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Original Article

MORPHOLOGY AND MORPHOMETRY OF ADULT HUMAN CRICOID CARTILAGE: A CADAVERIC STUDY IN NORTH INDIAN POPULATION

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ABSTRACT

Introduction: Out of different cartilages of larynx, cricoid is the strongest cartilage. It is the only cartilage which extends completely around the air passage. It is smaller but stronger and thicker than the thyroid cartilage. Though a lot of work has been done on thyroid cartilage it is not so for cricoid cartilage. This give us a impetus to design this study.

Material and method: The material for present study comprised of 30 adult (M:F::25:5) apparently normal cadaveric larynges, obtained from the Anatomy Department of Govt. Medical College, Amritsar. Different morphometric diameters of the cricoid cartilage were measured with help of vernier caliper with least count 0.01 mm and these were noted on a predesigned proforma. All the data thus obtained was tabulated, analysed, scrutinized and compared with the earlier studies available in the literature. An attempt has been done to provide a base line data for this region.

Result and Conclusion: Cricoid cartilage was oval in shape in all the specimens. Outer and inner transverse diameters and outer and inner anteroposterior diameters of cricoid cartilage were larger in males as compared to females. As we compare both diameters in males and females, outer transverse diameter was found to be larger than outer anteroposterior diameter, while inner anteroposterior diameter was larger than inner transverse diameter. Height and thickness of cricoid arch and lamina were observed to be larger in males as compared to females.

KEY WORDS: Cricoid cartilage, Larynx, Thyroid cartilage.

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INTRODUCTION

Larynx is an air passage, a sphincter and an organ of phonation. Skeletal framework of larynx is formed by series of cartilages viz. unpaired thyroid, cricoid and epiglottis and paired arytenoid, cuneiform and corniculate [1].

A basic knowledge of anatomy of larynx is necessary from clinical point of view. It is necessary for those who are involved in fields of surgical treatment of larynx such as speech therapists, anaesthetists, oncologists, pulmonologists, radiologists, general practitioners, ENT specialist and phoniatricians [2]. A variant anatomy of laryngeal cartilages even influences morphology of blunt injuries of neck [3].

A knowledge of dimensions of cartilages of larynx and trachea is a must for transplantation, stenting, intubation, cricothyroidotomy and endoscopic procedures [4]. Subglottic stenosis

and postintubational stenosis of lower respiratory tract were two main factors which led anatomists to work for measurements of various cartilages in early nineties [5].

The increasing application of sophisticated electrophysiological, radiological and surgical methods for the diagnosis and treatment of laryngeal disorders requires profound knowledge of size and proportion of human larynx and its cartilaginous components [6,7].

Such data on endolaryngeal angles, airway lumina and thickness of parts of laryngeal skeleton can be helpful in planning of endolaryngeal surgical intervention or transcutaneous placement of electrodes for laryngeal electromyography or the analysis of CT and MRI scans of the larynx [6].

Out of different cartilages of larynx, the cricoid cartilage is the only supporting element of larynx and trachea which extend completely around the air passage [1,8]. It is the lowest of laryngeal cartilages [9]. It is signet ring shaped with lower half of signet removed [10]. It is smaller but thicker and stronger than thyroid cartilage.

The diameters of cricoid cartilage vary a lot. According to Too Chung and Green [11] the coronal diameter of cricoid cartilage is greater than sagital diameter upto age of 15 years and thereafter sagital diameter increases faster.

Lately Randestad et al [4] found that in some females, the inner diameter of cricoid ring does not permit passage of a standard size (7mm internal diameter) tracheal tube or endoscope through the larynx without mucosal damage. These females receive pressure necrosis at medial side of arytenoid cartilages due to tracheal intubation with standard tubes.

Thus knowledge of different parameters of various laryngeal cartilages is necessary before attempting different surgical or other interventions. A lot of work has been done on thyroid cartilage but the cricoid cartilage is the neglected one in this respect. So this study was designed to attain a knowledge about this important but unattended laryngeal cartilage.

MATERIALS AND METHODS

The material for present study comprised of 30 adult (M:F::25:5) apparently normal cadaveric larynges, obtained from the Anatomy Department of Govt. Medical College, Amritsar.

All the larynges were removed along with hyoid bone and trachea up to third tracheal ring. All the muscles and ligaments attached to larynx were removed carefully. Then these were serialised from 1-30 with suffix M or F for male or female respectively. Different morphological features were observed, measurements were taken and recorded on the predesigned proformas.

Any larynx with any cartilage having broken or indistinct margins were excluded from the study.

A vernier caliper with least count of 0.01 mm was used for taking different measurements.

Following measurements of cricoid cartilage were taken:

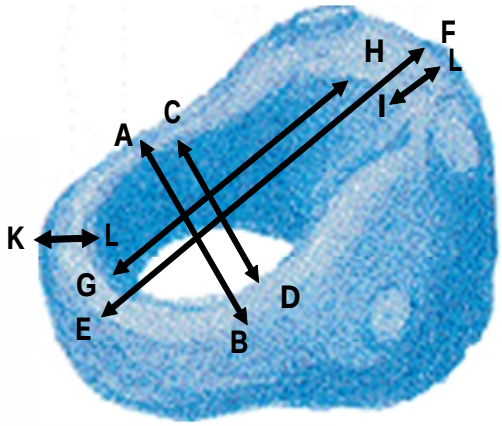
1. Outer transverse diameter of cricoid cartilage: It was measured as maximum transverse distance between outer walls of cricoid cartilage.
2. Inner transverse diameter of cricoid cartilage: It was measured as maximum transverse distance between inner walls of cricoid cartilage.
3. Outer anteroposterior diameter of cricoid cartilage: It was measured as maximum anteroposterior distance between outer aspect of anterior and posterior walls of cricoid cartilage.
4. Inner anteroposterior diameter of cricoid cartilage: It was measured as maximum anteroposterior distance between inner aspects of anterior and posterior walls of cricoid cartilage.
5. Height of cricoid arch: It was measured as distance between the midpoint of upper and lower border of cricoid arch.
6. Height of cricoid lamina: It was measured as distance between midpoint of upper and lower border of cricoid lamina on posterior aspect.
7. Thickness of cricoid arch: It was measured as distance between outer and inner surfaces of the arch.
8. Thickness of cricoid lamina: It was measured as distance between outer and inner surfaces of lamina.

RESULTS AND OBSERVATIONS

Parameters		Ajmani [5] (Nigerians)		Eckel et al [6] (Germans)		Jain and Dhall [7] (Indian)		Ajmani et al [12] (Indian)		Chievitz [13] (Europeans)		Maue and Dickson [14] (North Americans)		Present Study (North Indians)	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
Transv. Diam	Outer	-	-	-	-	25.7 ±3.2	21.3 ±4.7	-	-	-	-	-	-	24.77 ±3.43	21.94±0.52
	Inner	29.84±6.10	25.84±3.48	26.40 ±2.40	21.40 ± 2.04	17.2 ±3.6	15.7 ±4.4	22.00±5.20	18.30 ±5.20	21.4	15.9	-	-	12.99 ±2.38	9.12 ±1.38
A-P Diam.	Outer	-	-	-	-	28.6 ±4.9	23.2 ±4.1	-	-	-	-	-	-	20.01 ±3.8	19.89±1.41
	Inner	28.82±4.07	24.06±2.53	30.90 ±3.06	25.20 ±2.33	19.5 ±2.5	16.5 ±5.0	22.00±5.20	18.30 ±5.20	20.7	16	16.03	16.43	13.69 ±3.10	13.63±2.90
Height	Arch	8.35 ±4.80	7.50±4.25	6.90 ±1.35	6.20 ±1.11	6.0 ±0.8	5.6 ±1.0	-	-	8.1	6.8	3.1	3.14	7.56 ±1.15	7.0 ±0.53
	Lamina	26.50±6.30	24.60±5.32	24.60 ±1.84	21.30 ±1.44	22.0 ±1.9	19.0 ±2.3	20.00±6.20	19.30 ±5.00	25.3	20.7	24.53	19.13	21.81 ±2.93	18.55±0.65
Thickness	Arch	-	-	-	-	3.1 ±0.84	2.8 ±0.7	-	-	-	-	-	-	3.31 ±0.83	2.91 ±0.31
	Lamina	-	-	-	-	4.8 ±1.3	4.4 ±0.8	-	-	-	-	-	-	5.21 ±0.83	4.71 ±0.22

Transv. Diam. – Transverse Diameter, A-P Diam. : Anteroposterior Diameter

Fig. 1: measurements of cricoid cartilage.



AB : Outer Transverse diameter
CD: Inner Transverse diameter
EF: Outer Anteroposterior diameter
GH: Inner Anteroposterior diameter
IJ: Thickness of cricoid lamina
KL: Thickness of cricoid arch

DISCUSSION

Outer transverse diameter of cricoid cartilage: Mean outer transverse diameter was found to be 24.77±3.43 mm (Range = 18.93-30.7mm) and 21.94±0.52mm (Range = 21.5-22.78 mm) in males and females respectively. Thus it was larger in males as compared to females. Table I compares it with the only earlier study by Jain and Dhall [7]. It is evident that our values are almost same as those seen by them.

Inner transverse diameter of cricoid cartilage: Mean inner transverse diameter was found to be 12.99±2.38 mm (Range = 8.39-15.54 mm) in males and 9.12±1.38 mm (Range=7.58-10.98 mm) in females. The difference between the two sexes was statistically significant (p value-0.002). Table I shows the comparison of inner transverse diameter of cricoid cartilage in different populations. It is found to be minimum in the present study both in males and females. In Nigerians, Germans and Europeans it is almost double as compared with Indians of the present study.

Outer Anteroposterior diameter of cricoid cartilage: Mean outer anteroposterior diameter was found to be 20.01±3.8 mm (Range =15.92-30.23 mm) in males and 19.89±1.41 mm(Range= 17.89-21.2 mm) in females. Table I compares it with the only study done earlier on this parameter by Jain and Dhall[7] . They found it to be 28.6 mm in males and 23.2 mm in females.

Inner anteroposterior diameter of cricoid cartilage: Mean inner anteroposterior diameter in males was found to be 13.69±3.10 mm (Range = 9.82-22.54 mm) and in females it was 13.63±2.90 mm (Range = 11.1-18.49 mm). Thus it was larger in males as compared to females. Table I shows the comparison of inner anteroposterior diameter with earlier studies. It was seen that values vary a lot in different populations e.g. Eckel et al [6] found it 30.90 mm and 25.50 mm in German males and females respectively i.e. almost double than our values. Similarly values observed by Ajmani [5] in Nigerians were almost double than our values. In fact, our values have been minimum amongst all the studies. One of the factors which seems to be responsible for this great discrepancy is that in the present study this measurement were taken with mucous membrane intact. It was done so as it give the value closer to the actual value in livings which is more helpful in guiding the anaesthetist to choose the size of endo-tracheal tube or endoscope without damag-ing mucosa. However the other workers are silent whether they had taken this diameter with mucosa intact or after removing it.

Clinical Implication: If we compare the inner transverse and anteroposterior diameters with the other races (Table I) it is seen that both these diameters are almost half as compared with Europeans, Nigerians and Germans. So an endotracheal tube which can easily pass through larynges of these races may be a misfit for Indians. Thus the Indians need a small diameter tube for them. On comparison of different diameters of cricoid cartilage an interesting and important observation was found that in both the sexes, outer transverse diameter was found to be larger than outer anteroposterior diameter, while inner antero-posterior diameter was larger than inner transverse diameter. This is partially in consonance with Ajmani [5] who found transverse diameter to be more than Antero-posterior diameter. However he is silent about whether it is inner or outer.

1. Height of cricoid arch: Mean height of cricoid arch was found to be 7.56±1.15 mm (Range = 5.11-9.74 mm) in males and 7.0±0.53 mm (Range= 6.51-7.64 mm) in females. Table I shows the comparison of height of cricoid arch. It is seen that in both the sexes, the present study was in consonance with Chievitz [13], Ajmani [5] and Eckel et al [6].
2. Height of cricoid lamina: Mean height of cricoid lamina was found to be 21.81±2.93 mm (Range = 15.62-27.63 mm) in males and 18.55±0.65 mm(Range= 17.58-19.17mm) in females. The comparison of height of cricoid lamina is depicted in table I. The present study in males was in consonance with study of Jain and Dhall [7] while in females, it was in consonance with study conducted by Ajmani et al [12] and Jain and Dhall [7].
3. Thickness of cricoid arch: Mean thickness of cricoid arch was found to be 3.31±0.83 mm (Range = 1.81-4.85mm) in males and 2.91±0.31 mm(Range= 2.4-3.21 mm) in females. Thus it was larger in males as compared to females. Table I shows the comparison of thickness of cricoid arch with the only available study. Values of present study were in consonance with values given by Jain and Dhall [7].
4. Thickness of cricoid lamina: Mean of thickness of cricoid lamina was found to be 5.21±0.83mm (Range = 4.05-7.02mm) in males and 4.71±0.22 mm (Range= 4.43-4.98mm) in females. Results of the present study in females were in consonance with earlier one by Jain and Dhall [7] while in males it was more than them.

CONCLUSION

Cricoid cartilage was oval in shape in all the specimens. Outer and inner transverse diameters and outer and inner anteroposterior diameters of cricoid cartilage were larger in males as compared to females. A wide range of racial variations are observed in inner anteroposterior and transverse diameters. These are almost half in Indians as compared with Europeans, Nigerians and Germans. So endotracheal tube designed for those population may be larger in diameter. When used in Indians it causes pressure necrosis in the later. The present study provides a baseline data of different diameters of cricoid cartilage to enable the anaesthetist to use endotracheal

tubes of appropriate size. As we compare both diameters in males and females, outer transverse diameter was found to be larger than outer anteroposterior diameter, while inner anteroposterior diameter was larger than inner transverse diameter. Height and thickness of cricoid arch and lamina were observed to be larger in males as compared to females.

Conflicts of Interests: None

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