

Measurement of distance and angle between the arytenoids in eastern Indian population and their applied importance

Shirshendu Ganguly¹, Prerana Aggarwal^{2*}, Biswarup Banerjee³,
Indra Datta² and Anwesa Pal²

¹Department of Anatomy, Calcutta Medical College & Hospital, 88, College Street Bow Bazar, Kolkata-12 West Bengal, India, ²Department of Anatomy, Institute of Post Graduate Medical Education & Research (IPGME&R), 244B, Acharya Jagdish Chandra Bose Road, Kolkata-20, West Bengal, India and ³Department of Neurology, Medica Institute of Neurological Diseases, Medica Superspecialty Hospital, 127, Mukundapur, EM Bypass, Kolkata-99, West Bengal, India

Abstract: *Objectives:* The inter-arytenoid distance and inter-arytenoid angle have predictive significance for the development of iatrogenic subglottic stenosis (SGS) or arytenoid subluxation/ dislocation (AS/AD). *Method:* Present work was conducted over a period of one year in the Dept. of Forensic & State Medicine, in a state-run hospital in Kolkata. The inter-arytenoid distance, the inter-arytenoid angle and the stature of 150 fresh cadaveric samples of both the sexes, between 18-80 years of age were measured and compared for their predictive use. *Result:* The inter-arytenoid distance obtained in males ranges between 11.16 & 16.68mm, that in females ranges between 8.38 & 13.88mm. This distance has a higher correlation with the stature of the individual in males than in females. The females tend to have a more acute inter-arytenoid angle, between 36 & 46 degrees, while the men have a wider angulation, between the 38 & 48 degrees. *Conclusion:* The present study states that the inter-arytenoid distance is significantly less in females than in males, as does the angle. The narrower and more acute angled posterior part of the subglottis proposes a gender bias for iatrogenic injuries towards the females in absence of use of properly calibrated endotracheal tubes. Further, statistically significant correlation between the stature and the inter-arytenoid distance can be used to choose the proper sized endotracheal tube especially in males. Hence the results of this study can be used to prevent or reduce the complications of the post-intubational injuries like subglottic stenosis and subluxation or dislocation of arytenoids in the different genders amongst the Eastern Indian subjects.

Keywords: Cricoid, Arytenoids, Inter-arytenoid distance, Inter-arytenoid angle.

Introduction

Morphometrical evaluation of the larynx has always interested both morphologists and physicians. The increasing application of sophisticated electrophysiological 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. Skeletal framework of larynx is formed by a series of cartilages viz-unpaired thyroid, cricoid and epiglottis and paired arytenoid, cuneiform and corniculate.

Knowledge of dimensions of larynx and trachea is a must for transplantation, stenting, intubation, cricothyroidotomy and endoscopic procedures. Subglottic stenosis and post intubational stenosis of lower respiratory tract were two main factors,

which led anatomists to work for measurements of various cartilages in early nineties [1]. The crico-arytenoid joint is the primary moving structure of the intrinsic larynx. Each crico-arytenoid joint sits at a surprisingly steep 45° angle with the horizontal plane on the cricoid cartilage and permits motion in a sliding, rocking, and twisting fashion [2].

The distance between the oval, convex facets of this joint (inter-arytenoid distance) has always been a focus of studies as it marks the smallest distance in the posterior part of the subglottis. The subglottis is the terminal part of the larynx, extending between the vocal folds to the lower border of the cricoid cartilage. The endotracheal tubes are chosen keeping in mind the inter-arytenoid distance

as dislocations and subluxation of the arytenoid cartilage may occur not only during difficult and prolonged intubation but also following uncomplicated intubation.

Various texts have provided standardization for the choice of the size of endotracheal tubes used. The choices are age and weight calibrated in neonates and infants but in case of adults, the choice is quite empirical and varies from author to author. The external diameters of the endotracheal tubes are more important because they have to negotiate the smallest cricoid diameters so that the risk of injury is kept at a minimum. According to Holinger, the width of the posterior glottis (i.e. the inter-arytenoid distance) corresponds to approximately 80% of the subglottic lumen. If the median inter-arytenoid distance is calculated at 80% of the subglottic lumen's median diameter, then all recommended ETTs are oversized and cannot fit the posterior glottis without excessive pressure on the mucosa [3].

Several international observers in the past have noted the dimensions of the subglottic framework, but none have shown the variation amongst genders. There is paucity of such work in India, and none based on the eastern Indian population. In this study we have measured the inter-arytenoid distance, its correlation with the stature and inter-arytenoid angle and their variations amongst the genders as well as population subgroups is found out.

Material and Methods

150 fresh cadaveric larynges belonging to both the sexes (95 males & 55 females) were dissected from adult subjects aged between 18 and 80 years over a period of one year, which were brought for medico-legal autopsies at the police morgue of the Department of Forensic & State Medicine of a reputed state-run hospital in Kolkata within 24 hours of death. Cadavers with no gross features of putrefaction and whose length was below 56 inches, as measured from head to heel were chosen. The samples were cleaned by dissection and only the dry cricoid cartilages were used for measurements.

Any specimen that was decomposed or showed the evidence of instrumentation like tracheostomy or was grossly deformed or burnt was excluded

from the sampling population. The distance between the mid-point of the medial borders of the oval, convex articular facets on the lateral ends of the cricoid lamina for the arytenoids was measured (fig.1) with the help of Vernier Calipers and the results were tabulated. The oval and convex facets where the arytenoids articulate with the lateral ends of the superior border of the cricoid lamina are directed forwards and laterally. A longitudinal axis passing through these facets when projected backwards, meets at an angle behind the cricoid. This angle (inter-arytenoid angle, fig.2) was also measured. The stature (supine length) was measured from vertex to heel.

Fig-1: Inter-arytenoid distance

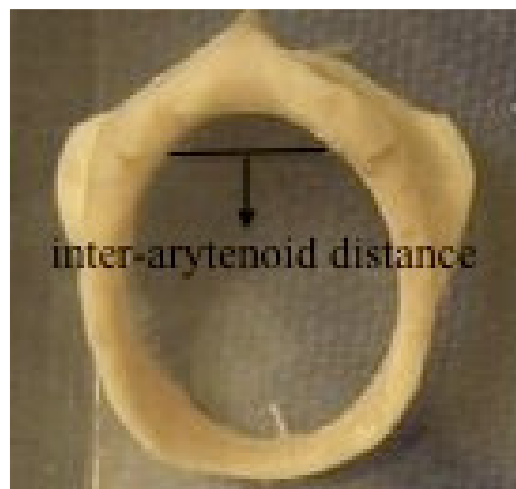


Fig-2: Inter-arytenoid angle



Appropriate statistical tools like calculation of central tendencies, one-way ANOVA test, using software MEDCALC were further used

to compare the values obtained between males and females and these were also corroborated with findings of previous workers to find out the clinical implication of the statistical data.

Results

The inter-arytenoid distance is defined as the distance between the midpoints of the medial or inner margins of the oval, convex articular facets

of the arytenoid on the lateral ends of the cricoid lamina. The distance was smaller in females ranging between 8.38 & 13.88mms while males had significantly higher value ranging between 11.16 & 16.68mms. The difference between the 2 subgroups is found to be significant, confirmed by the P value of less than 0.001(Table 1).

Gender	Values	Sample size	Mean+/- SD (mm)	Median (mm)	Highest (mm)	Least (mm)
Males		95	13.66+/-1.07	13.64	16.68	11.16
Females		55	9.99+/-0.18	9.88	13.88	8.38
Total		150	12.32+/-2.03	12.87	16.68	8.38

The inter-arytenoid distance was found to have a significant correlation with the stature of the study population, correlation coefficient being 0.645. Further this distance has a higher correlation with the stature of the individual in males than in females with Pearson’s correlation coefficient in males being at 0.527and at 0.47 in females. P value for both <0.001 (Table 2). The inter-arytenoid angle (angle alpha) is defined as

the angle between the backward extensions of the longitudinal axes of the articular facets of the arytenoids on the cricoid, which are facing antero-laterally. The females tended to have a more acute angle, between 36 & 46 degrees while men had a wider angulation, between the 38 & 49 degrees. The difference in the two gender subgroups was statistically significant (ANOVA < 0-001) (Table 3).

Study	Present study			Western India	Swedish	
	Both genders	Males	Females	Both sexes	Males	Females
Mean	12.32	13.66	9.99	12.07	12.6	10.3
Standard deviation	2.03	1.07	0.81	2.35	2.8	1.5

Gender	Angle	Samples	Mean ± sd	Median	Highest	Least
Male		95	43.67 ± 2.56	44.0	49	38
Female		55	40.2 ± 2.74	41.0	46	36
Total		150	42.4 ± 3.11	43.0	49	36
(P<0.001)						

Discussion

The synovial crico-arytenoid joints are the majorly important joints of the larynx and are liable to be injured during instrumentation of the larynx for invasive airway managements, both diagnostic and therapeutic. Subglottic stenosis and arytenoids subluxation and dislocations are

very uncommon entities encountered in clinical practice and mostly are results of iatrogenic injury to the larynx. The commonest cause of the iatrogenic or traumatic injury is intubation injuries. The incidence of arytenoids dislocations has been reported to be 0.2% in cases requiring endotracheal intubation [4].

The inter-arytenoid distance is important for it marks the space where any foreign body whether accidentally inhaled or iatrogenically introduced occupies and brushes by the side of the vocal process as it marks the smallest distance in the posterior part of the subglottis. The inter-arytenoid distance as found in this study is significantly wider in males ranging between 11.16 & 16.68mm, with the central tendency of mean= 13.66+/- S.D = 1.07 in comparison to the females who have narrower distance ranging between 8.38 & 13.88mm and a central tendency of mean= 9.99mm, S.D= 0.81mm. For the total cohort the values are respectively between 8.38 & 16.68 and 12.32+/-2.03.

The same distance has been previously measured in different population subgroups and the table 2 shows the comparison of the obtained values. The inter-arytenoid distance came out in the range of 7.52-20.74mm and the central tendency of 12.07±2.35 mm in a study amongst a section of the Western Indian population [5]. The same diameter was measured in a section of the Swedish population and the diameter in males was higher with a central tendency of mean = 12.6+/- 2.8mm. The females had a smaller diameter with central tendency of mean= 10.3mm+/- S.D = 1.5mm [6].

A comparison between the central tendencies of the inter-arytenoid distances between the western and eastern Indian population subgroups suggest that the central tendencies of the overall population subgroups match which suggests a common racial evolutionary background. But they have not taken into account the gender of the study population. So even though the central tendencies of the 2 populations are very close to each other, the result of the present study is more specific, which is gender based. Yadav Y et al in their study on cricoid cartilage have found greater values for the dimensions of cricothyroid and cricoarytenoid facets [7].

In another study done on the morphology of human larynx in Karnataka, it is found that there is a significant difference in dimensions of larynges in males and females, all morphometric measurements of larynx were more in males compared to females [8]. Both the studies have however not measured the interarytenoid distance or angle. Zrunek and his coworkers in 1988 had

also stated that the different dimensions of the laryngeal cartilages vary considerably in males and the females; the dimensions of male human larynges are 10-30% greater than in females [9]. The comparison between Indian and European population subgroups also suggest that males have greater distance than the females. Comparing the gender wise values between the two populations, it is seen that the Swedish males have lower values in comparison to their Indian counterparts while Swedish females have wider distance than the Indian females. This can be explained by difference in the genetics and environmental factors influencing the two population subgroups.

The inter-arytenoid distance is found to be as low as 8.38mm in females and 11.16mm in males in the present study (Table 1). The ordinary endotracheal tube with 7mm internal diameter(ID), used for orotracheal prolonged intubation or prolonged anaesthesia in females has its outer diameter of 9.5-10mm and a corresponding tube (8mm ID) for males has the outer diameter of 10.5-11.5mm. When such tube is wedged between the arytenoid cartilages, it is obvious that they may cause subluxation of the arytenoid cartilages and with prolonged use, it may cause pressure necrosis on the medial side of the arytenoid cartilages. Sometimes the pressure necrosis even causes dense scar formation along the entire posterior larynx and such sequel are very difficult to tackle surgically, the results being lifelong and serious [10-11].

Hence we reach a conclusion that the endotracheal tubes used for instrumentation in case of females belonging to the Eastern parts of India should be standardized to a lower caliber (maximum external diameter should preferably be kept less than 8.38mm) if we want to prevent post-instrumentation injuries. The correlation coefficient of 0.645 signifies a good correlation between the stature of the entire population and their inter-arytenoid distance. Moreover the result of the correlation study seems to suggest that the height of the male has a better correlation with the distance than the females. Thus the findings in the previous studies, that the height of the individual correlates better with

male cricoids is upheld by this study. By using the above set of data, one can make a prediction of the average inter-arytenoid distance, thence the appropriate size of the endotracheal tube to be used, although the statistical accuracy can be well debated because of the poorly localized nature of the coefficient.

In the present study inter-arytenoid angle found in the females was between 36 & 46 degrees while men had a wider angulation, between the 38 & 49 degrees. The angles were found to be ranging from 42⁰ to 74⁰ in females and between 37 to 75

degrees in males in a sample of the Swedish population [6]. The data suggests a narrower angle in females and wider in males in the present study while in Swedish study males seem to have a narrower angle than the females. The more acute angle between the longitudinal axes of the crico-arytenoid joint facets, making the posterior part of the subglottis narrower may lead to more chances of iatrogenic injuries like subglottic stenosis and arytenoid subluxation/dislocations in females belonging to the Eastern part of India.

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*All correspondences to: Dr. Prerana Aggarwal, Assistant Professor, Department of Anatomy, Institute of Post Graduate Medical Education & Research (IPGME&R), 244B, Acharya Jagdish Chandra Bose Road, Kolkata-700020, West Bengal, India.
E-mail: dr_prerana@yahoo.com