EVALUATION OF STAFF AND AMBIENT EXPOSURES DURING ORTHOPEDIC PROCEDURES

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Presentation outlines

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Introduction

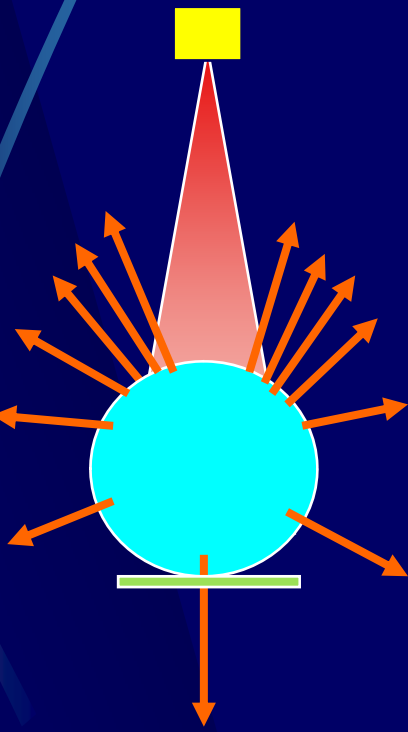
- The use of fluoroscopic guidance's in orthopedic surgery now is common practice because of their lower infection and small incision wounds at surgery's sites.

- Orthopaedic surgeon use c-arm machine : either conventional or mini C-arm

Introduction cont

The radiation dose of a surgeon depends on many factors:-

- The type and the generator of the C-arm
- Fluoroscopic time
- The distance from the beam's central axis
- The orientation of the fluoroscopic beam relative to the patient.
- The position of the surgeon within the operative field and the use of protective shields



Introduction cont

- There is little information available on the level of exposure to staff during orthopedic procedures.
- Measurements of radiation doses to unprotected organs of the staff as well as scattering radiation within the theatre room is crucial.
- In Sudan, as far as we know, no study has been published in open literature regarding patient and staff radiation doses during orthopedic procedure.

Objectives

The objectives of this study were to:

(i) measure and evaluate staff radiation dose during dynamic hip screw [DHS] and dynamic cannulated screw (DCS).

(ii) measure the ambient dose in three orthopedic departments in Khartoum state –Sudan that will known by A,B and C through out this presentation.

DHS

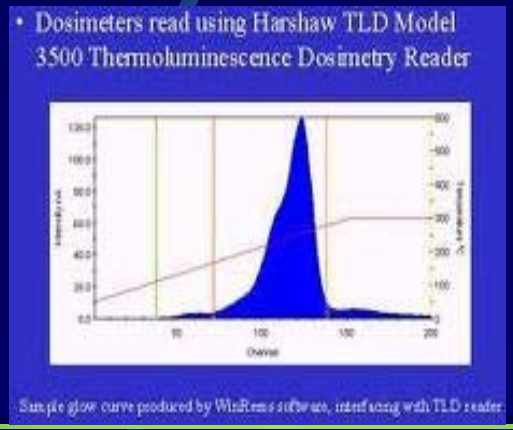
DCS

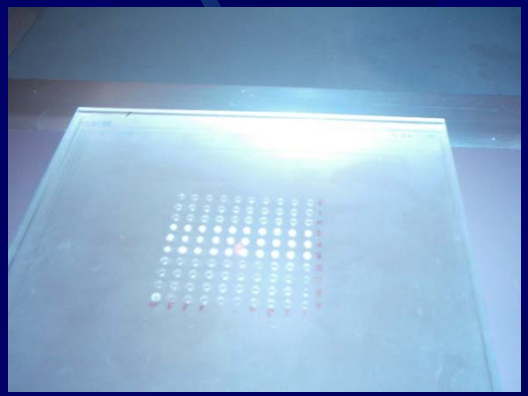
Materials and Methods

Dosimeters

- A total of 72 thermo luminescence dosimeters (TLD) of lithium fluoride (LiF: Mg, Ti:P, GR: 200) chips (Fimel-France) were used,

- The TLDs calibration was performed according to the protocol reported by Sulieman et al (2007).





Materials and Methods

Dosimeters

The TLD signal was read using a manual TLD reader (Fimel-France).

- The readout was at a 100°C preheat temperature and reading temperature of 100–300°C with heating rate 10°C s^{-1}
- Before each irradiation all dosimeters were annealed in a computerized annealing oven (TLDO; PTW, Freiburg, Germany).

Materials and Methods cont

- The mean background signal for un irradiated TLDs was subtracted before any calculation.
- The minimum detection limit was determined to be 15 µGy.
- The uncertainty of TLD reading was estimated to be not more than 10% of all measurements procedures.
- Three TLDs enclosed in a transparent polyethylene foil envelope were placed at different staff body sites and kept in the required positions with cello-tape

Materials and Methods cont

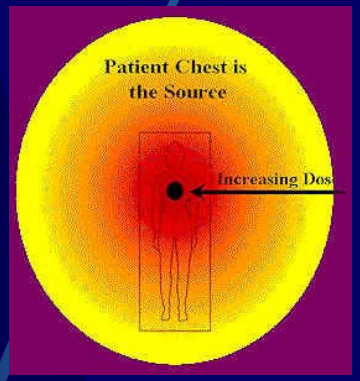
Dosimeters

- Calibrated Electronic personal dosimeters (thermo EDP-N2) were used to measure surgeon radiation dose at level of chest and left leg beside TLD envelope.

- Personnel electronic dosimeter was calibrated in Secondary Radiation Dosimetry Laboratory (SAEC).
- All reference standard equipment have been calibrated against primary standards through IAEA.

Materials and Methods *cont*

Ambient dose measurements



- Ambient dose within the theatre room around the c-arm machine were measured using 0.6 cc Farmer type ionization chamber model PTW 3001 connected to UNIDOS universal dosimeter (PTW, Freigburg, Germany).

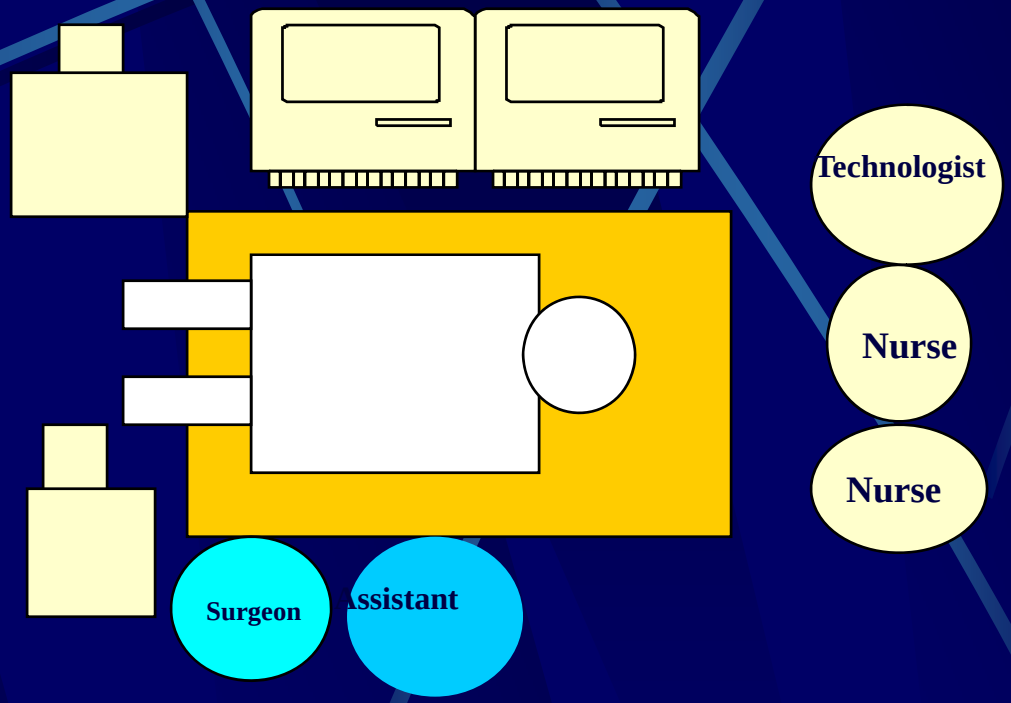
- The chamber was calibrated by the manufacture with its calibration traceable to the German Standard Laboratory (PTB).

Materials and Methods cont

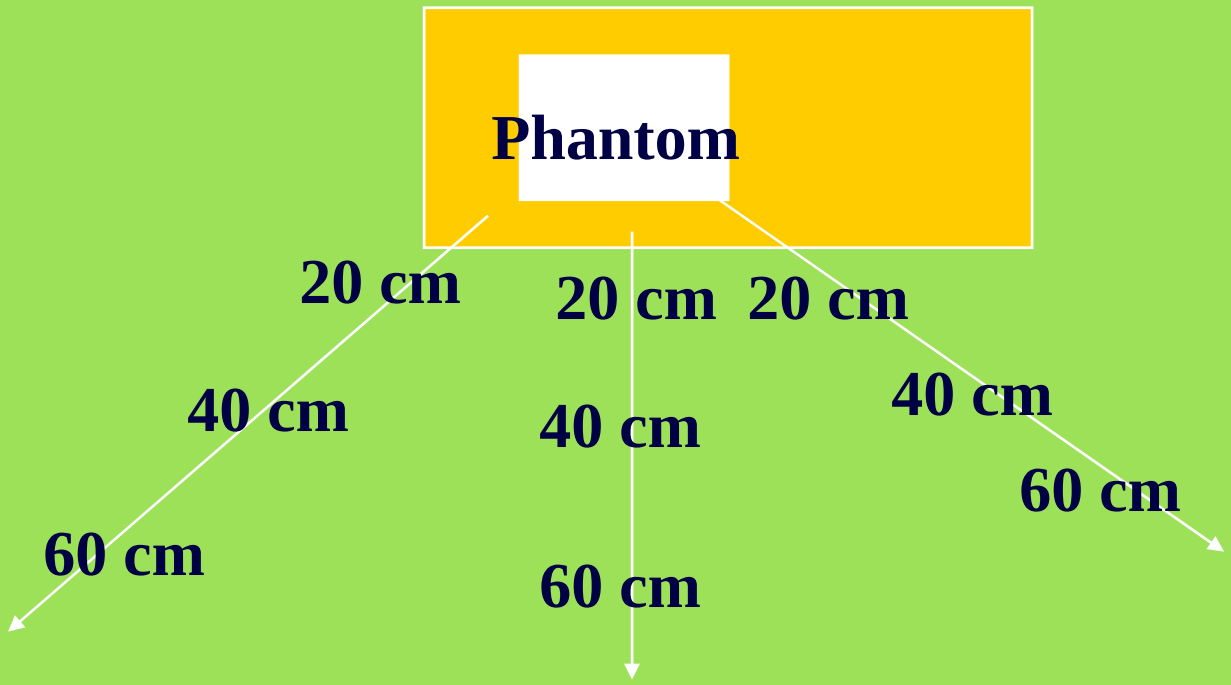
Ambient dose measurements

- Ambient dose measurement was performed using phantom to simulate the real intervention condition.
- The ionization chamber was placed at different distances (20 cm, 40cm, and 60cm) from beam central axis, in different directions at the level of operational surgery couch.

Staff locations



Ambient dose measurements



Materials and Methods

X-ray machines

- Three different x-ray C -arm machines were used throughout this study.
- Two of them equipped with single phase high frequency (HF) generator and are conventional c-arm.
- Two of them are Siemens[(siremobil 2000) and (siremobil 4K)],And the third is Wolverson X-ray (Italy).
- The three machines subjected to extensive quality control tests performed by SAEC.

Results and discussions

- The mean fluoroscopic exposure factors for DHS and DCS in three centers were 71±17 kVp and 1.3±9 mA 1.68±21 min.

- The mean radiation doses for the surgeon during DHS and DCS procedure using TLDs were **0.15** mGy for the forehead, **0.18** for the thyroid, **0.20** for the chest, **0.23** for the right hand and **0.19** for the left leg.

- The radiation dose comparable to other studies (Table 1)

Surgeon Dose Comparison

Table 1

Organ	Present study	Bahari et al 2006
Eye	0.15	N.A
Thyroid	0.18	0.21
Chest	0.20	N.A
Hands	0.23 right	0.80
Leg	0.19	N.A

Results and discussion cont

Table 2.the mean staff radiation dose rate using electronic dosimeters

Department	Chest (msv/h)	Leg (msv/h)
A	0.45 ± 34	0.34 ± .36
	(0.38-0.50)	(0.28-0.40)
	0.44 ±2	0.33 ±8
B	(0.37-0.49)	(0.30-0.40)
	0.45± 65	0.33±58
C	(0.37-0.55)	(0.25-0.42)

Results and discussion cont

- DHS procedure need more fluoroscopic time and higher fluoroscopic exposure factor (mean 1.97 min,75kV,1.8 mA).

- In comparison with DCS that required about (mean fluoroscopic time 1.11 min, 69kV, 1.1mA) therefore DHS result in more radiation dose to surgeons.

- according to this fact orthopedic surgeon voiced to reduce the DHS procedure through their workload during a year.

Results and discussion cont

Table 2 shows the mean surgeon radiation dose rate (mSv/h) at level of chest and leg from both procedures averaged over three departments

Procedure	Chest (mSv/h)	Leg (mSv/h)
DHS	0.45	0.34
DCS	0.43	0.32

Results and discussion cont

- Surgeon exposure was much greater with use of the large c-arm compared to mini C-arm (Brian (2009)).

- Compared to present study the three machines was large c-arm, so mini C-arm were to be encouraged,

Results and discussion cont

Table 3 mean ambient dose values scattered dose (μSv/min) at specific distances from central beam averaged over three centers

Distance(cm)	Present study	Badman et al (2005)	Mesbahi et al (2008)
20	4.63	2.4	3.68
40	1.09	0.65	0.75
60	0.48	0.26	0.36

Results and discussion cont

- This study showed higher ambient values in comparison with literature (Badman et al(2005), Mesbahi et al(2008)).

- The higher dose may be due to surgeons experience or c-arm unit specifications (filtration, collimation and fluoroscopic factor encountered field of view FOV selected)

Results and discussion cont

- Effective shield and barriers must be used to prevent radiation exposure.

- In this study, not all personnel in theatre wear the protective lead apparel in spite of their availability.

- Heavy weight, inconvenience, less knowledge about hazard are the reasons

Conclusions

- The mean radiation doses for the surgeon during DHS and DCS procedure are within the acceptable limits .
- Electronic dosimeters are less efficient in low dose values from scatter radiation.
- Ambient dose measurements are useful in staff dose prediction since the staff may change their location.
- More optimization can be achieved in the light of the current practice.

Recommendations

- Training in radiation safety should be provided, in spite of the low radiation doses during selected procedures.
- Combination of both active and passive dosimeters are valuables for providing accumulative dose.
- a written protocol is recommended for fellows.
- DRL has to be set for orthopaedic procedures.
- Mini C arm should be used, When they are suitable .

Thank you for your kind attention

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