5	L.Spine Lateral	90	125	100	36	223255	223.005	22.3005
7	Test 6	L.Spine Lateral	90	100	100	30	106377	106.127	10.6127
8	Test 7	L.Spine Lateral	80	70	100	26	45773	45.523	4.5523

Mean	11.01
± S.D	60.16

Vienna 1996. For Lumbar Spine lateral-Non digital unit procedure the ESD value stated to be around 30 mGy which is not very much different from what is estimated in the present study viz 19 mSv⁶ calculated with Standard Deviation ±11.05 (Table 1).

DISCUSSION

The entrance skin dose experimentally obtained as well as the concerned effective dose as per published data in a given X-ray procedure have been projected here. Also the ESD values in conventional and digital X-ray units were compared in lumbar spine lateral procedure in this study. There was reduction of ESD value in digital as good as 42%. The reason for the reduction could be due to various factors including the higher efficiency in signal conversion in digital technology. The aspects like quality of image and lesser patients' dose perhaps demand more work to be done during procedure followed in X-ray diagnostic technology which is a very vast area of research.

CONCLUSION

1. The mean ESD values for conventional X-ray Lumbar Spine lateral is 19.15 mSv and for digital X-ray study is 11.01 mSv and there was a reduction of 42% in Digital X-ray unit procedure.

2. The individual variations would be present which are stated to be machine dependent and also patient built and factors like ESD mAs etc.
3. The mean ESD value estimated for lumbar spine lateral procedure i.e. 19 mSv which may be comparable with 30 mGy as per BSS within the usual range of deviation.

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REFERENCES

1. Indian Atomic Energy Act:1962
2. Shrimpton P.C, Wall BF, Jones DC et al. A National survey of Doses to patients undergoing selected routine X-ray exams in English Hospitals. National Radiological protection Board R-200 London: HMSO, 1986.
3. Pradhan A.S, Shiva V.K, Dash Sharma PK et al. radiation protection Dosimetry 48:359, 1993
4. Hart D, Jones DG, Wall BF et al. Estimation of effective dose in diagnostic radiology from Entrance Surface Dose and dose area product measurements NRPB R-262 London HMSO, 1994.
5. Yaffe MJ and Rowlands JA. X-ray detectors for digital radiography Physics in Med. And Bio. 42:1-39, 1997.
6. International Basic Standard for protection against ionizing radiation and for safety of radiation sources (BSS) IAEA Safety series. No. 115, 1996.

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