RADIATION EXPOSURE OF BRAIN IS WITHIN ACCEPTABLE RANGE EVEN WITH EXTENSIVE AND REPEATED CT-BASED NEUROIMAGING FOR ACUTE ISCHEMIC STROKE

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Background and aims-

The preferred neuroimaging in acute ischemic stroke continues to remain CT based, largely due to the widespread availability, rapid acquisition, and acceptable image quality. However, whether repeated neuroimaging leads to an increased risk of somatic and genetic effects of ionizing radiation remains debatable. Dose tracking software can automatically monitor the radiation received by patients during computerized tomography (CT) based imaging. We evaluated radiation exposure during standard imaging protocols consisting of non-contrast CT head (NCCT), CT Angiography (CTA) and CT Perfusion (CTP).

Methods: Radiation data was retrieved for various CT based imaging studies, performed for ischemic stroke patients during the year 2015. The volume-weighted CT dose index, dose-length product, scan length, effective dose and whole body integral dose were extracted from dose-tracking software. Radiation doses for brain, skin, eye, thyroid and red bone marrow were extracted.

Results: The radiation data for brain imaging for NCCT (n =391), CTA (n=149) and CTP (n=61) were retrieved from the institutional dose tracking system attached to a dedicated CT scanners (Phillips iCT256 with iDose4).

Table 3. Radiation Dose Metrics

Variable	NCCT		CTA		CTP	
	Standar d Dose (n=391)	Low Dose (n=32)	Standard Dose (n=149)	Low Dose (n=32)	Standard Dose (n=61)	Low Dose (n=32)
Mean CTDI vol in mGy (SD)	52.4 (0.3)	47.4 (0.05)	28.7 (8.1)	14.7 (2.4)	93.0 (0.9)	72.0 (1.4)
Mean DLP in mGy.cm (SD)	1061.9 (272.8)	972.9 (260.2)	1415.5 (471.1)	584.6 (281.6)	1916.2 (339.7)	995.1 (233.2)
Mean ED ICRP 103 in mGy (SD)	2.6 (0.7)	2.4 (0.6)	4.5 (2.5)	1.6 (0.7)	4.5 (0.9)	2.2 (0.5)
Whole Body integral in mGy (SD)	0.4 (0.1)	0.39 (0.1)	0.6 (0.2)	0.2 (0.02)	0.8 (0.14)	0.4 (0.09)

***All differences are statistically significant (p<0.001)**

Table1. Stroke Protocol Scanning Parameters.

Variable	NCCT		CTA		CTP	
	Standard Dose	Low Dose	Standard Dose	Low Dose	Standard Dose	Low Dose
Scan type	Helical	Helical	Helical	Helical	Axial	Axial
Detector Cofiguration	64 X 0.625	64 X 0.625	128 X 0.625	128 X 0.625	64 X 0.625	64 X 0.625
Pitch	0.4	0.4	0.4	0.4	-	-
FOV (mm)	250	250	260	250	250	250
kVp	120	120	120	100	80	80
mAs/SLICE	220	280	300	200	150	100
Rotation Time (sec)	0.5	0.5	0.5	0.5	0.5	0.5
Section thickness (mm)	3	3	1	1	5	5
CTDI vol (mGy)	54.4	44.4	38.3	15.6	120	72

Table 2. Patient Metrics

Variable	NCCT			CTA			CTP		
	Standar d Dose (n=391)	Low Dose (n=32)	P value	Standar d Dose (n=149)	Low Dose (n=32)	P value	Standar d Dose (n=61)	Low Dose (n=32)	P value
Mean Age in years (±SD)	62 (17)	63 (17)	0.098	59 (14)	63 (17)	0.087	60 (17)	63 (17)	0.082
Mean Skull Diameter in mm (±SD)	171.4 (6.9)	171.3 (7.3)	0.092	186.8 (17.6)	186.3 (24.3)	0.074	172.7 (23.1)	172.6 (30.1)	0.95
Water Equivale nt Diameter in mm	164.9 (7.9)	164.3 (7.9)	0.022	186.8 (17.6)	192.5 (38.5)	0.067	172.4	176.2	0.068
Scan length in mm	202.8 (52.1)	204.5 (54.8)	0.091	558.1 (364.9)	395.1 (320.8)	<0.001	2114.4 (278.1)	1912.4 (418.9)	<0.001

Table 4. Radiation Dose to Various Sensitive Organs

Variable	NCCT		CTA		CTP	
	Standard Dose (n=391)	Low Dose (n=32)	Standard Dose (n=149)	Low Dose (n=32)	Standard Dose (n=61)	Low Dose (n=32)
Mean Brain dose in mGy (SD)	57.7 (12.1)	43.1 (9.1)	101.8 (17.8)	20.7 (5.7)	82.1 (3.2)	55.7 (4.5)
Mean Skin dose in mGy (SD)	8.5 (3.1)	5.8 (1.6)	11.6 (2.2)	2.6 (1.8)	11.2 (1.7)	6.1 (1.5)
Mean Red Bone Marrow dose in mGy (SD)	7.4 (2.9)	5.2 (1.5)	9.7 (2.9)	2.6 (1.5)	8.7 (0.9)	4.7 (1.3)
Mean Eye dose in mGy (SD)	83.4 (17.4)	63.6 (17.8)	159.1 (26.7)	33.6 (11.7)	152 (3.2)	100.3 (24.6)
Mean Thyroid dose in mGy (SD)	26.6 (9.4)	8.7 (3.8)	13.4 (5.8)	11.9 (3.9)	5.1 (0.9)	3.3 (0.8)

***All differences are statistically significant (p<0.001)**

Conclusions:

1. Radiation exposures of sensitive organs are within acceptable limits with standard neuroimaging protocols for AIS.
2. Lower-dose CT imaging protocols could reduce the radiation doses to the radiosensitive organs without appreciable deterioration in image quality.