

## Study of tracheal dimension in adult cadavers from Eastern India

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### Abstract

**Aim:** To study the dimension of trachea on various parameters in male and female cadavers from eastern India.

**Objectives:** The present article is based on the study of the shape of tracheal opening, an anatomical measurement of length, diameters and the angle of bifurcation of the adult trachea in cadavers from eastern India and their sexual dimorphism.

**Materials and Method:** The cadaveric specimens of adult trachea comprising of 20 males and 20 females were studied. The length of the trachea, the internal and external transverse diameter at upper and lower end and the angle of bifurcation was measured. The shapes of the tracheal opening were noted by making the cross section of trachea at the inferior border of cricoid cartilage. Mean and standard deviation were calculated for all parameters. Sexual differences between the mean of measurements were calculated by applying unpaired student 't' test.

**Results:** Significant difference was seen in the length and the transverse diameter of the trachea between the male and female. There was no significant difference seen in the thickness of the posterior membrane as well as the angle of bifurcation of trachea.

**Discussion:** It may have their clinical implication in the maintenance of airways in anesthesiology and emergency medicine.

**Keywords:** Trachea, airways, Oropharynx, Sub carinal angle.

### Introduction

The trachea an unpaired organ, located in the midline and functions to conduct air from the oropharynx to the lungs. The position in the neck is superficial and follows an oblique Course and is well protected in middle of the mediastinum.<sup>(1)</sup> It is important to realize that the human trachea is a dynamic distensible organ of continuously varying size, shape and tone. Tracheal shape and circumference also alter with posture particularly with position of head in relation to the rest of the body, coughing, inspiration, expiration and during mechanical ventilation.<sup>(2)</sup> Since it has become very essential to obtain the dimension of trachea in order to prevent the complication of commonly used technique of endotracheal intubation in anesthesiology and other medical emergencies. Information's are available regarding the dimensions of human trachea and tracheobronchial angle in the Caucasians for western countries as well as of a few regions of India. Therefore, the present study has been carried out to observe the dimensions of various parameters and shape of adult trachea in the cadavers of eastern India.

### Material and Method

For the purpose of study 40 adult tracheas comprising of 20 males and 20 females were collected from the cadavers used for the dissection by the undergraduate students in the department of anatomy. During the process of routine dissection in the neck and superior mediastinum the relation of important structures around the trachea were identified. In the thorax heart was removed from the middle mediastinum and also both the lungs were separated from the principal bronchi close to the surface of the lung. The trachea was completely exposed by removing thyroid gland from its position and

by cutting the major blood vessels in the thorax. At the upper region trachea was cut along with the cricoid cartilage and was taken out and cleaned the connective tissue from its surface. The trachea was cut along the inferior margin of cricoid cartilage and the shape of the upper end was recorded. Placing the trachea straight on a graph sheet on a smooth wooden surface the length of the trachea was measured in centimeter by taking two point between upper ends of trachea from the inferior border of cricoid cartilage to the inferior margin of the bifurcation of the trachea. Using a digital Vernier calipers with an accuracy of 1mm the outer and inner transverse diameter of the upper end was recorded in millimeter, and the similar measurement was taken for the lower end by cutting the cross section just proximal to the tracheal bifurcation. For subcarinal angle the trachea was placed straight on the graph sheet. A median line was drawn in the midline of the tracheal length, which was extended caudally. In relation with median line a straight point was taken on the medial margin of the right bronchus and similar point were taken on the medial margin of the left bronchus. Two points on each margin were joined together by a line AA' for right and BB' for left and were extended upwards until the two lines were intersected and formed an angle facing downward which was taken as the total sub carinal angle. The angle between the median line and the medial margin of right bronchus was taken as right bronchial angle (RBA) and the angle between the median line and the medial margin of left bronchus was taken as left bronchial angle (LBA). (Fig. 1) Mean and standard deviation were calculated for all parameters. Sexual differences between the mean of measurements were calculated by applying unpaired student 't' test. Various

cross sectional shapes of tracheal opening were recorded following the description given by Mehta and Myat.<sup>(2)</sup>



**Fig. 1: Showing the tracheobronchial angle. RBA-Right bronchial angle, LBA-Left bronchial angle Subcarinal angle (SCA) = RBA+LBA**

## Result

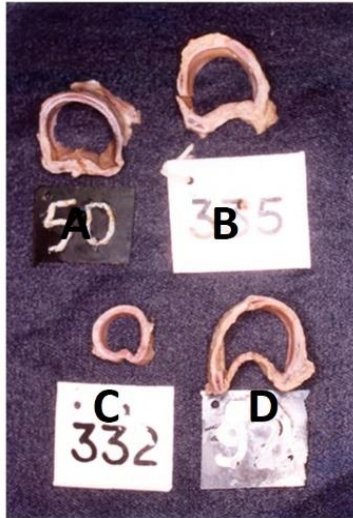
In the present study the total length of trachea in case of male was ranged from 10cm to 12.30cm (mean  $11.13 \pm 0.713$ ) and in female it was ranged from 8.30cm to 11cm (mean  $9.58 \pm 0.752$ ). (Table 1) Significant difference was seen between the tracheal length in male and female. The outer transverse diameter at the upper end in case of male was ranged from 19mm to 26.50mm (mean  $22.80 \pm 2.14$ ) and in female it was ranged from 13mm to 19mm (mean  $15.07 \pm 1.69$ ). The inner transverse diameter of male at the upper end was ranged from 11mm to 21mm ( $16.95 \pm 2.62$ ) and in female it was ranged from 8.90mm to 13.7mm ( $11.03 \pm 1.59$ ). In the lower region just proximal to the tracheal bifurcation the outer transverse diameter in case of male was ranged from 21.10mm to 29.80mm (mean  $25.13 \pm 2.039$ ) and in case of female it was ranged from 18.10mm to 32.80mm (mean  $20.72 \pm 3.063$ ). The inner transverse diameter in the lower end in case of male was ranged from 17.20 mm to 24mm (mean  $20.10 \pm 1.88$ ) and in case of female it was ranged from 14.10mm to 17.10mm (mean  $15.85 \pm 1.051$ ). Highly significant difference was seen in outer and inner transverse diameter at both upper and lower end of the trachea between male and female. (Table 1) Thickness of the posterior membrane at the upper end in case of male was ranged between 1.90mm to 4.5mm (mean  $3.115 \pm 0.716$ ) and in case of female it was ranged between 1.80mm to 4.10mm (mean  $2.96 \pm 0.710$ ). There was no significant difference seen in the thickness of the posterior membrane between male and female. The subcarinal angle in case of male was ranged between  $45^\circ$  to  $96^\circ$  (mean  $72.15 \pm 1.38$ ) and in case of female it was

ranged between  $58^\circ$  to  $70^\circ$  (mean  $70.60 \pm 7.75$ ). The RBA in case of male was ranged between  $14^\circ$  to  $45^\circ$  (mean  $29.95 \pm 8.80$ ) and in the female it was ranged between  $21^\circ$  to  $40^\circ$  (mean  $28.05 \pm 4.89$ ). On the other hand, the LBA in the male was ranged between  $28^\circ$  to  $51^\circ$  (mean  $42.70 \pm 7.76$ ) and in female it was ranged between  $28^\circ$  to  $52^\circ$  (mean  $42.55 \pm 5.808$ ). No significant difference was seen in tracheobronchial angles between male and female.

**Table 1: OTDU-Upper outer transverse diameter, ITDU-Upper inner transverse diameter, OTDL-Lower outer transverse diameter, ITDL-Lower inner transverse diameter, SCA-Subcarinal angle, RBA-Right bronchial angle, LBA-Left bronchial angle, TPM-Thickness of posterior membrane, M-Mean, STD-Standard deviation**

| SI No                      | Male                       | Female                    | F-Value | P-Value |
|----------------------------|----------------------------|---------------------------|---------|---------|
| Total Length M<br>N<br>STD | 11.13<br>20<br>$\pm 0.713$ | 9.58<br>20<br>$\pm 0.75$  | 44.40   | 0.000   |
| OTDU M<br>N<br>STD         | 22.80<br>20<br>$\pm 2.14$  | 15.07<br>20<br>$\pm 1.69$ | 160.56  | 0.000   |
| ITDU M<br>N<br>STD         | 16.95<br>20<br>$\pm 2.82$  | 11.03<br>20<br>$\pm 1.59$ | 66.49   | 0.000   |
| OTDL M<br>N<br>STD         | 25.13<br>20<br>$\pm 2.04$  | 20.72<br>20<br>$\pm 3.06$ | 28.65   | 0.000   |
| ITDL M<br>N<br>STD         | 20.10<br>20<br>$\pm 1.88$  | 15.85<br>20<br>$\pm 1.05$ | 77.58   | 0.000   |
| SCA M<br>N<br>STD          | 72.15<br>20<br>$\pm 1.39$  | 17.60<br>20<br>$\pm 7.75$ | 0.191   | 0.665   |
| RBA M<br>N<br>STD          | 29.95<br>20<br>$\pm 8.80$  | 28.05<br>20<br>$\pm 4.89$ | 0.712   | 0.404   |
| LBA M<br>N<br>STD          | 42.70<br>20<br>$\pm 7.62$  | 42.55<br>20<br>$\pm 5.80$ | 0.005   | 0.945   |
| TPM M<br>N<br>STD          | 3.12<br>20<br>$\pm 0.72$   | 2.96<br>20<br>$\pm 0.71$  | 0.472   | 0.496   |

Based on the study done by Mehta and Myat the cross sectional shape of 20 male tracheal openings were found to be D shaped in 11, E shape in 5, U shaped in 3 and C shaped in 1 cases. Whereas in case of female out of 20 specimens 10 were D shaped, 6 were U shaped, 3 were E shaped and 1 was C shaped. (Fig. 2)



**Fig. 2:** Showing the cross sectional shapes of tracheal opening, A is U shaped, B is E shaped, C is C shaped, D is D shaped

### Discussion

Engel in 1962 reported that the length of the trachea in adults is 9 to 15cm.<sup>(3)</sup> William et al has reported that the length of the adult trachea is 9 to 11cm.<sup>(4)</sup> Series of the data regarding the length of trachea has been reported by Harjeet and Inderjeet ranging from mean of  $82.43 \pm 5.79$  to  $91.85 \pm 6.55$  in the various age groups of northwest Indian population.<sup>(5)</sup> In the present study the mean tracheal length in case of male was  $11.17 \pm 0.69$ cm and in case of female it was  $10.1 \pm 0.98$ cm. There was significant difference seen between the male and female tracheal length ( $p=0.03, <0.05$ ). The length of the trachea in this study is found to be in a higher range than those of previous study, this could be due to the difference in the methodology as the tracheal length in this case was taken from inferior border of cricoid cartilage to the inferior margin of carina. Various authors have studied the tracheal diameters. In a cadaveric study done by Jesseph and Merindino in an age group of 13 to 86 years the mean tracheal diameter was found to be  $22.0 \pm 2.6$  in male and  $17.0 \pm 2.2$  in female.<sup>(6)</sup> Fraser RG has reported mean value of tracheal diameter of 19.5 in male and 15.5 in female. In a radiological study done by Breatnach et al. they have recorded a mean value of  $19.58 \pm 2.25$  in male and  $16.57 \pm 2$  in female.<sup>(7)</sup> In the present study the upper outer and upper inner transverse diameter in male were  $22.80 \pm 2.14$  and  $16.95 \pm 2.82$  and in female  $15.07 \pm 2.039$  and  $11.03 \pm 1.59$  respectively. The lower outer and lower inner transverse diameter in male were  $25.13 \pm 1.78$  and  $20.10 \pm 1.88$  and in female  $20.72 \pm 3.063$  and  $15.85 \pm 1.051$  respectively. Significant difference in the transverse diameter seen at both the level between male and female.

The thickness of posterior membrane at the upper end in case of male was  $3.09 \pm 0.187$  and in female  $2.85 \pm 0.79$  and there was no significant difference seen between the two sexes. This finding resembles with the

finding of Harjeet and Inderjeet who has reported that the thickness of posterior membrane was almost similar in both the sexes after 46 years of age.<sup>(5)</sup>

Radiological study by Haskin and Goodman have reported the subcarinal angle in degree of  $62.0 \pm 11.97$  in male and  $60.9 \pm 10.99$  in female.<sup>(8)</sup> Kher and Makhani have reported that the average angle of bifurcation in case of adult ranges from 30-105 degrees.<sup>(9)</sup> Harjeet and Inderjeet have recorded the value of subcarinal angle in degree ranging from  $43.50 \pm 10.12$  to  $57.21 \pm 12.97$  in a various age group of adult male and  $50 \pm 15.44$  to  $69.29 \pm 5.18$  in different age group of adult female.<sup>(5)</sup> In the present study the subcarinal angle in male was  $73.39 \pm 13.96$  and  $70.14 \pm 9.75$ . RBA in male was  $30.65 \pm 8.68$  and in female  $28.57 \pm 3.15$  and LBA in male was  $43.73 \pm 7.72$  and in female  $40.14 \pm 7.08$ . The data of the present finding seems to be little higher than the one recorded by previous authors and also the result did not show any significant difference between male and female.

Campbell and Liddellow,<sup>(10)</sup> Mehta and Myat<sup>(2)</sup> have described the incidence of various shapes of the trachea in cross sections. But there is no unanimity in the classification of the various shapes. In this study 55% of adult male had D shaped tracheal opening followed by E shaped in 25% and in female it was 50% D shaped and 30% U shaped respectively. Whereas Harjeet and Inderjeet did not find 'U' shaped trachea in female.

### Conclusion

Besides some parameters in adult trachea, the other dimensions are significantly larger in male than in female possibly a result of the difference in its growth rate. This could probably be helpful in anesthesiology for selecting the appropriate size of endotracheal tube and to minimize the hazard out of it. The limitation of the present study would be the cadavers utilized in the material were embalmed for variable period which could affect the results in the tracheal morphometry. Hence it is highly suggested to carry out the similar study in tracheal sample obtained from fresh cadavers with proper ethical clearance.

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