Original Article

Capsula Eburnea

Major Anatomical Variations in the Division of Tracheobronchial Tree as Visualised by Fiberoptic Bronchoscopy – A Study of 500 Cases

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SUMMARY

Fiber optic bronchoscopy is a tool that is widely used for diagnostic and therapeutic purposes in pulmonary medicine. Though variations in tracheobronchial divisions are well known, investigators often tend to neglect them during bronchoscopies. These variations may have important implications in intubation, bronchoscopy, brachytherapy, bronchial thermoplasty and pulmonary resections. Though there have been reports of variations in anatomy of the tracheobronchial tree, there hasn't been a study regarding the same in the Indian population in our knowledge.

In the present study we retrospectively analyzed 500 cases of fiberoptic bronchoscopies , done over a period of four and half years. Major variations were found in 29 (5.8%) patients. Commonest variation was found in right upper lobe 18 (62.06%) followed by left upper lobe (17.56%). 35.7% patients had four divisions in right lobe. 28.2% patients had two divisions in right upper lobe. 17. 56% patients had four divisions in left upper lobe.

Introduction

Variations in division of tracheobronchial tree are not uncommon (1). Identification of such variations is made easier with the advent of fibreoptic bronchoscopy. It is a tool which is now increasingly being used for various diagnostic and therapeutic purposes. However despite its regular use it is still not a standard practice with many bronchoscopists to record such variations observed. These variations in bronchial divisions are most often due to displacement of segmental and subsegmental bronchi. Such displacements are thought to occur during the process of embryonic development and growth (2).

Knowledge and understanding of variations in anatomical division of tracheobronchial tree may have important implications for brachytherapy, bronchoscopy, surgery, intubations and bronchial thermoplasty (1,3).

We undertook this study to analyse major variations in tracheobronchial division in the population of our region.

Materials and methods

We conducted a retrospective analysis of 500 fibreoptic bronchoscopies done over a period of four and a half years from July 2004 to Dec 2008. Both diagnostic and therapeutic bronchonscopies were included in the analysis. All the bronchoscopies were done by a single chest physician. Informed and written consent was obtained from all the

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patients prior to the procedure. Immediately after the procedure the findings, variations in tracheobronchial divisions and the diagnostic or therapeutic procedure performed were entered in detail in the bronchoscopy register by the chest physician who performed the procedure.

Only cases were all segments could be properly visualized were included in the study. In cases where there was distortion due to fibrosis or collapse and where all the segments could not be visualized due to tumor or foreign body obstruction were excluded from the study.

The variations were defined as per the descriptions given in standard text books (4,5,6). The conditions considered as normal patterns were as follows : 1) The trachea divides into right and left main bronchus. 2) The right main bronchus divides into the right upper lobe bronchus, which in turn divides into anterior, apical, and posterior segmental bronchus and the bronchus intermedius. 3) This bronchus intermedius gives off middle lobe and apical lower lobe bronchi and divides into the four basal segmental bronchi: anterior, medial, posterior, and lateral. 4) The middle lobe bronchus divides into medial and lateral segmental bronchi. 5) On the left side the left main bronchus gives off upper and lower lobe bronchi: the upper lobe bronchus divides into apico posterior and anterior segmental bronchi and a lingular bronchus. 6) Lingular bronchus in turn divides into superior and inferior bronchi. 7) The left lower lobe bronchus gives off an apical bronchus and divides into anterior, lateral and posterior segmental bronchi.

Results

A total of 500 cases done over a period of four and a half years were analyzed. Twenty-nine (5.8%) patients had variations in their tracheobronchial tree anatomy (Figure 1). Right upper lobe was found to be the commonest site of variations (Figure 2) followed by left upper lobe (Figure 3). The details are as follows:

1) 10 patients (35.7%) had four divisions in right upper lobe.

2) 8 patients (28.2%) had two divisions in right upperlobe.

3) 3 patients (10.7%) had only four divisions in right lowerlobe.

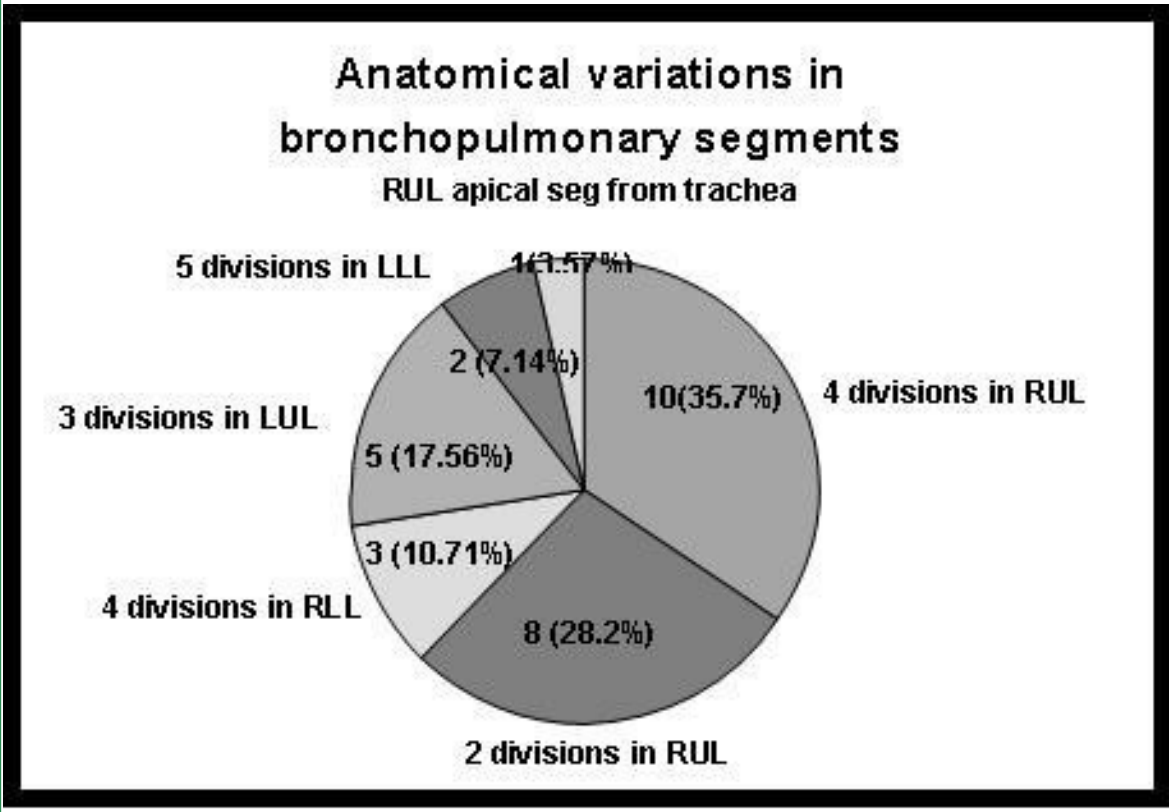

Fig 1: Anatomical variations in bronchopulmonary segments. RUL:-Right Upper Lobe, LUL:-Left Upper Lobe, RLL:-Right Lower Lobe, LLL:-Left Lower Lobe.
n= 29 patients. Left lobe variations =7, Right lobe variations = 21, Tracheal variation = 1

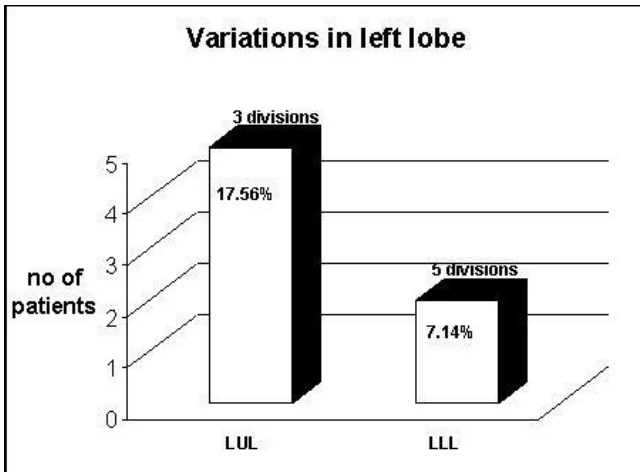

Fig. 2: Variations in left lobe. LUL= Left upper lobe, LLL= Left lower lobe. n=7 patients

4) 5 patients (17.56%) had four divisions in left upper lobe.
5) 2 patients (7.14%) had five divisions in left lower lobe.
6) 1 patient (3.57%) had right upper lobe apical segment bronchus directly arising from trachea.

Discussion

First successful attempt to outline the tracheobronchial tree was done by Jackson in 1918. He used bismuth subcarbonate insufflations through a rigid bronchoscopy to map tracheobronchial tree in cases with suspected foreign body in the bronchus (7). In 1922 Sicard and Forestier published their first article on visualization of tracheobronchial tree by using 40% iodized oil. (7)

With the advent of flexible fiberoptic bronchoscopy in 1967 by Ikeda one could visualize the anatomy of tracheobronchial tree directly. (8) Since then fiberoptic bronchoscopy is regularly being used for diagnostic and therapeutic purposes in pulmonary medicine.

It is important for every bronchoscopist to know the tracheobronchial tree anatomy and its possible variations, in order to be able to differentiate normal from the abnormal. This knowledge of the variations becomes important while applying it into a therapeutic setting. In the current day literature available, majority of the published data regarding anatomical variations are by imaging techniques - mainly computed tomography (CT) scan. This observation suggests that bronchoscopists do not routinely identify and record the anatomical variations. Unfortunately many of the investigators often neglect the variations found in the normal anatomy. Because of this, there are only limited data available in English literature describing the anatomical variations in tracheobronchial division (1, 3, 7, 9, 10, and 11).

The largest case series on this topic till date is by Gonlugur U et al which were published in September 2005 (11). They analyzed 2550 cases and found major variations in 2.6% of the patients. In their study the most frequent finding was of a bifurcate pattern in right upper lobe (47.7%). The variations were localized to the right upper lobe in 71.6% patients. Our study also showed a similar finding with the commonest site of variations being observed in the right upper lobe.

In another case series by Sumu Beder et al , analysis of 1114 cases showed variation in 475 patients, with almost equal left and right lung distribution(10). The five most frequently observed tracheobronchial variation were 1) right upper basal orifice with two sub segments 2) left lower lobe basal orifice with two sub segments, 3) left upper lobe with three segments 4) right upper lobe with two segments 5) right lower lobe with a sub apical segment. Our study did not reflect this finding. Probably ethnic variations do occur in the anatomy of tracheobronchial tree.

All the 500 bronchoscopies in our case series were performed by a single chest physician thereby obviating any operator dependant error in reporting of the variations. Findings were entered immediately after the procedure in the bronchoscopy register. This was again helpful in reducing the chance of observer variation and error in reporting even though it is a retrospective analysis. The only limitation of our study was that it was a retrospective analysis.

Diagnosing these variations is important. It is useful in intubations, brachytherapy,

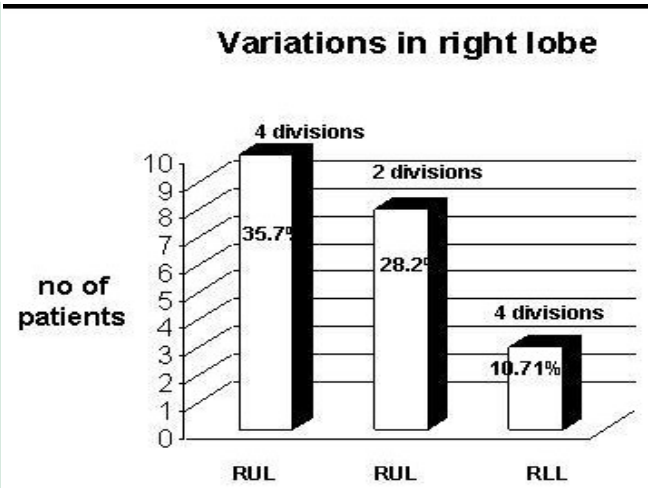

Fig. 3: Variations in right lobe. RUL = Right upper lobe, RLL = Right lower lobe. n= 21 patients

bronchial thermoplasty, postural drainage, lung resection, photodymanic therapy and laser therapy (1). Also, it is observed by some investigators that, an abnormal division in the bronchus can lead to repeated infections due to impaired ventilation and drainage of the affected area (1).

Conclusion

Identifying the variations in tracheobronchial tree anatomy is important for every bronchoscopist. Apart from helping in identifying and treating various pathologies, this will also help in a better understanding and training for the junior colleagues. It is important to emphasize this to all bronchoscopists.

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