

CHAPTER V

RESULT

5.1. Radiation Dosimetry

Tables 1 presents calculated values of $CTDI_w$ and table 2 shows $CTDI_{vol}$ per examination for each of the protocol parameters in Siemens Sensation 4 MDCT scanner.

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	CTDI(mGy)			
					Air	Center	Peripheral	$CTDI_w$
80	100	4x1mm	4.0 mm	4mm	12.7	5.85	8.94	7.91
		2x8mm	8.0mm	16mm	8.01	5.4	6.57	6.18
	120	4x1mm	4.0 mm	4mm	15.18	8.84	10.75	10.11
		2x8mm	8.0 mm	16mm	11.1	6.32	7.82	7.32
	150	4x1mm	4.0 mm	4mm	19.05	10.87	13.37	12.54
		2x8mm	8.0 mm	16mm	13.93	8.3	10.09	9.49
	260	4x1mm	4.0 mm	4mm	33.11	19.69	24	22.56
		2x8mm	8.0 mm	16mm	24.21	14.33	17.53	16.46
320	4x1mm	4.0 mm	4mm	40.85	24.16	29.41	27.66	
	2x8mm	8.0 mm	16mm	29.86	17.44	24.49	22.14	
120	100	4x1mm	4.0 mm	4mm	30.89	20.77	23.76	22.76
		2x8mm	8.0 mm	16mm	22.39	15.14	17.29	16.57
	120	4x1mm	4.0 mm	4mm	36.85	24.89	28.5	27.30
		2x8mm	8.0 mm	16mm	26.91	18.19	20.82	19.94
	150	4x1mm	4.0 mm	4mm	46.03	31.71	27.91	29.18
		2x8mm	8.0 mm	16mm	33.64	23.13	26.39	25.30
	260	4x1mm	4.0 mm	4mm	80.08	55.1	62.81	60.24
		2x8mm	8.0 mm	16mm	58.57	40.28	45.73	43.91
320	4x1mm	4.0 mm	4mm	98.72	68.24	77.35	74.31	
	2x8mm	8.0 mm	16mm	72.15	49.71	56.51	54.24	

Table 1 : $CTDI_w$ values of Siemens Sensation 4 scanner in sequential mode for head examination without contrast agent and rotation time is 1.0 sec

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	CTDI _{vol}	
80	100	4x1mm	4.0mm	2.6mm	7.49	
		4x2.5mm	8.0mm	6.5mm	6.84	
	120	4x1mm	4.0mm	2.6mm	8.99	
		4x2.5mm	8.0mm	6.5mm	8.20	
	150	4x1mm	4.0mm	2.6mm	11.33	
		4x2.5mm	8.0mm	6.5mm	9.71	
	260	4x1mm	4.0mm	2.6mm	19.83	
		4x2.5mm	8.0mm	6.5mm	16.94	
	320	4x1mm	4.0mm	2.6mm	24.28	
		4x2.5mm	8.0mm	6.5mm	20.93	
	120	100	4x1mm	4.0mm	2.6mm	19.89
			4x2.5mm	8.0mm	6.5mm	17.09
120		4x1mm	4.0mm	2.6mm	23.83	
		4x2.5mm	8.0mm	6.5mm	20.41	
150		4x1mm	4.0mm	2.6mm	29.59	
		4x2.5mm	8.0mm	6.5mm	25.80	
260		4x1mm	4.0mm	2.6mm	52.50	
		4x2.5mm	8.0mm	6.5mm	45.04	
320		4x1mm	4.0mm	2.6mm	64.01	
		4x2.5mm	8.0mm	6.5mm	55.53	

Table 2 : CTDI_{vol} values of Siemens Sensation 4 scanner in spiral mode for head examination without contrast agent and rotation time is 0.75 sec

Tables 3 reveals calculated values of CTDI_w and table 4 demonstrates CTDI_{vol} per examination for each of the protocol parameters in Siemens Sensation 16 MDCT scanner.

The radiation dose values obtained for a PMMA head phantom 16 cm in diameter. The results show that the radiation dose was increased if kV and mAs were increased (slice collimator, slice width, and feed/scan are constant). In increasing slice collimator, slice width, and feed/scan, while the kV and mAs were constant, the radiation dose was decreased. As the result, the central radiation dose was lower than the peripheral.

The radiation doses of Siemens Sensation 4, 60.24 mGy (in sequential mode), and 29.59 mGy (in spiral mode) were found for routine protocol parameters at King Chulalongkorn Memorial Hospital. The radiation doses of Sensation 16 was 66.36 mGy (in sequential mode), and 24.77 mGy (in spiral mode) for routine protocol parameters.

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	CTDI(mGy)			
					Air	Center	Peripheral	CTDI _w
100	100	0.75 mm	4.5mm	9.5 mm	17.67	11.32	13.22	12.59
		1.5 mm	9.0mm	19.0 mm	15.57	9.86	11.5	10.95
	120	0.75 mm	4.5mm	9.5 mm	21.24	13.6	15.87	15.11
		1.5 mm	9.0mm	19.0 mm	18.71	11.83	13.85	13.18
	150	0.75 mm	4.5mm	9.5 mm	26.55	17	19.84	18.89
		1.5 mm	9.0mm	19.0 mm	23.38	14.79	17.21	16.40
	260	0.75 mm	4.5mm	9.5 mm	46.36	29.69	34.8	33.10
		1.5 mm	9.0mm	19.0 mm	40.87	25.86	30.19	28.75
	320	0.75 mm	4.5mm	9.5 mm	61.98	39.65	45.96	43.86
		1.5 mm	9.0mm	19.0 mm	52.66	33.24	38.89	37.01
120	100	0.75 mm	4.5mm	9.5 mm	26.08	17.41	19.91	19.08
		1.5 mm	9.0mm	19.0 mm	22.96	15.13	17.28	16.56
	120	0.75 mm	4.5mm	9.5 mm	31.26	20.9	23.69	22.76
		1.5 mm	9.0mm	19.0 mm	27.6	18.14	20.78	19.90
	150	0.75 mm	4.5mm	9.5 mm	39.2	26.21	29.87	28.65
		1.5 mm	9.0mm	19.0 mm	34.61	22.75	26.17	25.03
	260	0.75 mm	4.5mm	9.5 mm	68.18	45.46	52.07	49.87
		1.5 mm	9.0mm	19.0 mm	60.18	39.56	45	43.19
	320	0.75 mm	4.5mm	9.5 mm	91.1	60.69	69.19	66.36
		1.5 mm	9.0mm	19.0 mm	77.56	49.89	55.53	53.65

Table 3 : CTDI_w values of Siemens Sensation 16 scanner in sequential mode for head examination without contrast agent and rotation time is 1.0 sec :

5.2. Comparison of Radiation Dose

To compare the radiation doses of two MDCT scanners, the CTDI_w was used. This CTDI_w values provide a radiation dose to each scanning protocol parameter, are calculated from our data. The protocol parameters (i.e. kVp, mAs) of two scanners that used to calculate CTDI_w must be similar.

Note that the result of radiation dose from two MDCT scanners, only in the series of 120 kVp, were compared. Because, Sensation 16 MDCT scanner could not used protocol parameter at 80 kV. The lowest kV for Sensation 16 is 100 kV.

The comparison between the radiation doses of two MDCT scanners are shown in Figure 10 and 11.

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	CTDI _{vol}	
100	100	0.75 mm	4.0mm	5.1mm	12.28	
		1.5 mm	8.0mm	13.7mm	10.79	
	120	0.75 mm	4.0mm	5.1mm	14.33	
		1.5 mm	8.0mm	13.7mm	12.5	
	150	0.75 mm	4.0mm	5.1mm	17.66	
		1.5 mm	8.0mm	13.7mm	16.01	
	260	0.75 mm	4.0mm	5.1mm	30.54	
		1.5 mm	8.0mm	13.7mm	27.14	
	320	0.75 mm	4.0mm	5.1mm	37.74	
		1.5 mm	8.0mm	13.7mm	34.06	
	120	100	0.75 mm	4.0mm	5.1mm	18.76
			1.5 mm	8.0mm	13.7mm	16.42
120		0.75 mm	4.0mm	5.1mm	21.82	
		1.5 mm	8.0mm	13.7mm	19.52	
150		0.75 mm	4.0mm	5.1mm	24.77	
		1.5 mm	8.0mm	13.7mm	24.63	
260		0.75 mm	4.0mm	5.1mm	47.18	
		1.5 mm	8.0mm	13.7mm	42.12	
320		0.75 mm	4.0mm	5.1mm	57.86	
		1.5 mm	8.0mm	13.7mm	52.35	

Table 4 : CTDI_{vol} values of **Siemens Sensation 16** scanner in **spiral mode** for head examination without contrast agent and **rotation time is 0.75 sec**

Figure 10 : Comparison of Radiation Doses between Siemens Sensation 4 and 16 in Sequential Mode at 120 kV

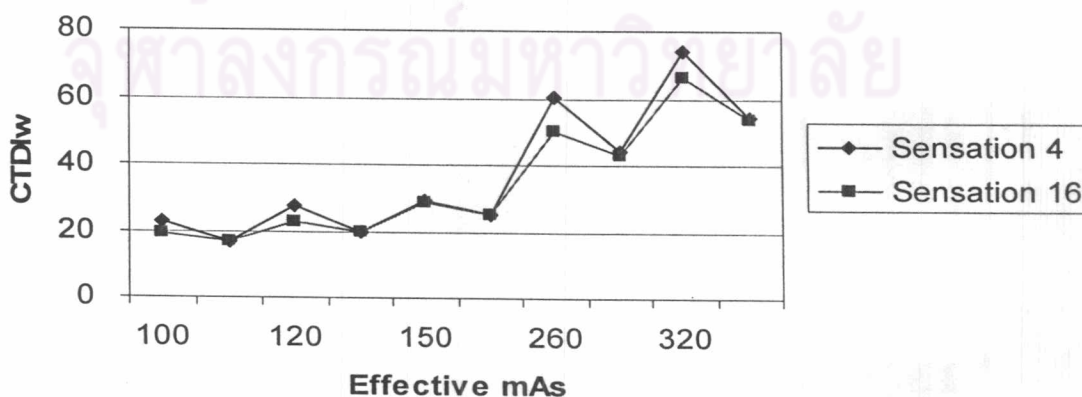
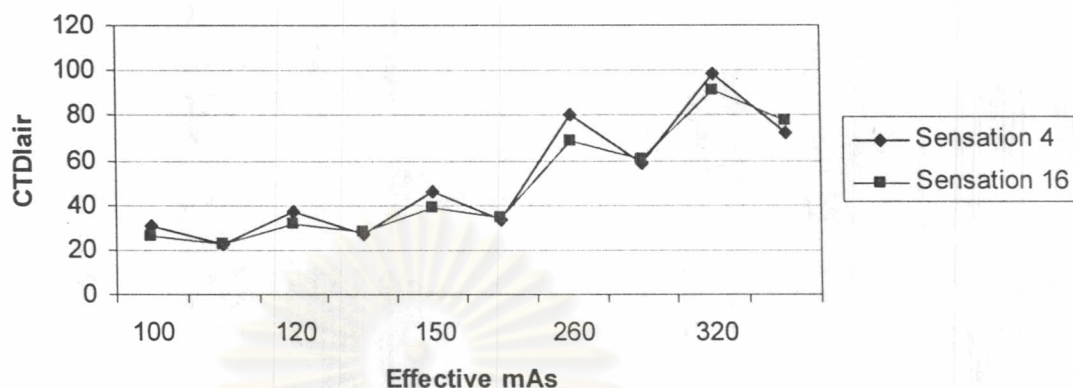


Figure 11 : Comparison of Radiation Dose in Air between Siemens Sensation 4 and 16 in Sequential mode at 120 kV



The radiation dose from Siemens Sensation 4 MDCT scanner is greater than Siemens sensation 16 for the same protocol parameter such as kVp or mAs. The difference was significant ($p < 0.05$).

5.3. Image Quality

Image quality was assessed upon analysis of image noise. Noise is expressed as a standard deviation of the measured density values (in Hounsfield units, HU) within a selected ROI in an image taken from a PMMA phantom. Noise always higher in the center than in the surface position. This was particularly pronounced in measurements with the head phantom.

A good to strong correlation between central $CTDI_w$ or $CTDI_{vol}$ and noise was found for protocols measured with the 16 cm phantom. For Siemens Sensation 4 (Table 5 and 6), in sequential mode with thin slice protocol $R^2 = 0.9668$ centrally, $p < 0.05$, and $R^2 = 0.9922$ peripherally, $p < 0.05$, with thick slice protocol $R^2 = 0.9208$ centrally, $p < 0.05$, and $R^2 = 0.9392$ peripherally, $p < 0.05$ (Figure 12 and 13).

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	Noise(HU)	
					Center	Peripheral
80	100	4x1mm	4 mm	4mm	10.7	8.7
		2x8mm	8mm	16mm	5.6	5.40
	120	4x1mm	4.5mm	4mm	10.2	8.5
		2x8mm	9.0mm	16mm	5.6	5
	150	4x1mm	4.5mm	4mm	10.4	7.6
		2x8mm	9.0mm	16mm	5	4.6
	260	4x1mm	4.5mm	4mm	7.4	5.7
		2x8mm	9.0mm	16mm	3.9	3.6
	320	4x1mm	4.5mm	4mm	6.9	5.0
		2x8mm	9.0mm	16mm	3.9	3.5
120	100	4x1mm	4.5mm	4mm	6.9	5.7
		2x8mm	9.0mm	16mm	3.5	3
	120	4x1mm	4.5mm	4mm	6.3	5.1
		2x8mm	9.0mm	16mm	3	2.9
	150	4x1mm	4.5mm	4mm	5.7	5.1
		2x8mm	9.0mm	16mm	2.5	2.3
	260	4x1mm	4.5mm	4mm	4.4	3.8
		2x8mm	9.0mm	16mm	1.9	1.7
	320	4x1mm	4.5mm	4mm	3.9	3.5
		2x8mm	9.0mm	16mm	2	1.6

Table 5 : Image noises of Siemens Sensation 4 scanner in sequential mode for head examination without contrast agent and rotation time is 1.0 sec

Figure 12 : Siemens Sensation 4 Image Noise in Sequential Mode with Thin Slice Parameters

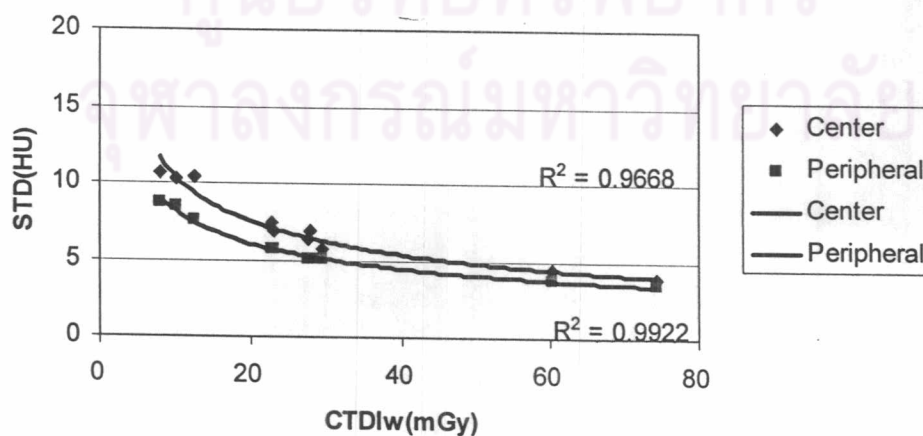
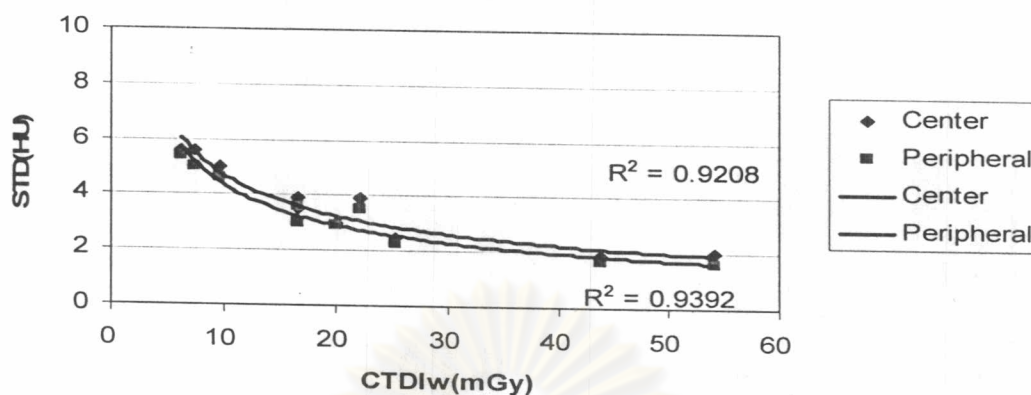


Figure 13 : Siemens Sensation 4 Image Noise in Sequential Mode with Thick Slice Parameters



In spiral mode with thin slice protocol $R^2 = 0.9073$ centrally, $p < 0.05$, and $R^2 = 0.9387$ peripherally, $p < 0.05$, with thick slice protocol $R^2 = 0.7906$ centrally, $p < 0.05$, and $R^2 = 0.8709$ peripherally, $p < 0.05$ (Figure 14 and 15).

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	Noise(HU)	
					Center	Peripheral
80	100	4x1mm	4.0mm	2.6mm	7	6.1
		4x2.5mm	8.0mm	6.5mm	4.1	3.3
	120	4x1mm	4.0mm	2.6mm	5.2	4.9
		4x2.5mm	8.0mm	6.5mm	3.7	3.2
	150	4x1mm	4.0mm	2.6mm	5.1	4.6
		4x2.5mm	8.0mm	6.5mm	3.7	3.0
	260	4x1mm	4.0mm	2.6mm	4.9	3.7
		4x2.5mm	8.0mm	6.5mm	3	2.8
320	4x1mm	4.0mm	2.6mm	3.6	3.2	
	4x2.5mm	8.0mm	6.5mm	2.8	2.4	
120	100	4x1mm	4.0mm	2.6mm	3.3	2.8
		4x2.5mm	8.0mm	6.5mm	2.5	2.1
	120	4x1mm	4.0mm	2.6mm	3.3	2.4
		4x2.5mm	8.0mm	6.5mm	2.6	2.0
	150	4x1mm	4.0mm	2.6mm	3.2	2.1
		4x2.5mm	8.0mm	6.5mm	2.5	2.0
	260	4x1mm	4.0mm	2.6mm	2.5	1.8
		4x2.5mm	8.0mm	6.5mm	2.4	1.9
	320	4x1mm	4.0mm	2.6mm	2.2	1.5
		4x2.5mm	8.0mm	6.5mm	2.5	1.4

Table 6 : Image noises of Siemens Sensation 4 scanner in spiral mode for head examination without contrast agent and rotation time is 0.75 sec

Figure 14 : Siemens Sensation 4 Image Noise in Spiral Mode with Thin Slice Protocol

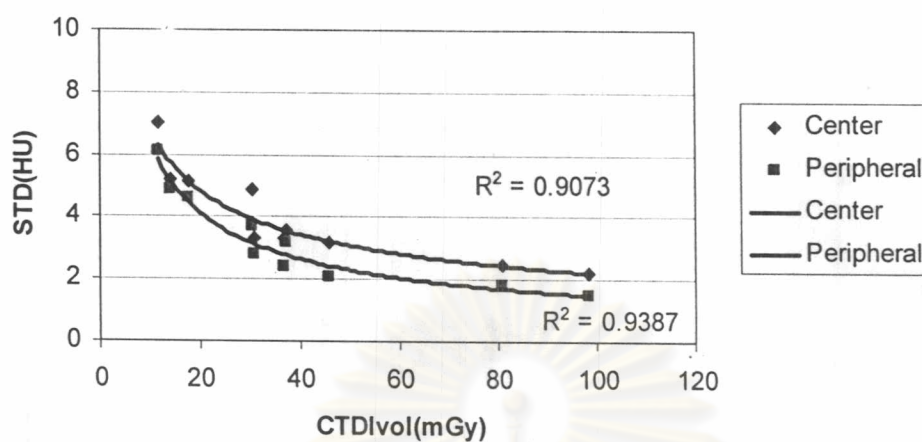
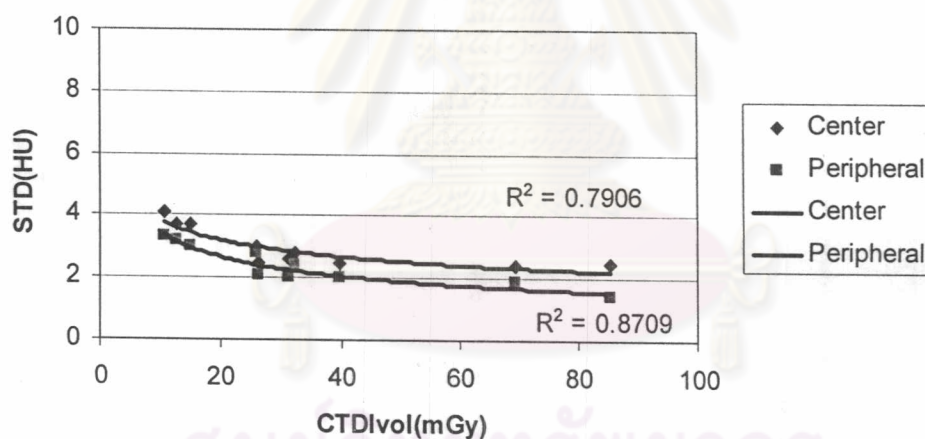


Figure 15 : Siemens Sensation 4 Image Noise in Spiral Mode with Thick Slice Protocol



For Siemens Sensation 16 (table 7 and 8), in sequential mode with thin slice protocol $R^2 = 0.9357$ centrally, $p < 0.05$, and $R^2 = 0.9853$ peripherally, $p < 0.05$, with thick slice protocol $R^2 = 0.9034$ centrally, $p < 0.05$, and $R^2 = 0.9961$ peripherally, $p < 0.05$ (Figure 16 and 17).

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	Noise(HU)	
					Center	Peripheral
100	100	0.75 mm	4.5mm	9.5 mm	6.5	5.6
		1.5 mm	9.0mm	19.0 mm	5.2	3.9
	120	0.75 mm	4.5mm	9.5 mm	6.6	5.1
		1.5 mm	9.0mm	19.0 mm	5.1	3.6
	150	0.75 mm	4.5mm	9.5 mm	6.3	4.7
		1.5 mm	9.0mm	19.0 mm	4	3.2
	260	0.75 mm	4.5mm	9.5 mm	4.7	3.7
		1.5 mm	9.0mm	19.0 mm	3.2	2.5
320	0.75 mm	4.5mm	9.5 mm	3.9	3.1	
	1.5 mm	9.0mm	19.0 mm	3.2	2.2	
120	100	0.75 mm	4.5mm	9.5 mm	5.6	4.6
		1.5 mm	9.0mm	19.0 mm	4	3.1
	120	0.75 mm	4.5mm	9.5 mm	5.7	4.4
		1.5 mm	9.0mm	19.0 mm	3.7	2.9
	150	0.75 mm	4.5mm	9.5 mm	4.5	3.6
		1.5 mm	9.0mm	19.0 mm	3.6	2.6
	260	0.75 mm	4.5mm	9.5 mm	3.4	2.9
		1.5 mm	9.0mm	19.0 mm	3	2.1
320	0.75 mm	4.5mm	9.5 mm	3.5	2.7	
	1.5 mm	9.0mm	19.0 mm	2.9	1.9	

Table 7 : CTDI_w values of **Siemens Sensation 16** scanner in **sequential mode** for head examination without contrast agent and **rotation time is 1.0 sec**

Figure 16 : Siemens Sensation 16, Image Noise in Sequential Mode with Thin Slice Parameters

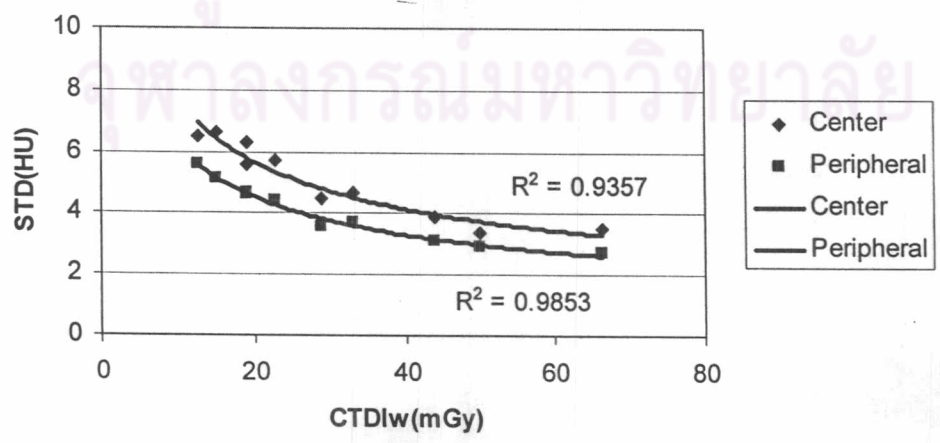
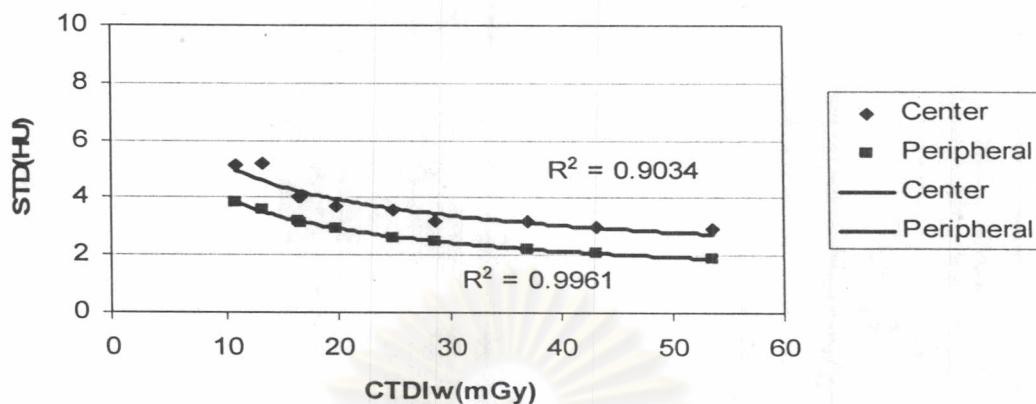


Figure 17 : Siemens Sensation 16, Image Noise in Sequential Mode with Thick Slice Parameters



In spiral mode with thin slice protocol $R^2 = 0.9857$ centrally, $p < 0.05$, and $R^2 = 0.9916$ peripherally, $p < 0.05$, with thick slice protocol $R^2 = 0.9962$ centrally, $p < 0.05$, and $R^2 = 0.9909$ peripherally, $p < 0.05$ (figure 18 and 19).

kV	Effective mAs	Slice Collimation	Slice width	Feed/Scan	Noise(HU)	
					Center	Peripheral
100	100	0.75 mm	4.0mm	5.1mm	6.0	5.1
		1.5 mm	8.0mm	13.7mm	4.4	3.7
	120	0.75 mm	4.0mm	5.1mm	5.6	4.7
		1.5 mm	8.0mm	13.7mm	4.1	3.3
	150	0.75 mm	4.0mm	5.1mm	4.9	4.2
		1.5 mm	8.0mm	13.7mm	3.5	3
	260	0.75 mm	4.0mm	5.1mm	3.6	3.1
		1.5 mm	8.0mm	13.7mm	2.8	2.2
320	0.75 mm	4.0mm	5.1mm	3.4	3	
	1.5 mm	8.0mm	13.7mm	2.4	2.1	
120	100	0.75 mm	4.0mm	5.1mm	5	4.1
		1.5 mm	8.0mm	13.7mm	3.5	3
	120	0.75 mm	4.0mm	5.1mm	4.6	3.8
		1.5 mm	8.0mm	13.7mm	3.2	2.8
	150	0.75 mm	4.0mm	5.1mm	4.1	3.4
		1.5 mm	8.0mm	13.7mm	2.8	2.4
	260	0.75 mm	4.0mm	5.1mm	3.2	2.6
		1.5 mm	8.0mm	13.7mm	2.2	1.9
320	0.75 mm	4.0mm	5.1mm	2.8	2.3	
	1.5 mm	8.0mm	13.7mm	2	1.7	

Table 8 : Image noises of Siemens Sensation 16 scanner in spiral mode for head examination without contrast agent and rotation time is 0.75 sec

Figure 18 : Siemens Sensation 16 Image Noise in Spiral Mode with Thin Slice Protocol

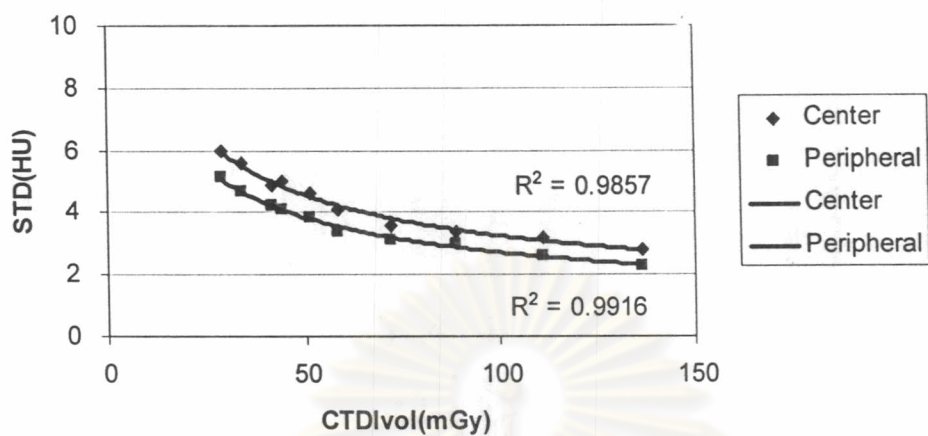


Figure 19 : Siemens Sensation 16 Image Noise in Spiral Mode with Thick Slice Protocol

