



## CADAVERIC STUDY OF CRICOTHYROID SPACE – ANATOMICAL PERSPECTIVE

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### ABSTRACT

Cricothyroid space is the indentation between the thyroid and cricoids cartilages and is covered by the anterior/median cricothyroid ligament, a useful site for emergency access to the airway. The aim of the present study was to collect data on the cricothyroid space in Indian population by measuring the height & width of the cricothyroid space and also measure anterior length of larynx. Sixty apparently healthy looking specimens were obtained from embalmed cadavers. Height of cricothyroid space ranged from 6.64 - 12.56 mm, Transverse width of cricothyroid space ranged from 9.8 - 18.9 and length of larynx in anterior midline ranged from 27.12 - 42.96 mm. understanding of the dimensions and crucial anatomy of the cricothyroid space and related area is important to avoid or manage complications during surgical cricothyroidotomy. The dimensions are variable in different population, there is scope for more such study to corroborate these findings and its clinical relevance.

**KEYWORDS :** Cricothyroid Space, Tracheostomy, Cricothyroidotomy, Cricothyroid Membrane

### INTRODUCTION

Cricothyroid space is the indentation between the thyroid and cricoids cartilages and is covered by the anterior/median cricothyroid ligament, a useful site for emergency access to the airway in cases of obstruction at or above the vocal cords (cricothyroid puncture or cricothyroidotomy).<sup>1</sup> In the neonate, the dimensions of the cricothyroid membrane are too small to allow safe passage of an airway.<sup>1</sup> The surface anatomy of the region is essential prior to performing a tracheostomy, cricothyroid puncture or cricothyroidotomy.

The American Society of Anes-thesiologists (ASA) and the DifficultAirway Society (DAS) provided frameworks for the anaesthetist to manage the unanticipated difficult airway and both guidelines end with the 'can't intubate, can't ventilate' (CICV) scenario, recommending either a needle or surgical cricothyroidotomy as the next step.<sup>2,3</sup>

The laryngeal prominence (Adam's apple) of the thyroid cartilage is palpable in the midline neck, and the thyroid laminae can be felt passing posterolaterally. In the male, the prominence is usually visible, whereas in the female it is not usually apparent. The curved upper border of the thyroid cartilage, the midline thyroid notch and the superiorly located depression of the thyrohyoid membrane/ligament are easily palpable.<sup>1</sup> The upper border of the thyroid cartilage usually lies between the fourth and fifth cervical vertebrae.<sup>4</sup> The firm, smooth anterior arch of the cricoid cartilage is palpable below the inferior border of the thyroid cartilage. The inferior border of the cricoid commonly sits at the level of the seventh cervical vertebra (range C5-T1); the posterior cricoid overlaps the sixth cervical vertebra.<sup>4</sup>

The aim of the present study was to collect data on the cricothyroid space in Indian population by measuring the height & width of the cricothyroid space and also measure anterior length of larynx.

### MATERIALS

Sixty apparently healthy looking specimens (51 males and 9 females) were obtained from embalmed cadavers from a tertiary care teaching institute. All the cadavers were adult ranging between the age group of 18-65 years. The study consisted of meticulous dissection using standard dissection kit. In each cadaver, the larynx was looked for any gross deformity and specimens were selectively included in this

study. The study was done only after due permission from the ethics committee of the institution.

### METHODS

After the MBBS students had finished the dissection of face and the triangles of the neck the specimens were obtained. The sternohyoid and omohyoid muscles were cut and reflected down from its insertion near the hyoid bone and after which the sternothyroid and thyrohyoid muscle was separated from the oblique line of thyroid cartilage. The thyroid gland is cut and removed. As the mandible was already removed the styloglossus and stylopharyngeus muscles were cut and then the constrictor muscles of the pharynx were incised. The trachea was transected between the fifth and sixth tracheal rings along with the oesophagus. This completes the separation and the larynx specimen was recovered along with tongue, hyoid bone, proximal trachea, pharynx and proximal part of oesophagus. Then the epiglottis was separated from tongue by cutting the medial and lateral glossoepiglottic folds. The thyrohyoid membrane was cut to separate the hyoid bone from the thyroid cartilage. The specimen was cleaned to remove the extra laryngeal soft tissue so that all the laryngeal landmarks used in this study were easily seen. At the last the trachea rings were removed from the caudal end of the cricoid cartilage.

Measurements were made with a Vernier caliper (0 - 150 mm with a precision of 0.02 mm). The distance between the lower border of thyroid cartilage to upper border of cricoid arch (Height of cricothyroid space) was measured by the vernier caliper in anterior midline as seen in the figure 1 (Left Side)

The linear distance between the midpoint of cricoid & thyroid was measured by the vernier caliper (transverse width of cricothyroid space)

The distance between superior thyroid notch to lower border of cricoid cartilage is measured in anterior midline by vernier caliper as shown in figure 1 (right side)



**Fig 1 – Measurement of distance between the lower border of thyroid cartilage to upper border of cricoid arch(Left Side)**

**and distance between superior thyroid notch to lower border of cricoid cartilage (Right Side)**

**RESULTS**

The study pertaining to measurements of dimensions of cricothyroid space and also total length of larynx taking various landmarks on the cartilages as reference points was done in laryngeal specimens obtained from 60 cadavers. Of these 60 cadavers, 9 were females. Following observations were made:

The distance between lower border of thyroid cartilage to upper border of cricoid arch (Height of cricothyroid space) in the anterior midline ranged from 6.64 - 12.56 mm with a mean of  $8.98 \pm 1.60$  mm in males and ranged from 5.18 - 10.38 with a mean of  $7.79 \pm 1.61$  mm in females. The frequency distribution of the distance showed that 70.1% of the values were between 7-10 mm in males and 77.7% of the values were in the range of 6-10 in mm.

The linear distance between the midpoint of cricoid & thyroid was measured by the vernier caliper (transverse width of cricothyroid space) ranged from 9.8 – 18.9 with a mean of  $12.38 \pm 1.94$  in males and ranged from 6.1 – 11.7 with a mean of  $8.92 \pm 2.17$  in females.

The distance between superior thyroid notch to lower border of cricoid cartilage ranged from 27.12 - 42.96 mm with a mean of  $34.40 \pm 2.83$  mm in males and ranged from 24.26 - 30.18 mm with a mean of  $27.10 \pm 2.11$  mm in females.

**DISCUSSION**

Cricothyroid space is a space in between the lower border of thyroid cartilage and upper border of cricoid. The space has a membrane connecting the two margins. Puncture of the membrane is a component of several important clinical procedures. These include cricothyroidotomy, botox injection into vocal cord for patients with adductor spasmodic dysphonia, scintigraphic measurement of tracheal mucus velocity in patients with muco-ciliary dyskinesia, retrograde intubation of larynx, intraoperative neuromonitoring of the recurrent laryngeal nerve during thyroid surgery, minitracheostomy for clearance of excess tracheobronchial secretions and percutaneous collagen augmentation for treatment of parkinsonian hypophonia. Carcinoma of larynx spreads extralaryngeally by invading the cricothyroid membrane.<sup>5</sup>

Develi et al stated that on the upper half and lower left quadrant of the cricothyroid membrane important vital anatomical structures (cricothyroid vessels, pyramidal lobe of thyroid gland) were mostly located. They further recommend that the lower right quadrant of the membrane is safer for invasive procedures such as needle cricothyroidotomy or other cannulation techniques.<sup>6</sup>

**TABLE 1: Comparison of mean distance between lower border of thyroid cartilage to upper border of cricoid cartilage with other studies (Height)**

Study	Year	Country	Male	Female
Dover et al <sup>7</sup>	1996	USA	10.9	9.5
Zieliński R <sup>8</sup>	2001	Poland	6.82	7.40
Tayama et al <sup>9</sup>	2001	USA	10.16	8.06
Embate JRS et al <sup>10</sup>	2003	Philippines	9.80	8.00
Prithishkumar et al <sup>11</sup>	2010	India	6.53	5.74
Yadav Y <sup>12</sup>	2014	India	9.91	8.70
Anand V et al <sup>13</sup>	2018	India	9.61	7.26
Present study		India	8.98	7.79

The mean distance between lower border of thyroid cartilage to upper border of cricoid cartilage was greater than the study done on senile population by Zieliński R<sup>8</sup> and Prithishkumar et al<sup>11</sup> and was lesser than the Dover et al<sup>7</sup> Tayama et al<sup>9</sup>, Embate

JRS et al<sup>10</sup>, Yadav Y<sup>12</sup> Anand V<sup>13</sup> study. In present study the distance was more in males than females in accordance with all other except Zieliński R<sup>8</sup>.

The mean linear distance between the midpoint of cricoid & thyroid (Width) was found to be greater than Dover et al<sup>7</sup> and Prithishkumar et al<sup>11</sup> but slightly lesser than Anand V et al<sup>13</sup>. In present study the distance was more in males than females in accordance with all other study.

**TABLE 2 : Comparison of mean distance from superior thyroid notch to lower border of cricoid cartilage with other studies (Length of Larynx in Anterior midline)**

Study	Year	Country	Male	Female
Ajmani <sup>14</sup>	1990	Nigeria	45.06	38.08
Williams RG and Eccels R <sup>15</sup>	1990	United Kingdom	36.50	30.60
Eckel et al <sup>16</sup>	1994	Germany	34.60	28.20
Jain and dhall <sup>17</sup>	2008	India	33.7	31.2
Present study		India	34.40	27.10

The values of mean distance from superior thyroid notch to lower border of cricoid cartilage in our study are approximately similar to Eckel et al<sup>16</sup>. It was lower than values of Ajmani<sup>14</sup> and Williams RG et al<sup>15</sup>. There was a difference of 6 to 7 mm in male and female as evident from the above table. Williams RG et al also measured the distance on volunteers it was 46.1 mm in males and 38 mm in females.<sup>15</sup> Joshi et al reported the distance as  $32.42 \pm 3.41$  mm which was the inclusive of both genders.<sup>18</sup>

Williams RG et al stated that measurement of superior thyroid notch to lower border of cricoid cartilage acts as a surface landmarks in humans and because the vocal fold reach across the two cartilage and therefore if either of them were abnormally large or small this might affect the size of vocal fold, such a change in vocal fold could therefore be missed only if one cartilage was measured.<sup>15</sup>

**CONCLUSIONS**

Whenever rapid access to the airway is required, especially in case of trauma or difficult thyroidectomy, cricothyroidotomy is the procedure of choice. Placing oversized tubes results in fracture of the laryngeal cartilages and later dysphonia and subglottic stenosis.<sup>19,21</sup>

So, understanding of the dimensions and crucial anatomy of the cricothyroid space and related area is important to avoid or manage complications during surgical cricothyroidotomy. The dimensions are variable in different population of different countries, so there is scope for more such study to corroborate these findings and its clinical relevance.

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