Title : THE RELATIONSHIP OF HUMAN TRACHEAL SIZE TO BODY HABITUS

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Introduction. Before intubation, the anesthesiologist may choose a specific size of endotracheal tube on the basis of personal experience, age, sex or body size of the patient. Frequently the size chosen may be wrong. If this is not recognized, damage to the trachea will result from too large a tube or pressure necrosis will occur from overinflation of too small a cuff. To determine if a more rational choice could be made by objective assessment of tracheal dimensions and body habitus, the trachea was measured.

Method. With the Research Committee's approval, retrospective analysis was made of computerized axial tomography (CAT) scans taken at the level of the sternoclavicular joint in 105 patients. This landmark was chosen as the reference point because it is fixed and easily identifiable on scan, and because it corresponds to the point where the cuff of an orotracheal or tracheostomy tube might be positioned during intubation. All the patients were supine with the neck held in the anatomic position. None were endotracheally intubated or had pathology within or around the trachea. From the scans, measurements were made of greatest anteroposterior (AP) and transverse cross-sectional tracheal diameters, and the length of the posterior membrane. Tracheal shape was noted and the age, sex, race, height, and weight of the patients was obtained from their charts when recorded and body surface area (BSA) was calculated.

Results. The 105 patients had a mean age of 50.2 (range 15-76) years, 70 were males. The AP, transverse, and posterior tracheal dimensions (mm) were mean ($\bar{x}$) $\pm$ standard deviation (SD) 20.5 $\pm$ 4.91, 17.1 $\pm$ 2.88, 13.6 $\pm$ 3.37 respectively. Table I shows the correlation coefficients of tracheal size and body habitus:-

	Weight	Height	BSA	Age
AP	.37	.43	.42	.35
Trans.	.38	.40	.39	.30
Post.	.31	.48	.50	.39

Male AP tracheal diameters ($\bar{x}$ = 21.6 $\pm$ SD 4.96) were significantly larger (p 0.01) than female ($\bar{x}$ = 17.8 $\pm$ 3.61) although 31 of the 40 U-shaped tracheas were found in males. No other sex differences were noted in tracheal size. Triangular and circular shapes were found in males and females respectively. There was no correlation between age, race, height, weight or BSA and tracheal shape. Distribution of cross-sectional tracheal shape is shown in Table 2:-

Shape	C	U	Elliptical	D	Δ	O
Number	42	40	9	8	3	3

Discussion. Many previous investigations on cuff tracheal wall pressure (CTWP), and cuff compliance have used dog specimens or artificial tracheal models.[1] Other studies discussing tracheal trauma in humans[2] have not stressed the great variation in tracheal size and shape. In this study of 105 human adults, tracheal transverse diameters varied from 9.3-22.7 mm. and AP diameters from 12-33.5 mm. The length of the posterior membranous portion varied from 7.4-22.7 mm. The correlation with height, weight, body surface area, age and tracheal size was poor, no coefficients exceeding 0.5. Fifty-seven (54.8%) tracheas were non-circular in cross section having U, Elliptical, or D-shapes. The difficulty of matching cuffs and trachea is compounded by the variations between manufacturers in endotracheal cuff volume and size which bears no relation to internal tube diameter.[2] CTWP will be increased with deformity of the non-circular trachea by the circular cuff when cuff compliance falls. This may occur with inadvertent overinflation, diffusion of nitrous oxide into the cuff or when ventilating a patient with low lung compliance or high positive end-expiratory pressure (PEEP). Low lung compliance and high PEEP may be a common combination during prolonged mechanical ventilation in the critically ill patient. Since there is poor correlation between body habitus and tracheal size and shape, the matching of tracheal and cuff sizes by measurement will ensure the cuff remains compliant, allowing conformity to the non-circular tracheal shapes. Where large differences are shown on CAT scan between transverse and AP tracheal diameters, an anatomically designed cuff may be indicated for prolonged use. Manufacturers of high compliance cuffs should be encouraged either to standardize or record the cuff residual volume and size so that cuff size not internal tube diameter may be used to determine the best fit within the trachea.

References.

1. Cooper JD, Grillo HC: Experimental production and prevention of injury due to cuffed tracheal tubes. Surg Gynec & Obstet 1235-1241, 1969.

2. Bernhard WN, Yost LC, Turndorf H, et. al: Physical characteristics of and rates of nitrous oxide diffusion into tracheal tube cuffs. Anesthesiology 48:413-417, 1978.