

Cadaver Study of the Diameter of the Cricoid Cartilage in Different Age Groups in A Bangladeshi Population

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ABSTRACT

Background: Accurate anatomic knowledge is essential in diagnostic and therapeutic procedures in the field of laryngology.

Objective: The present study aims to determine the diameter of cricoid cartilage and demonstrate differences among different age groups in a Bangladeshi population.

Materials and methods: This cross-sectional, descriptive study was done between October 2008 and March 2009. A total 60 human larynges were collected through purposive sampling from. Among them, 45 (male 23 and female 22) were collected from cadavers (9 to 60 years) at the autopsy laboratory of Department of Forensic Medicine & Toxicology, and 15 (male 6 and female 9) from stillborn infants of viable age (28 to 40 weeks of gestation) from Department of Obstetrics & Gynaecology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh. The diameter of the cricoid cartilage was measured using slide calipers and the difference between age groups was determined by One-way ANOVA test.

Results: The mean±SD transverse diameter of the cricoid cartilage was found as 7.40±1.72 mm ranged from 3 to 9 mm in age group A (28 to 40 weeks of gestation), 11.31±1.30 mm in age group B (9 to 16 years) ranged from 9 to 13 mm and 17.10±3.99 mm in age group C (17 to 60 years) and ranged from 10 to 24 mm. The mean transverse diameter of cricoid cartilage was highest in age group C (17.10 mm) and was lowest in age group A (7.40 mm). The difference of transverse diameter of cricoid cartilage between group A & B (P=0.001), A & C and B & C (P=0.000) were statistically significant. The mean±SD anteroposterior diameter of the cricoid cartilage was found as 10.33±1.54 mm ranged from 7 to 12 mm in age group A, 20.56±2.66 mm in age group B ranged from 15 to 25 mm and 26.79±4.37 mm in age group C and ranged from 16 to 38 mm. The mean anteroposterior diameter of cricoid was found the highest in age group C (26.79 mm) and the lowest in age group A (10.33 mm). The difference of anteroposterior diameter of cricoid cartilage between group A & B, A & C and B & C were statistically significant (P=0.000).

Conclusion: Our study revealed that significant difference exists in transverse and anteroposterior diameter of the cricoid cartilage among different age groups and the values were found to increase with age.

Keywords: Larynx, cricoid cartilage, diameter, Bangladeshi people

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INTRODUCTION

The larynx is essentially an organ of respiration and phonation, as set in the respiratory tract between the pharynx and trachea. However, the main function of the larynx is to provide a protective sphincter at the inlet of the air passages to prevent entry of any materials other than air.¹⁻³ The larynx is made up of skeletal framework of cartilages, which are connected by synovial joints, ligaments, and fibrous membranes (cricovocal and quadrate) and are moved by a number of intrinsic muscles. The cavity of the larynx is lined by mucous membrane.²⁻⁴ The larynx is composed of nine cartilages, of which three are unpaired and three are paired. Unpaired cartilages are thyroid, cricoid & epiglottis. Paired cartilages are arytenoids, corniculate & cuneiform. The cricoid cartilage is smaller but thicker and stronger than the thyroid cartilage and forms the lower and posterior parts of the wall of the larynx. It presents a signet-shaped complete ring with a narrow anterior arch and a broad posterior quadrate lamina.^{3,4} The lamina is broad and quadrilateral and measures vertically about 20 or 30 mm. On its posterior surface, in the midline, is a vertical ridge to the lower part of which are attached the longitudinal fibers of the esophagus and on either side of this a broad depression for the posterior cricothyroid muscle.⁴ The arch is narrow and convex and measures vertically from 5 to 7 mm. It affords attachment externally in front and at the sides to the cricothyroid muscle and behind, to part of the constrictor pharyngis inferior. On either side, at the junction of the lamina with the arch, is a small round articular surface for articulation with the inferior cornu of the thyroid cartilage. The lower border of the cricoid cartilage is horizontal and connected to the highest first cartilaginous ring of the trachea by the cricotracheal ligament.^{3,4} The upper border of cricoid cartilage runs obliquely upward and backward, owing to the great depth of the lamina. It gives attachment in front of the middle cricothyroid ligament; at the side to the conus elasticus and the lateral cricoarytenoid muscle; behind, it presents in the middle, a shallow notch and on either side of this is a smooth, oval, convex surface, directed upward and lateral ward for articulation with the base of an arytenoid cartilage. The inner surface of the cricoid cartilage is smooth and lined by mucous membrane.⁴

Detail anatomical knowledge is necessary for the diagnosis of diseases by endoscopic evaluation, laryngoscopy, CT scan and MRI. The MRI measures

8% smaller than the anatomical measures and 12% smaller than data reported in the literature.⁵ Laryngeal surgery demands precise method of investigation to provide accurate anatomical details of the laryngeal abnormalities. Hence, for management purpose specially in surgical procedures as intubation, tracheotomy, medialization, implant, sublaxation, thyroplasty, laryngoplasty, laryngotomy, laryngectomy, minute anatomical knowledge of larynx is essential.⁶⁻¹⁰ The cricoid lumen configuration was elliptic, and its mean area was smaller than that of available endotracheal tubes. This lumen area was mostly influenced by weight and height. Detailed morphometric data on the anatomy of the cricoid cartilage and its relationship with growth and body characteristics of fetuses is essential for fetal crico-tracheal manipulation.⁹ Moreover, there is disagreement regarding the anatomy of the pediatric airway, particularly regarding the shape of the cricoid cartilage and the location of the narrowest portion of the larynx.⁹ The present study was designed with a view to contribute to data pool to establish a Bangladeshi standard metrics in the gross anatomy of larynx.

MATERIALS AND METHODS

The present study was performed on 60 postmortem human larynges at the Department of Anatomy of Mymensingh Medical College, Mymensingh, Bangladesh. Specimens containing larynx were collected from unidentified dead bodies under autopsy at Department of Forensic Medicine & Toxicology, and dead babies from the Department of Obstetrics & Gynaecology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh, between October 2008 and March 2009. All the collected specimens of cadavers were from medico-legal cases (unnatural death) and another group from stillborn infants. Only fresh specimens from persons who died within the preceding 12 to 24 hours and stillborn infants just after delivery were chosen. The age range of persons whose larynx was collected varies from 9 years to 60 years for groups after birth and 28 to 40 weeks for intrauterine group.

From each cadaver the larynx and related neighboring structures were collected by "Block Dissection", during routine postmortem examination. Then the tissue block was washed gently with running tap water to remove the blood and blood clots as far as possible. Each specimen was duly tagged by a piece

of waxed cloth, which bore an identifying number representing individual serial number. Then the specimen was fixed and preserved in 10% formal-saline solution. For convenience of differentiating the diameter of cricoid cartilage in relation to age, the collected specimens were divided into three groups: e.g., A (28 to 40 weeks of gestation), B (from 9 to 16 years) and C (from 17 to 60 years). Associated muscles, membrane and ligaments were detached from the cricoid cartilage specially. The transverse diameter of cricoid cartilage was measured at the level of junction between anterior arch and posterior lamina of cricoid cartilage, which corresponds outside with the cricothyroid articulation⁸ (Fig. 1). The anteroposterior diameter was measured from midpoint of the superior border of anterior arch to middle of the superior border of the posterior lamina of cricoid cartilage⁸ (Fig. 1). Both the measurements were done using slide calipers and values were expressed in millimeters.

All the data were compiled, sorted properly, and analyzed statistically using Statistical Package for Social Science (SPSS) version 11.0. One-way ANOVA test was performed to compare between age groups. P value <0.05 was considered as significant. This study was approved by the Ethical Review Committee of Mymensingh Medical College, Mymensingh, Bangladesh.

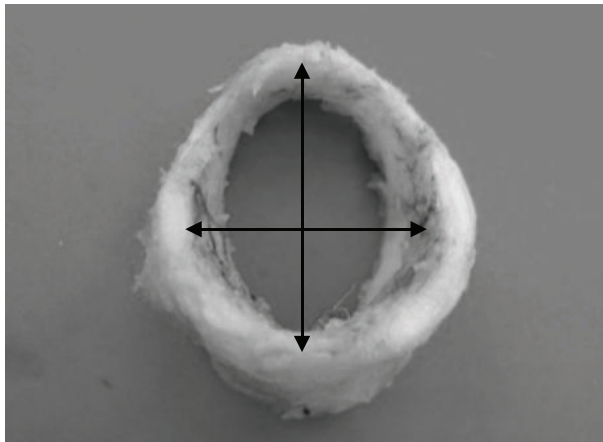


Fig.-1: Photograph of the cricoid cartilage (superior view) shows transverse diameter (horizontal arrow) and anteroposterior diameter (vertical arrow).

RESULTS

The mean transverse diameter of cricoid cartilage was found as 7.40 ± 1.72 mm (ranged between 3 and 9 mm) in age group A, 11.31 ± 1.30 mm in age group B (ranged

between 9 and 13 mm) and 17.10 ± 3.99 mm in age group C (ranged between 10 and 24 mm). The mean transverse diameter of cricoid cartilage was found the highest in age group C (17.10 mm) and the lowest in age group A (7.40 mm). The mean difference of transverse diameter of cricoid cartilage between group A & B ($p=0.001$), A & C and B & C ($p=0.000$) were statistically significant (Table-I). The mean anteroposterior diameter of cricoid cartilage was found as $10.331.54$ mm in age group A (ranging from 7 to 12 mm), 20.56 ± 2.66 mm in age group B (ranging from 15 to 25 mm) and 26.79 ± 4.37 mm in age group C (ranging from 16 to 38 mm). The mean anteroposterior diameter of cricoid was found highest in age group C (26.79 mm) and the lowest in age group A (10.33 mm). The mean difference of anteroposterior diameter of cricoid cartilage between group A & B, A & C and B & C were statistically significant ($p=0.000$) (Table-II).

Table-I: Transverse diameter of cricoid cartilage in different age groups

Age group	Number of specimen	Diameter in mm	P value
A (28 to 40 weeks of gestation)	15	7.40 ± 1.72 (3 - 9)	0.001^S
B (Up to 16 years)	16	11.31 ± 1.30 (9 - 13)	0.000^S
C (17 years and above)	29	17.10 ± 3.99 (10 - 24)	0.000^S

Figures in parentheses indicate range. P value reached from one-way ANOVA test; S=significant.

Table-II: Anteroposterior diameter of cricoid cartilage in different age groups

Age group	Number of specimen	Diameter in mm	P value
A (28 to 40 weeks of gestation)	15	10.33 ± 1.54 (7 - 12)	0.000^S
B (Up to 16 years)	16	20.56 ± 2.66 (15 - 25)	0.000^S
C (17 years and above)	29	26.79 ± 4.37 (16 - 38)	0.000^S

Figures in parentheses indicate range. P value reached from one-way ANOVA test; S=significant.

DISCUSSION

Due to the irregular shape of the larynx, measured values of different parts of the larynx may vary from one study to another.⁶⁻¹⁷ The fact that some of the absolute data differs quite heavily between these studies may be explained by different definitions of measuring points.¹⁰ Moreover, variations exist among different ethnic population in specific geographic area.^{7,10-12} According to Lima et al., the main constriction point of the infants' larynx is the mid-cricoid area.⁹ They studied nineteen larynges from 17 stillborn infants and 2 newborn infants ranging in gestational age from 5 to 9 months (i.e., ~20 to 36 weeks of gestation). The cricoid lumen configuration showed an almost elliptical in shape, which did not change with gestational age. The mean inner subglottic cricoid area was $19.27 \pm 9.62 \text{ mm}^2$ and was related to weight and body surface area. The mean area of cricoid lumen was identified smaller than that of available endotracheal tubes.⁹ Jain & Dhall found the antero-posterior diameter and transverse diameter $28.6 \pm 4.9 \text{ mm}$ $25.7 \pm 3.2 \text{ mm}$ respectively in men, while $23.2 \pm 4.1 \text{ mm}$ and $21.3 \pm 4.7 \text{ mm}$ respectively in women.¹¹ Joshi et al. found that the transverse diameter ranged from 13.88 to 24.05 mm, with an average of $18.33 \pm 2.26 \text{ mm}$, while the antero-posterior diameter ranged from 13.68 to 24.56 mm with an average of $19.29 \pm 2.47 \text{ mm}$ in a western Indian population.¹² Fayoux et al.¹³ also reported that the diameter of the cricoid lumen was significantly less than that of the trachea and glottis lumen. Ajmani et al. found that the transverse diameter of the cricoid cartilage is greater than the anteroposterior diameter in both sexes.⁸ In another similar study done by Ajmani in adult Nigerian population, the mean anteroposterior diameter was found 28.82 mm, while the mean transverse diameter was 29.84 mm in males and the mean antero-posterior diameter is 24.06 mm and the mean transverse diameter as 25.84 mm in females. This study was carried out on 40 specimens (28 males and 12 females) aged between 17 and 50 years.¹⁴ Randestad et al. carried out a study on 34 men and 27 women of Sweden and demonstrated the dimensional differences of the inner cricoid ring. In men, the mean diameter was 15.0 mm (ranged between 11.0 and 21.5 mm), while in women, the mean diameter was 11.6 mm (ranged between 8.9 and 17.0 mm).¹⁵ Kim & Song studied on 48 cadavers (33 males and 15 females) in Korea and found the antero-posterior diameter and transverse diameter

$18.78 \pm 0.47 \text{ mm}$ $17.19 \pm 0.40 \text{ mm}$ respectively in men, while $15.97 \pm 0.54 \text{ mm}$ and $13.36 \pm 0.50 \text{ mm}$ respectively in women.¹⁶ The findings of the present study are more or less similar to those of the previous studies as mentioned above. In contrast, Too-Chung & Green found that in age group from neonatal to 15 years, the coronal diameter of the cricoid cartilage is greater than the sagittal diameter,¹⁷ which is not similar to the observation of the present study. However, they also reported that with age, the sagittal diameter increases faster than that of the coronal one, and both coronal and sagittal diameters bear a linear relationship with height of the individual.¹⁷

CONCLUSION

To summarize, our study revealed significant difference exists in values among different age groups and the values were found to increase with age. The data obtained from this study may contribute to increase understanding in anatomy of laryngeal framework in our population. However, further studies with larger samples and based on different ethnicities in the country are recommended.

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