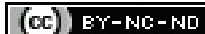


Morphometry of Adult Human Trachea and its Clinical Implications: A Cadaveric Study in Northern India

STUTI MAHAJAN¹, ANUPAMA MAHAJAN², MONIKA LALIT³, POONAM VERMA⁴

ABSTRACT

Introduction: There is a wide variation in different dimensions of trachea in same age group as well as in different age groups in both sexes. Besides anthropometry, the study of these morphometric variations is of profound clinical importance as it may help the pulmonologists to understand the aetiology of several pulmonary diseases like bronchitis, emphysema, pulmonary fibrosis and tuberculosis.

Aim: To determine the variations in the dimensions of human trachea in the cadavers of age group 20-70 years in Northern India.

Materials and Methods: This cross-sectional study was conducted in the Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar, Punjab, India, during March 2019 to December 2021. A total of 40 tracheas were obtained from adult human cadavers which were included in present study by convenience sampling. The trachea was

dissected with the larynx and principal bronchi and measurements were taken. Data collected was saved on Microsoft excel and was analysed by calculating percentages, mean and Standard Deviation (SD).

Results: Mean length of trachea was 109.25 mm, mean subcarinal angle was 75.45°. Mean anteroposterior diameter, transverse diameter, mean height and distance between posterior ends of rings was 16.70 mm and 18.10 mm, 4.53 mm and 12.15 mm respectively and mean of inter-ring distance between 1st-2nd, 5th-6th, 10th-11th, 15th-16th tracheal rings was 1.12 mm.

Conclusion: The present study revealed a wide variation in different dimensions viz. length, transverse and anteroposterior diameters, mean height, intertracheal ring distance and the subcarinal angle. Accurate anatomical knowledge of the variations is essential for understanding the pathophysiology and management of different airway disorders and in reconstructive surgery of tracheobronchial tree.

Keywords: Dimensions, Pulmonary fibrosis, Sleep apnoea, Subcarinal angle, Tracheal rings, Variations

INTRODUCTION

The trachea is an unpaired hollow tube that descends as a continuation of the larynx from C6 to the upper border of T5 vertebra where it divides into right and left principal bronchi [1]. There is a wide variation in different dimensions of trachea in same age group as well as in different age groups in both sexes [2-8]. There is wide variation in dimensions of trachea described in different textbooks and by different authors in different journals [1,9]. Gray's anatomy by standing states that adult trachea is 10-11 cm long, external transverse diameter is 2 cm in adult males and 1.5 cm in adult females, lumen has an average transverse diameter of 12 mm [1]. Schwartz in Text book "Principles of Surgery" stated that range of tracheal length is 10-13 cm, 18-22 semicircular cartilage rings, 2.3 cm transverse diameter and 1.8 cm anteroposterior diameter [9].

Besides anthropometry, knowledge of morphometric variations is essential as it may help the pulmonologists to understand the aetiology of several pulmonary diseases like bronchitis, emphysema, pulmonary fibrosis and tuberculosis [10]. The present study was taken up to measure different dimensions of trachea (length, subcarinal angle, anteroposterior and transverse diameter, height of rings and distance between posterior ends of tracheal rings) which can be helpful in pulmonary physiology and anaesthesiology to conduct some maneuvers like endotracheal intubation, diagnostic and therapeutic bronchoscopic procedures with skill and perfection. Though, the study measuring the dimensions of trachea are available from different parts but the studies related to this area are sparse [3-5,7,11]. Hence, present study was conducted to determine the variations in the dimensions of human trachea in the cadavers of age group 20-70 years in Northern India.

MATERIALS AND METHODS

The present cross-sectional study was done on 40 tracheas obtained from adult human cadavers in the Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar, Punjab, India, from March 2019 to December 2021.

Inclusion criteria: Adult human cadavers aged between 20-70 years were included in this study.

Exclusion criteria: Cadavers aged more than 70 years and less than 20 years, mutilated cadavers, cadavers having sternal and tracheal deformities, Human Immunodeficiency Virus (HIV) and corona positive cadavers were excluded in this study.

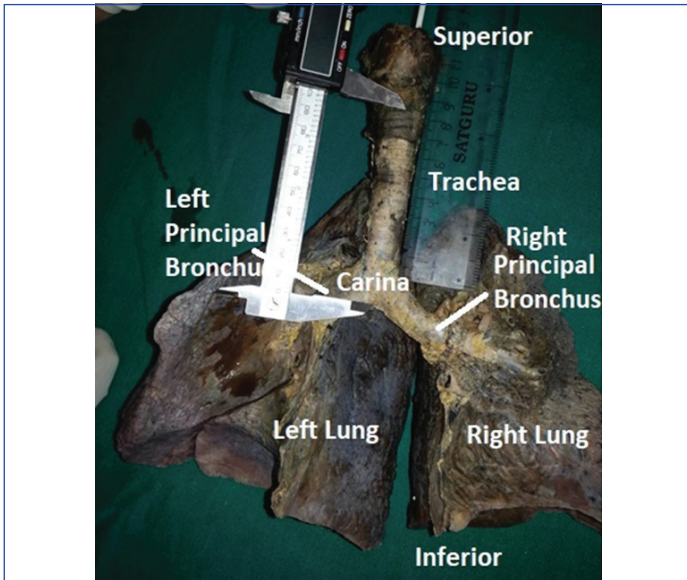
A total of 40 trachea, obtained from adult human cadavers were enrolled for the study by convenience sampling.

Study Procedure

Cadaver was placed in supine position on dissection table with extended neck. Skin incision was given from symphysis menti to xiphoid process of sternum. Lateral incision was given from symphysis menti along the lower border of mandible and from xiphoid process upwards and laterally along the floor of axilla. After reflecting skin, superficial fascia, deep fascia, muscles (sternohyoid, sternothyroid and sternocleidomastoid), the sternoclavicular joint was disarticulated, sternum was reflected downward after cutting the ribs at the costal cartilages with the bone cutter. Viscera like lungs, heart, thyroid gland were removed along with great vessels, nerves and prevertebral muscles. The trachea was dissected with the larynx and principal bronchi [11]. The measurements were taken as follows:

Tracheal length were measured with vernier caliper from the lower border of cricoid cartilage to the apex of subcarinal angle where the trachea was bifurcating [Table/Fig-1].

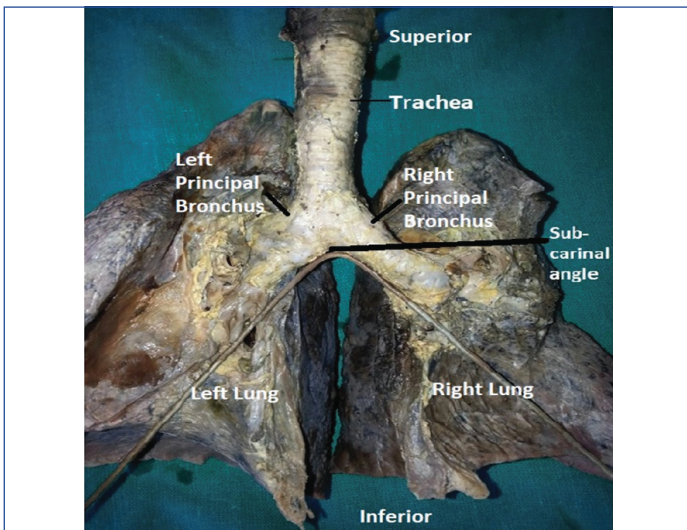
Total number of tracheal rings were measured in the mid-sagittal line.



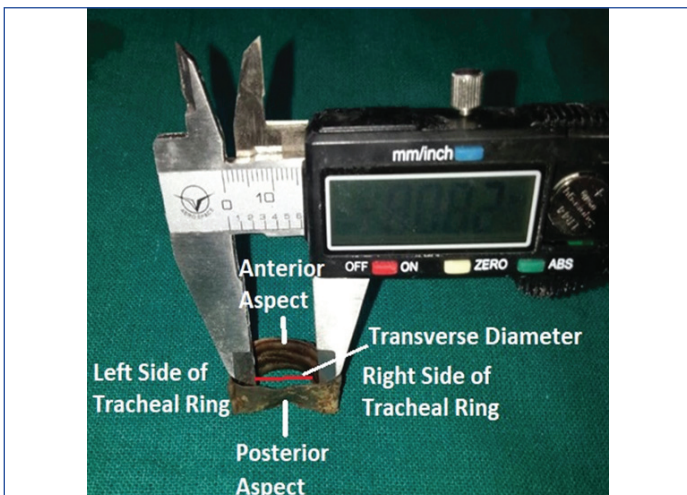
[Table/Fig-1]: Showing measurement of trachea from lower border of cricoid cartilage to carina.

Subcarinal angle was measured with the help of thin wire and goniometer and was rechecked by protractor [Table/Fig-2].

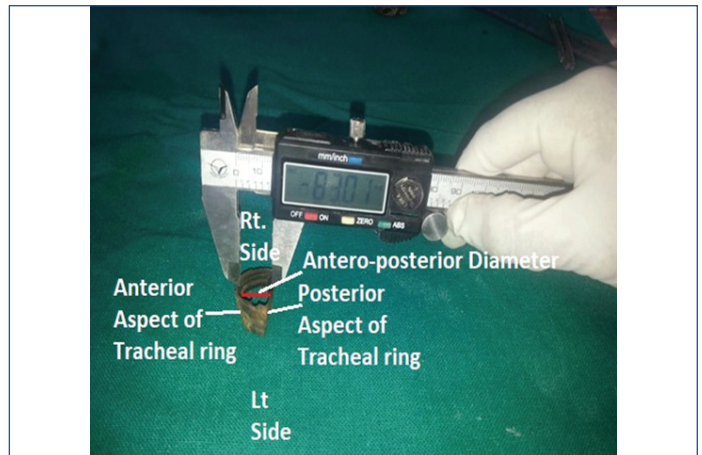
Anteroposterior diameter of trachea was measured in the mid-sagittal plane and transverse diameter was measured in the mid-coronal plane with the help of vernier caliper by taking horizontal section of trachea at the level of 1st, 5th, 10th and 15th tracheal rings [Table/Fig-3,4].



[Table/Fig-2]: Showing measurement of subcarinal angle.

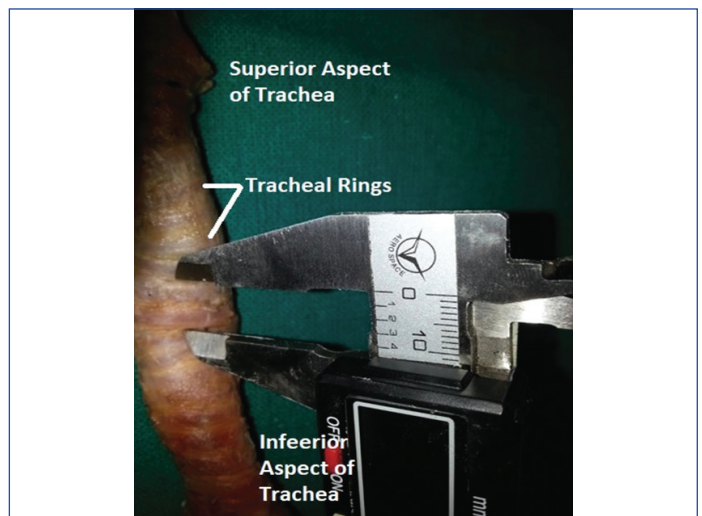


[Table/Fig-3]: Showing transverse diameter measured in mid coronal plane.



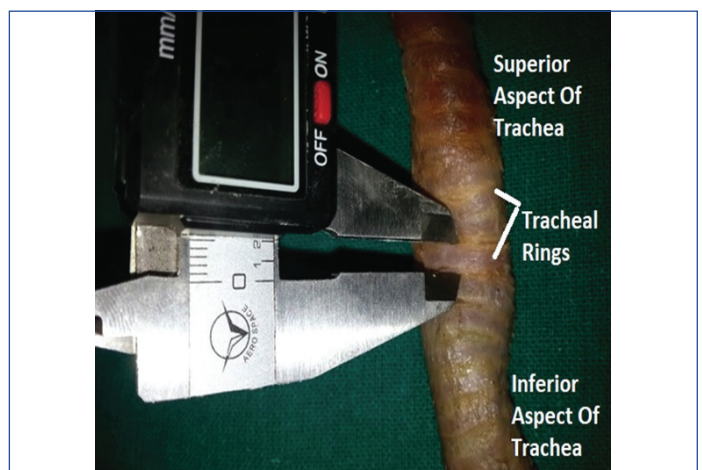
[Table/Fig-4]: Showing anteroposterior diameter measured in mid sagittal plane.

Height and distance between posterior ends of rings was measured with the help of vernier caliper at the level of 1st, 5th, 10th and 15th tracheal rings [Table/Fig-5].



[Table/Fig-5]: Showing measurement of intertracheal ring distance.

Inter-ring distance between 1st and 2nd, 5th and 6th, 10th and 11th, 15th and 16th rings was measured in midline with the help of vernier caliper [Table/Fig-6].



[Table/Fig-6]: Showing measurement of vertical height of tracheal ring.

In the specimens having less than 15 rings, measurements were taken only at the level of 1st, 5th and 10th tracheal rings [12]. Vernier calliper of the company airspace with least count 0.02 mm was used to measure length, breadth, height and diameter of the trachea.

STATISTICAL ANALYSIS

The data were statistically analysed for calculating the range, mean and SD using manual computation.

RESULTS

In this study, 40 adult human cadavers were aged between 20-70 years. It was found that the range of tracheal rings was 14-19 and 17 was the most frequent value. The mean length of trachea from lower border of cricoid cartilage to carina was 105.25±6.03 mm, range being 90.50-121.20 mm.

Mean subcarinal angle was 77.45±13.15°, range being 47-122°. Mean of inter-ring distance between 1st-2nd, 5th-6th, 10th-11th and 15th-16th tracheal rings was 1.12±0.51 mm and range 0.10-3.50.

The mean anteroposterior dimension of trachea was 16.07 mm ranging from 8.90-23.75 mm and mean transverse diameter was 18.10 mm (ranging from 12.75-25.75 mm). Mean height of tracheal ring was 4.53 mm (ranged between 2.10-14.04 mm), in present study mean distance between posterior ends of rings was 12.15 mm (ranging from 5.30-24.80 mm) [Table/Fig-7,8].



respectively [4,15]. Rosen FS, studied 50 specimens and observed that trachea on average contains 13.3 rings [16]. Michael J et al., told that for every two cms there were two rings [17]. In the present study, the range of tracheal rings was 14-19 which was in accordance with the study of Kamel LS et al., Munguia DA, Mridula C and Krishnaiah M, and Toremalm NG who reported the range of tracheal rings was 14-19, 14-21, 14-24 and 14-20 respectively [6,7,18,19].

Kamel KS et al., measured subcarinal angle of bifurcation between first two cms of inferior wall of the right and left principal bronchi in 60 specimens using High Resolution Computed Tomography (HRCT) scans and reported that the range of angle was 36-121° with mean 78±20° [6]. Haskin PH and Goodmann LR concluded that the mean subcarinal angle was 60.8±11.8° in the radiographs of 47 males and 53 females in 21-80 years of age group [20]. Chunder R et al., measured the subcarinal angle on the photograph along the inferior border of principal bronchi after dividing 87 cadavers (51 males and 36 females) into five age groups and reported that the mean angle in males was 64.3° in 0-15 years, 56.4° in 16-25 years, 58.4° in 26-40 years, 57.1° in 41-55 years and 59.5° in more than 55 years of age [21].

As depicted in [Table/Fig-8], mean anteroposterior diameter, transverse diameter, mean height and distance between posterior ends of rings was 16.70 mm and 18.10 mm, 4.53 mm and 12.15 mm respectively and mean of Inter-ring distance between 1st-2nd, 5th-6th, 10th-11th and 15th-16th tracheal rings was 1.12 mm. According to Standring S, the external transverse diameter of trachea is 2 cm in adult males and 1.5 cm in adult females while its internal transverse diameter is 1.2 cm in live adults [1]. Kim IKS et al., in their study on 33 male Korean bodies reported anteroposterior and transverse diameter at the level of 1st tracheal ring- 21.97±0.61 mm and 22.54±0.41 mm, 5th ring- 22.40±0.48 mm and 20.84±0.51 mm, 10th ring-19.85±0.40 mm and 20.60 0.35 mm, 15th ring- 19.60±0.54 mm and 22.12±0.57 mm respectively [4]. Kamel KS et al., in their study on 60 specimens using HRCT scans reported tracheal anteroposterior diameter from sagittal slices was

Level	Anteroposterior diameter (mm)			Transverse diameter (mm)			Height of tracheal ring (mm)			Distance between posterior ends of rings (mm)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1 st	17.10	4.12	10.20-23.75	18.12	3.35	13.85-22.95	5.97	2.00	3.30-14.04	12.02	3.12	5.32-20.18
5 th	17.05	4.02	9.80-22.95	17.35	3.79	12.75-24.90	4.00	0.65	2.10-6.30	11.15	2.80	5.30-17.90
10 th	16.55	4.28	8.96-22.45	17.85	3.36	12.90-24.90	4.41	0.66	2.22-6.10	11.55	3.32	5.50-19.75
15 th	16.05	4.10	8.90-22.80	19.00	3.89	12.80-25.75	4.12	0.71	3.01-6.98	13.99	4.15	5.50-24.80
Total	16.70	4.25	8.90-23.75	18.10	3.78	12.75-25.75	4.53	1.31	2.10-14.04	12.15	3.42	5.30-24.80

[Table/Fig-8]: Anteroposterior and transverse diameter of trachea, height of tracheal ring and distance between posterior ends of rings at the level of 1st, 5th, 10th and 15th tracheal rings.

DISCUSSION

The mean length of trachea from lower border of cricoid cartilage to carina was 105.25 mm, range being 90.50-121.20 mm with standard Deviation 6.03. Strenberg in the text book of diagnostic surgical pathology 3rd edition described the length of trachea to be 11 cms [13]. Kamel KS et al., measured the length of trachea in vivo using high resolution chest Computed Tomography (CT) scan in the age group of 22-88 and documented that the length was 102.8±9.9 mm [6]. Munguia DA, carried out a study of 44 Mexican cadavers in the age group of 18-65 years and found that tracheal length was 9.1±0.9 cm in males and 8.6±0.6 cm in females [7]. Begum T et al., measured the length of 47 trachea of Bangladeshi adult males after dividing the cases into four age groups and found that mean length was 8.73±0.21 cm in group A (20-29 years), 9.53±0.46 cm in group B (30-39 years), 9.63±0.23 cm in group C (40-49 years) and 9.79±0.39 cm in group D (50-59 years), overall mean was 9.32±0.42 cm [14].

Regarding number of tracheal rings, Cinar U et al., in their study on 75 male trachea and Kim IKS et al., in their study on 33 male tracheas reported that the number of tracheal rings were 13.3±1.6 and 16.8±0.3

21.4±3.2 mm, range (12.7-28.6 mm) and transverse diameter from coronal slices was 25.7±3.7 mm, range (17.3-34.5 mm) [6]. Munguia DA, in their study on 44 cadavers reported anteroposterior diameter in midsagittal plane was 1.8±0.3 cm, range (1.4-2.5 cm) and transverse diameter in mid coronal plane was 1.9±0.2 cm, range (1.6-2.3 cm) [7]. Mridula C and Krishnaiah M measured diameter of trachea in 16 patients with small peripheral pulmonary nodules at four horizontal positions by special window technique (window width 500 Hu, window level 100 Hu) and reported that tracheal diameter at thoracic entrance was 18.9±1.7 mm, at the level of aortic arch was 18.8±1.6 mm, at the level of two cms higher than carina of trachea was 19.0±1.6 mm and at narrowest trachea was 18.4±1.5 mm respectively [18]. Strenberg described the tracheal diameter as 2-2.5 cms [13]. Chunder R et al., recorded upper external transverse diameter (width) and upper anteroposterior diameters (depth) at the junction of upper third and middle third of trachea in 51 male human trachea and reported that the results were 1.95 cm and 1.35 cm in 0-15 years, 2 cm and 1.6 cm in 16-25 y, 2.1 cm and 1.7 cm in 26-40, 2 cm and 1.6 cm in 41-55 Y, 2 cm and

1.9 cm in >55 years age groups of males respectively [21]. Lower external transverse diameter and lower anteroposterior diameters at the junction of middle third and lower third of trachea were 1.85 cm and 1.05 cm in 0-15 years, 2 cm and 1.6 cm in 16-25 years, 2.1 cm and 1.6 cm in 26-40 years, 2 cm and 1.5 cm in 41-55 years, 2.1 cm and 1.5 cm in >55 years age groups respectively [21]. Solanki S and Zarana A measured anteroposterior and transverse diameters of trachea on 28 cast of trachea prepared by luminal cast plastination and reported mean AP diameter was 1.70 cms (range 1.16-2.25 cm) and mean transverse diameter was 1.78 cm (range 1.42-2.1 cm) [22]. Hampton T et al., reported that transverse diameter of trachea was 1.75±0.26 cm [23]. Li C et al., observed Tracheal diameter 1.99 cms, range (1.2-2.5 cms) [24]. Breatnach E et al., studied X-rays of 808 patients and found tracheal diameter 2.5-2.7 cms in males and 2.1-2.3 cm in females [25].

Regarding vertical height of tracheal ring, Kim IKS et al., reported vertical height of tracheal ring in 33 male specimens at the level of 1st ring- 6.47±0.36 mm, 2nd ring- 3.71±0.19 mm, 5th ring- 3.97±0.19 mm, 10th ring- 4.31±0.18 mm, 15th ring- 4.66±0.37 mm [4]. Kamel KS et al., in their study on 10 cadavers reported the vertical height of tracheal ring 4.6±0.1 mm, range 2.3-12.2 mm [6]. Munguia DA reported 4.5±0.3 mm, range 3.0-9.0 in accordance with the present study where the vertical height in 40 specimens was 4.53±2.6 mm [7].

Kim IKS et al., reported inter- ring distance between 1st and 2nd was 1.98±0.19 mm, between 5th and 6th ring 1.63±0.11 mm, between 10th and 11th ring 1.61±0.16 mm, between 15th and 16th ring 1.81±0.20 mm [4]. Kamel KS et al., in their study on 10 cadavers noted that mean of inter-ring distance was 1.6±0.2 mm in accordance of present study where the mean of inter-ring distance 1.12±0.4 mm [6].

Kim IKS et al., reported the distance between posterior ends of rings, at the level of 1st ring 13.19±0.72 mm, 5th ring- 11.61±0.84 mm, 10th ring- 12.14±0.83 mm, 15th ring- 15.53±1.07 mm [4]. Present study showed distance between posterior ends of rings at the level of 1st, 5th and 10th tracheal rings was 12.15±3.42 mm which was very near to the study of Kamel KS et al., who reported the mean distance between posterior ends of rings at the level of 1st, 5th and 10th tracheal rings was 15.9±2.3 mm [6].

The comparison of parameters such as- tracheal length, subcarinal angle, anteroposterior and transverse diameter with previous studies are shown in [Table/Fig-9,10,11] [3-7,11,12,14,15,18,20-22,26-28].

Authors	Place	Year	No of specimen	Method	Mean tracheal length (cm)
Shaik Z et al., [3]	Kurnool	2016	40	Dissection	7.4-9.2
Kim IKS et al., [4]	Korea	2015	48	Dissection	10.4±0.41
Sharma N et al., [5]	Napalese	2017	29	Dissection	11.15±0.6
Kamel KS et al., [6]	New Zealand	2009	60	CT scan (High resolution)	10.28±0.9
Munguia DA [7]	Mexico	2011	44	Dissection	9.1±0.9
Datta D et al., [11]	West Bengal	2019	60	Dissection	10.42±0.495
Premakumar Y et al., [12]	London	2018	10	Dissection	10.38±0.85
Chunder R et al., [21]	Kolkata	2010	87	Dissection	10.45
Leader JK [26]	Pittsburgh	2004	24	CT scan	7.86±1.68
Solanki S and Zarana A [22]	Gujarat	2015	24	Luminal cast plastination	9.37±0.56
Begum T et al., [14]	Dhaka	2009	47	Dissection	9.32±0.42
Mridula C and Krishnaiah M [18]	Hyderabad	2011	50	Dissection	7.87
Cinar U et al., [15]	Turkey	2016	75	Dissection	8.7±1.1
Present study	Punjab	2022	40	Dissection	10.52±0.60

[Table/Fig-9]: Comparison of tracheal Length with previous studies [3-7,11,12,14,15,18,21,22,26].

Authors	No. of specimen	Place	Year	Method	Mean subcarinal angle° (Range)
Shaik Z et al., [3]	40	Kurnool	2016	Dissection	53 (40-70)
Kamel KS et al., [6]	60	New Zealand	2009	High resolution CT scan	78±20 (36-121)
Chunder R et al., [21]	51	Kolkata	2010	Dissection	59.5
Mridula C and Krishnaiah M [18]	50	Hyderabad	2011	Dissection	77.58 (50-130)
Haskin PH and Goodman LR [20]	100	Philadelphia	1982	Radiographs	60.8±11.8
Coppola V et al., [27]	700	Italy	1998	Ct scans	79.7 (37-105)
Daroszewski M et al., [28]	73	Poland	2013	Dissection	73.1±12.7
Present study	40	Punjab	2022	Dissection	77.45±13.15 (47-122)

[Table/Fig-10]: Comparison of subcarinal angle with previous studies [3,6,18,20,21,27,28].

Authors	Place	Year	No. of specimen	Method	AP diameter	Transverse diameter
Kim IKS et al., [4]	Korea	2015	33	Dissection	19.85±0.40	20.6±0.35 mm
Kamel LS et al., [6]	New Zealand	2009	60	HRCT (High resolution computed tomography)	21.4±3.2 mm	25.7±3.7 mm
Munguia DA [7]	Mexico	2011	44	Dissection	1.8±0.3 cm	1.9±0.2 cm
Datta D et al., [11]	West Bengal	2019	60	Dissection	1.55±0.183 cm	1.29±0.124 cm
Solanki S and Zarana A [22]	Gujarat	2015	24	Luminal cast plastination	1.70 cms (1.16-2.25)	1.78 cm (1.42-2.1)
Present study	Punjab	2022	40	Dissection	16.70±4.25 mm	18.10±3.78 mm

[Table/Fig-11]: Comparison of AP and transverse diameter with previous studies [4,6,7,11,22].

The differences in parameters in the preset study may be due to cultural differences, ethnic or genetic variations and environmental or geographical change. Changes may occur in the tracheal dimensions like tracheabronchomegaly or tracheomalacia where there is widening of trachea or in tracheobonchopathia where there is generalised narrowing of trachea. So, the knowledge of these parameters on human trachea is very useful in such conditions as well as in conduction of endotracheal intubation in both diagnostic and therapeutic applications.

Limitation(s)

The present study does not include different age groups and sex on which the authors are still working to carry forward this study.

CONCLUSION(S)

There is wide variation in the dimensions of human trachea in same age group as well as in different age groups. The mean length of trachea was 105.25 mm, mean subcarinal angle was 77.45° and mean of intertracheal ring distance was 1.12 mm in the present study. The study of these morphometric variations is of profound clinical importance as it may help the clinicians to understand the aetiology of several pulmonary diseases and the surgeons to deal with resection and reconstruction of the tracheobronchial tree. Knowledge of length and diameter of trachea also helps the clinicians

in choosing the proper size of tracheostomy tube in emergency situations and in proper selection of endotracheal tube. Accurate anatomical knowledge of the variations is essential for knowing pathophysiology and management of different airway disorders.

REFERENCES

- [1] Standing S. Gray's anatomy. 40th ed. Philadelphia: W.B. Saunders company; 2008. pp. 989-1007.
- [2] Moore KL, Dalley AF, Agur AMR. In: Clinically oriented anatomy. 7th ed. Philadelphia: Lippincott Williams and Wilkins; 2014. pp. 1045.
- [3] Shaik Z, Ramulu V, Hanimann KS. A study on anatomical dimensions of bronchial tree. *Int J Res Med Sci.* 2016;4(7):2761-65.
- [4] Kim IKS, Lim JM, Chai OH, Han EH, Kim HT, Song CH. Morphometric study of Trachea in Korean. *Korean J Phys Anthropol.* 2015;28(4):185-95.
- [5] Sharma N, Khan GA, Pandit R. A cadaveric study of length of trachea in Nepalese population of various age groups. *J Univ Coll Med Sci.* 2017;5(1):17-21.
- [6] Kamel KS, Lau G, Stringer MD. In vivo and in vitro morphometry of the human trachea. *Clin Anat.* 2009;22:571-79.
- [7] Munguia DA. Tracheal dimensions in the Mexican population. *Cir.* 2011;79(6):505-10.
- [8] Wani TM, Buchh B, AlGhamdi FS, Jan R, Tumin D, Tobias JD. Tracheobronchial angles in children: Three dimensional computed tomography based measurements. *Paediatric Anaesthesia.* 2018;28(5):463-67.
- [9] Schwartz SI, Rusch VW, Ginsberg RJ. Chest wall, pleura, lung and mediastinum. *Principles of Surgery, 7th edition.* McGraw-Hill: 1999;764.
- [10] Althnazio R. Airway disease: Similarities and differences. *Clinics.* 2012;67(11):1335-43.
- [11] Datta D, Kundu D, Pal S, Das A. morphometric study of adult human trachea in west Bengal population. *Int J Med Res Rev.* 2019;7(1):36-42.
- [12] Premakumar Y, Griffin MF, Szarko M. Morphometric characterization of human tracheas: Focus on cartilaginous ring variation. *BMC Res Notes.* 2018;11:32.
- [13] Strenberg. Tracheobronchopathia- A clinical and spirometric study. *Chest J.* 1981;80(6):706-09.
- [14] Begum T, Naushaba H, Alam J, Paul UK, Alim AJ, Akter J, et al. Cadaveric length of trachea in Bangladesh adult male. *Bangladesh J Anat.* 2009;7(1):42-44.
- [15] Cinar U, Halezeroglu S, Okur E. Tracheal length in adult human: The results of 100 autopsies. *Int J of Morphology.* 2016;34(1):232-36.
- [16] Rosen FS. Study of bronchial tree. *Ann Otol Rhinol Laryngol.* 2003;112(10):869-76.
- [17] Rutter MJ, Cotton RT, Azizkhan RG, Manning PB. Slide tracheoplasty for the management of complete tracheal rings. *J Pediatr Surg.* 2003;38(6):928-34.
- [18] Mridula C, Krishnaiah M. The study of bronchial tree. *Int J Pharm Biosci.* 2011;2(1):166-72.
- [19] Toremalm NG. Airflow pattern and ciliary activity in Trachea. *Laryngoscope.* 1972;82(1):108-14.
- [20] Haskin PH, Goodmann LR. Normal tracheal bifurcation angle. *AJR.* 1982;139:879.
- [21] Chunder R, Nandi S, Guha R, Satyanaryana N. A morphometric study of human trachea and principal bronchi in different age groups in both sexes. *Nepal Med Coll J.* 2010;12(4):207-14.
- [22] Solanki S, Zarana A. Morphometric analysis of human trachea in adult Gujrat region by luminal cast platination. *J Res Med Den Sci.* 2015;3(3):235-37.
- [23] Hampton T, Armstrong S, Russell WJ. The left main bronchus. *Anaesth Intensive Care.* 2000;28:540-42.
- [24] Li C, Zhang C, Wang H, Cao J, Mi W. Measurement and analysis of tracheobronchial tree in Chinese population using CT. *Plos One.* 2015;10(6):0130239.
- [25] Breatnech E, Abott GC, Fraser RG. Dimensions of normal human trachea. *AJR.* 1984;142:903.
- [26] Leader JK. Measurement of trachea. *AJR AM J Roentgenol AVG.* 2004;183(2):315-21.
- [27] Coppola V, Vallone G, Coscioni E, Coppola M, Maraziti G, Alfinito M, et al. Normal value of tracheal bifurcation angle. *Radiol Med.* 1998;95(5):461-65.
- [28] Daroszewski M, Szpinda M, Wisniewski M, Flisinski P, Szpinda A, Woyniak A, et al. Tracheo-bronchial angles in the human fetus- an anatomical, digital and statistical study. *Med Sci Monit Basic Res.* 2013;19:194-200.

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AUTHOR DECLARATION:

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- Was informed consent obtained from the subjects involved in the study? NA
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