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Measurement of Subcarinal Angle: A Cadaveric study

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ABSTRACT

Introduction

The bifurcation of trachea into two primary bronchi at the level of fourth thoracic vertebra creates an angle at the bifurcation. This angle can be seen clearly in routine chest X-rays where the measurement can throw light on many medical conditions within the mediastinum. This study aimed at finding the subcarinal angle, which is the angle formed by inferior borders of two primary bronchi.

Methods

The measurements were taken from photographs of tracheal specimen of 92 cadavers, 63 male and 29 female. Angle was measured by photographic software and analysis of subcarinal angle was done in the study population.

Results

The mean subcarinal angle was found to be 41.09^0 with standard deviation of 17.14^0. This measurement was found to be significantly more in males (68.02 ± 15.72^0) than in females (60.14 ± 17.71^0).

Conclusion

The subcarinal angles in the study population were seen to be different among sexes. Also, the mean subcarinal angles from other studies, radiological or on specimen were close to the observations made in this study.

Keywords: *Bronchus, subcarinal angle, trachea*

INTRODUCTION

Trachea ends at the level of fourth thoracic vertebra by bifurcating into two primary bronchi.[1] This bifurcation is visible internally during bronchoscopy as the sharply demarcated carina.[2] Air filled trachea and primary bronchi can easily be identified in routine chest x-rays and the angles of bifurcation can be measured.[3] The angles of bifurcation of two primary bronchi differ according to age and sex[4–7], and may be highly atypical in diseases of the mediastinum like pericardial effusion[8–10], left atrial enlargement[11–14] or mediastinal masses[15,16]. Diseases of lungs[17] and surgeries[18] may also pull or push bronchi causing changes in the angle. Angle of branching of the primary bronchi deviating from the normal angle for the population can thus serve as an affordable and informative indicator of various disease processes going on in the mediastinum. This study aims to find if subcarinal angles of the study population and its differences within the age and sex groups are similar to studies done elsewhere.

Measurement of angle of bifurcation of primary bronchi may sound pretty straightforward at first glance, but in practice, it may be a lot ambiguous and confusing. Measurement of angle formed by each bronchus with the median plane requires the measurement to be taken in vivo and a well defined median plane or axis. The interbronchial angle, on the other hand measures angle between lines drawn through the axes of two primary bronchi. This term is sometimes used synonymously to the angle formed by the inferior borders of two primary bronchi. But this angle is more strictly defined as the subcarinal angle.19 To avoid ambiguity, the subcarinal angle has been measured in this study as the angle formed by the lines along inferior borders of two primary bronchi. This type of measurement eliminates the ambiguity caused by stating of right and left such angles which need the definition of an axis or a specific midline.

Figure 1. Part of the GIMP window showing photograph of a specimen with measurement of subcarinal angle (number at bottom of window). The reading of 41.77^0 was rounded off to 42^0 during entry

METHODS

Cross sectional observational study of 92 cadavers was done during a period of six months at the department of forensic medicine and toxicology, Maharajgunj medical campus, out of which 63 were male and 29 were female. Cadavers with trauma to the respiratory tract, putrefied cadavers, non Nepalese cadavers or those below 18 year age were excluded from the study. Convenience sampling was done and ethical approval was obtained from the Institutional Review Board. Informed consent was taken from relatives of the deceased.

Data collection equipment included scalpel, dissecting forceps, and digital camera. After standard autopsy procedure removal of viscera by M.Letulle's method, the primary bronchi were cut at each lung hilum and the trachea was removed Each trachea with the primary bronchi was washed and placed on a piece of cloth. Code number was given to each specimen. Photograph of such specimen was taken showing the anterior view. Photographs thus obtained were transferred to computer and imported into GNU image manipulation (GIMP) softwareversion 2.8.22. Using the software, line passing through inferior border of each principal bronchus was drawn and the angle between them was measured digitally by the help of the angle measuring tool in the software as shown in figure 1. Blurry photographs or those showing ambiguous bifurcations were excluded from observation.

Each case number, age, sex, and subcarinal angle to the nearest whole number was recorded in Libreoffice calc software version 6.2.0.3. After all cases were recorded, this

Table 1. Descriptive statistics of age among study population

Sex	Age range (years)	Mean age (years)	Standard deviation
Male	18-86	40.62	14.88
Female	18-82	42.1	21.52
Total	18-86	41.09	17.14

Table 2. Descriptive statistics of subcarinal angle among study population

Sex	Range (degree)	Mean subcarinal angle (degree)	Standard deviation
Male	33-105	68.02	15.72
Female	32-112	60.14	17.71
Total	32-112	65.53	16.69

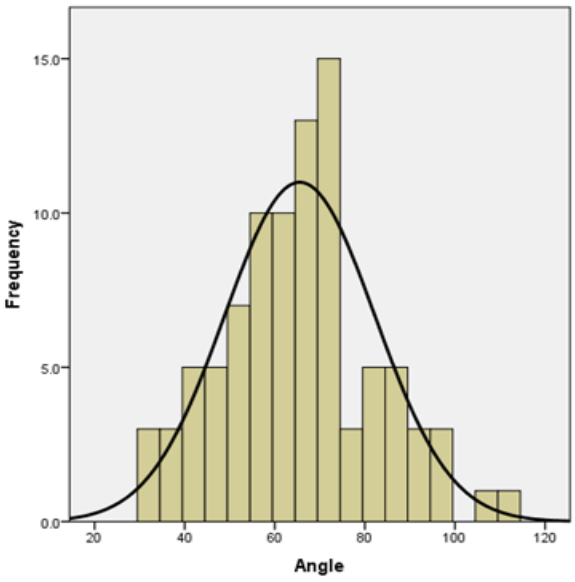

Figure 2. Histogram showing frequency of subcarinal angles

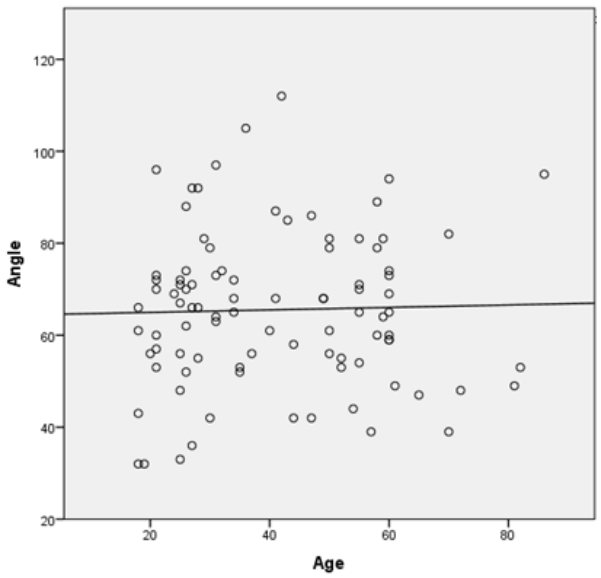

Figure 3. Scatterplot showing relation between age and subcarinal angle. Pearson correlation coefficient was calculated to be 0.028, p = 0.794

data was transferred to SPSS version 17 for analysis. Descriptive statistics for age, sex and subcarinal angle were calculated among total population as well as among male and female population of study. Graphs were built using SPSS. Difference of mean of subcarinal angles in male and females was calculated using independent samples T test and correlation between age and subcarinal angle was calculated using Pearson's correlation coefficient. Statistical significance was considered if p-value < 0.05.

RESULTS

Over the past 11 years, 27 cases needed relaparotomy/laparotomy for the hemorrhagic complications following Gynaecological surgeries.

The study included 92 specimens of trachea. Sixty three (68.5%) of them were from male cadavers while 29 (31.5%) were from female cadavers. The descriptive statistics of age and subcarinal angle are shown in table 1 and table 2 respectively. Frequency of subcarinal angles was normally distributed as depicted in figure 2.

This study found that specimens from male cadaver had statistically significantly more subcarinal angle (68.02 ± 15.72^0) compared to specimens from female cadavers (60.14 ± 17.71^0), t (90) = 2.145, p = 0.035. Correlation between age and subcarinal angle is shown in figure 3.

DISCUSSION

The current study showed that the mean subcarinal angles were higher in both male and female groups than those noted by Chunder and Guha (2015) in India.[20] However, the decreasing trend of subcarinal angle with increasing age that they found was not seen in the current study.

The subcarinal angles of female cadavers in the current study were similar to that found by Haskin and Goodman (1982) in Philadelphia[3] but the angle in males was higher in the current study. However, they failed to demonstrate any difference in angles among age or sex groups. The difference in the two studies could be because of differing heights of the two study populations. Length of cadavers was not measured in the current study. So, its relation to subcarinal angle couldn't be studied. It is worthwhile to note that they have used in vivo measurements using radiographs instead.

The mean subcarinal angle measured by Turner (1962) in California[19] was more acute than that of the current study. The measurements done by Chen et al (1982) in USA8 also confirms to this difference. Haskin and Goodman have noted that subcarinal angles tend to be more acute in subjects with higher stature. However, it should be noted that Turner has measured subcarinal angles by projecting actual specimens on tracing film and drawing the angles while Chen et al did it on X-ray films.

The angles measured in current study were smaller than those measured by Kamel, Lau and Stringer (2009)[21] in CT scan data in vivo in New Zealand. Although they studied cadaveric specimens as well, they didn't measure subcarinal angles in those specimens. The differences could point towards a difference in cadaveric and in vivo measurements.

The mean subcarinal angle measured preoperatively by Kakeda et al (2003) radiologically in Japan was close to the measurement in total population of the current study. The similarities of body length and other features between the two populations could

be the underlying reason for this.[18]

CONCLUSION

In the current study, the subcarinal angles were seen to be different among sexes. This difference could also exist among people of different stature, races or ethnicity. A larger study needs to be done and analyses of subcarinal angle with ethnicity, body length and other factors could be added to see the larger picture. Further, subcarinal angles can be measured in vivo using x-ray of the cadavers and that could be compared to the measurement in excised specimen to find whether there's a difference.

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CONFLICTS OF INTEREST

None declared.

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