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Original Research Article

STUDY OF SUB CARINAL ANGLE OF HUMAN TRACHEA BY COMPUTERIZED TOMOGRAPHY

Bipinchandra Khade *[1], Abdur Rafe Abdul Waheed [2], Nisha Yadav [3], C.V.Diwan [4].

[*1] Assistant Professor, Department Of Anatomy,CMCH, Bhopal, India.

[2] Assistant Professor, Department Of Anatomy,GMC, Aurangabad, India.

[3] Assistant Professor, Department Of Anatomy, CMCH, Bhopal, India.

[4] Professor, Department Of Anatomy, DSCGMC, Nanded, India.

ABSTRACT

Introduction: The study of bronchial tree is done by both invasive and non-invasive techniques like cadaveric dissection, bronchograms, virtual bronchoscopy, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) scan.

Materials and Methods: The subcarinal angle of trachea was measured on chest CT scans of 110 normal adult individuals in the age group of 10-70 years (69 males and 41 females) attending the department of Radio-diagnosis at Government Medical College, Aurangabad.

Result: The mean value for subcarinal angle was 80.01 ± 12.53 in males, 79.75 ± 9.99^0 in females and 79.92 ± 11.60^0 in total study population.

The difference between means of subcarinal angle in male and female population was not significant statistically ('p' value=0.902). In the age group 11-20 years, the differences between the mean values of subcarinal angle were affected by sex to a very small extent as compared to other age groups.

Discussion: It was observed that widening of the tracheal bifurcation angle had long been accepted as a sign of left atrial enlargement, but conflicting data are present about its reliability.

Conclusion: The mean value of subcarinal angle is independent of age and gender. This study is useful for clinicians to know the changes in left atrium and while doing endotracheal intubation and bronchoscopy.

KEY WORDS: Trachea, Subcarinal angle, CT Scan.

Address for Correspondence: Dr. Bipinchandra Khade, Assistant Professor, Department Of Anatomy,CMCH, Bhopal, India. **E-Mail:** drbipinkhade@gmail.com

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INTRODUCTION

The trachea, a tube formed of cartilage and fibro-muscular membrane, is about 10-11 cm long & extends from the level of sixth cervical vertebra to the upper border of fifth thoracic vertebra [1]. It splits into right & left mainstem bronchi which enter the respective lungs & progressively branch off throughout the entire organ, the tracheo-bronchial tree. The study of bronchial tree is done by both invasive and non-invasive techniques like cadaveric dissection, bronchograms, virtual bronchoscopy, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) scan.

As cited by Reed J.M. et al (1996) [2], direct examination by endoscopy provides excellent

visualization of the intraluminal structures; however, overall orientation and angulation cannot be assessed endoscopically because of optical distortion and the limited field of view. Additionally, manipulation of the airway to accommodate rigid instruments may result in stretching, pulling, or bending, potentially imparting inaccuracies to measurements.

Cadaveric studies also are limited in application because of post-mortem changes and necessary tissue fixation techniques [2]. These types of studies were replaced by CT because of the ability to more easily and accessibly gather and study the different age groups.

Computed tomography adds a 3-dimensional component to the understanding of tracheobronchial anatomy. It has proven to be an excellent technique for evaluating mediastinal structures and is an excellent method of displaying the cross-sectional anatomy of the trachea. Unlike autopsy and bronchoscopy, CT causes little or no disturbance of tracheal anatomy. Non invasive CT area calculations may be useful in demonstrating and quantifying tracheal obstruction when mediastinal neoplasms are staged and, also to decide about treatment plan. The morphology of the trachea varies in healthy and diseased individuals. Changes in tracheal dimensions occur in a variety of conditions. Knowledge of normal tracheal dimensions is essential to the diagnosis of these conditions, in problems in respiratory physiol-ogy, and also in endotracheal intubation, endoscopy, and tracheostomy. In patients with left atrial enlargement, subcarinal lymphadenopathy, bronchogenic cyst, and mediastinitis, the subcarinal angle may be abnormally large.

In present study, subcarinal angle of human trachea were measured on CT scans of patients with no known respiratory disease and intra- thoracic pathology to establish normal ranges in men and women of various ages and to compare the data with that of the other studies.

MATERIALS AND METHODS

"The study of subcarinal angle of human trachea by computerized tomography (C.T.)" was a prospective study of 18 months duration in which subcarinal angle of trachea was measured on chest CT scans of 110 normal adult individuals in the age group of 10-70 years (69 males and 41 females) attending the department of Radio-diagnosis at Government Medical College, Aurangabad for chest CT scan excluding the patients with history of prior cardio thoracic surgery, distorting intra thoracic pathology and history of prior tracheostomy, tracheal surgery, or neck injury. The permission of the institutional ethics committee and the Head of Department of Radio-diagnosis was taken.

Chest CT scan of these patients were performed on GE light-speed VCT MULTI SLICE (64 SLICE) MULTI DETECTOR SPIRAL CT SCANNER with a scan time of 2-4 seconds and slice thickness of 0.6 millimetres.Patients were given detailed information about the study and written informed consent was obtained from them for the use of their CT scan images for the purpose of this study.

Mean values of subcarinal angle, gender related differences and age-group wise changes in the subcarinal angle were studied.

Subcarinal angle (SCA) was measured on coronal reformatted images. It was determined by the intersection of the inferior margins of the main bronchi using the angle measurement tool of the DICOM software (Figure 1).

Fig. 1: Measurement of sub-carinal angle.

Statistical analysis: Quantitative variables were expressed as mean ± 2 standard deviation (2SD)

of the mean. The minimum and maximum values in study population were established forsubcarinal angle. The null hypothesis of nodifference between male and female population was tested using 't' test. Also the 't' test was used to compare the means of subcarinal angle, age-group wise in male and female population. Statistical significance was defined as 'p' value < 0.05. Statistical Package for Social Sciences (SPSS) 16 was used for statistical analysis.

OBSERVATIONS AND RESULTS

In graph no. 1 it was observed that the subcarinal angle did not show any sex-wise and age-wise distribution of mean values among population.

In age group 41-50 and 51-60 ('p' value >0.05) and in age group 61-70 year, the mean subcarinal angle increased in the female population while it decreased in the male population.

Graph 1: Sub-Cranial angle Male Vs Female.

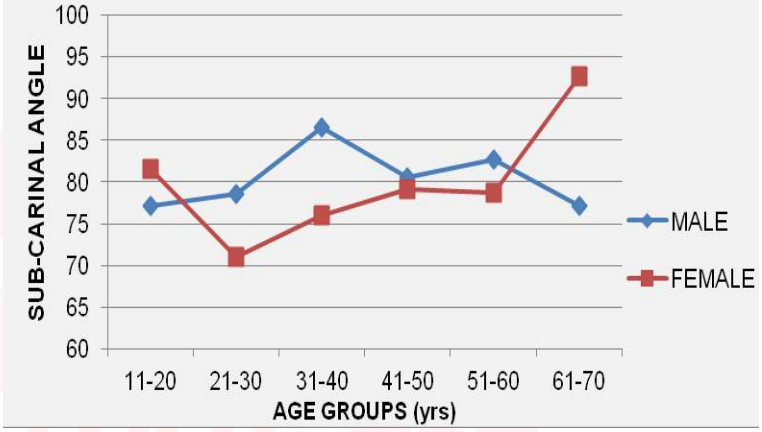

Table 1: Mean Sub-Cranial Angle In Age Groups.

	11-20	21-30	31-40	41-50	51-60	61-70
MALE	77.13 ± 10.09^0	78.54 ± 7.22^0	86.6 ± 1.63^0	80.51 ± 8.28^0	82.76 ± 15.54^0	77.21 ± 15.35^0
FEMALE	81.5	71 ± 3.50^0	76 ± 8.61^0	79.1 ± 6.92^0	78.7 ± 11.27^0	92.6 ± 3.81^0

Table 2: Sub-carinal angle.

Sr. no.	Author (year)	Method	n	Sub carinal angle		
				Male	Female	Total#
1	Alavi S.M.et al (1970)	R	87	56.4± 5.66	57.73±6.37	57.16± 6.06
2	Haskin P.H. & Goodman L.R. (1982)	R	100	-	-	60.8±11.80
3	Chen J.T.T. et al (1982)	R	54	-	-	62.3± 8.6
4	Murray J.G. et al (1995)	R	108	61.2±13.1	63.6±15.9	62.6±14.8
5	Coppola V. et al (1998)	R	500			79.7 (37-105)
6	Karabulut N. (2005)	CT	120	70±16	77±14	-
7	Kamel K.S. et al (2009)	CT	60	76±20	81±20	78±20
8	Mrudula C. & Krishnaiah M.(2011)	CD	25	-	-	77.8 (50-130)
9	Present study(2011)	CT	110	80±12.53	79.7±9.99	79.9±11.60

R= radiograph,
CT= Computed tomography,
CD= cadaveric dissection,
n= study sample,
'#'- values in column 'total' are the mean values in total study population.

DISCUSSION

The subcarinal angle indirectly helps the cardiologist to know the changes in left atrium [6]. According to Taskin V. et al (1991) [6], left atrial enlargement was a significant finding, usually indicating elevated left ventricular end-diastolic pressure. An increased tracheal carinal angle had been reported as one indicator on chest radiography of left atrial

indicator on chest radiography of left atrial enlargement. The left atrium could be accurately predicted to be larger than 5.0 cm in diameter if the carinal angle was 100° or greater. Finding a carinal angle greater than 100° was an easy, inexpensive, reliable method of predicting left atrial enlargement. Murray J.G. et al (1995) [7] showed that widening of the tracheal bifurcation angle was an insensitive and nonspecific sign of left atrial enlargement and clinicians should be aware that although this sign was widely referenced as a manifestation of left atrial enlargement, it was of little value in diagnosing atrial enlargement. Karabulut N. (2005) [9] concluded that tracheal bifurcation angle ranged widely in normal subjects, and absolute measurements of the carinal angle were of little diagnostic value. Thus, it was observed that widening of the tracheal bifurcation angle had long been accepted as a sign of left atrial enlargement, but conflicting data are present about its reliability.

Alavi S.M. et al (1970) [3] measured tracheal bifurcation angle in 87 subjects (41 males and 46 females). In age group of > 16 years the mean tracheal bifurcation angle was 56.40 ± 5.66^0 in males and 57.73 ± 6.37^0 in females. In study population the angle was 57.16 ± 6.06^0. The angle was more in females than males. Haskin P.H. & Goodman L.R. (1982) [5] measured the subcarinal angle in 100 normal adults (47 males and 53 females) (21-80 years) using chest radiographs. The mean subcarinal angle was 60.8 ± 11.80^0. Chen J.T.T. et al (1982) [4] studied effect of pericardial effusion on subcarinal angle on chest radiographs in 54 patients (27 male and 27 females) (8-75 years). The mean subcarinal angle was 62.3 ± 8.6^0. Murray J.G. et al (1995) [7] measured the subcarinal angle on chest radiographs in 108 patients (53 males and 55 females)(27-85 years). The mean subcarinal angle in normal population was 62.6 ± 14.8^0. In males the subcarinal angle was 61.2 ± 13.1^0 and in females it was 63.6 ± 15.9^0.The subcarinal angle was more in females than males.

Coppola V. et al (1998) [8] correlated the subcarinal angle measurements with left atrial volume. The subcarinal angle was measured in 500 normal chest radiographs. The mean value was found to be 79.7^0 (range37-105^0). Karabulut N. (2005) [9] measured the subcarinal angle in 120 patients (65 males and 55 females) (17-85years) using CT. The mean subcarinal angle was 70 ± 16^0 and 77 ± 14^0 in males and females respectively. The angle was larger in females than males. Kamel K.S. et al (2009) [10] studied tracheal morphology using CT and cadaveric dissection. The mean subcarinal angle using CT in 60 subjects (40 males and 20 females) (22-88 years) was 76 ± 20^0 in males and 81 ± 20^0 in females and it was 78 ± 20^0 in the study population. The subcarinal angle was greater in females than males. Mrudula C. & Krishnaiah M. (2011) [11] did a cadaveric study to find various dimensions of trachea. In 25 cadaver tracheas, mean subcarinal angle was 77.8^0 (50-130^0).

In present study comprising CT measurements of trachea of 110 subjects (69 males and 41 females) the mean subcarinal angle was 80.0 ± 12.53^0 in males and 79.7 ± 9.99^0 in females and it was 79.9 ± 11.60^0 in the total study population. The subcarinal angle was greater in males than females. The mean subcarinal angles in present study correspond with the previous studies. In previous studies the mean subcarinal angle in female population was larger than the male population but in present study the subcarinal angle was more in the male than the female population. The subcarinal angle did not correlate with age and sex like in a previous study [7].

CONCLUSION

The purpose of present study was to define the normal range of tracheal dimensions with computerized tomography using standardized technique. The mean value for subcarinal angle was measured using CT scan and is found to be independent of age and gender. This study is useful for clinicians to know the changes in left atrium. Also, practical applications of this data may be useful when tracheal intubation or endoscopy is to be performed.

ABBREVIATIONS

R - radiograph

CT - Computed tomography

CD - cadaveric dissection,

n - study sample

Conflicts of Interests: **None**

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