



Phantom CT: 3 Window<sup>1</sup>

reconstruction interval:1.5mm] window 3 CT phantom 5cc  
 : -1000HU, : -300HU -500HU 50HU ) window ( CT[collimation(mm)/table speed(mm/sec): 3/3,  
 window 3 phantom 12.55mm ±3.19 가 (p<0.0001).  
 500HU window 가 가 가  
 : - 3 CT -500HU window 가  
 CT - 3 tom 가 phan- (Fig. 1).  
 가 (1,2). Picker 2000(Piker International, Ohio,U.S.) ,  
 130 kVp, 150 mA collimation: 3 mm, pitch: 1,  
 (reconstruction interval): 1.5 mm, matrix size: 512  
 × 512, pixel size: 0.59 × 0.59 mm, FOV: 300 mm  
 . Work station(Voxel Q; Piker Interna-tional, Ohio, U.S.)  
 SSD(Shaded Surface Display) 3 SSD(Shaded Surface Display) 3  
 (3) 가 (brightness)  
 tom window phan- (gradient) (contrast) 50 . 3  
 window (minimal threshold  
 value) -1000HU , (maximal threshold  
 value) -300HU -500HU 50HU ,  
 (Fig. 2).  
 5cc ( 가 5  
 )  
 ( ) Venier  
 caliper (Mitutoyo co., Japan)  
 0.05 mm (Table 1). SAS  
 (multiple linear regression  
 test) 2 (two way ANOVA)

<sup>1</sup>  
<sup>2</sup>  
<sup>3</sup>

(con- window (Table 1). , , trols) 가 R-square 0.6064, p< 0.0001 . (%) = 12.7840+( 0.819× ) + ( 0.0343 × window ) window 3 2 window (interaction) (p<0.0001). window 가

phantom 12.55 mm ± 3.19

Table 1. Control and Measured Values of Inner Diameter at Varying Angles and Windows

Angle (°)	Control (mm)	Inner Diameter at varying Maximal HU				
		-300HU	-350HU	-400HU	-450HU	-500HU
-95	12.55	14.5	14.2	13.9	13	12.5
-89	12.55	14.5	14.1	13.3	12.6	12.5
-80	12.60	14.1	13.9	13.4	12.6	12.6
-63	12.50	13.7	13.2	12.9	12.6	12.5
-55	12.55	13.8	13.2	12.5	12.5	12.4
-47	12.55	13.2	12.9	12.8	12.6	12.5
-39	12.60	13.4	12.7	12.6	12.6	12.5
-32	12.60	12.9	12.7	12.6	12.6	12.5
-22	12.55	12.7	12.6	12.5	12.5	12.4
-14	12.55	12.9	12.8	12.6	12.5	12.3
-7	12.55	12.7	12.6	12.5	12.4	12.4
0	12.50	12.7	12.5	12.5	12.4	12.3
7	12.55	12.6	12.5	12.5	12.4	12.3
14	12.55	12.9	12.6	12.6	12.5	12.3
23	12.55	13	12.7	12.5	12.5	12.4
32	12.55	12.9	12.5	12.5	12.4	12.4
39	12.50	12.9	12.6	12.5	12.4	12.4
49	12.50	13.1	12.7	12.5	12.4	12.4
58	12.55	13.4	13.0	12.6	12.5	12.5
64	12.55	13.9	13.3	12.5	12.5	12.5
74	12.55	14	13.6	12.7	12.5	12.5
83	12.60	14.3	14.2	13.3	12.6	12.5
92	12.60	14.7	14.1	13.5	12.9	12.5

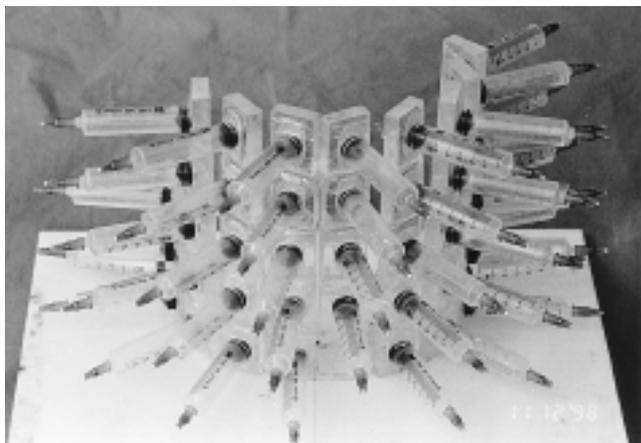


Fig. 1. The Bronchial Phantom consisting of Air-filled Syringes Oriented in Varying Angles Relative to the Scan Plan

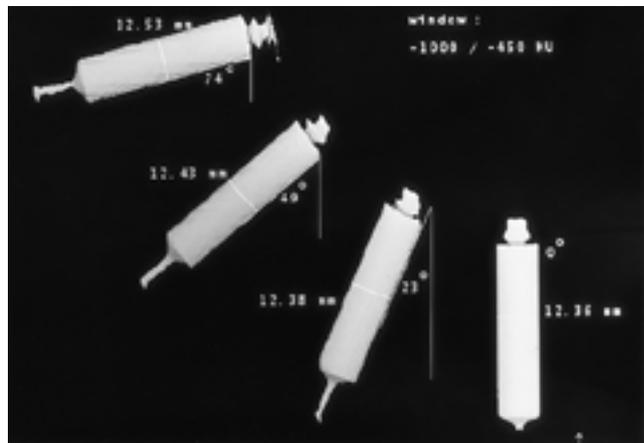


Fig. 2. The 3D Image of Bronchial Phantom : Air-filled Syringes Oriented in Varying Angles ( Window: Minimal -1000HU, Maximal -450HU )

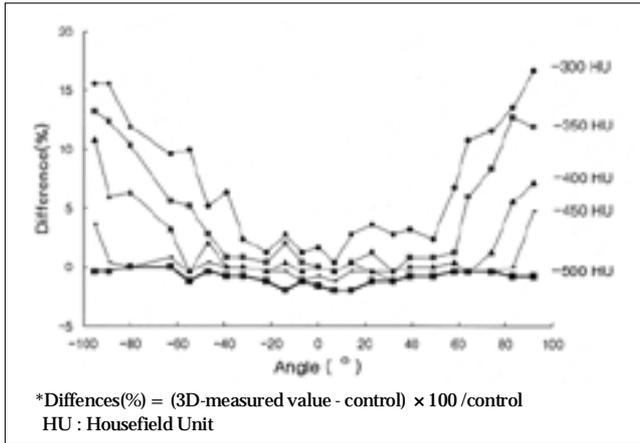


Fig. 3. \*Differences at varying angles show the closest value to real size at the maximal HU of -500.

가 , window 가  
 가  
 -500HU win-  
 dow 가 (Fig. 3).

가 . 2  
 CT Koehler (4) window width  
 window center control

partial volume effect  
 Webb(5) window

window  
 window level  
 -450HU -600HU ,  
 -150HU 가

window level  
 , collimation  
 collimation -150HU window 1cm

가 30  
 0.15 0.5cm collimation

2 collimation 가  
 partial volume effect

CT 0.3cm collimation  
 collimation  
 가

3 가  
 가

가 (1,2,3,6). window level ,  
 , collimation CT

Section sensitivity profile interpolation, pitch,  
 (slice thickness), (7). Hans  
 (8) CT 3

가가  
 (stairstep & transaxial cut off artifact)

. William  
 (9) 1mm collimation

pitch 2 3mm collimation ,  
 collimation 가  
 pitch

3- 5 mm collimation pitch  
 1- 1.5 . Schaefer (10) 3  
 가 -650HU -750HU

, window가  
 . William (9) SSD 3  
 가 SSD

voxel  
 air casting  
 (11)

partial volume effect 가 voxel value  
 (12,13).  
 partial volume effect가 , (threshold

value)  
 (14,15). Adrew(16) SSD  
 1000HU -500HU -300HU

window  
 window level  
 -500HU -300HU  
 window - 3

, (3) -1000HU  
 가 -450HU -

550HU , -500HU -600HU 가  
 가

가  
 가

window  
 (Table 1).

window  
 가  
 가 -1000

-500HU window partial volume effect  
 window  
 가 Phantom  
 가  
 Webb(5) phantom CT  
 3  
 partial volume  
 mation pitch window colli-  
 - 3 CT  
 dow window 가 win-  
 window 가

1. Im J, Song JG, Chung MJ, Yeon KM, Han MC. Clinical utility of 2D and 3D spiral CT in the tracheal evaluation of the tracheobronchial disease(abs). *Radiology* 1994;193(Suppl):261
2. Lee KS, Yoon JH, Kim TK, Kim JS, Chung MP, Kwan OJ. Evaluation of the tracheobronchial disease with helical CT with multiplanar and three dimensional reconstruction : correlation with bronchoscopy. *RadioGraphics* 1997;17:555-567
3. , , , , , , , . CT

: - Phantom CT  
 Window  
 :1997;36:991-994

4. Koehler PR, Robert EA, Brent B. The effect of computed tomography viewer controls on anatomical measurements. *Radiology* 1979;130:189-194
5. Webb WR, Gamsu G, Susan DW, et al. CT of a bronchial phantom: factors affecting appearance and size measurements. *Invest Radiol* 1984;19:394-398
6. Kuhlman JE, Ney DR, Fishman EK. Two-dimensional and three dimensional imaging of the in vivo lung: combing spiral computed tomography with multiplanar and volumetric techniques. *J Digit Imaging* 1994;7:42-47
7. Arkadiusz P, Willi AK, Guy M. Evaluation of section sensitivity profiles and image noise in spiral CT. *Radiology* 1992;185:29-35
8. Hans UK, Benno W, Berthold F, et al. Three-dimensional helical CT of the tracheobronchial tree : evaluation of imaging protocols and assessment of suspected stenoses with bronchoscopic correlation. *AJR* 1996;167:419-424
9. William JD, Nancy AO, Obuchowski, Philip MB, Robert KZ. A Phantom study : Evaluation of renal artery stenosis using helical CT and 3D reconstruction. *J Comput Assist Tomogr* 1997;21(1): 156-161
10. Schaefer EM, Prokop M, Doehring W, Schaefers F, Galansk M. Spiral CT of the Tracheobronchial system:Optimized Technique and Clinical Application. *Radiology* 1991(P);274
11. Stern RL, Cline HE, Johnson GA, Ravin C. Three dimensional imaging of the thoracic cavity. *Invest Radiol* 1989;24:282-288
12. Elliot KF, Donna M, Derek R, et al. Three-dimensional imaging. *Radiology* 1991;181:321-337
13. Geoffey DR, Michael DD, Sandy AN, et al. Three-dimensional spiral CT angiography of the abdomen: initial clinical experience. *Radiology* 1993;186:147-152
14. Manson D, Babyn P, Filler R, Holowka S. Three-dimensional imaging of the pediatric trachea in congenital tracheal stenosis. *Pediatr Radiol* 1994;24:175-179
15. Marc L, Jean PT, Bernard EVB, Patrick W. 3D spiral CT of the tracheobronchial tree. *J comput Assist Tomogr* 1995;19(3):341-347
16. Andrew SZ, Paul MS, Roy BS, Thomas RT, Wiliam JD, Robert KZ. Helical CT of the Upper Airway with Three-Dimensional Imaging: Technical & Clinical assessment. *AJR* 1996;166:293-299

## **Helical CT of a Tracheobronchial Phantom: Angle and Optimal Window Affecting Size Measurements of Three Dimensional Images<sup>1</sup>**

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**Purpose:** To determine the effect of angle variation, relative to scan plan and optimal window setting, on the size of three dimensional spiral CT images of a tracheobronchial tree using a phantom.

**Materials and Methods:** Spiral CT [collimation(mm)/table speed(mm/sec): 3/3; reconstruction interval:1.5 mm] was performed on a tracheobronchial phantom consisting of a box filled with saline solution containing air-filled 5cc syringes oriented at varying angles relative to the scan plan. The diameter of three dimensional images was measured at each window (minimal threshold value; -1000 HU; maximal threshold value: from -300 HU to -500 HU; 50 HU interval).

**Results:** The inner diameter of syringes used for tracheobronchial phantom was  $12.55 \pm 3.19$ mm. At all windows, as the angle became more perpendicular, the diameter of three-dimensional images increased, and at all angles, as maximal HU increased, measured diameter also increased ( $P < 0.0001$ ). In particular, at a maximal value of -500HU, measured values were closest to control values at all angles.

**Conclusion:** Diameter can be measured close to control value from three dimensional spiral CT images at maximal HU of -500 window, regardless of angle.

**Index words:** Trachea, CT  
Bronchi, CT  
Computed tomography(CT), three-dimensional

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