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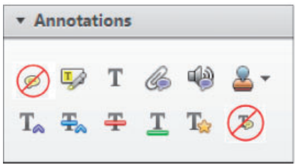

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The importance of protection glasses during neuroangiographies: A study on radiation exposure at the lens of the primary operator

JB Tavares[1,2], E Sacadura-Leite[2,3], T Matoso[2], LL Neto[1], L Biscoito[1], J Campos[1] and A Sousa-Uva[3]

Abstract

Background: In interventional neuroradiology, few operators routinely use radiation protection glasses. Moreover, in most centers, radiation dose data only accounts for whole body dose without specific information on lens dose. In 2012, the International Commission on Radiological Protection advised that the threshold limit value for the lens should be 20 mSv/year instead of the previous 150 mSv/year limit. The purpose of this study was to compare the radiation dose in the operator's lens during real diagnostic and interventional neuroangiographies, either using or without lead protection glasses.

Methods: Using the Educational Direct Dosimeter (EDD30 dosimeter), accumulated radiation dose in the lens was measured in 13 neuroangiographies: seven diagnostic and six interventional. Operators with and without radiation protection glasses were included and the sensor was placed near their left eye, closest to the radiation beam.

Results: Without glasses, the corrected mean dose of radiation in the lens was 8.02 μSv for diagnostic procedures and 168.57 μSv for interventional procedures. Using glasses, these values were reduced to 1.74 μSv and 33.24 μSv, respectively.

Conclusion: Considering 20 mSv as the suggested annual limit of equivalent dose in the lens, neuroradiologists may perform up to 2494 diagnostic procedures per year without protecting glasses, a number that increases to 11,494 when glasses are used consistently. Regarding intervention, a maximum of 119 procedures per year is advised if glasses are not used, whereas up to 602 procedures/year may be performed using this protection. Therefore, neuroradiologists should always wear radiation protection glasses.

Keywords

Radiation protection, lens radiation exposure, lead protection glasses

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Introduction

In interventional neuroradiology, there is exposure to ionizing radiation of the lens of the primary operator.[1,2] Ionizing radiation may be associated with deterministic and stochastic effects. For deterministic effects there is a threshold that defines the value above which the effect presents itself, whereas no threshold can be defined for stochastic effects.[3]

Traditionally, cataracts have been considered to be a deterministic effect and the International Commission on Radiological Protection (ICRP) had published threshold values for detectable opacities in the lens, recommending for professionals an equivalent dose limit for the lens of 150 mSv/year.[4]

However, with increasingly better diagnostic procedures regarding the presence of opacities in the lens (they can be detected by modern microscopic ophthalmological techniques like slit lamp),[5] in 2012 a new statement from ICRP was released acknowledging that, regarding these tissue reactions at the lens, threshold values are lower than previously considered.[6] Subsequently, the proposed occupational equivalent dose limit for the lens of the eye was lowered from the previous 150 mSv/year to 20 mSv/year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

[1]Departments of Neuroimaging, North Lisbon Medical Center, Lisbon, Portugal
[2]Department of Occupational Health, North Lisbon Medical Center, Lisbon, Portugal
[3]CISP, National School of Public Health/NOVA, Lisbon, Portugal

Corresponding author:
Joana Barata Tavares, Neuroradiology, Lisbon North Medical Center, Av. Prof. Egas Moniz 1649-035 Lisboa, Portugal.
Email: joanabaratatavares@gmail.com

Over the years, many studies have been published confirming that lead protection glasses reduce the lens exposure from 2 to 10 times,[7–11] and nowadays every radiologist is obliged to use a variety of lead protection equipment, including glasses. Nevertheless, in daily practice most interventional radiologists do not wear lead glasses, mainly because they are uncomfortable and no gain in using them is immediately perceived.[12]

In fact, all these confirmatory studies were performed with phantoms,[7–10] and studies with real interventional procedures were only conducted in the interventional cardiology setting.[13–15] To our knowledge, no study has ever been conducted during real neuroradiological procedures, which could considerably have more impact on the neuroradiologists' perception of radiation exposure in daily practice. Since they are the primary operator, they are the ones nearer the beam of radiation, thus receiving the most amount of ionizing radiation of all the professionals involved in neuroangiographies.

The purpose of this study was to compare the radiation dose in the operator's lens during real diagnostic and interventional neuroangiographies, either using or without lead protection glasses. The number of procedures that may be performed per year within the suggested limit of exposure was calculated.

Methods

Research design

This was a field experimental study in which 13 consecutive diagnostic and interventional neuroangiographies were evaluated.

Subjects

A total of 13 neuroangiographies were evaluated and four experienced interventional neuroradiologists of a Neuroradiology Department in a Portuguese central hospital participated in the study. All angiographies were performed in a conventional and similar way: at the patient's right side, using a common femoral artery approach.

Material used

An Educational Direct Dosimeter (EDD30 dosimeter®) was used. This equipment has a small sensor on a cable connected to a display unit. The sensor can measure the dose and dose rate to a specific part of the body, namely to eyes, hands, and feet.

The dose rate range and the dose range of this equipment were, respectively, between 0.03 mSv/h and 2000 mSv/h and between 0.001 μSv and 9999 Sv.

In our study, its sensor was placed near the left eye of the main operator, since it is the one nearer the beam of radiation.

Evaluations were performed with the sensor below and above the lead glasses in order to quantify the actual radiation at the lens with and without radiation protection, respectively. We measured the total dose for each diagnostic or therapeutic procedure and also the total time of exposure.

All glasses used in this study had both front (0.5 mm lead thickness) and lateral (0.25 mm lead thickness) protection.

Ethical issues

We explained the aims of the study and four neuroradiologists of a Neuroradiology Department in a Portuguese central hospital agreed to participate on it.

Statistical methods

Angiographies were categorized as diagnostic without glasses, diagnostic with glasses, interventional without glasses, and interventional with glasses. Means for the total dose measured by the dosimeter for each group were performed and they were later corrected for the variable time.

A statistical analysis was performed in order to extrapolate how many neuroangiographies, either with or without glasses, each main operator may perform per year keeping within the limits of equivalent dose for the lens proposed in the last ICRP recommendation.[6]

Results

Seven of the 13 neuroangiographies evaluated were diagnostic and six were interventions. Regarding diagnostic procedures, three were evaluated with glasses and four without.

The six interventions in which the evaluation was performed were: three aneurysms, one treated with coils and two with stents (one with glasses and two without), two dural arterial-venous fistulae embolized with glue and particles (one with glasses and one without), and one facial venous malformation treated with percutaneous sclerotherapy (with glasses).

Without glasses, the mean dose of radiation at the lens was 6.38 μSv for diagnostic procedures and 248.67 μSv for interventional procedures. With glasses, these values were reduced to 2.10 μSv and 17.45 μSv, respectively.

However, since we were evaluating real procedures, the mean exposure time for each group is not the same. Controlling the dose results for time, we calculated the corrected mean total dose per procedure detected by dosimeter at the lens. The results are presented in Table 1.

Considering the corrected mean total dose per procedure detected by the dosimeter's sensor, we then extrapolated the number of procedures each interventional neuroradiologist may perform in order to keep

Table 1. Average dosimeter readings and radiation exposure at the lens of the primary operator.

	Diagnostic procedures		Interventional procedures	
	Without glasses	With glasses	Without glasses	With glasses
Number of procedures	4	3	3	3
Mean total dose (μSv)/ procedure detected by dosimeter	6.38	2.10	248.67	17.45
Radiation time emitted by the angiograph (min)	6.07	9.20	122.23	43.50
Corrected mean total dose (μSv)/procedure detected by dosimeter	8.02	1.74	168.57	33.24
Averaged time assumed (min)	7.63	7.63	82.86	82.86

Table 2. Extrapolated number of procedures per year to reach the limits suggested by ICRP.

	150 mSv		20 mSv	
Number of procedures to reach the suggested limits	Without glasses	With glasses	Without glasses	With glasses
Diagnostic procedures	18,703	86,207	2494	11,494
Interventional procedures	890	4513	119	602

within the proposed ICRP equivalent dose limit for the lens of the eye. Considering the former 150 mSv limit, one could perform up to 890 intervention procedures per year without lead protection glasses and up to 4513 intervention procedures if the glasses are used.

However, with the new suggested annual limit of equivalent dose at the lens (20 mSv), neuroradiologists may only perform a maximum of 119 procedures/year if glasses are not used and up to 602 procedures/year may be performed using this protection. These results are presented in Table 2.

Discussion

The results of the detected doses are obviously very different in diagnostic and intervention procedures, with averages of radiation exposure considerably lower in the diagnostic group as they take less time to perform and the main operator can step back during acquisitions instead of being near the radiation beam while inserting an embolization agent.

The use of lead glasses reduces, in diagnostic procedures, from 8.02 μSv to 1.74 μSv the total dose of radiation per procedure, which means they reduce the lens' exposure to radiation by a factor of about 4.6. In the interventional procedures, the use of lead glasses reduces from 168.57 μSv to 33.24 μSv the total dose of radiation per procedure, which means they reduce the lens' exposure to radiation by a factor of about 5.1.

Our results are in agreement with those published previously in the literature. Thornton et al. concluded that the use of lead protection glasses reduced lens exposure by a factor of 5–10.[7] McVey et al. confirmed a factor of 5 reduction with the use of lead glasses,[8] while Galster et al. stated that, in association with the use of ceiling shields, lead glasses reduced the lens' exposure to radiation by a factor of 8–10.[9] In our study, since there were real procedures, it would have not been ethical to take off the ceiling shields, so all procedures were performed with them and only the use or not of lead glasses was evaluated by putting the dosimeter's sensor below or above them.

The major limitation of our study is the reduced number of procedures that are evaluated. The sensitivity of the equipment can be also a limitation to determine the total dose in the operator lens. Nevertheless, this is, to our knowledge, the first study to confirm the usefulness of lead glasses in real procedures and we were able to extrapolate the number of angiograms a primary operator may perform, keeping the lens radiation exposure within the annual limits suggested by ICRP.

For diagnostic procedures the results are above the number of angiograms usually performed by neuroradiologists. However, relating to interventional procedures, with the new 20 mSv proposed dose limit, if one does not use glasses, only 119 procedures can be performed per year, which is a lot less than what is usually performed by interventional neuroradiologists (it is less than three procedures per week!). Using glasses raises this number to 602, translating into more or less 12 procedures per week, which is a number closer to reality. Therefore, it is imperative for interventional neuroradiologists to always wear radiation protection glasses, especially since they usually perform not only interventional but also diagnostic angiograms, raising even more the exposure to ionizing radiation of the lens.

Conclusion

With the new suggested annual limit of equivalent dose at the lens (20 mSv), neuroradiologists may only perform a maximum of 119 procedures/year if glasses are not used, whereas up to 602 procedures/year may be performed using this protection.

Since most interventional neuroradiologists perform more than 119 procedures/year, plus all the diagnostic ones, they should always wear radiation protection glasses.

Declaration of conflicting interests

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