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Radiation Exposure during Dynamic Hip Screw Fixation: A Comparative Study

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Abstract

Background: The safe amount of radiation permissible during fixation of neck of femur fractures has long been studied. Factors including surgeons' experience have been highlighted. We aimed in this study to compare different factors for quality and safety improvement. **Methods:** It was a retrospective study, including all patients who had undergone a standard DHS fixation between January 2018 and June 2019 for inter-trochanteric neck of femur fractures. Two groups were stratified; (Group A) had the procedure performed by a specialist non-consultant surgeon (NCG) and (Group B) by an established consultant (CG). The Dose Area Product (DAP) and the duration of radiation exposure were recorded. **Results:** Over a period of 18 months, 91 cases were included with a mean age of 82 years old. The mean weight was 62 kg. 42 patients had complex fractures, and 49 patients had simple fractures. 12% of patients were ASA II, 70% of cases were ASA III and 18% of the patients were ASA IV. The mean DAP for group A was 345.131 CGYCM2 (SD 273.65) and for group B 234.63 CGYCM2 (SD 165.30). The time of exposure was 8.6 sec and 13.16 sec in groups B and A respectively. **Conclusion:** The data collected from this study were comparable to others. The amount of radiation exposure was of difference related to the decision-making intra-operatively. Other factors were not statistically significant.

Keywords

DHS, Radiation Exposure, Comparative Study, Neck of Femur Fracture

1. Introduction

The amount of radiation exposure during Dynamic Hip screw (DHS) fixation for hip fractures has been studied extensively in the past. Moreover, the risk of

radiation exposure to health professional personnel during such procedures has been investigated in several studies. The incidence of cancer in exposed orthopaedic surgeons was 29% and this was eight times higher than unexposed ones [1] [2].

The limitation for safe radiation exposure was 20 mSv averaged over five years with no more than 50 mSv in any one year as recommended by The International Commission on Radiological Protection (ICRP) [3]. In addition, the effect of surgical experience on radiation exposure has been scrutinized in several research studies [4] [5] [6].

The primary operating surgeon is exposed the most to a higher dose of radiation. There is some recommendation that the main surgeon should not operate more than 280 surgeries a year. In the meantime, scrub nurses are less prone to exposure hazards from fluoroscopy [7].

The effect of surgical experience was reflected in the amount of radiation used. Junior doctors were attributed to higher surgical duration which could be justified in terms of improving their learning curve. Moreover, it was assumed the senior surgeon utilizes less radiation during the operation [8] [9].

The purpose of this study was to assess whether there was any difference between the two experienced surgeon groups in the amount and time of radiation during hip fracture reduction and fixation. Also, it correlates with patients' factors.

2. Methods

This is a retrospective study that included all patients who had undergone a standard four-hole plate DHS fixation from January 2018 to June 2019 for a simple two- or three-part extra-articular inter-trochanteric fracture. Patients were identified from the hospital neck of femur fracture database and radiology department archives records.

Demographics included age, sex, weight, and American Society of Anaesthesiologists (ASA) grading, were located on patients' records on the Meditech V6 system. Also, the fracture pattern was identified according to Evans's classification.

Inclusion criteria were; Patients were operated on by a specialist or a consultant, the fracture pattern was inter-trochanteric, and any ASA was included.

Exclusion criteria were; patients who had Body mass index (BMI) over 40, surgery carried out by a junior trainee under supervision, and trainee radiographers operating the Fluroscan were excluded from the study.

Patients were stratified into (Group A) who had the procedure performed by a specialist non-consultant surgeon (NCG) and (Group B) who operated on by a consultant (CG). The demographics between these groups of patients were established. The Dose Area Product (DAP) and the duration of exposure to radiation during the procedure on these patients were obtained from the image intensifier data archive stored in radiology.

Data were fed to the computer and analyzed using IBM SPSS software package

version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using numbers and percentages. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, and median. The significance of the obtained results was judged at the 5% level and Pearson correlation method to detect the attribution of patient factors.

3. Results

Ninety-one patients underwent a standard DHS during this period out of 133 patients identified (**Figure 1**). The mean age of the patients was 82 years old (39 - 99 years). Sixty-eight percent and thirty-two percent of the samples were female and male respectively. The mean weight was 62 kg ranging from 32.80 to 94 kg. The fracture patterns were as follows; 15 patients were type 1, 35 patients were type 2, 6 patients were type 3, 25 patients were type 4 and 10 patients were type 5. The ASA classification was: 3 patients were ASA2, 70 patients were ASA 3 and 18 patients were ASA 4.

The mean DAP of the patients was 289.277 cGY/cm^2 with, while the mean duration in seconds was 8.66. Two groups were established, group A had 45 cases while group B had 46 cases. The mean DAP for group A was 345.13 cGY/cm^2 (5 - 1452 cGY/cm^2) and was 234.63 cGY/cm^2 for the group B surgeons. The mean duration of radiation exposure was 13.2 seconds and 8.6 seconds for the former and latter groups respectively (**Table 1**).

There was a statistically significant difference with a p-value of 0.04 for both the DAP and the duration of exposure between the groups (**Figure 2**). The body mass index, ASA, or fracture configuration did not have a statistically significant correlation to the DAP or the duration of exposure between the groups (**Table 2**).

4. Discussion

Radiation exposure has been a hot topic. In Orthopaedic practice, we use lots of radiation, especially in trauma. There is some guidance on how to practice safely during surgical procedures, but there is no safety limitation regarding the permissible amount used.

DHS is the bread-and-butter operation for neck of femur fractures, and in the context of this study, it was useful to look at and highlight the doses of radiation used in such a procedure. Moreover, light was shed on such a topic in previous studies [8] [9].

In this study, there was a difference in the DAP between two experienced groups of surgeons with more than ten years of experience. Nevertheless, recent research had emphasized the importance of seniority between juniors and consultants [8]. Our figures that were recovered showed that not only the experience of the operating surgeon affected the DAP but also the ability to accept reduction and fixation for these procedures.

Moreover, we studied the effect of patients' weight on the DAP which surprisingly did not correlate with the overall radiation exposure which could be

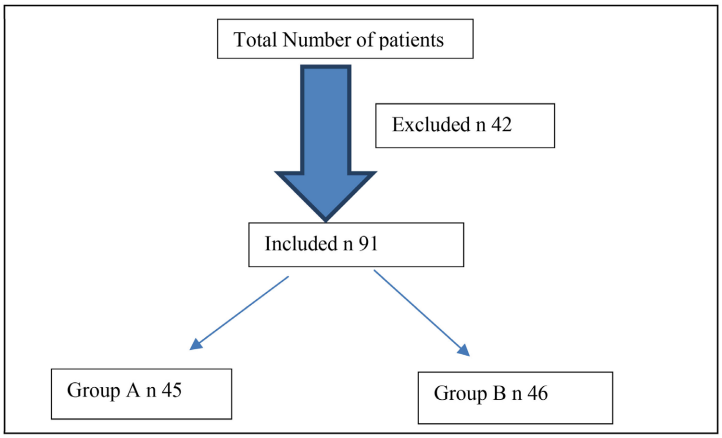

Figure 1. Flowchart for patient selection.

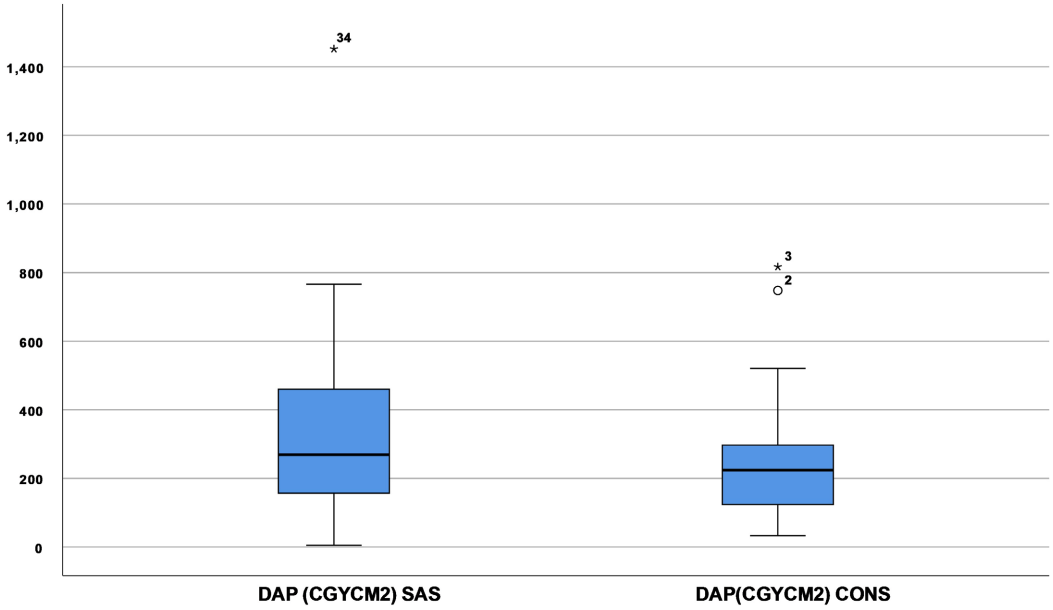

Figure 2. Comparison of DAP between the two groups.

Table 1. Summary of the statistical results.

	N	Minimum	Maximum	Mean	Std. Deviation
Age	91	39.0	99.0	82.292	12.1008
Weight	91	32.80	94.00	62.3841	14.24828
DAP (cGY/cm^2)	91	0.15	1452.00	289.2775	230.99627
Duration (Sec)	91	0.00	109.00	8.6609	20.75259
DAP (cGY/cm^2) Cons	46	0.15	816.70	234.6380	165.30212
Duration (Sec) Cons	46	0.00	60.00	4.2585	11.21856
DAP (cGY/cm^2) SAS	45	5.0	1452.0	345.131	273.6539
Duration (Sec) SAS	45	0.00	109.00	13.1611	26.66880
Valid N (listwise)	45				

Table 2. Correlation between DAP and ASA, weight, and fracture pattern.

		ASA Grade	Weight	Fracture	DAP (cGY/cm^2)
ASA Grade	Pearson Correlation	1	0.019	−0.032	−0.021
	Sig. (2-tailed)		0.860	0.765	0.846
	N	91	91	91	91
Weight	Pearson Correlation	0.019	1	−0.056	0.025
	Sig. (2-tailed)	0.860		0.597	0.815
	N	91	91	91	91
Fracture	Pearson Correlation			1	−0.069
	Sig. (2-tailed)	0.765	0.597		0.517
	N	91	91	91	91
DAP (cGY/cm^2)	Pearson Correlation		0.025		1
	Sig. (2-tailed)	0.846	0.815	0.517	
	N	91	91	91	91
Duration (Sec)	Pearson Correlation	0.118	0.061	0.059	0.072
	Sig. (2-tailed)	0.266	0.566	0.579	0.495
	N	91	91	91	91

attributed to the small sample number or the advances in medical digital radiography, after excluding patients with high weight. As high weight patients will affect the quality of images and the maneuvering done by the radiographer to obtain clear and good-quality images.

Also, the fracture pattern did not correlate with any significant radiation, which has been confirmed by Quah *et al.* in 2017 [9]. As the reduction method is the same for any fracture configuration, and it is performed initially as soon as the patient is mounted on a fracture table, which explains the reason why there is no association with DAP.

Patients' fitness for surgery is completed by ASA grading of the patient and could not correlate to any effect on the duration of radiation, this is owing to the advances in local and regional anaesthetic techniques which facilitate safe practice [10], which will influence surgeon practice indirectly.

The average DAP was 289.277 cGY/cm^2 which is equal to 29 m SV, which is lower than the average cumulative radiation exposure in orthopaedic surgery, which was 35.2 m SV, as highlighted by Mastrangelo G et al in 2005 [2]. In addition, a dose area restraint has been set as 10 mSv per year by Kirousis et al in 2009 [7].

5. Conclusions

As there are no national guidelines regarding the permissible dose, we feel that the numbers recovered from this study could help in setting national limits, which will help improve practice and decrease the incidence of radiation-induced cancer. We would like to urge surgeons to start monitoring their annual exposure as used by the radiographer.

In this research, we tried to minimize the confounding factors during dynamic

hip screw fixation. We recommend the presence of a consultant during such procedures which will aid in decreasing the amount of radiation exposure as set by other studies as well, despite the experience of the operating physician.

Funding Information

Ethics approval and registration were conducted according to principles enshrined in the Declaration of Helsinki and in accordance with the Medical Research Involving Human Subjects Act (WMO). Reference number is: UHDB50, contact email is: nicola.wheeldon@nhs.net.

Consent for publication: All authors revised the manuscript and approved the version to be published.

Conflicts of Interest

All authors declare that they have no conflict of interest.

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