

## COMPARISON BETWEEN DISSECTION AND CT MEASUREMENTS OF THYROID AND CRICOID CARTILAGES IN ADULTS

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### ABSTRACT

**Background:** The increasing application of sophisticated electro-physiological & radiological methods for the diagnosis and treatment of laryngeal disorders requires an extensive knowledge of the size and proportions of the human larynx & its cartilaginous components.

**Aims:** To study the various morphometric measurements of the Thyroid & Cricoid cartilages in male & female in dissection & CT method and to compare the measurements of Thyroid & Cricoid cartilages between living (CT measurements) & Cadaver (dissected specimens).

**Materials and Methods:** The present study was carried on 62 (31 Male, 31 Female) patients undergoing CT neck attending the Department of Radiology, K.R Hospital attached to Mysore Medical College & Research Institute, Mysore, Karnataka, India. In the Computerized Tomography of Neck, measurements of Thyroid & Cricoid cartilages were taken at two levels by using Radiant Dicom Viewer software. Thyroid and Cricoid cartilages from 62 cases (Male: 31, Female: 31) of postmortem in the department of Forensic medicine, MMC and RI, Mysore were studied. Various parameters on thyroid and cricoid were measured using vernier caliper.

**Results:** The results by two methods showed significant differences after death i.e. by dissection method the AP measurements of both thyroid & cricoid cartilages are less compared to AP measurements of both cartilages by CT method in both sexes i.e. in living.

**Conclusion:** We can conclude that there is decrease in AP distance of both thyroid & Cricoid cartilages in both the sexes after death. These morphological differences have important clinical and surgical implications.

**KEY WORDS:** Larynx, Thyroid Cartilage, Cricoid Cartilage, Morphometry, Sex determination.

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### INTRODUCTION

The skeletal framework of the larynx is formed by a series of cartilages interconnected by ligaments and fibrous membranes. The laryngeal cartilages are the unpaired cricoid, thyroid and epiglottic cartilages, and the paired arytenoid, cuneiform, corniculate and tritiate

cartilages [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 specialists and Phoniatrians [2].

A knowledge of dimensions of cartilages of larynx and trachea is a must for transplantation, stenting, intubation, crico - thyroidotomy and endoscopic procedures [3].

Subglottic stenosis and post intubational stenosis of lower respiratory tract were two main factors which lead anatomists to work for measurements of various cartilages in early ninties [4].

Data such as 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 electromyography or the analysis of CT and MRI scans of the larynx [5].

The increasing application of sophisticated electro physiological, radiological and surgical methods for the diagnosis and surgical methods for the diagnosis and treatment of laryngeal disorders requires profound knowledge of size and proportion of human larynx and its cartilaginous compounds [5,6].

Symmetry of larynx is extremely important as a rotated thyroid cartilage with dislocation of superior thyroid cornua projecting in to ipsilateral pyriform fossa may lead to globus pharyngeous, sticking of food in upper neck, dysphagia or odynophagia [7].

It has also been hypothesized that foramen thyroideum may provide a pathway for adeno carcinoma and pyriform recess or transglottic tumours but remains resistant to laryngeal cancer as rest of thyroid lamina [8].

A procedure called 'laryngofissure' that is cutting through the thyroid cartilage and removing the inner perichondrium and everything inward of that in an area of carcinoma is effective in a high percentage of carefully chosen cases. It is emphasized that this approach avoids the necessity of removing the entire larynx [9].

Thus, knowledge of different parameters of various laryngeal cartilages is necessary before attempting different surgical or other interventions. So, the present study was designed to attain this information in detail about thyroid and cricoid cartilages.

Morphology of larynx has gained clinical significance with the introduction of CT scan and MRI. This knowledge is helpful for transcutaneous transcricothyroid membrane approach to endolaryngeal structures which is used for several techniques such as placement of electrodes for laryngeal electromyography and transcutaneous botulinum injection of the paralyzed vocal fold [10].

## MATERIALS AND METHODS

The present study was carried on 62 (31 Male, 31 Female) patients undergoing CT neck attending the Department of Radiology, K.R Hospital attached to Mysore Medical College & Research Institute, Mysore. The present study includes CT scans of both the sexes of adult age group (18 to 70 years). CT scans of below 18 years, above 70 years age group and CT scans with history of any previous laryngeal surgery were excluded.

The details of the case such as name, age, sex, address, in patient number and indications for CT scan were collected. In the Computerized Tomography of Neck measurements of Thyroid & Cricoid cartilages were taken.

**In the present study, the computerized tomography films will be taken in 3 – 4 slices and measurements will be taken at two levels by using Radiant Dicom Viewer software.**

Following five measurements of Thyroid cartilage was taken at one level, where both Thyroid laminae were clearly visible and joined to each other at an angle and the length of lamina was maximum. (Figure 1)

- Thyroid angle (angle between two thyroid laminae)
- Antero-posterior length of right lamina (distance from Thyroid angle to the posterior margin of the right lamina)
- Antero-posterior length of left lamina (distance from thyroid angle to the posterior margin of the left lamina)
- Maximum thyroid breadth (distance between the posterior margins of the two laminae)
- Median antero-posterior diameter (distance between the thyroid angle and a point midway between maximum thyroid breadth)

Following measurements of Cricoid cartilage were taken at one level where a complete ring of cartilage was clearly visible. (Figure 2)

- Transverse diameter (outer)
- Antero-posterior diameter (outer)
- Thickness of arch
- Thickness of lamina

The 62 (31 Male, 31 Female) postmortem larynx specimens were collected from the department of Forensic medicine, MMC and RI, Mysore. A written consent was taken from the relatives of the subject. The study includes Post-mortem larynx specimens of both the sexes of adult age group (18 to 70 years). Postmortem larynx specimens of hanging, strangulation, lacerated wound over the neck, with history of any previous laryngeal surgery and larynx specimens of below 18 years, above 70 years age group were excluded.

Soon after postmortem, larynx specimens from Hyoid bone to trachea were collected prospectively and fixed in 10% formalin solution. After fixation careful dissection was done to isolate Thyroid and Cricoid cartilages by removing muscles, ligaments, small cartilages (arytenoid, epiglottis) and mucous membrane. Measurements were taken with the help of digital vernier caliper.

Thyroid angle was measured as angle between two laminae. It was measured with help of protractor and two scales. For measuring this angle two scales were kept touching the anterior surface of two thyroid laminae near their upper borders. Then the angle between these two scales was measured with the protractor.

Following 7 measurements were taken on each thyroid cartilage as shown in figure 4 and tabulated.

- Thyroid angle (figure -3)
- The anterior height of thyroid cartilage (figure -5)
- Maximum thyroid width (the distance between the roots of superior horns)
- Height of right thyroid lamina (vertical distance from maximum point on superior border of right lamina)
- Height of left thyroid lamina (vertical distance from maximum point on superior border of

left lamina)

- Antero-posterior length of right thyroid lamina (horizontal distance from the laryngeal prominence to the posterior margin of the right lamina)
- Antero-posterior length of left thyroid lamina (horizontal distance from the laryngeal prominence to the posterior margin of the left lamina)

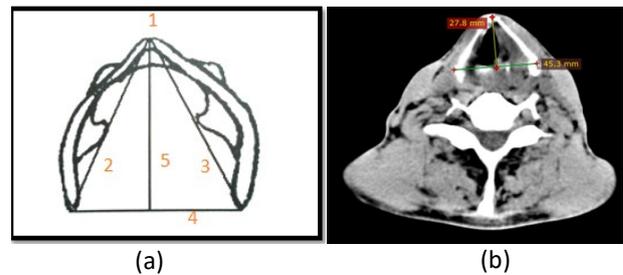


Fig. 1: Showing various measurements of thyroid cartilage (a) line diagram (b) CT photograph.

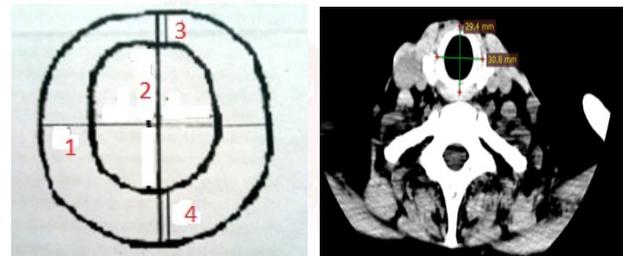


Fig. 2: Showing various measurements of Cricoid cartilage (a) line diagram (b) CT photograph

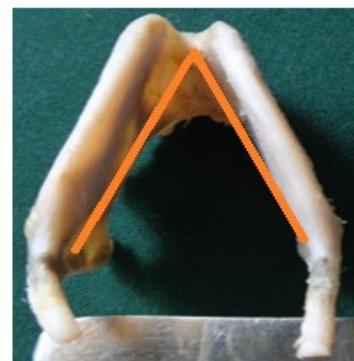


Fig. 3: Showing thyroid angle in Dissected specimen of Thyroid Cartilage.

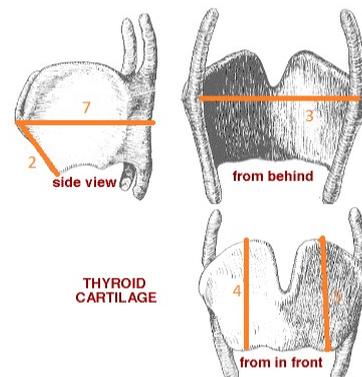


Fig. 4: Showing various measurements of thyroid cartilage (Source of Image #)



**Fig. 5:** Showing height of thyroid cartilage measured by using Digital Vernier Caliper.

**RESULTS**

By CT method the mean values of all the parameters of thyroid cartilage in males were correspondingly higher than the mean values of female except for angle between thyroid laminae (Table 1).

A significant difference was ( $p < 0.05$ ) between the values of both sexes were found in all parameters.

In thyroid cartilage the antero-posterior length of right & left lamina is almost equal in females whereas in males, the Antero-posterior length of left lamina is slightly more compared to right lamina [15].

**Table 1:** Comparison of various Parameters of Thyroid and Cricoid cartilages measured between male and female by CT scan that is in living individuals [15].

Parameters	Male				Female			
	mean	Std.dev	min	max	mean	Std.dev	min	max
<b>Thyroid cartilage</b>								
Thyroid angle	75.43	12.09	52.9	111.2	89.87	12.79	69.1	123.3
Maximum thyroid width	40.81	5.98	30.8	57.3	35.52	4.64	27.1	45.3
Median AP diameter	29.45	4.57	19.1	38.8	21.1	3.52	16.6	29.6
AP of right lamina	36.9	5.12	22.7	45.8	28.7	4.63	20.9	38.6
AP of left lamina	38.4	4.17	27.1	44.7	28.8	4.17	22.4	38.7
<b>Cricoid cartilage</b>								
AP diameter	27.5	2.84	23.4	34.4	22.72	2.61	18.6	31.2
Transverse diameter	27.27	2.36	22.2	30.5	20.89	2.06	16.8	24.9
Thickness of Arch	1.96	0.84	0.5	3.8	1.94	0.9	0.9	4.1
Thickness of Lamina	4.24	1.31	2	7.6	4.51	1.18	3	7.8

**Table 2:** Comparison of various Parameters of Thyroid cartilage and Cricoid cartilage between male and female by dissection method [13,14].

Parameter	Male		Female	
	Mean ± SD	Range	Mean ± SD	Range
<b>Thyroid cartilage</b>				
Thyroid angle	66.29 ± 9.20	42° - 86°	84.61 ± 5.37	70° - 94°
Median height	16.15 ± 2.08	10.78 - 19.63	12.46 ± 2.57	9.32 - 18.4
Max thyroid width	41.00 ± 4.86	30.53 - 48.57	33.81 ± 6.31	25.1 - 48.31
Height of right lamina	25.31 ± 3.11	17.44 - 29.9	20.11 ± 3.4	11.97 - 28.77
Height of left lamina	25.22 ± 2.91	17.35 - 30.45	20.03 ± 3.26	16.33 - 28.03
AP length of right lamina	37.09 ± 3.89	28.74 - 41.4	28.48 ± 4.55	24.06 - 40.06
AP length of left lamina	37.43 ± 3.71	26.86 - 41.01	28.54 ± 4.77	22.28 - 42.17
<b>Cricoid cartilage</b>				
Height of arch	5.97 ± 0.94	4.49 - 8.49	4.94 ± 1.01	3.63 - 7.27
Height of lamina	21.3 ± 1.90	16.42 - 24.51	17.91 ± 2.29	14.13 - 23.02
AP diameter	23.84 ± 2.43	16.15 - 27.90	19.18 ± 2.34	15.58 - 24.87
Transverse diameter	25.53 ± 2.23	17.43 - 27.43	19.29 ± 2.52	15.77 - 25.87

In Cricoid cartilage the Antero-posterior and transverse diameter are equal in males, whereas in females Antero-posterior diameter is more compared to transverse diameter. There was no difference between male and females about thickness of arch and thickness of lamina. The thickness of lamina was more compared to thickness of arch in both the sexes [15].

Table 2 shows that by dissection method the mean values of all the parameters of thyroid cartilage in males were correspondingly higher than the mean values of female except for angle between thyroid laminae [13]. Whereas the mean values of all parameters of Cricoid cartilage were more in males compared to females. The mean value of outer AP diameter was equal to the mean transverse diameters in females and in males the mean transverse diameter was more than AP diameter [14].

## DISCUSSION

**Table 3:** Comparison between dissection and CT measurements of thyroid and cricoid cartilages.

Sl. No.	Parameter	MALE (Mean ± SD)		FEMALE (Mean ± SD)	
		Dissection	CT scan	Dissection	CT scan
1	Thyroid angle	66.29±9.20	75.43±12.09	84.61±5.37	89.87±12.79
2	Maximum thyroid width	41.00±4.86	40.81±5.98	33.81±6.31	35.52±4.64
3	AP of right lamina	25.31±3.11	36.90±5.12	20.11±3.46	28.7±4.63
4	AP of left lamina	25.22±2.91	38.40±4.17	20.26±3.26	28.8±4.17
5	AP diameter of Cricoid cartilage	23.84±2.43	27.75±2.84	19.18±2.34	22.72±2.61
6	Transverse diameter of Cricoid cartilage	25.53±2.23	27.27±2.36	19.29±2.52	20.89±2.06

The morphometric measurements of Thyroid & Cricoid cartilages by CT method were compared with measurements taken by dissection method. There was significant difference after death i.e. by dissection method the AP measurements of both thyroid & cricoid cartilages are less compared to AP measurements of both cartilages by CT method in both sexes i.e. in living. So, we can summarize that there is decrease in AP diameter of larynx after death.

With respect to the thyroid width, in females there is 2 mm decrease after death where as in males, there is no change this may be due to the fact that thyroid cartilage is more thick & rigid & also ossification is more evident in males which may resist changes after death, where as in females it is thin & flexible.

Similar study done by Monica Jain [10] in 2010 reported that all the measurements by CT method are lower than autopsy measurements although the difference is not statistically significant. The CT measurement of angle is significantly lower than autopsy measurement in both male and female. This may be explained by the fact that muscles are relaxed after death, so relatively mean value of angle is more in autopsy specimens. The significant difference in length of thyroid lamina and thickness of arch and lamina of cricoid cartilage is difficult to explain. This may be due to the fact that in CT scan, sections were cut at different levels and it was not possible to take measurements exactly at the same points as used for autopsy measurements.

Laryngological imaging and elaboration of new surgical concepts for the treatment of phonatory disorders has recently awakened new interest in larynx morphometry [11].

The size of thyroid and cricoid cartilages is reported to be smaller in women as compared to men in cadaveric studies [4]. Several workers noted that 90% of adults with post-intubation glottis and subglottic stenosis were women [12]. This can explain higher incidence of post intubation laryngeal injury in women.

## CONCLUSION

Thus, to conclude in the present study all parameters of thyroid and cricoid cartilages were more in males compared to females except thyroid angle which was more in females in both CT and dissection methods. The AP distance of thyroid laminae is more in CT method compared to dissection method i.e. in living AP distance of thyroid cartilage is more.

The maximum thyroid width, when we compare between CT & dissection method, it is almost equal in males whereas in females 2 mm more in CT method compared to dissection method.

**In Cricoid cartilage: By CT method** in males the mean AP is equal to the mean transverse diameter whereas in females, the mean AP is more compared to the mean transverse diameter. **By Dissection method** in males, the mean transverse diameter is more compared to the mean AP diameter whereas in females the mean AP is equal to the mean transverse diameter.

We can conclude that there is decrease in AP distance of both thyroid & Cricoid cartilages in both the sexes after death. There is not much change in the transverse diameter of both thyroid & cricoid cartilages after death, except there is slight decrease in the

thyroid width in females.

**Conflicts of Interests: None**

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