A Morphological Study of Adult Human Larynx in Jharkhand Population

Krishna Kumar Prasad Singh¹, Kumar Martand²

¹(Department of Anatomy, Rajendra Institute of Medical Sciences, Ranchi/Ranchi University, Jharkhand, India)
²(Department of Anatomy, Rajendra Institute of Medical Sciences, Ranchi/Ranchi University, Jharkhand, India)

Abstract:

Background: The larynx is an air passage which extends from the tongue to trachea. Its functions include protection the lower respiratory tract and production of voice. Morphometric data of the larynx is useful during procedures like intubation, endoscopy, laryngeal micro-surgeries in cases of sub-glottic stenosis and post intubation stenosis and surgery of laryngeal framework such as partial or total laryngectomies. So, precise knowledge of the morphometry of the larynx is important.

Materials and Methods: In this observational study, 30 adult human larynges from cadavers of different age group between 30 to 60 years of both sexes were used. Out of 30 larynges, 22 were from male and 8 from female adult cadavers. Measurement of various external and internal structures of larynges was taken using digital vernier calliper and thread and scale. Mean and standard deviation were used to assess the variation in measurements.

Results: The mean of the various measurements showed statistically significant differences in both both internal and external parameters. There was no statistically significant difference in the measurements on right and left side of the bilateral structures.

Conclusion: There was a considerable variation in various external and internal dimensions of larynges both in male and female groups of larynges as well as between male and female.

Key Word: Morphometry, Human larynx, External and internal dimension

Date of Submission: 30-12-2019

Date of Acceptance: 14-01-2020

I. Introduction

The larynx is an air passage, a sphincter and an organ of phonation. It extends from the tongue to trachea. It projects ventrally between the great vessels of the neck and is covered anteriorly by skin, fasciae and the infrahyoid strap muscles that lower the hyoid bone and the larynx. Above it opens into the laryngopgarynx and forms its anterior wall; below, it continues into the trachea.

It is mobile on deglutition. At rest, the larynx lies opposite 3rd to 6th cervical vertebrae in adult males; it is somewhat higher in children and adult female.

Until puberty the male and female larynges are similar in size. After puberty, the male larynx enlarges considerably in comparison with that of the female, all the cartilages increase in size and weight, the thyroid cartilage projects in the anterior midline of the neck and its sagittal diameter nearly doubles. The male thyroid cartilage continues to increase in size until 40 years of age after which no further growth occurs.¹

The larynx is the upper part of the respiratory tract. Its main function is to protect the lower respiratory tract so that foreign bodies do not enter the trachea. If a foreign body comes in contact with the mucosa of the larynx, it reflexly gives rise to violent coughing till the foreign body is expelled.²

Another function of the larynx is the production of voice. Hence the name voice box. The anterior border of each thyroid lamina fuses with its partner at an angle of 90° in men and 120° in women. The shallower angle in men is associated with laryngeal prominence, the greater length of the vocal cords and the resultant deeper pitch of voice.¹, ²

From embryologic, anatomic, physiologic and surgical standpoints, the larynx is one of the most complex organs of the human body.³

The increasing application of sophisticated electro-physiological and radiological methods for the diagnosis and treatment of laryngeal disorders requires an extensive knowledge of the size and proportions of the human larynx and its cartilaginous components.³, ⁴

Recent interest in the condition of subglottic stenosis and post-intubational stenosis of the lower respiratory tract led to a search through the literature to ascertain the measurements of the various cartilages of the larynx.³, ⁴, ⁵
Morphometric data of the larynx is useful in otorhinolaryngology during procedures like intubation, endoscopy, laryngeal micro-surgeries, and surgery of laryngeal framework (partial/total laryngectomy). Pure anthropometry of laryngeal framework has potential application to studies in laryngeal physiology, advanced methods of laryngeal imaging techniques and advanced surgical procedures of the larynx.

The elaboration of new surgical concepts for the treatment of phonatory disorders has recently awakened new interest in larynx morphometry. They are critical to the accurate placement of needles and probes in laryngeal electro-myography, vocal cord injection and medialization procedures.

The most common form of committing suicide in our region is “hanging”. We can expect the fracture of the Thyroid cartilage both in hanging and strangulation. The detailed description of Thyroid cartilage morphology can be used in further research to determine the connection between the location of the Thyroid cartilage fracture in strangulation, the level of ossification and the force applied in strangulation.

Precise knowledge of the morphometry of the laryngeal cavity is useful in various interventions like bronchoscopy and endoscopy. Morphometric data is also useful in Otorhinolaryngology procedures such as partial or total laryngectomies, laryngeal microsurgery in cases of sub-glottic stenosis and post intubation stenosis.

Researchers have worked on geometric characterisation of laryngeal cartilage for biomechanical modelling. This can help in adjustments in the prephonatory its periodicity in vibration and to ease of phonation. Moreover in electrophysiology in radiodiagnostic studies like EMG, CT, MRI and surgical treatments like thyroplasty and arytenoid adduction, canine model is used for the study of mechanics and physiology of voice production, due to similarities in morphometry.

The laryngeal diameter in senile and its usefulness in ORL diagnostic and operational methods. To select right operational tools, sizes, the technique of choice, preoperative designing and building virtual and plastic models for physician training.

Aims and Objectives

The aims of the present study were:
1. To measure the dimension of larynges in the cadavers available for dissection.
2. To analyze variation in the dimension of larynx in subjects under study.

II. Material And Methods

This study was carried out in the Department of Anatomy, Rajendra Institute of Medical Sciences, Ranchi for a period of 2 years from December 2017 to November 2019. Donated and unclaimed embalmed cadavers meant for the purpose of medical teaching, training and researches were used for the study after obtaining the clearance from institutional ethical committee. The study sample included 30 specimen of larynx dissected from cadavers. Fully developed normal adult human larynges of different age group between 30 to 60 years of both sexes were used for the study. Out of 30 larynges, 22 were from male and 8 from female adult cadavers.

The study consisted of meticulous dissection using standard dissection kit. Measurements were taken using Digital Vernier callipers, measuring tape/thread and scale. Data taken was transferred to Master chart and then analyzed.

PROCEDURE

Larynx specimen was dissected extending from suprahypoid to upper part of the trachea and stored in 10% formalin. The specimen was cleaned to remove extra laryngeal soft tissue so that all the laryngeal landmarks used in this study were easily seen.

Following measurements were taken:

External dimensions (Length of larynx): (Image 1)
- From the floor of Thyroid notch to lower border of Cricoid cartilage (L1)
- From upper border of Hyoid bone to lower border of Cricoid cartilage (L2)
- Length from tip of Epiglottis to lower border of Cricoid cartilage (L3)

Internal dimensions (Laryngeal cavity): (Image 5, 6, 7 and 8)
- **Length of the Vestibule (a)** – From tip of Epiglottis to upper border of Vestibular folds.
- **Length of Sinus (b)** – Between Vocal and Vestibular
- **Length of Infraglottic cavity (c)** – From Vocal folds to lower border of Cricoid cartilage
- **Total length of laryngeal cavity (d)** – From tip of Epiglottis to lower border of Cricoid cartilage
5. **Length of Vestibular folds (VeF) and Vocal folds (VoF)** – Bilaterally measured with the help of thread and scale.

6. **Length of Aryepiglottic folds (AEF)** – Bilaterally measured with the help of thread and scale.

**Statistical Analysis:** Data of all external and internal measurements were transferred to Master chart. Data was analysed using Microsoft Office Excel 2007 version. For each parameter, the Mean, Range and SD were calculated. Z-value was used to test significant variation. P-value <0.05 was taken significant.

**Image 1:** Front view of larynx showing external measurement; **Image 2:** Showing length from the floor of Thyroid notch to lower border of Cricoid cartilage (L1)

**Image 3:** Showing length from upper border of Hyoid bone to lower border of Cricoid cartilage (L2); **Image 4:** Showing length from tip of Epiglottis to lower border of Cricoid cartilage (L3)
A Morphological Study of Adult Human Larynx in Jharkhand Population

Image 5: Dimensions of laryngeal cavity

Image 6: Showing various dimensions of laryngeal cavity

Image 7: Showing Vestibular folds (VeF) and Vocal fold (VoF) (Bilaterally)

Image 8: Showing Aryepiglottic Folds (AEF) (Bilaterally)
A Morphological Study of Adult Human Larynx in Jharkhand Population

Figure 9: Showing measurement of length of vestibule(a); Figure 10: Showing measurement of length of cavity (b)

Figure 11: Showing measurement of length of infraglottic cavity(c); Figure 12: Showing measurement of total length of laryngeal cavity (d)

III. Result

The data obtained from this research work showed that mean length of larynx (L1) was 34.03±2.91mm, mean height of larynx from Hyoid bone to Cricoid cartilage (L2) was 52.00±4.22 mm and mean height of Larynx from tip of Epiglottis to Cricoid cartilage (L3) was 62.42±7.54 mm in male. The same measurement in female was 28.30±1.36 mm, 37.97±3.83mm and 46.09±1.41mm respectively. (Table 1, Figure 1)

The mean length of Vestibule(a) was 35.05±3.61mm, mean length of Sinus (b) was 2.71±0.60mm, mean length of Infraglottic cavity(c) was 26.06±4.58mm and mean total length of laryngeal cavity(d) was 66.16±9.24mm in male. Corresponding length in female was 25.70±2.35mm, 1.04±0.28mm, 19.63±0.55mm, 40.11±7.66mm respectively. (Table 2, Figure 2)
In larynges obtained from male cadavers, mean length of Vestibular fold (VeF) on right side was 16.01±1.53mm and on left side was 16.08±1.56mm.

In female larynges, it was 12.99±0.18mm on right side and 13.03±0.23mm on left side.
The mean length of Vocal folds (VoF) was 15.82±1.54mm on right side and 15.81±1.54mm on left side in male larynges whereas 12.79±0.17mm on right side and 12.83±0.19mm on left side in female larynges.

(Table 3, Figure 3)
Mean length of aryepiglottic folds (AEF) was 15.21±2.34mm on right side and, 15.8±2.34mm in male larynges.
The AEF in female larynges was 10.34±0.17mm on right side and 10.40±0.19mm on left side respectively.

(Table 4, Figure 4)

Table 1: External measurement of larynx

<table>
<thead>
<tr>
<th>S. No</th>
<th>External measurement of larynx</th>
<th>Mean±S.D.(mm)</th>
<th>Range(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M  F</td>
<td>M  F</td>
</tr>
<tr>
<td>1</td>
<td>L1</td>
<td>34.03±2.91</td>
<td>28.30±1.36</td>
</tr>
<tr>
<td>2</td>
<td>L2</td>
<td>52.00±4.22</td>
<td>37.97±3.83</td>
</tr>
<tr>
<td>3</td>
<td>L3</td>
<td>62.42±7.54</td>
<td>46.0±1.41</td>
</tr>
</tbody>
</table>

Table 2: Measurement of laryngeal cavity

<table>
<thead>
<tr>
<th>S. No</th>
<th>Measurement of laryngeal cavity</th>
<th>Mean ± S.D.(mm)</th>
<th>Range(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M  F</td>
<td>M  F</td>
</tr>
<tr>
<td>1</td>
<td>a</td>
<td>35.05±3.61</td>
<td>25.70±2.35</td>
</tr>
<tr>
<td>2</td>
<td>b</td>
<td>2.71±0.60</td>
<td>1.04±0.28</td>
</tr>
<tr>
<td>3</td>
<td>c</td>
<td>26.06±4.58</td>
<td>19.63±0.55</td>
</tr>
<tr>
<td>4</td>
<td>d</td>
<td>66.16±9.24</td>
<td>40.11±7.66</td>
</tr>
</tbody>
</table>

Table 3: Showing the measurements of fold length.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±SD(mm)</th>
<th>Range(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M  F</td>
<td>M  F</td>
</tr>
<tr>
<td>R L</td>
<td>R L</td>
<td>R L</td>
</tr>
<tr>
<td>Vestibular Folds (VeF)</td>
<td>16.01±1.53</td>
<td>16.08±1.56</td>
</tr>
<tr>
<td>Vocal Folds (VoF)</td>
<td>15.82±1.54</td>
<td>15.81±1.54</td>
</tr>
</tbody>
</table>
IV. Discussion

The present study provides a thorough detail of external and internal measurements of larynx. The external and internal measurements of the laryngeal cavity in the present study was similar to the work done by and Poornima et al (2017)12 and M M Joshi et al (2013)13.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>34.03±2.91mm</td>
<td>28.30±1.36mm</td>
<td>33.51±3.6mm</td>
</tr>
<tr>
<td>L2</td>
<td>52.00±4.22mm</td>
<td>37.97±3.83mm</td>
<td>50.43±6.77mm</td>
</tr>
<tr>
<td>L3</td>
<td>62.42±7.54mm</td>
<td>46.09±4.41mm</td>
<td>60.17±8.12mm</td>
</tr>
<tr>
<td>a</td>
<td>35.05±3.61mm</td>
<td>25.70±2.35mm</td>
<td>33.45±6.37mm</td>
</tr>
<tr>
<td>b</td>
<td>2.71±0.60mm</td>
<td>1.04±0.28mm</td>
<td>2.32±1.01mm</td>
</tr>
<tr>
<td>c</td>
<td>26.06±4.58mm</td>
<td>19.63±0.55mm</td>
<td>24.21±3.52mm</td>
</tr>
<tr>
<td>d</td>
<td>66.16±9.24mm</td>
<td>40.11±7.66mm</td>
<td>62.31±11.16mm</td>
</tr>
<tr>
<td>VeF</td>
<td>Right: 16.01±1.53mm, Left: 16.08±1.56mm</td>
<td>Right: 12.99±0.18mm, Left: 12.79±0.17mm</td>
<td>Right: 12.42mm, Left: 12.86mm, Right: 14.84mm, Left: 14.86mm</td>
</tr>
<tr>
<td>VoF</td>
<td>Right: 15.82±1.54mm, Left: 15.81±1.54mm</td>
<td>Right: 12.79±0.17mm, Left: 12.83±0.19mm</td>
<td>Right: 12.94mm, Left: 12.98mm, Right: 14.89mm, Left: 14.92mm</td>
</tr>
<tr>
<td>AEF</td>
<td>Right: 15.21±2.34mm, Left: 15.28±2.34mm</td>
<td>Right: 10.34±0.82mm, Left: 10.40±0.81mm</td>
<td>Right: 12.97mm, Left: 13.01mm, Right: 16.43mm, Left: 15.85mm</td>
</tr>
</tbody>
</table>
In the present study, mean length from the floor of Thyroid notch to lower border of Cricoid cartilage (L1) was 34.03±2.91mm in male and 28.30±1.36mm in female as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 33.51±3.6mm and 32.42±3.41mm respectively. The mean length from upper border of Hyoid bone to lower border of Cricoid cartilage (L2), was 52.00±4.22mm in male and as compared to the that of study of Poornima et al (2017) and M M Joshi et al (2013) which was 50.43±6.77mm and 54.39±6.04mm respectively. The mean length from tip of Epiglottis to lower border of Cricoid cartilage (L3) was 62.42±7.54mm in male and 46.09±4.11mm in female as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 60.17±8.12mm and 57.13±7.32mm respectively. (See Table 5, Figure 5) 

Ajmani [1990] observed higher length of larynx from floor of thyroid notch to lower margin of Cricoid cartilage (L1) in Nigerians which was 45.06±8.41 mm in males and 38.08±8.25mm in females which in present study was 34.03±2.91mm in male and 28.30±1.36mm in female respectively.5

The mean length of the vestibule (a) was 35.05±3.61mm in male and 25.70±2.35mm as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 33.45±6.37mm and 32.11±5.77mm respectively. The mean length of the sinus (b) was 2.71±0.60mm in male and 1.04±0.28mm in female as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 2.32±1.01mm and 2.87±1.37mm respectively. The mean length of the infraglottic cavity (c) was 26.06±4.58mm in male and 19.63±0.55mm in female as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 24.21±3.52mm and 23.05±3.13mm respectively. The mean total length of the vestibule (d) was 66.16±9.24mm in male 40.11±7.66mm in female as compared to the finding in study conducted by Poornima et al (2017) and M M Joshi et al (2013) which was 62.31±11.18mm and 62.31±11.18mm respectively. (Table 5, Figure 6) 

Zielinski et al [2001] reported that mean height of Infraglottic cavity was 25.90±3.80 mm in male and 22.18±3.67 mm in female which in the present study was 26.06±4.58mm in male and 19.63±0.55mm in female.24

In the present study, the mean total length of vestibular fold(VeF) was 16.01±1.53mm on right side and 16.08±1.56mm on left side while 12.99±0.18mm on right side and 12.79±0.17mm on left side in female. The same parameter was 12.42mm on right side and 12.86mm on left side in study conducted by Poornima et al (2017) whereas 14.84mm on right side and 14.86mm on left side in study conducted by M M Joshi et al (2013).

The mean total length of vocal fold (VoF) was 15.82±1.54mm on right side and 15.81±1.54mm on left side in male whereas 12.79±0.17mm on right side and 12.83±0.19mm on left side in female. The same parameter was 12.94mm on right side and 12.98mm on left side in study conducted by Poornima et al (2017) whereas 14.89mm on right side and 14.92mm on left side in study conducted by M M Joshi et al (2013). (Table 5, Figure 7)

Eckel et al reported the average total length of vocal folds to be 13.8 mm. ±2.92 mm. in males and 10.7 mm. ±1.63 mm. in females. There was no difference between the right and the left side. 

Rawal J D et al found the average total length to be 16.11 mm. ± 2.62 mm. in males and 14.10 mm. ± 1.54 mm. in females. They also did not find any difference between the right and left sides.25

Wysocki et al commented on the sexual dimorphism in the length of the membranous part of the vocal fold which they said was significantly smaller in female than in males.26

The mean length of aryepiglottic fold(AEF) was 15.21±2.34mm on right side and 15.28±2.34mm on left side in male whereas 10.34±0.82mm on right side and 10.40±0.81mm on left side in female. The same parameter was 12.97mm on right side and 13.01mm on left side in study conducted by Poornima et al (2017) whereas 16.43mm on right side and 15.85mm on left side in study conducted by M M Joshi et al (2013). (Table 5, Figure 8)

The variation in measurements of various external and internal dimensions was highly significant (p-value < 0.01) in both male and female as well as between male and female. There was no significant differences (on left and right in measurements of bilateral structures such as vestibular fold, vocal folds and aryepiglottic folds( p-value >0.05).

V. Conclusion

The data obtained from this research work showed that there is considerable variation in various external and internal dimensions of larynges in the given population. There is also a marked variation in various external and internal dimensions of the larynx between male and female. Variation in different dimensions and between male and female is of utmost importance and must be considered while performing endotracheal intubation, oncological or any microsurgery of larynx or preparing a plastic virtual model for training and teaching purposes.
References


