



International Joint Conference Radio 2019

Comparative Study of the Use of Bismuth Shielding on Head Computed Tomography Scans Using Phantoms

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Introduction: Computed Tomography (CT) has been one of the most used exam for radiologic diagnostic in medicine. The increase of CT is a global concern due to high doses of radiation [1]. The dose evaluation in CT is one of many steps that can contribute for reducing patient doses [2,3]. The head CT scans helps to diagnose disorders that affect the brain, including tumors, infarction, bleeding within the brain, hematoma and other diseases. The aim of this work is to compare the reduction of absorbed dose in the head CT scan with and without the use of bismuth shielding using a male and female anthropomorphic phantom model Alderson Rando.

Methods: The head CT scan were done from the cervical vertebra C1 to the top of skull, in a GE CT scanner, LightSpeed VCT model, with 64 channels. The scan parameters used in this experiment were 120 kV, 175 mA, 0,8 s and 0.984 of pitch. Radiochromic films strips were used to evaluate the doses in the organs such as lenses, thyroid, hypophysis, spinal cord, pharynx, breasts, salivary and parotid glands. Films strips were calibrated in a reference radiation for CT (RQT9) that were reproduced in the Calibration Laboratory of the Development Center of Nuclear Technology (CDTN/CNEN) [4,5,6]. It was conducted two head CT scans using the same protocol, with the phantom in supine position with and without bismuth shielding. After the phantom head CT scan the radiochromic film strips were digitized. Digital images were worked and the film calibration curve was used to obtain the organ absorbed doses. With the data obtained, it was found the organs dose variation for the CT scans.

Results: Absorbed doses in the organs positions such as: lenses, thyroid, pharynx, hypophysis, breast, spinal cord, parotid gland and salivary gland are shown in Table 1.

Table 1: Mean absorbed dose in some organ positions in the phantoms during head CT scans with and without bismuth shielding on eyes.

Organ	Absorbed Dose (mGy)	
	Without Bismuth Shielding	With Bismuth Shielding

	Male	Female	Male	Female
Lenses	19,01 ± 0,77	17,44 ± 0,66	12,83 ± 0,90	9,49 ± 0,57
Hypophysis	9,59 ± 0,45	15,36 ± 0,47	7,06 ± 0,54	13,79 ± 0,46
Pharynx	2,46 ± 0,62	2,46 ± 0,28	0,93 ± 0,41	1,20 ± 0,41
Spinal Cord	0,76 ± 0,56	1,74 ± 0,56	0,61 ± 0,58	0,48 ± 0,58
Parotid Gland	18,35 ± 0,67	22,98 ± 0,69	16,67 ± 0,76	20,18 ± 0,81
Salivary Gland	7,30 ± 0,55	4,29 ± 0,55	6,55 ± 0,36	2,65 ± 0,38
Thyroid	1,62 ± 0,35	2,35 ± 0,30	0,61 ± 0,41	1,49 ± 0,41
Breast	0,91 ± 0,26	0,95 ± 0,31	0,64 ± 0,22	0,49 ± 0,22

Record doses were lower with the use of bismuth shielding in both phantoms for all organs, mainly in the lenses. The analysis of noise in the image of the head central slice presented acceptable values for soft tissues, less than 1%.

Conclusions: Dose values were significantly reduced and they suggested that the use of bismuth shielding would be a proper procedure for protection during a head CT scan.

References:

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