

Radiation Dose From Uterine Artery Embolization Procedures: A Single Center Study

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ABSTRACT

AIM: To establish a local radiation dose reference level for uterine artery embolization procedures conducted at a large tertiary care medical city; and to benchmark our data with the internationally published reference levels worldwide.

MATERIALS AND METHODS: In this work analysis was performed on the available data from the modality dose report obtained by the imaging system at the end of the procedure for eighty four patients, and archived in the picture archiving and communication system (PACS).

RESULTS: We have found a median P_{KA} value of 347 [Gy.cm²] for 84 UAE procedures conducted in our medical center. Comparisons with the internationally published data are discussed.

CONCLUSIONS: The reported patient P_{KA} are comparable with internationally reported studies and current trends. The medical use

of x-ray imaging during interventional procedures is a safe practice for all categories of involved personnel including the patients. Further deeper analysis of the factors affecting the levels of radiation dose is recommended. Such analysis will allow potential optimization of the procedure.

Key words: Uterine artery embolization; Air kerma area product; Patient radiation dose; Interventional radiology

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INTRODUCTION

The number of procedures utilizing image guided noninvasive interventions is increasing, therefore attention must be paid to closely monitor both patients and staff radiation doses as results of that increase. Regular application of radiation protection measures plays an important role in ensuring that patients' doses are optimized.

During the last decade the number, complexity and variety of interventions using fluoroscopy guidance has increased. Radiation protection regulations require routine monitoring of radiation doses received by patients undergoing interventional procedures using fluoroscopy guidance.

Uterine artery embolization (UAE) is a minimal invasive procedure that requires fluoroscopic and angiographic imaging and this causes a concern regarding the radiation dose received by the patient during the intervention. It is known that angiographic imaging systems can deliver a significant amount of radiation to the patient's skin; therefore radiation dose monitoring is required^[1].

METHODS

UAE procedure is a minimally invasive procedure performed under fluoroscopic guidance in the Interventional Radiology Department. A catheter is introduced to the sheath that is inserted either in radial or femoral arteries, the micro-catheter is then placed in the uterine

artery and embolic agents is injected to block the artery in order to prevent hemorrhages and cut off blood supplies to uterine fibroids. The routine fluoroscopy pulse rate used in our institution is 10 pulses/sec, maximum collimation is applied at all times and angulation projections are routinely used.

In this study we have retrospectively collected from the angiographic system registered dose report data concerning 84 patients who underwent UAE procedures in 2019. Radiation dose indicators such as, the fluoroscopy time (FT) in minutes, the cumulative kerma area product (P_{KA}) in $[Gy.cm^2]$, the cumulative reference air kerma ($K_{a,r}$) in $[mGy]$. We used a biplane system C-arm with flat detector angiography, AXIOM Artis dBA (Siemens, Erlangen, Germany) to conduct the UAE procedures.

RESULTS

As expected a linear regression relationship was found between the cumulative air kerma measured at the reference point ($K_{a,r}$) and the cumulated kerma area product (P_{KA}). Figure 1 shows the relationship between P_{KA} and $K_{a,r}$. Equation 1 has the mathematical relationship between P_{KA} and $K_{a,r}$ that was found for the angiographic imaging system used in this study: $P_{KA} [Gy.cm^2] = 84.6 + 0.125 K_{a,r} [mGy]$ ($R = 0.779, p < 0.001$)^[1].

There are a number of published studies reporting radiation dose assessments and dose reduction and optimization techniques^[2-7]. The reported values of P_{KA} are in table 4. In this study we have found a median P_{KA} value of 347 $[Gy.cm^2]$ for 84 UAE procedures conducted in our medical center.

DISCUSSION

Comparing radiation dose values and dosimetric quantities among published studies are very difficult because the procedures identification are not standardized and also their complexity vary considerably and there is no classification for procedures in accordance with their respective complexity level^[8]. Therefore there is always a need to perform regular local clinical dose audits. In this work we have analyzed available patient dose related metrics with the aim of identifying the metrics or variables that affect the most the patient radiation exposure represented by the kerma area product during UAE.

The recommended DRL for UAE was set at 450 $[Gy.cm^2]$ and the reported 75th percentile P_{KA} from the radiation doses in interventional radiology procedures study (RAD-IR) data was 392 $[Gy.cm^2]$ ^[2].

Procedures with DAP values above 300 $[Gy.cm^2]$ should be optimized if possible. A recent study suggests to use a DAP value of 50 $Gy.cm^2$ as target value for UAE procedures. In this study the authors suggested strategies for reducing radiation exposure during UAE; the strategies included: optimized source-image and object-image distances, avoidance of magnification, use of tight collimation, use of road-mapping, avoidance of oblique projections, use pulsed fluoroscopy with low images per second, use low frame rates, use last-image-hold and avoid 3D rotational angiography^[9].

The use of optimization strategies will reduce the radiation dose received by the patients as well as the staff performing the procedure especially in cases expected to lead to a higher than usual radiation dose like for obese patients^[10].

CONCLUSIONS

The reported occupational doses in interventional radiology including fluoroscopically guided procedures was well below the ICRP

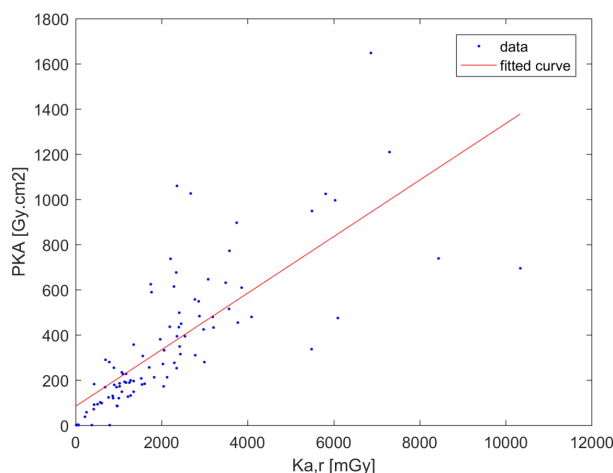


Figure 1 Cumulative P_{KA} in $[Gy.cm^2]$ as a function of $K_{a,r}$ in $[mGy]$.

Table 1 summary of patient and radiation dose metrics

	Time [min]	$P_{KA} [Gy.cm^2]$	$K_{a,r} [mGy]$
average			
minimum	7.3	0.46	9
maximum	105.9	1648	10340
standard deviation	15.6	304	1878
Coeff of variation	0.56	0.87	0.89

Table 2 Comparison of this study with few of the reported PKA values in the literature.

Author	Year	$P_{KA} [Gy.cm^2]$	$K_{a,r} [Gy]$	n
Miller	2009	392	2.5	90
Vano	2009	236		
Ruiz-Cruz	2016	214		56
Durrani	2016	437 (267) *		
Kohlbrener	2017	438 (175) *		
Scherthaner	2018	527 (146) *		
This study	2020	347	2.1	100

The values in parentheses are the values obtained after applying imaging system optimization.*

recommended annual dose limit of 20 mSv. The obtained results are in agreement with internationally reported studies and current trends. The medical use of x-ray imaging during interventional procedures is a safe practice for all categories of involved personnel when close adherence to basic radiation protection methods are observed.

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