ID 2359347
Comparison of CT Dose Modulation Systems: Results in an optimization process

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INTRODUCTION

The automatic adjustment of CT scanners flow have been improved continuously and builds an important resource of otimization. To ensure its effectiveness and adequacy to the local population, this system must be evaluated periodically and before use. There are four main ways which modulation can be done: modulation in axis Z, angular modulation, XY plan, temporal modulation and combining all the previous ones.

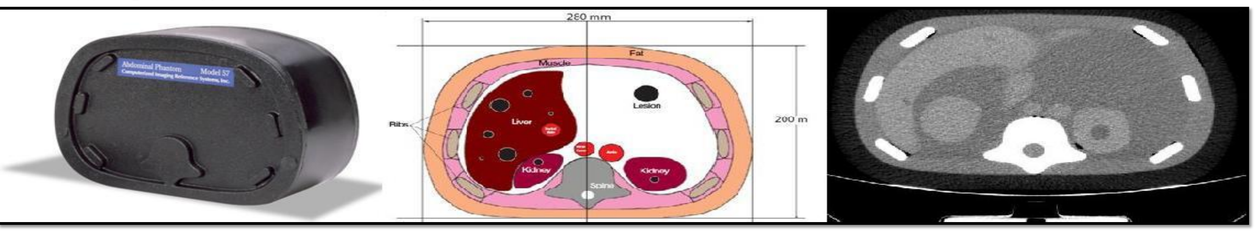
OBJECTIVES

Verify the influence of the dosis modulation system in the quality of images checking noise's variation and the respective dose amounts during exposure in the abdomen simulator for GE and Philips equipments.

MATERIALS AND METHODS

The work was developed by two institutions in Rio de Janeiro, Brazil.

Equipments: Philips 64 e Siemens Duo
Number of Images: 115
Parameters: filter and reconstruction increment, cut thickness, kVp, mAs, collimation, Pitch, scanning length, number of cuts per rotation, field of view (FOV), AEC type and window.
Estimated dose: CVOL e PKL values were estimated for each simulation based on the nCTDIW of each scanner.
Image Quality's Evaluation: The noise was analysed in each organ through ROIs using image J software. The relations between noise and mAs were analysed in different organs of each image obtained and using different modulation systems.
Phantoms: 3D Abdominal Phanton, Triple Modality, model 057 (Figure 02) and Dosimetric Phantom.



Picture 02: Simulator of abdomen: outside part, inside part and tomographic image.

RESULTS

To quantify the modulation and compare with the one done without modulation system, the relations between noise and mAs were analysed in different organs of each image to the different modulation systems considered to check how the noise level reacts with an anatomic change and mAs (picture 04).

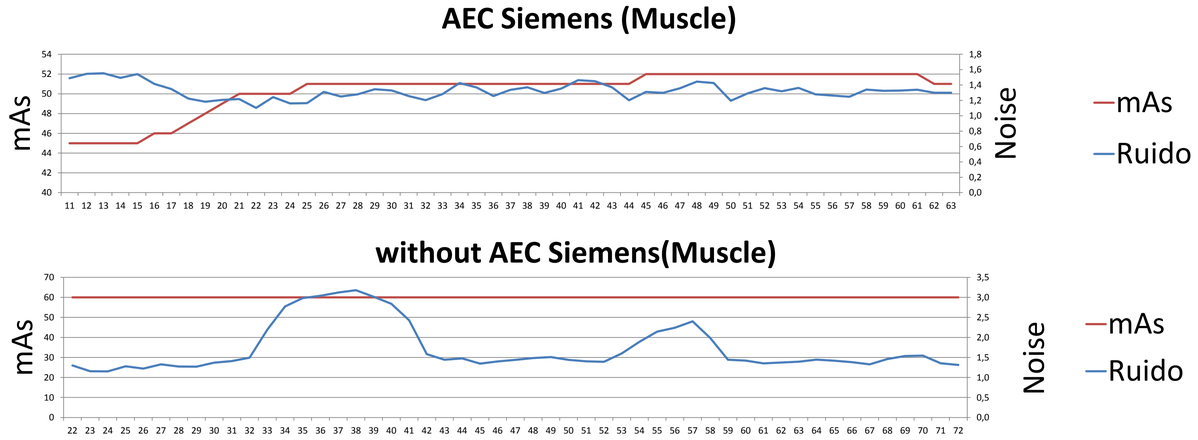


Chart 04: mAs and noise values relation to muscle with and without dose modulation using Siemens equipment.

RESULTS (cont.)

The dosimetry was done to compare the modulation systems in both equipments. It was observed a reduction of dose in **52%** when compared with the value of the simulation done without modulation using Philips equipment (chart 01).

Chart 01: CVOL and DLP amounts measured for each system.

Fabricante	Sistema de Modulação	mAs_{med}	$nCTDI_W$ (mGy/mAs)	Cvol (mGy)	ΔX	DLP (mGy.cm)
Philips	ZDOM	120,77	0,057	6,88	50,0	344,0
	DDOM	112,08	0,057	6,39	50,0	319,5
	Sem AEC	129,00	0,057	7,35	50,0	367,5
Siemens	CARE dose	50,03	0,090	3,75	51,5	192,12
	Sem AEC	60	0,090	4,5	51,5	230,4

One part of the chart was illustrated to show mAs varition per image and the respective values of CT and noise for each organ of the simulator which represents several organs and regions of interest with different CT numbers.

Chart 02: Siemens values with CARE dose modulation.

imagens	mAs	Coluna		Fígado		Músculo	
		# CT	Ruido	# CT	Ruido	# CT	Ruido
11	45	478,1	1,1	-	-	35,98	1,5
12	45	481,1	1,0	-	-	38,09	1,5
13	45	435,5	1,2	-	-	36,44	1,6
14	45	446,8	1,5	-	-	37,01	1,5
15	45	486,1	1,2	-	-	35,24	1,5
16	46	458,5	1,0	-	-	41,2	1,4
17	46	455,1	1,2	-	-	45,4	1,3
18	47	451,6	1,2	-	-	46,2	1,2
19	48	451,1	1,1	25,5	2,0	43,9	1,2
20	49	448,3	1,0	43,0	1,2	48,8	1,2
21	50	447,9	0,9	59,2	1,5	48,2	1,2
22	50	449,3	1,0	76,6	1,4	47,9	1,1
23	50	451,0	1,0	82,5	1,2	46,9	1,2
24	50	446,5	1,1	87,2	1,3	48,4	1,2
25	51	447,7	1,2	84,9	1,3	49,5	1,2
26	51	440,9	1,2	84,3	1,3	48,0	1,3
27	51	436,9	1,2	85,1	1,3	47,4	1,3

Chart 03: Phillips values with ZDOM dose modulation.

Imagem	mAs	coluna			Fígado		
		#CT	Ruído	Contraste	#CT	Ruído	Contraste
12	109	452,7	1,0	231,0	78,6	1,7	158,7
13	110	453,6	1,2	217,6	78,9	1,7	149,3
14	110	457,1	1,1	235,7	79,6	1,6	161,0
15	110	458,0	1,1	165,8	80,3	1,6	112,0
16	111	460,0	1,1	147,4	81,4	1,7	96,3
17	111	459,8	1,1	228,0	81,8	1,7	142,6
18	111	461,4	1,1	553,2	81,4	1,9	335,9
19	111	461,9	1,1	532,3	80,1	1,8	314,7
20	111	459,5	1,2	190,5	80,0	1,8	102,4
21	111	456,3	1,4	196,7	80,0	1,8	37,8
22	112	452,1	1,4	411,2	79,5	1,8	49,0
23	112	447,7	1,4	396,1	81,8	1,8	48,6
24	113	444,5	1,4	445,9	83,5	1,8	57,5
25	113	440,5	1,4	351,3	82,8	1,9	44,0
26	113	437,4	1,5	281,9	80,7	1,9	35,3
27	114	433,9	1,7	302,0	81,0	1,7	38,9

The noises varition values were acquired for both types of simulation in several organs using Siemens system (chart 04).

Chart 04: Values of noise's variation for both types of simulation.

Variação de Ruído					
Fabricante	Sistemas de modulação	Rim	Coluna	Fígado	Músculo
Philips	Sem AEC	34,02%	59,80%	39,22%	50,28%
	DDOM	27,28%	55,90%	35,32%	30,12%
	ZDOM	27,07%	57,66%	38,10%	33,42%
Siemens	Sem AEC	149,34%	175,63%	175,63%	175,63%
	CARE dose	**16,58%**	77,75%	135%	40,93%

CONCLUSIONS

In the absence of simulation, the amounts of mAs were lower; however, in thicker anatomic regions happened a higher variation of noise. Despite this, the system done with modulation presented higher levels which is a trace of images with modulation, but respecting some linearity and with much less variation. The quality of image remained equal apart of abdomen anatomic changes. Modulation was very efficient reducing the dose in 20%.

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