HALO CT Phantom : Successful Implementation for Continuous Dose Monitoring using Average Male Chest CT Protocols

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I. Introduction

The CT phantom is designed to simulate human anatomy. X-rays are short wavelength electromagnetic waves. These waves pass through human anatomy and are attenuated by tissue,fat and bone. The differences in attenuation are used to distinguish between similar tissues of different densities. CT systems use multiple x-ray exposures and a computer reconstruction process to generate tomographic or slice images of the human body. The CT system calculates absorbed dose (mGy) for the patient. Absorbed dose is the concentration of energy from radiation that an object absorbs.

II. Problem

The HALO CT phantom design addresses the problem of the inability of current CT phantoms to measure absorbed dose with a physical size that is light and easy to setup. This new phantom design will allow a continuous dose monitoring program to be implemented.

III. Methods

The HALO phantom represents a 97 cm average male chest size. It evaluates x-ray exposure reference using a CT chest protocol. An exposure probe is inserted into the exposure chamber position of the phantom (Fig. 1). A routine adult chest protocol is selected and the entire thickness of the phantom is scanned at CT isocenter (center of CT gantry bore). The measured x-ray dose (mGy) is recorded and compared to the OEM CTDI reference dose (mGy) that is indicated on the console display for the selected protocol.

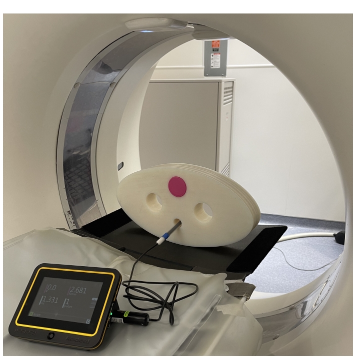

Fig. 1 HALO CT phantom positioned in CT isocenter

IV. Results & discussion

A CT Dose Monitoring Program was setup in 2023 at the University Health Network, Mount Sinai Hospital and Women's College Hospital. The purpose of the program is to provide dose measurements of CT systems after a repair or upgrade has been completed. This is necessary to confirm CT system stability.

1. A baseline HALO CT phantom dose reference (mGy) is measured and recorded (Fig. 2).
2. Follow up testing is completed after CT system repairs or upgrades. The HALO CT phantom dose reference is recorded along with the CT console dose reference (Fig. 3).
3. HALO CT phantom dose results are compared to the previous baseline results to confirm system dose stability. Dose variations of (±) 3mGy were noted with no issues of hardware stability after the repair was completed.

CT Dose Monitoring Program 2023

Site	Room	Model	Site#	Date	Routine Chest -NC
				2023	Measured mGy / Console mGy
TGH	1PMB229	Aquilion 64	06066135C	10-May	11.9 / 14.6
TGH	1PMB233	AQ Prime	ON443914CT	09-May	5.2 / 4.2
TGH	1EB510A	AQ Vision	ON443912CT	05-May	7.2 / 6.2
TGH	1EB510C	AQ Prism	L2SA2132033CT	01-May	1.8 / 1.9
TGH	RFE-G-456	Aquilion 1	ON44393CT	16-May	5.6 / 7.6
MSH	5-510	Aquilion 64	06064074C	03-May	12.2 / 15.2
MSH	5-512	Aquilion 64	06064105C	02-May	13.1 / 15.2
MSH	5-522	Aquilion 64	06064136C	08-May	12.6 / 15.2
MSH	F5-03	Somatom	10059	19-May	6.9 / 6.4
TWH	3-410	Aquilion 64	06293024C	11-May	12.8 / 15.2
TWH	3-414	Aquilion 64	06293056C	04-May	13.6 / 15.2
TWH	1FP402	AQ Prism	ON44374CT	17-May	4.1 / 4.0
PMH	3-555	Aquilion 64	06322056C	07-May	15.8 / 15.2
PMH	3-557	Aquilion 64	06322015C	07-May	15.7 / 15.2
PMH	3-663	AQ Vision	ON44386CT	07-May	8.0 / 6.7
WCH	2340	Aquilion 1	ON41900CT	18-May	8.1 / 7.6

Fig. 2 CT dose monitoring baseline results

CT QC Testing

Site	Room	Model	Service	Date	Routine Chest -NC
				2023	Measured mGy / Console mGy
TWH	1FP402	AQ Prism	CT detector replaced	25-May	4.2 / 4.0
WCH	2340	Aquilion 1	HV unit replacement	04-Jun	9.1 / 9.4
MSH	5-512	Aquilion 64	Scan computer replaced	07-Jun	13.9 / 15.2
TGH	1PMB229	Aquilion 64	X-ray tube / SRU replaced	30-Jun	12.4 / 15.2
MSH	F5-03	Somatom	X-ray tube replaced	12-Jul	5.6 / 5.6
PMH	3-557	Aquilion 64	Recon boards replaced	19-Jul	17.4 / 15.2
TGH	1PMB229	Aquilion 64	SRUH unit replaced	27-Jul	13.2 / 15.2

Fig.3 CT dose follow up testing results

References

1.ICRP 87 Managing Patient Dose in Computed Tomography, Elsevier Science Ltd. (2001). J. Valentin.
2.Quality and Safety in Imaging,Springer Nature Switzerland AG (2018).Lluis Donoso-Bach,Giles W.L.Boland.