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Original Article

MORPHOMETRIC STUDY OF THYROID CARTILAGES IN WESTERN INDIA

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ABSTRACT

Background: Morphometrical evaluation of the larynx has always been interesting for both morphologists and the physicians. A good understanding of the anatomy and the knowledge of variations in the laryngeal cartilages is important

Objective: Objective of the present study was to collect exact and reliable morphometric data of thyroid cartilage in adult human larynx of regional population.

Methods: The totals of 50 thyroid cartilage specimens were studied. The cartilages were preserved in 5% formalin. The measurements were taken with the help of Digital Vernier Caliper. The cartilages were weighed on Single pan electronic balance. For each of the parameters, the mean, standard deviation (S.D.) and range was calculated.

Results: Mean depth of superior thyroid notch was 9.7± 3.36 mm. Asymmetry between the length of superior horn of thyroid cartilages in left and right sides can be seen, but difference was not statistically significant ($p>0.05$). It is observed that inner thyroid angle varies from 55 to 104^0 and outer thyroid angle varies from 53 to 99^0. In present study mean weight of thyroid cartilage was 6.70±1.55 grams.

Conclusions: A fair amount of intersubject variability in the dimensions was observed. Bilateral asymmetry, though present in majority of specimens, was insignificant. Various dimensions of thyroid cartilages are smaller as compared to the western population.

KEY WORDS: Larynx, Thyroid Cartilage, Morphometry.

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INTRODUCTION

Morphometrical evaluation of the larynx has always been interesting for both morphologists and the physicians. A good understanding of the anatomy and the knowledge of variations in the laryngeal cartilages is important. The large and prominent thyroid cartilage forms most of the anterior and lateral wall of larynx. Entrance to the trachea is supported by cricoid cartilage; located posteriorly are paired arytenoid cartilages which in turn are placed close to the small corniculate cartilages. In aryepiglottic fold there is a pair of small cuneiform cartilages. Epiglottic cartilages form the anterior wall of the

laryngeal aditus [1]. Thyroid cartilage consists of two laminae that are joined at a greater or lesser angle. Superior pair of horns is attached to the hyoid bone, and the inferior pair to the cricoid cartilage. The increasing application of sophisticated electrophysiological and radiological methods for the diagnosis and treatment of laryngeal disorders requires a profound knowledge of the size and proportions of the human larynx and its cartilaginous components [2]. With this background the aim of the present study is to collect exact and reliable morphometric data of thyroid cartilage in adult human larynx of regional population.

MATERIALS AND METHODS

The study was carried out in 50 Laryngeal preparations from cadavers of both sexes. Topic was presented and cleared by the Institutional Ethical and Research committee. Larynx was separated from tongue from the level of hyoid bone to 3rd tracheal ring. Cricothyroid joint was disarticulated by separating the lower part of the lamina of cricoid cartilage and inferior horn of thyroid cartilage with the help of stab knife. All the soft tissue and mucous membrane attached to the thyroid cartilages was removed. The cartilages were preserved in 5% formalin. The measurements were taken with the help of Digital Vernier Caliper to the nearest 0.01 mm.

The cartilages were weighed on Single pan electronic balance (Shimadzu BL series 2204; sensitive to 0.01 gm). The cartilages were dried with blotting paper before taking weight. Protractor was used for measuring thyroid angle

The following measurements of the cartilages were taken:

- Depth of superior thyroid notch(T0): vertical distance from highest level of laminae to the floor of the superior thyroid incisure.
- Anterior Thyroid height(T1): distance from upper to lower thyroid incisure.
- Transverse Distance between tips of superior horn(T2).
- Transverse Distance between bases of superior horn (T3).
- Transverse Distance between tips of inferior horn(T4).
- Transverse Distance between bases of inferior horn (T5).
- Posterior Midvertical transverse distance between tip of superior and inferior horn(T6).
- Length of Superior Horn (T7): distance from tip to base.
- Length of Inferior Horn (T8): distance from tip to base.
- Vertical distance between tips of superior and inferior horn (T9).
- Curvilinear distance between tips of superior and inferior horn (T10).
- Maximum height of lamina (T11): maximum vertical distance from upper to lower border of lamina.
- Upper breadth of lamina (T12): horizontal distance from laryngeal prominence to the posterior margin of lamina.

Fig A: Showing the Dimensions of Thyroid cartilage:

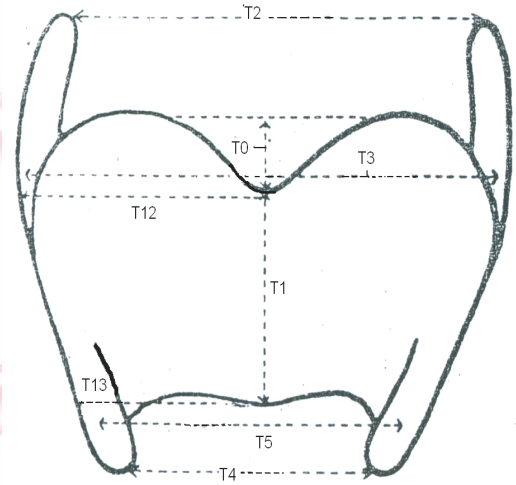

Fig. A-i: T0: Depth of superior thyroid notch.; T1: Anterior Thyroid height; T2Transverse Distance between tips of superior horn; T3:Transverse Distance between bases of superior horn ;T4:Transverse Distance between tips of inferior horn;T5:Transverse Distance between bases of inferior horn, T12:Upper breadth of lamina and T13:Lower breadth of lamina.

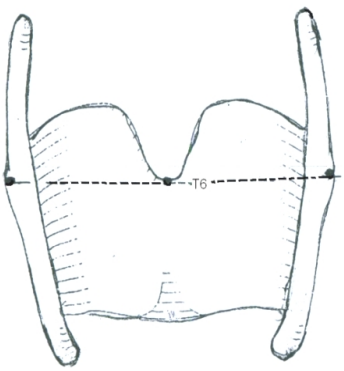

Fig. A-ii: T6:Posterior Midvertical transverse distance between tip of superior and inferior horn.

- Lower breadth of lamina (T13): from lower end of anterior border to posterior margin of lamina.
- Inner thyroid angle(T14): angle between inner margin of the two thyroid laminae.
- Outer Thyroid angle(T15): angle between outer margin of the two thyroid laminae.
- Thyroid weight (T16).

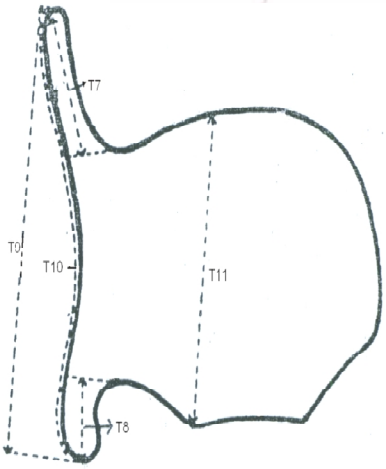

Fig. A –iii: T7: Length of Superior Horn; T8:Length of Inferior Horn; T9 :Vertical distance between tips of superior and inferior horn; T10:Curvilinear distance between tips of superior and inferior horn and T11: Maximum height of lamina.

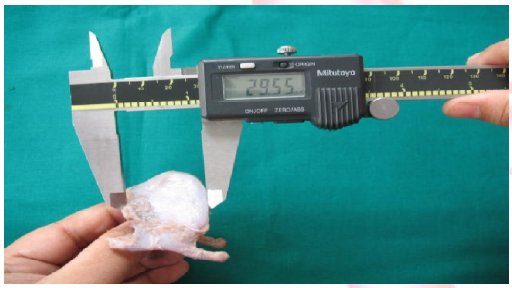

Fig. B –i: Measurement of thyroid lamina with digital Vernier caliper.

Fig. B –ii: Weighing thyroid cartilage.

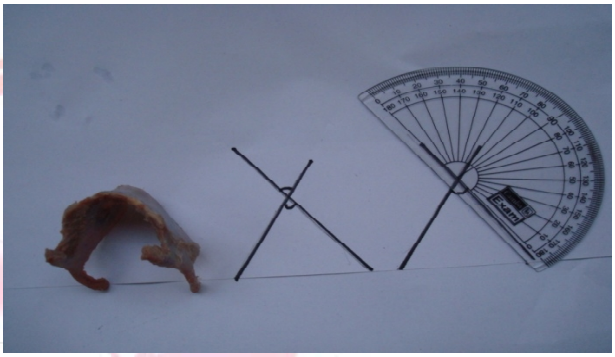

Fig. B –iii: Measurement of thyroid angle.

Statistical analysis: For each of the parameters, the mean, standard deviation (S.D.) and range (minimum value-maximum value) was calculated. Z test was used to test significance of difference between the two mean.

RESULTS

The totals of 50 thyroid cartilage specimens were studied. For each of the parameters, the mean,

Sr.No	Parameter	Mean (mm)	S.D. (mm)	Range (mm)
1	Depth of Superior thyroid notch (T0)	9.7	3.36	3.54-16.1
2	Anterior Thyroid height (T1)	16.71	2.5	8.7-20.29
3	Transverse Distance between tips of superior horn (T2)	32.58	6.44	21.86-47.56
4	Transverse Distance between bases of superior horn (T3)	39.07	4.75	26.97-47.23
5	Transverse distance between tips of inferior horn of thyroid cartilage (T4)	27.79	3.92	18.75-42.4
6	Transverse Distance between bases of inferior horn (T5)	32.48	3.83	22.67-40.2
7	Posterior Midvertical transverse distance between tip of superior and inferior horn (T6)	36.99	4.61	27.13-49.69

Table 1: Thyroid Cartilage Morphometric Parameters (General).

Sr.No	Parameter	Right side Mean± S.D. and Range (mm)	Left side Mean± S.D. and Range (mm)	'Z' value	p-value	Result
1	Length of Superior Horn (T7)	15.20±3.69 (6.8-25.84)	14.53±3.06 (7.3-22.3)	1.48	>0.05	not significant
2	Length of Inferior Horn(T8)	9.50±1.63 (6.56-12.5)	9.36±1.63 (5.93-12.75)	1.4	>0.05	not significant
3	Vertical distance between tips of superior and inferior horn (T9)	39.43±5.13 (28.32-49.11)	39.16±5.44 (25.38-49.3)	0.24	>0.05	not significant
4	Curvilinear distance between tips of superior and inferior horn (T10)	43.55±5.84 (30-54)	42.28±5.92 (27-55)	0.92	>0.05	not significant

Table 2: Thyroid Cartilage Morphometric Parameters (Horns).

standard deviation (S.D.) and range (minimum value-maximum value) was calculated.

Mean depth of superior thyroid notch was 9.7± 3.36 mm. Anterior Thyroid height varied from 8.7-20.29 mm. Transverse Distance between bases of superior horn (T3) was more than the transverse distance between tips of superior horn of thyroid cartilage (T2). Similarly transverse distance between bases of inferior horn (T5) was more than transverse distance between tips of inferior horn of thyroid cartilage (T4).

It is evident from Table 2 that superior horn of thyroid cartilage is longer than inferior horn. Asymmetry between the length of superior horn of thyroid cartilages in left and right sides can be seen, but difference was not statistically significant (p>0.05).The mean length of inferior horn of thyroid cartilages was also almost similar on right (9.50±1.63 mm) and left side (9.36±1.63 mm).Similarly mean vertical distance between tips of superior and inferior horn of thyroid cartilage was 39.43±5.13mm on right side and 39.16±5.44mm on left side. 'Z' value for comparison of means for all these parameters was less than 1.96 and hence the difference in means of measurement in right and left side was not significant (p >0.05).

It is evident from Table 3 that maximum height of lamina, upper breadth of lamina and lower breadth of lamina were almost similar on both the sides of the thyroid cartilages.

Table 4: Thyroid Cartilage Morphometric Parameters (Angle and Weight).

Sr.No	Parameter	Mean	S.D.	Range
1	Inner thyroid angle (^{0}) (T14)	74.8	11.3	55-104
2	Outer Thyroid angle(^{0}) (T15)	73.46	10.78	53-99
3	Thyroid weight gms (T16)	6.7	1.55	3.23-8.81

It is observed that inner thyroid angle varies from 55 to 104^0 and outer thyroid angle varies from 53 to 99^0. In present study mean weight of thyroid cartilage was 6.70±1.55 grams.

DISCUSSION

The present study provided detailed morphometric description of the thyroid cartilage in adult human larynx of regional population. In the present study depth of Superior thyroid notch (T0) was 9.7± 3.36mm. Similar to present study Ajmani et al (1980) [3] observed that in Indian the depth of Superior thyroid notch was 9.5± 3.00 in male and 6.40± 2.50mm in female. In study carried out by Harjeet and Jit (1992) [4] in North-west Indians depth of Superior thyroid notch was

Sr.No	Parameter	Right side Mean ± S.D. and Range(mm)	Left side Mean ± S.D. and Range(mm)	'Z' value	p-value	Result
1	Maximum height lamina(T11)	26.73±4.27 (6.8-32.01)	26.80±3.05 (18.55-31.75)	0.12	>0.05	not significant
2	Upper breadth of lamina(T12)	36.72±4.10 (26.79-42.34)	36.90±5.03 (19.49-43.32)	0.21	>0.05	not significant
3	Lower breadth of lamina(T13)	28.93±3.16 (21.25-33.97)	28.93±3.40 (19.93-34.34)	0	>0.05	not significant

Table 3: Thyroid Cartilage Morphometric Parameters (Lamina).

11.87± 2.38 in male and 8.28±1.36mm in female. In the present study anterior thyroid height (T1) was 16.71± 2.50mm.Present finding are concordance with those of Harjeet and Jit (1992) [4] in North-west Indians and Jain et al (2008) [5] in Haryana. In the present study posterior midvertical transverse distance between tip of superior and inferior horn (T6) was 36.99±4.61mm (27.13-49.69). Tayama et al (2001) [6] observed that posterior midvertical transverse distance between tip of superior and inferior horn was 41.65± 2.82mm in males and 34.05± 4.55 in females. In the present study transverse distance between bases of inferior horn (T5) was more than transverse distance between tips of inferior horn of thyroid cartilage (T4). Harjeet and Jit (1992) [4] have also reported similar findings. In the present study the average length of superior horn of thyroid cartilage (T7) was 15.20 ± 3.69mm on right side and 14.53 ±3.06mm on left. The average length of inferior horn of thyroid cartilage (T8) was 9.50±1.63 mm on right side and 9.36±1.63 mm on left side. Ajmani (1990) [7] observed that in Nigerians the average length of superior horn of thyroid cartilages was 20.70±2.99mm in male and 20.92± 3.01mm in female. In Nigerians the average length of inferior horn of thyroid cartilages was 18.35±3.11 in male and 17.35± 2.67mm in female. In a study by Eckel et al (1994) [8] average length of superior horn of thyroid cartilages was 12.90±2.94mm in male and 13.10± 2.35mm in female and average length of inferior horn of thyroid cartilages 8.30±1.27 in male and 7.40± 1.24mm in female. In Haryana based study by Jain et al (2008) [5] length of superior horn was 19.10±4.49mm in male and 13.10± 3.95mm in female; while length of inferior horn was 8.04±1.60mm in male and 7.20± 2.29mm in female. Thus it can be inferred from these observations that the length of superior horn is approximately one and half times that of inferior horn. The reason for the disproportionately greater length of inferior horn amongst Nigerians, as reported by Ajmani (1990) [7], cannot be explained. In the present study average vertical distance between tips of superior and inferior horn of thyroid cartilage (T9) on right side was 39.43±5.13mm and left side was 39.16±5.44mm.Similar to present study, Harjeet and Jit (1992) [5] reported that vertical distance between tips of superior and inferior horn of thyroid cartilage was 38.96± 4.49mm.In the present study curvilinear distance between tips of superior and inferior horn (T10) was 43.55±5.84mm on right side and 42.28±5.92mm on left side. Harjeet and Jit (1992) [5] also reported that curvilinear distance between tips of superior and inferior horn was greater (42.84± 4.83mm) than the vertical distance amongst North-west Indians.

All the parameters of thyroid cartilage studied in the present series did not show any statistically significant differences between right and left sides ($p>0.05$). Findings of present work in relation to height and breadth of lamina are close to that observed by Harjeet and Jit (1992) [4] in North-west Indians. In Haryana based study length of lamina was 27.50±2.96mm in male and 22.70±3.71mm in female. Breadth of lamina in this study in male was 36.80±4.84mm and 30.00±6.50mm in female [5]. Park et al (2003) [9] reported that male subjects exhibited larger values of height of lamina than female subjects ($p < 0.01$). Comparison of present observations in regional population with other populations reveals that the absolute values differ in different populations which could be due to differences in body built and racial differences.

In the present study it is observed that average inner thyroid angle was 74.8 ±11.30^0 (55^o to 104^0) and average outer thyroid angle was 73.46± 10.78^0 (53^o to 99^0). Jotz et al (2007)[10] noted that the angle of the thyroid cartilage varied from 50^o to 132^o. Eckel et al (1994)[8] in 20 specimens of German origin noted that the external angle of the thyroid cartilage varied from 58.8^o to 100.4^o. In a study by Harjeet and Jit (1992) [4] in North-west Indians thyroid angle in male varied from 55-106^o and in female 70-115^o. Jain et al (2008) [5] showed in Haryana population that the thyroid angle in male varied from 65-90^o and in female 85-118^o.

In the present study average weight of thyroid cartilage was 6.70± 1.55 grams. Harjeet and Jit (1992)[4] reported the mean weight of the thyroid cartilage as 6.539±1.29 grams in males and 3.047±0.55 grams in females.

Jain et al (2008) [5] observed that the mean weight of thyroid cartilage was 6.87±2.56 grams in males and 4.38± 2.30 grams in females. But slightly higher weight was observed in North Americans in a study by Maue and Dickson (1971) [11], who found the mean weight of thyroid cartilage as 8.32± 2.18 grams in males and 3.93± 0.62 grams in females. Findings of the present work corroborate well with all these workers.

CONCLUSION

This study provides a comprehensive and detailed description of the dimensions of the thyroid cartilages of an adult human larynx. A fair amount of intersubject variability in the dimensions was observed. Bilateral asymmetry, though present in majority of specimens, was insignificant. Various dimensions of thyroid cartilages are smaller as compared to the western population. Comparison of present observations with other populations reveals that the absolute values differ in different populations which could be due to differences in body built and racial differences.

Conflicts of Interests: None

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