

Patient Radiation Doses during Diagnostic Cerebral Angiography Procedures: Experience at a Tertiary Level Center of India

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ABSTRACT

Objective: To assess patient radiation doses during diagnostic cerebral angiography from a tertiary neuro-intervention center.

Materials and methods: We studied 161 patients including 149 adults (83 male; 66 female) and 12 pediatric patients who underwent diagnostic cerebral angiography (DCA) for suspected or proven intracranial aneurysms which were performed with a biplane unit. Fluoroscopic time, dose-area product (DAP), and total angiographic image frames were obtained and analyzed in males, females and pediatric population separately.

Results: Mean fluoroscopic time, the total mean DAP, and total image frames were 11.6 minutes, 105.6 ± 60 Gy-cm², and 295 ± 82 frames for diagnostic procedures.

Separate assessment in males, females and pediatric population was made. No significant difference was found between male and female population. Pediatric population, however, showed reduced DAP values (104 vs. 84 Gy-cm²) and a number of frames (308 vs. 271.5) with increased fluoroscopic time (11.6 vs. 14.28 min) when compared to the adult population.

Conclusion: Radiation dose as measured by DAP, fluoroscopy time and image frames is consistent with previous studies. Further data from other institutes can help in establishing a national registry for radiation exposure and help in framing guidelines for radiation protection.

Keywords: Dose-area product, DSA, Radiation dose.

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INTRODUCTION

Interventional neuroradiology has emerged as an increasingly used modality for the treatment of various neurovascular disease processes. These procedures are prolonged and complex and require radiation exposure to staff as well as patients. There is increased awareness and questions about radiation safety for the patient and the staff involved in these diagnostic and therapeutic procedures.¹

Radiation effects are either deterministic or stochastic. In deterministic effects such as dermatitis and epilation, there is a threshold, and the severity of the effects is a function of the dose. In stochastic effects such as cancer induction and genetic hazards, only the probability of occurrence of the effect is a function of the dose.²

Stochastic risks to the patients are usually estimated through the calculation of effective doses from DAP or skin dose.¹

Aim of the present study was to evaluate the DAP cumulative dose delivered to the patients during diagnostic cerebral angiography procedures.

MATERIALS AND METHODS

This prospective observational study was carried out in the Department of Radiology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India over 1 year after taking ethical committee approval. Inclusion criteria were patients undergoing diagnostic subtraction angiography for suspected aneurysms where DAP data was available. Exclusion criteria were an incomplete diagnostic procedure or where DAP values could not be ascertained due to technical reasons. There were a total of 161 patients including 149 adults (83 male; 66 female) and 12 pediatric patients who underwent DCA for suspected or proven intracranial aneurysm. All examinations were performed on Philips Integris System: Allura Xper FD 20/10 Biplane flat panel

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digital subtraction angiographic system. It has a rotating anode grided maximum rotalix ceramic (MRC) X-ray tube, with anode material zirconium, Rn, tungsten; diameter of anode disk is 200 mm with anode rotation speed 4200 rpm. Anode angle 9–110 and two focal spots. Exposure factors used were KV-80, mAs-29 for adults and kv-80, mAs-8 for pediatric patients. These were adjusted at the time of acquisition for the variable thickness of the patient. Two fluoroscopic modes were used 30fr/s (used in pediatric procedures at low KV and mA settings) and 15/fr/s used for adults to reduce radiation dose to patients. DAP was measured using the new KermaX[®] plus TinO–Two in one–multifunctional measuring system which combines a real-time dosimeter and a DAP meter. It is a large flat plate ionization chamber fixed to the collimator on the x-ray tube and through which the whole X-ray beam passes.

RESULTS

Table 1 shows minimum, maximum and average number of runs taken, images per examination, fluoroscopy time and DAP per examination.

Table 1: Minimum, maximum and average number of runs taken, images per examination, fluoroscopy time and DAP per examination

Category	Minimum	Maximum	Mean
Runs taken	5	21	9.43
Images/exam	40	1728	295
Fluoro time	2.25 min	55.59 min	11.6 min
DAP (Gy-cm ²)	16.143	541.183	105.096

Table 2: Variation of number of runs, images per exam, fluoroscopy time, DAP/exam, DAP/image in male, female and pediatrics patients during the procedure

Average	Male	Females	Children
Runs taken	9.6	9.48	8.75
Images/exam	328.67	289.98	271.5
Fluoro time (min)	11.42	11.78	14.28
DAP/exam Gy-cm ²	111.58	97.44	84.32
DAP/image mGy-cm ²	339.49	336.027	310.59

Table 2 shows variation of number of runs, images per exam, fluoroscopy time, DAP/exam, DAP/image in male, female and pediatrics patients during the procedure.

Graph 1 shows DAP (mGy-cm²) among male, female and children per examination.

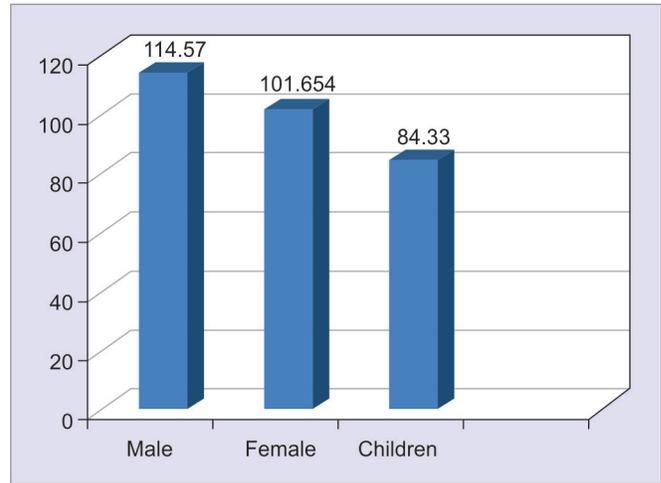
Our data is consistent with previous published reports³⁻⁷ which have estimated DAP, fluoroscopy time and number of frames in patients undergoing diagnostic cerebral angiography as shown in Table 3.

Review

Intervention neuroradiology procedures for both diagnostic and therapeutic indications have increased recently and are potentially associated with considerable radiation exposure which can cause both stochastic and deterministic effects. Thus it is of paramount importance to characterize risks to patients undergoing these procedures especially in case of pediatric population.⁸

Radiation dose with such procedures is difficult to due to the variability of institutional protocols, procedure-related complexities, differences in equipment and experience of the interventional neuroradiologist. The aim of this study was to calculate radiation exposure through DAP measurements in patients undergoing diagnostic cerebral procedures to provide reference data in Indian population at an apex tertiary institute and also to compare it with previously reported data.

A major cause of standardization of procedures and dose measurements is lack of standardization among hospitals, different



Graph 1: DAP (mGy-cm²) among male, female and children per examination

technique, and experience of interventionists and variability in machines which use different methods for dosage measurement. Various measurement indices which are commonly used are DAP, fluoroscopy time, ED, entrance skin dose and kerma.¹

Dose-area product can be a useful tool to determine the radiation exposure during neurointervention procedures which can be used to assess for possible radiation injuries on follow-up. The DAP meter uses an ionization chamber which is fixed to the collimator on the X-ray tube and through which the whole X-ray beam passes. DAP is measured in Gy-cm² and is a function of the cross section of an X-ray beam and the X-ray exposure at the level of the collimator. Conversion factors have been previously described which can be used for calculation of effective dose from DAP.^{9,10}

DAP cannot accurately delineate individual patient risk, but it may provide estimation about the risk of stochastic and deterministic effects by providing the effective dose and entrance skin dose.³

In addition, we have estimated these values by separating our study population into male, female and pediatric population which has not been extensively studied before. No significant difference was found between male and female population. Pediatric population, however, showed reduced DAP values (104 vs. 84 Gy-cm²) and a number of frames (308 vs. 271.5) with increased fluoroscopic time (11.6 vs. 14.28 min) when compared to the adult population. A probable explanation for lower DAP values in the pediatric population is the use of low KV and mAs settings in the pediatric population.

The main aim of this study was to provide a reference range in Indian population for radiation exposure as measured at a tertiary level care center with vast experience in neurointervention procedures.

Table 3: Review of previous studies with diagnostic cerebral angiography for intracranial aneurysms

Reference	No. of patients	DAP (Gy-cm ²)		
		Mean	Fluoroscopy time (Min) Mean	Number of frames Mean
Present study	161	105.1	11.6	295
Chang et al. ³	439	136.6	12.6	251
D’Ercole et al. ⁴	100	142.1	9.9	220
Aroua et al. ⁵	91	121	12.6	-
Verdun et al. ⁶	91	107	-	-
Brambilla et al. ⁷	188	158	13.7	-

There are a few drawbacks in our study. Data presented here is experience from a single tertiary-level center with its own set of protocols during such procedures and may vary from other institutes.

These values are for a biplane machine from a single vendor and values may vary from other institutes having different machines. These investigations were carried out by different operators and slight variation due to the skill and expertise of the operator may alter the radiation exposure.

However, we believe that this information can help in future risk estimation and prognostication of radiation exposure and help in the implementation of radiation safety measures. A future reference data from other premier institutes can help in standardization of radiation exposure and risks in patients undergoing such procedures.

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