



MORPHOMETRY OF PRIMARY BRONCHUS : GROSS AND CT STUDY

Sweta Maurya*

Department Of Anatomy , Vardhaman Mahavir Medical College And SJH.

*Corresponding Author

Anita Tuli

Department Of Anatomy ,maulana Azad Medical College .

Shashi Raheja

Professor And Head Dr. Baba Saheb Ambedkar Medical College And Hospital

ABSTRACT

INTRODUCTION: The exchange of respiratory gases is the basic essentiality of life process in all organisms. Morphometric parameters of tracheobronchial tree is of profound clinical importance as it helps the clinicians to understand the basis of aetiology of several pulmonary diseases; surgeons to deal with resection and reconstruction , anaesthetist for endotracheal intubation & bronchoscopic procedures. **MATERIAL AND METHODS:** 60 formalin fixed lungs without any gross malformation or pathology were used in the study. The length and the diameters of right and left primary bronchus were measured and analyzed. **OBSERVATIONS:** The length of right main bronchus in cadavers was 28.53±3.46mm and of left was 51.08±3.66mm ,the length in CT images was 26.41±5.38mm and of left was 45.86±7.28mm. Internal and the external diameters at different level were observed at different levels in both cadavers and ct studies. **CONCLUSION:** Tracheobronchial morphometry data of present study will be of used to clinicians for preparation of mathematical models and for optimizing surgical & anaesthesiological procedures like resection, reconstruction procedures, bronchoalveolar lavage, endobronchial biopsy and tracheal intubation.

KEYWORDS : : Tracheobronchial ,primary Bronchus , Ct Study,morphometry

INTRODUCTION

The exchange of respiratory gases is the basic essentiality of life process in all organisms. Morphometric parameters of tracheobronchial tree is of profound clinical importance as it helps the clinicians to understand the basis of aetiology of several pulmonary diseases; surgeons to deal with resection and reconstruction ,anaesthetist for endotracheal intubation & bronchoscopic procedures. It is also useful in studies of comparative anatomy and in describing normal and diseased states of an organ.[1]Trachea bifurcates at the level of carina into right and left main bronchi at the level of T5. Right bronchus is more vertically placed, while the left is more horizontal. It further divides into upper, middle and lower lobar bronchus in the right lung; upper and lower lobar bronchus in the left lung.[2]

Two types of nomenclatures are used to classify the airway. The most common one being the Jackson Huber classification that names the divisions in accordance with the anatomic spatial orientation and Boyden's classification for surgical purposes; this numerically divides each zone. The morphometry of trachea and principal bronchus has been documented by various researchers. A combined morphometric study with CT imaging of the trachea and the principal bronchus has not been documented. Morphometry of tracheobronchial tree, bronchi and pulmonary arterial branching pattern and frequency of their expression that are fundamental in the planning of endobronchial techniques or surgical procedures.[3,4]

MATERIALS AND METHOD

Present study was conducted in the Department of Anatomy, Department of Forensic Medicine of Lady Hardinge Medical College, and Department of Radiodiagnosis, Dr. RML Hospital, PGIMER, New Delhi. 60 formalin fixed adult cadaveric lungs categorized into 18 years and above procured from the Department of Forensic Medicine from autopsies of unclaimed and donated corpses. 60 CT chest of patients in comparable age groups obtained from The Department of Radio-diagnosis, Dr. Ram Manohar Lohia Hospital and PGIMER using Philips Brilliance 40 slice Contrast Enhanced CT scanner . The length of the right main stem bronchus and the length of the left main bronchus were measured as the distances between the tracheal bifurcation point and the point where right main bronchus or left main bronchus divides into secondary bronchus.

The principal bronchus diameters were taken at three different levels in both cadavers and CT images (Plate 4,19).

LEVEL 1: at subcarinal angle

LEVEL 2: in the middle of the main bronchus

LEVEL 3: before it divides into secondary bronchus

All the data collected was statistically analysed using SPSS software.

For quantitative variables, mean and standard deviations were calculated. Their significance was assessed using Independent – t test and Anova Test. P values less than 0.05 was considered statistically significant.

OBSERVATIONS AND RESULTS

The length of right main bronchus in cadavers was observed as 28.53±3.46mm with the range of 20-34.9mm and of left main bronchus was observed as 51.08±3.66mm with the range of 44.7-59.4mm. The length of right main bronchus in CT images was observed as 26.41±5.38mm with the range of 15.5-37mm and of left main bronchus was observed as 45.86±7.28mm with the range of 30-61mm. The p value for bronchus was 0.07, >0.05 which showed that it remains same after death. The p value for right bronchus was 0.07, >0.05 which showed that it remains same after death. The p value for left bronchus was 0.01, <0.05 which showed that it changes after death. It was in accordance with other authors.

TABLE 1: PRIMARY BRONCHUS LENGTH RIGHT AND LEFT SIDE

| | RIGHT 1°BRONCHUS LENGTH IN CADAVERS | RIGHT 1°BRONCHUS LENGTH IN CT IMAGES | LEFT 1°BRONCHUS LENGTH IN CADAVERS | LEFT 1°BRONCHUS LENGTH IN CT IMAGES |
|---------|--|---|---|--|
| Mean | 28.53 | 26.41 | 51.08 | 45.86 |
| Median | 28.85 | 25.0 | 51.6 | 46.5 |
| Mode | 26.9 | 23.0 | 52 | 48.0 |
| SD | 3.46 | 5.38 | 3.66 | 7.28 |
| Minimum | 20 | 15.50 | 44.7 | 30.0 |
| Maximum | 34.9 | 37.0 | 59.4 | 61.0 |

*All dimensions in mm.

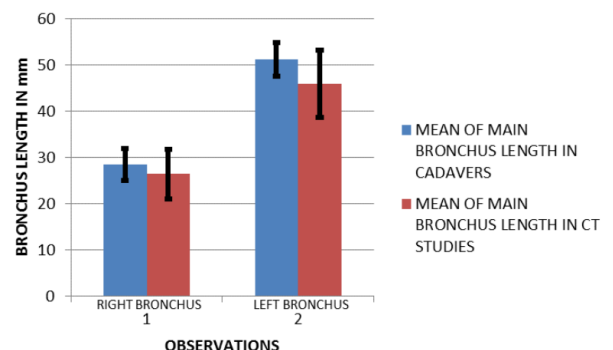


FIGURE 1: COMPARISON BETWEEN MEAN AND SD OF RIGHT AND LEFT MAIN BRONCHUS LENGTH IN CADAVERS AND CT IMAGES

PRINCIPAL BRONCHUS DIAMETER

The right primary bronchus diameter in cadavers at level 1 was observed as 19.37± 3.45mm with the range of 12-29.6mm, at level 2 was observed as 20.32±3.04mm with the range of 14.8-29.2mm, at level 3 was observed as 23.73±2.94mm with the range of 17-33.5mm. The primary bronchus internal diameter in cadavers at level 2 was observed as 17.8±3.1mm with the range of 12.1-26.5mm in cadavers and as 10.26±1.84mm with the range of 7.2-15mm in CT studies. The left primary bronchus diameter in cadavers at level 1 was observed as 16.65±2.59mm with the range of 11-25mm, at level 2 was observed as 16.80±2.78mm with the range of 12.5-25mm, at level 3 was observed as 19.89±4.33mm with the range of 10.5-32mm. The left primary bronchus internal diameter in cadavers at level 2 was observed as 14.8±2.8mm with the range of 9.9-22.3mm in cadavers and as 10.09±2.17mm with the range of 6.3- 14.4mm in CT studies. The diameters increase from level 1 to 3. The p-value for both rt and lt was <0.05 which shows that it increases after death might be due to relaxation of smooth muscles. It was in accordance with other authors but the Indian data was lacking.

TABLE 2: RIGHT PRIMARY BRONCHUS DIAMETER AT LEVEL 1,2,3

| | PRIMARY BRONCHUS AT LEVEL 1 | PRIMARY BRONCHUS AT LEVEL 2 | PRIMARY BRONCHUS AT LEVEL 3 |
|---------|-----------------------------|-----------------------------|-----------------------------|
| Mean | 19.37 | 20.32 | 23.73 |
| Median | 19.25 | 21 | 23.85 |
| Mode | 21 | 21 | 24 |
| SD | 3.45 | 3.04 | 2.94 |
| Minimum | 12 | 14.8 | 17 |
| Maximum | 29.6 | 29.2 | 33.5 |

*All dimensions in mm.

TABLE 3: COMPARISON BETWEEN PRIMARY BRONCHUS DIAMETER IN CADAVERS AND CT IMAGES

| | PRIMARY BRONCHUS DIAMETER IN CADAVERS AT LEVEL 2 | PRIMARY BRONCHUS DIAMETER IN CT IMAGES AT LEVEL 2 |
|---------|--|---|
| Mean | 17.8 | 10.26 |
| Median | 18.45 | 10.05 |
| Mode | 19.8 | 7.2 |
| SD | 3.1 | 1.84 |
| Minimum | 12.1 | 7.2 |
| Maximum | 26.5 | 15 |
| t value | | 12.7 |
| p value | | 0.000 |

*All dimensions in mm

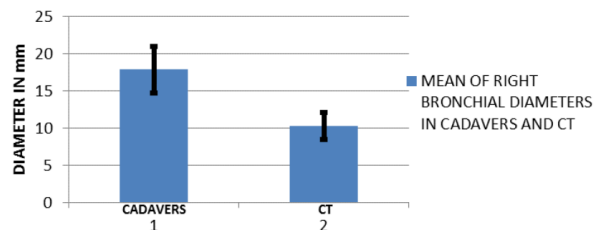


FIGURE 2: COMPARISON BETWEEN MEAN AND SD OF RIGHT PRIMARY BRONCHUS DIAMETERS IN CADAVERS AND CT IMAGES

TABLE 4: LEFT PRIMARY BRONCHUS DIAMETER IN CADAVERS AT LEVEL 1,2,3

| | PRIMARY BRONCHUS AT LEVEL 1 | PRIMARY BRONCHUS AT LEVEL 2 | PRIMARY BRONCHUS AT LEVEL 3 |
|---------|-----------------------------|-----------------------------|-----------------------------|
| Mean | 16.65 | 16.80 | 19.89 |
| Median | 16.95 | 16.75 | 19.55 |
| Mode | 17 | 16.7 | 15.5 |
| SD | 2.59 | 2.78 | 4.33 |
| Minimum | 11 | 12.5 | 10.5 |
| Maximum | 25 | 25 | 32 |

*All dimensions in mm.

TABLE 5: COMPARISON BETWEEN LEFT PRIMARY BRONCHUS DIAMETER IN CADAVERS AND CT IMAGES

| | PRIMARY BRONCHUS DIAMETER IN CADAVERS AT LEVEL 2 | PRIMARY BRONCHUS DIAMETER IN CT IMAGES AT LEVEL 2 |
|---------|--|---|
| Mean | 14.8 | 10.09 |
| Median | 14.2 | 10.00 |
| Mode | 14.5 | 9.90 |
| SD | 2.8 | 2.17 |
| Minimum | 9.9 | 6.30 |
| Maximum | 22.3 | 14.40 |
| t value | | 10.6 |
| p value | | 0.000 |

*All dimensions in mm

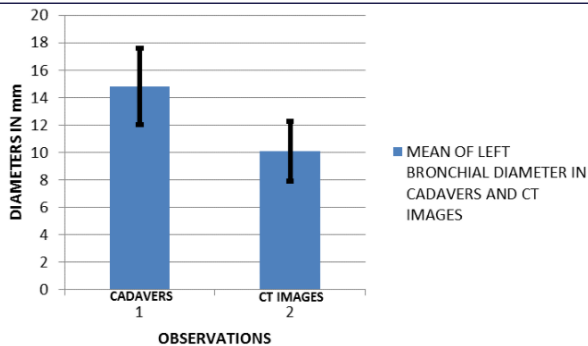


FIGURE 3: COMPARISON BETWEEN MEAN AND SD OF LEFT PRIMARY BRONCHUS DIAMETERS IN CADAVERS AND CT IMAGE

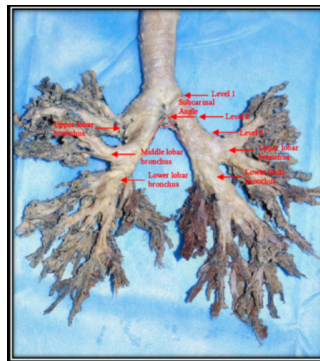


FIGURE 4 : TRACHEOBRONCHIAL TREE SHOWING VARIOUS MEASUREMENTS



FIGURE 5: CORONAL CT VIEW SHOWING TRACHEA AND PRIMARY BRONCHUS

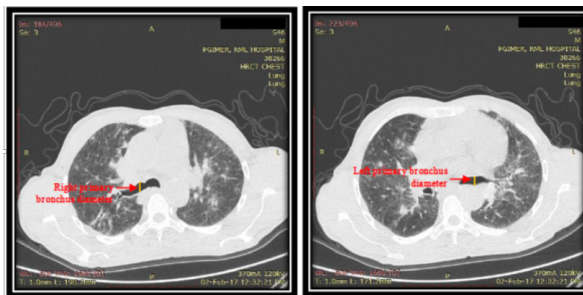


FIGURE 6: Axial view showing right & left primary bronchus

DISCUSSION

TABLE 6: COMPARISON OF GROSS MORPHOMETRY WITH OTHER AUTHORS

| GROSS PRESENT STUDY | Chunder et al ⁵ | Standring et al ² | Jit H & Jit I ¹ | |
|-------------------------|----------------------------|------------------------------|----------------------------|--|
| RT MAIN BRONCHUS LENGTH | 28.53mm | 22.7mm | 25mm | 27.26mm in males 23.82mm in females |
| LT MAIN BRONCHUS LENGTH | 51.08mm | 45.3mm | 55mm | 48.58mm in males 43.75mm in females |

The present study corresponds with Jit H & Jit I might be due to study

in same population. It also correlates with study done by Standing et al. It does not correlates exactly with Chunder et al.

TABLE 7: COMPARISON OF CT STUDIES

| CT | PRESENT STUDY | Zhang et al ⁶ |
|-------------------------|---------------|--------------------------|
| RT MAIN BRONCHUS LENGTH | 26.41mm | 13.6mm |
| LT MAIN BRONCHUS LENGTH | 45.86mm | 48.3mm |

The mean of left main bronchus of present study correlates with the studies done by Zhang et al but the right does not might be due to lack of study done in Indian population as best of our search.

TABLE 8: COMPARISON OF GROSS MORPHOMETRY WITH OTHER AUTHORS

| GROSS | PRESENT STUDY | Chunder et al ⁵ | Standing et al ² | Jit H & Jit I ¹ |
|-----------------------------|---------------|----------------------------|-----------------------------|----------------------------|
| RT.EXT.TRANS.DIA AT LEVEL 1 | 19.37mm | | | |
| RT.EXT.TRANS.DIA AT LEVEL 2 | 20.32mm | 16mm | 16mm | |
| RT.EXT.TRANS.DIA AT LEVEL 3 | 23.73mm | | | |
| LT.EXT.TRANS.DIA AT LEVEL 1 | 16.65mm | | | |
| LT.EXT.TRANS.DIA AT LEVEL 2 | 16.80mm | 15mm | 14mm | |
| LT.EXT.TRANS.DIA AT LEVEL 3 | 19.89mm | | | |
| RT.INT.TRANS.DIA AT LEVEL 2 | 17.8mm | | | 26.42mm |
| LT.INT.TRANS.DIA AT LEVEL 2 | 14.8mm | | | 10.09mm |

The values of left external diameter corresponds with the studies done by Chunder et al and Standing et al. The other values did not correspond might due to lack of available data in Indian population to best of our search.

TABLE 9: COMPARISON OF CT STUDIES

| CT | PRESENT STUDY | Zhang et al ⁶ |
|---------------------------|---------------|--------------------------|
| RT MAIN BRONCHUS DIAMETER | 10.26mm | 13.2mm |
| LT MAIN BRONCHUS DIAMETER | 10.09mm | 10.9mm |

The present study corresponds with the study performed by Zhang et al and there is lack of Indian data available to best of our search.

CONCLUSION

1. Tracheobronchial morphometry data of present study will be of used to clinicians for preparation of mathematical models and for optimizing surgical & anaesthesiological procedures like resection, reconstruction procedures, bronchoalveolar lavage, endobronchial biopsy and tracheal intubation.
2. This data will help to correlate anomalous and normal tracheobronchial tree dimensions, as it forms the baseline for comparison.
3. The length of tracheobronchial tree remains the same after death.
4. The diameters of tracheobronchial tree increases after death due to relaxation of smooth muscles.

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