

Original Article**Maximum Thickness of the Cartilaginous Ring of the Trachea in Different Age & Sex Group of Bangladeshi Cadaver**

*Nawshin N¹, Mannan S², Chowdhury MS³, Kabir A⁴, Afrin L⁵

1. * Dr. Nadia Nawshin, Associate Professor, Department of Anatomy, Delta Medical College.
2. Dr. Sabina Mannan, Professor, Department of Anatomy, Mymensingh Medical College.
3. Dr. Md. Shahjahan Chowdhury, Associate Professor, Department of Anatomy, Delta Medical College.
4. Dr. Anamul Kabir, Associate Professor, Department of Anatomy, Jahurul Islam Medical College.
5. Dr. Luisa Afrin, Assistant Professor, Department of Anatomy, Delta Medical College.

Address of correspondence*Abstract**

Background: The trachea is a cartilaginous tube supported by incomplete cartilaginous rings that keep the trachea patent during pressure changes of breathing. Accurate measurement of the thickness of the only cartilaginous rings can be done by histological measurement as uses of vernier caliper include the thickness of the other soft tissues. The study is done to establish an average thickness of tracheal cartilaginous rings in Bangladeshi people that help the Anatomist to increase their knowledge bank.

Objective: The present study was carried out to establish a reference for future studies in an attempt to expand the existing knowledge base concerning human tracheal cartilage thickness.

Materials and Methods: This cross-sectional descriptive study was performed on 30 post mortem human tracheal histological slide (15 of male and 15 of female) to find out the difference in maximum thickness of the cartilaginous ring of the trachea of Bangladeshi people in relation to age and sex. The specimens were collected from the morgue in the department of Forensic Medicine, Mymensingh Medical College, Mymensingh by purposive sampling technique. All specimens were grouped into three categories, Group A (up to 20 years), Group B (21-40 years) and Group C (41-60 years) according to age. Dissection was performed according to standard autopsy techniques. The trachea was cut horizontally through the upper border of the 5th tracheal ring. Tissue samples were processed routinely by following standard histological procedures, then sections were stained with hematoxylin and eosin (H&E) stain. Then permanent slides were made. 10 slides from 10 different trachea were prepared from each group. Thus 30 slides were examined under X 10 objective. From each slide one field was chosen where the thickness of cartilage is maximum. The values were put down in a tabulated form for convenient processing which led to a conclusion. The average thickness was expressed in micrometer (μm). All data were recorded in the pre-designed data sheet and statistical analysis was done using computer based statistical package, SPSS to evaluate the significance of variance between the different findings.

Results: The maximum thickness of cartilage of the trachea was 111.25, 116.25 and 110 μm in group A, B and C respectively. The minimum thickness of cartilage of the trachea was 65 μm in group A & B and 63.75 μm in group C. The mean (\pm SD) thickness of cartilage of the trachea was 86.88 \pm 15.65, 83.63 \pm 15.17 and 90.63 \pm 15.48 μm in group A, B and C respectively. The maximum mean thickness of cartilage of the trachea was in group C (90.63 μm) and minimum was in group B (83.63 μm). The mean difference of thickness of cartilage of the trachea between groups was statistically non-significant.

Conclusions: The study would help to increase the information pool on the Maximum Thickness of the Cartilaginous Ring of the Trachea of the trachea of Bangladeshi people.

Key words: Trachea, Cartilage, Thickness, Age, Sex, Bangladeshi people

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Introduction

The trachea is the part of lower respiratory airway that extends from the lower border of the larynx (2 cm below the vocal cords) to the carina, where it bifurcates into the right and left principal bronchi. Histologically the trachea consists of four layers from inwards to outwards -mucosa, submucosa, cartilaginous layer and adventitia. Mucosa composed of pseudostratified ciliated columnar epithelium and an elastic fiber rich lamina propria. Submucosa composed of loose connective tissue containing mixed gland. Cartilaginous layer composed of C-shaped hyaline cartilage bridge at its posterior end by a bundle of smooth muscle (trachealis muscle) and a sheet of fibroelastic tissue attaches to the perichondrium. Adventitia is made of fibroelastic connective tissue containing neurovascular structures. Tracheomalacia is a condition in which the cartilage in the wall of the trachea softens resulting in a floppy or weak airway that collapses with breathing and makes breathing difficult. Complete tracheal rings are a rare disorder that is present at birth. It is usually associated with other abnormalities of the heart or lungs. It may also be

associated with Down syndrome and Pfeiffer syndrome. Tracheal rings can also be associated with a condition in which the pulmonary artery (the artery carrying blood from the right ventricle of the heart to the lungs) wraps around the trachea and causes a narrowing of the opening¹. Full-thickness tracheal lesions (FTTLs) and tracheoesophageal fistulas (TEFs) are serious but rare (0.3%-3%) complications of prolonged invasive mechanical ventilation (MV)². With the coronavirus disease 2019 (COVID-19) outbreak, however an unprecedented increase in the incidence of FTTLs and TEFs in ventilated patients with COVID-19, the reasons for which are unknown³.

There is a limitation of published work on thickness of the cartilaginous rings of the trachea of Bangladeshi people. We mainly depend on foreign text and literatures. However, we need our own standard baseline from which we can compare the morphological parameter like maximum thickness of the trachea of our own population with those of Western & other Asian people. Therefore, it has been designed to study the thickness of cartilage to see the variation with age and sex in Bangladeshi people.

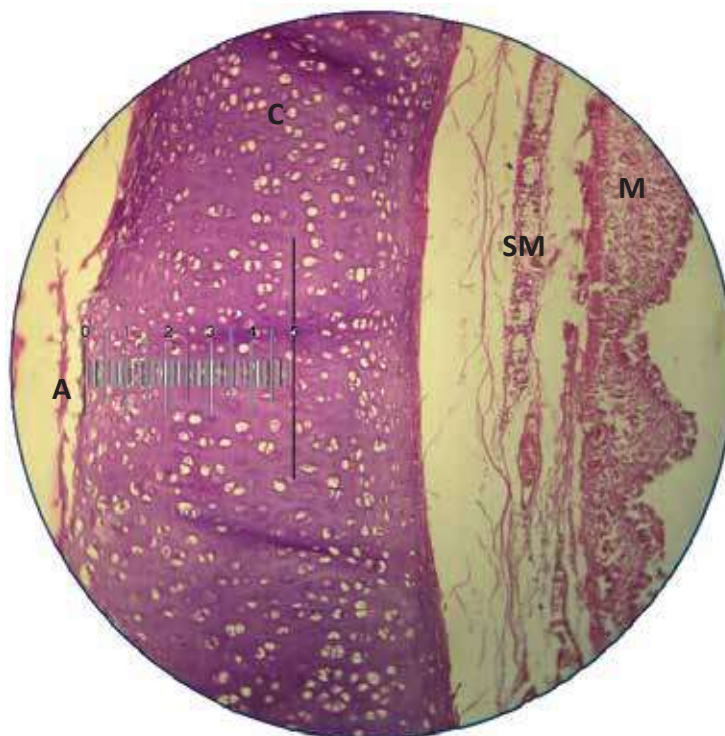


Figure 1: Photomicrograph of a transverse section of the trachea from age group A, showing all the layers with an ocular micrometer (H & E stain x 10 objective). Here, A=adventitia, C=cartilage, SM=submucosa, M=mucosa

Methods

The specimens comprising of the trachea up to principal bronchus were collected from Bangladeshi cadavers of age ranging from 6 years to 60 years, from autopsy laboratory of the Department of Forensic Medicine of Mymensingh Medical College, Mymensingh from July 2014 to June 2015. Dissection was performed according to standard autopsy techniques. The arch of the cricoid cartilage was carefully cleaned and defined. With the help of sharp scalpel, the trachea was freed posteriorly from the esophagus and anteriorly from thyroid and parathyroid gland. The specimens were washed thoroughly with normal saline water to remove the clotted blood from the specimen. Each specimen was examined externally to detect any abnormalities. Then the trachea was cleaned gently with taking precaution not to damage any part. The specimens were preserved in formol saline. All the collected specimens of cadavers were from medico-legal cases (unnatural death). Only fresh specimens from persons who died within the preceding 12 hours were chosen. Each specimen was duly tagged by a piece of waxed cloth which bore an identification number representing individual serial number. The collected specimens were divided into three groups: e.g., Group A (up to 20

years), Group B (21-40 years) and Group C (41-60 years) according to age. Each group was again subdivided into male & female groups.

Excess water or formol saline was soaked with blotting paper and the trachea was cut horizontally through the upper border of the 5th tracheal ring. Tissue samples were processed routinely by following standard histological procedures, then sections were stained with hematoxylin and eosin (H&E) stain. Then permanent slides were made.

10 slides from 10 different trachea were prepared from each group. Thus 30 slides were examined under X 10 objective. From each slide one field was chosen where the thickness of cartilage is maximum. After preparation of histological slides of the sections, the selected fields in the slides were photo-micro graphed by a special microscopic device in the Department of Anatomy of Mymensingh Medical College, Mymensingh. The values were put down in a tabulated form for convenient processing which led to a conclusion.

The measurement was expressed in micrometer (μm). All data were recorded in the predesigned data sheet, analyzed by SPSS program (version 21, 2012) using one way ANOVA Test.

Results

Table I: Mean Thickness of Cartilage of the Trachea in Different Age Groups

| Age Group | Number of specimens | Mean \pm SD (Minimum - Maximum) |
|-----------------------|---------------------|--------------------------------------|
| A (upto 20 years) | 10 | 86.88 \pm 15.65 (65-111.25) |
| B (21- 40 years) | 10 | 83.63 \pm 15.17 (65-116.25) |
| C (41 to 60 years) | 10 | 90.63 \pm 15.48 (63.75-110) |

Comparison of Thickness of Cartilage of the Trachea among the Age Groups

| Comparison between Variables | | Mean difference | Std. Error | P | Level of significance |
|------------------------------|---|-----------------|------------|-------|-----------------------|
| A | B | 3.25 | 6.891269 | 0.643 | Non significant |
| B | C | -7 | 6.853375 | 0.321 | Non significant |
| C | A | 3.75 | 6.960953 | 0.597 | Non-significant |

P < .001 is considered as Highly significant

P < .05 is considered as Significant

P = or > .05 is considered as Non significant

Table II: Mean Thickness of Cartilage of the Trachea in Different Sex

| Age Group | Sex | Number of specimen | Mean thickness in μm | \pm SD |
|-----------------------|--------|--------------------|---------------------------------|----------|
| A (upto 20 years) | Male | 5 | 92 | 13.85 |
| | Female | 5 | 81.75 | 17.13 |
| B (21- 40 years) | Male | 5 | 86.25 | 17.07 |
| | Female | 5 | 81 | 14.45 |
| C (41 to 60 years) | Male | 5 | 88.75 | 12.31 |
| | Female | 5 | 92.5 | 19.47 |

Comparison of Thickness of Cartilage of the Trachea between Sexes

| Age Group | Mean difference between sex | Std. Error difference | t | P | Level of significance |
|-----------|-----------------------------|-----------------------|--------|-------|-----------------------|
| A | 10.25 | 9.85203 | 1.04 | 0.329 | Non-significant |
| B | 5.25 | 10.00312 | 0.525 | 0.614 | Non-significant |
| C | -3.75 | 10.30018 | -0.364 | 0.725 | Non-significant |

Table II (Fig.2) depicts that the mean (\pm SD) thickness of cartilage of the trachea in male was 92 ± 13.85 , 86.25 ± 17.07 and 88.75 ± 12.31 μm in group A, B & C respectively and 81.75 ± 17.13 , 81 ± 14.45 and 92.50 ± 19.47 μm in female in group A, B & C respectively. It is evident from the results that the mean thickness of cartilage of the trachea in male was higher than that of female in group A & B but lower in group C.

Variance analysis shows that there was no significant difference in mean thickness of cartilage of the trachea between sexes in the groups, where for group A, $t=1.04$ & $P=0.329$, for group B, $t=0.525$ & $P=0.614$ and for group C, $t=-0.364$ & $P=0.725$.

All the above findings are shown in Figure:2

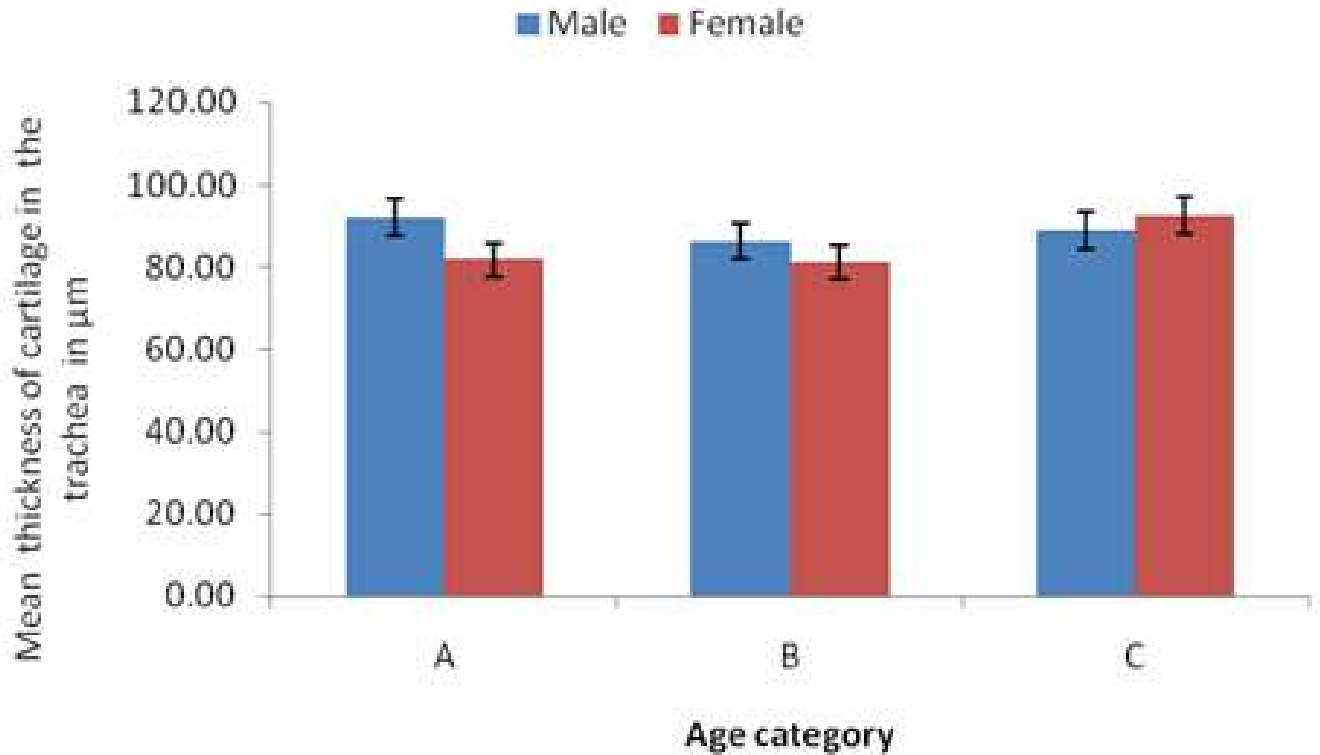


Figure 2: Bar diagram showing the mean thickness of the cartilage of the trachea in different age and sex groups

Discussion

The maximum thickness of cartilage of the trachea was 111.25, 116.25 and 110 μm in group A, B and C respectively. The minimum thickness of cartilage of the trachea was 65 μm in group A & B and 63.75 μm in group C.

The mean (±SD) thickness of cartilage of the trachea was 86.88±15.65, 83.63±15.17 and 90.63±15.48 μm in group A, B and C respectively. The maximum mean thickness of cartilage of the trachea was in group C (90.63 μm) and minimum was in group B (83.63 μm).

The mean difference of thickness of cartilage of the trachea between groups was statistically non significant.

The mean (±SD) thickness of cartilage of the trachea in male was 92.00±13.85, 86.25±17.07 and 88.75±12.31 μm in group A, B & C respectively and 81.75±17.13, 81.00±14.45 and 92.50±19.47 μm in female in group A,

B & C respectively. It is evident from the results that the mean thickness of cartilage of the trachea in male was higher than that of female in group A & B but lower in group C. Variance analysis shows that there was no significant difference in mean thickness of cartilage of the trachea between sexes in the groups.

Y. Premakumar⁴ on his research on 10 formaldehyde-fixed cadavers (8 male, 2 female, age range 70–96 years) found single Tracheal cartilage rings with 1 mm thickness. According to Allen⁵ the tracheal cartilages are up to 2 mm thick in adults. Pearson et al⁶ described that the average thickness of tracheal ring in an adult is approximately 1 mm. Tewfik TL⁷ stated that the tracheal cartilages measured about 1mm in thickness.

The findings of the present study are less than the above mention authors. It may be due to variation of the method or may be hard and shrinkage of specimens or more likely to be due to the racial factors.

Conclusion

From the present study, it was concluded that the maximum mean thickness ($90.63 \pm 15.48 \mu\text{m}$) of the tracheal cartilage at the level of 5th ring was in age ranging between 41-60 years and minimum ($83.63 \pm 15.17 \mu\text{m}$) was in age ranging between 21-40 years. The mean difference of thickness of cartilage of the trachea between groups was statistically insignificant. The maximum mean (\pm SD) thickness of the tracheal cartilage at the level of 5th ring was $90.63 \pm 15.48 \mu\text{m}$ in male in age ranging between 41-60 years and minimum mean (\pm SD) thickness was $81.00 \pm 14.45 \mu\text{m}$ in female in age ranging between 21-40 years. Histological findings showed that the thickness of cartilage of the trachea increased gradually with increasing age.

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