

Tracheobronchial Anatomical Variants during Bronchoscopy - An Observational Study

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Abstract: Introduction: A comprehensive knowledge of the normal pattern of endobronchial branching is essential in pulmonology. The classification systems available are predominantly static descriptions and only seldom do they refer to possible variations within normal spectrum. Most of variations are incidental findings during bronchoscopy. Bronchial variations may have important implications in bronchoscopy diagnostic and interventional procedures. Aim of the Study: To describe the frequency of anatomical variations in trachea bronchial tree or tracheobronchial variants (TBV) and analyse their types. Materials and Methodology: A retrospective observational study on patients undergone flexible bronchoscopy irrespective of indication and outcome in SDS TUBERCULOSIS RESEARCH CENTRE AND RAJIV GANDHI INSTITUTE OF CHEST DISEASES from 2021 January to 2022 December. Results and Discussion: Total 342 bronchoscopies were done for various indications, out of which 42 patients (12%) had anatomical variants. Male predominance was observed (69%), bilateral variants were seen in 11% patients and 9% had more than one variant. Over all we found 16 different variants. Right lung was more prone to anatomical variants (77%) and were most frequently found in right upper lobe (64%). Most common variant was bifurcation of right upper lobe followed by quadrivalent variant of right upper lobe. We identified 4 different patterns of bifurcation, one had tracheal bronchus just above carina. Our results were comparable to previous studies. Conclusion: The anatomical variations in trachea bronchial tree were found in 12% of the cases with majority involving right upper lobe. Bifurcation of upper lobe bronchus was the most common variant.

Keywords: Anatomical variants, Tracheobronchial tree, Bronchoscopy, Trifurcation, Bifurcation

1. Introduction

A comprehensive knowledge of the normal pattern of endobronchial branching is essential in pulmonology. The bronchial structure begins at the transverse thoracic plane (T4), where trachea bifurcates into two main bronchi, one for each lung. The main bronchi (primary bronchi) divides into secondary lobar bronchi per each lobe of lung. Right lung has three secondary lobar bronchi and left lung has two secondary lobar bronchi. Following, each lobar bronchi further divides into tertiary segmental bronchi. Each segmental bronchi supply a bronchopulmonary segment. There are ten bronchopulmonary segments in the right lung and eight - nine bronchopulmonary segments in left lung.¹

Jackson and Huber were the first to recognize the importance of systematic classification of trachea - bronchial tree. Infact their classification system presented in 1943 would end up as the basis of other classifications. The classification systems available are predominantly static descriptions and only seldom do they refer to possible variations within normal spectrum.²

The variations are believed to be the result of embryonic disturbances of normal branching pattern, but the aetiology of this phenomenon has never really been understood. Most of variations are incidental findings during bronchoscopy. Bronchial variations may have important implications in bronchoscopic diagnostic and interventional procedures, pulmonary resections and intubations.³

Aim of the study

To describe the frequency of anatomical variations in trachea bronchial tree or tracheobronchial variants (TBV) and analyse their types.

2. Materials and Methodology

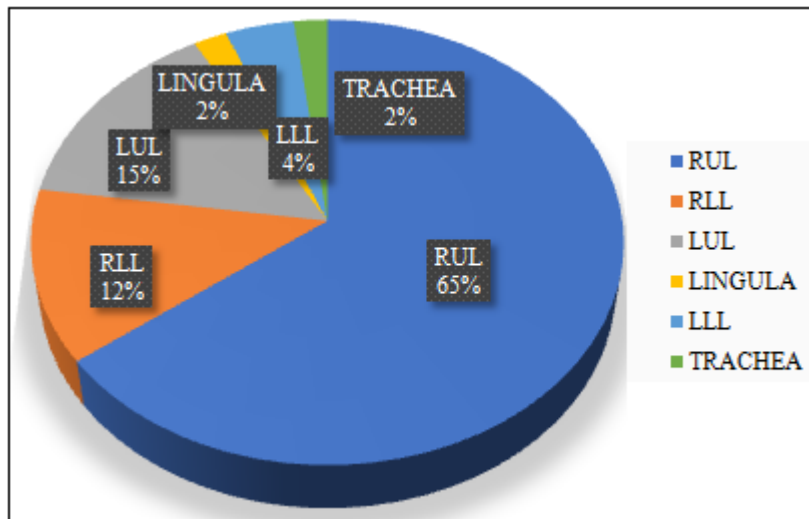
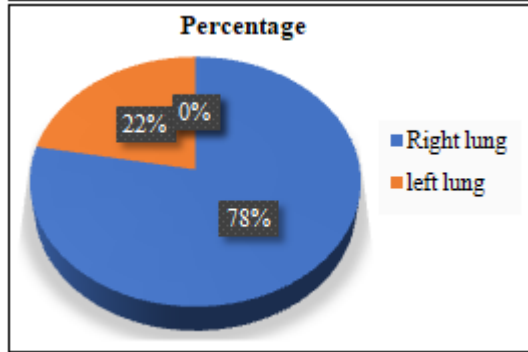
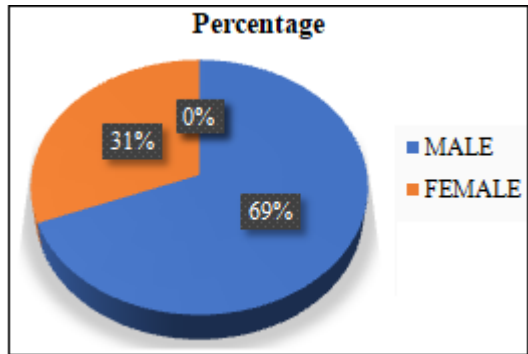
A retrospective observational study was conducted in SDS TUBERCULOSIS RESEARCH CENTRE AND RAJIV GANDHI INSTITUTE OF CHEST DISEASES from January 2021 to December 2022 on patients undergone flexible bronchoscopy irrespective of the indication and outcome. Patients having gross anatomical distortion were excluded from the study. All bronchoscopies were performed by expert pulmonologists using Olympus BF1T - 170.

All bronchoscopies were done under local anesthesia using 10% lignocaine spray, 2% lignocaine nebulization and 1% lignocaine solution for local instillation. Patients were monitored throughout the procedure and observed for 2 hours post procedure for any complications. Lobar and segmental bronchus were visualized and variants were recorded for each.

3. Results

A total of 342 bronchoscopies were done during the study period for various indications, out of which 42 patients (12%) had anatomical variants. Male predominance was observed (69%), bilateral variants were seen in 9.5% patients and 4.7% had more than one variant. Over all we found 16 different variants. Right lung was more prone to anatomical variants (78%) and were most frequently found in right upper lobe (64%). Most common variant was bifurcation of right upper lobe followed by quadrivalent variant of right upper lobe. We identified 4 different patterns of bifurcation, one had tracheal bronchus just above carina. Our results were comparable to previous studies.

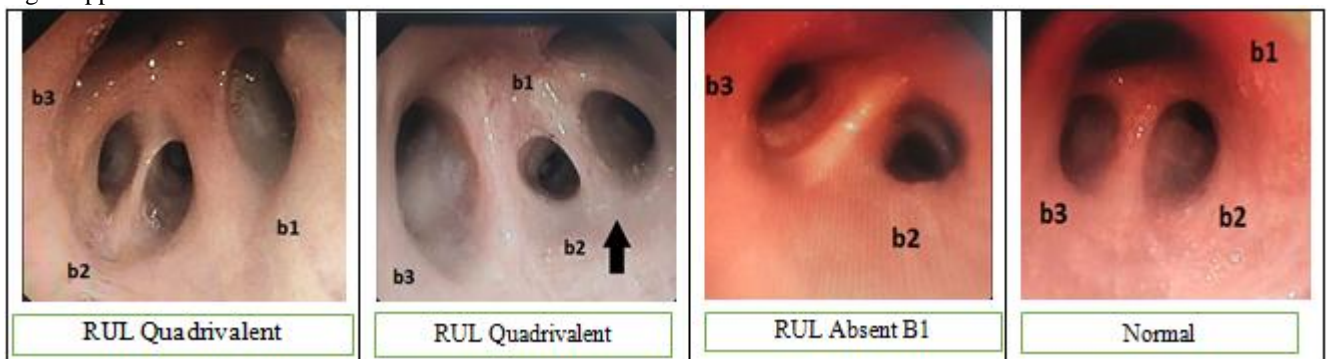
Systemic classification of variants observed and their relative frequencies			
	Number of observations	% of total patients	% of total of variations observed
Right lung	36	85.7	75
Right upper lobe	31	73.8	64.5
Bifurcation b1+2; b3	4	9.5	8.3
Bifurcation b2+3; b1	1	2.3	2.0
Bifurcation b1+3; b2	4	9.5	8.3
Bifurcation b2+b1b, b3+b1a	2	4.7	4.1
Absent b1	7	16.6	14.5
Quadrivalent	13	30.9	27.0
Right middle lobe	0	0	0
Right lower lobe	6	14.2	12.5
B6 2openings	2	4.7	4.1
Sub superior segments	2	4.7	4.1
B6 absent	1	2.3	2.0
B7 absent	1	2.3	2.0
Left lung	9	21.4	18.7
Left upper lobe	7	16.6	14.5
Trifurcation b1+b2+b3	5	11.9	10.4
Quadrivalent	2	4.7	4.1
Lingula 3 openings	1	2.3	2.0
Left lower lobe	2	4.7	4.1
B8 3openings	1	2.3	2.0
B6 and B7 absent	1	2.3	2.0
Tracheal bronchus	1	2.3	2.0
Bilateral variants	4	9.5	8.3
>1 variants in one lung	2	4.7	4.1



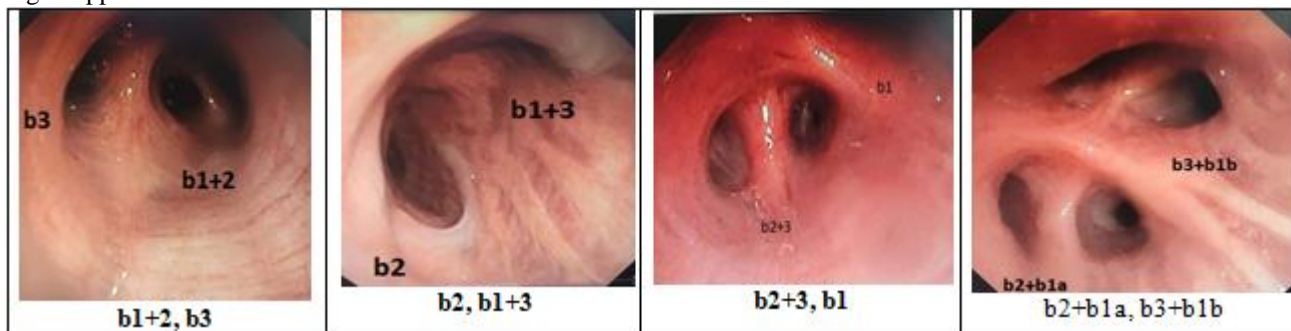
Percentage of variants in different lobes

Images of Variants Observed

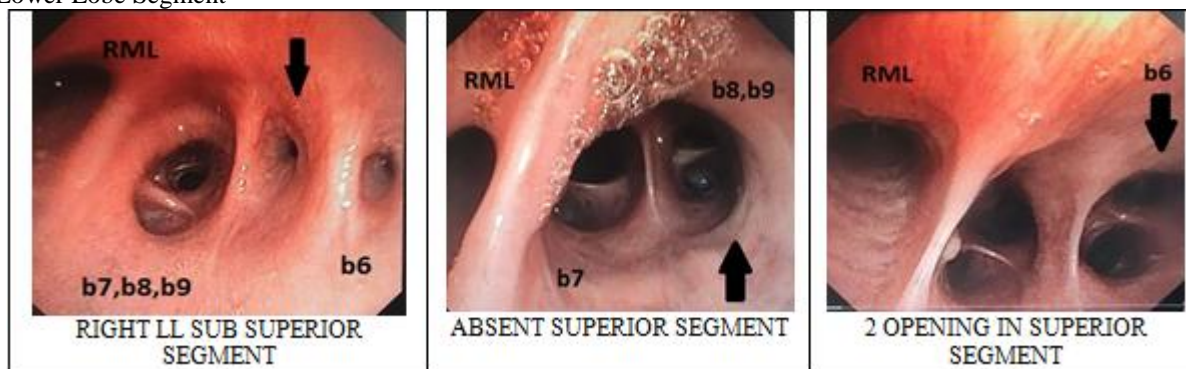
Right Upper Lobe



Right Upper Lobe Bifurcation



Right Lower Lobe Segment



4. Discussion

Tracheobronchial development begins in foetal life, bronchial arborization occurs during the embryonic phase (5 - 7 Week) and pseudoglandular phase (5 - 17 week). Most of these anomalies are either displaced or supernumerary bronchi.

Displaced bronchus is a bronchus with an abnormal origin, when the normal bronchus ventilating the corresponding parenchyma is absent. Supernumerary anomaly is seen in addition to the normal bronchus.⁴

TBVs are often asymptomatic but can present with recurrent pneumonias, haemoptysis and bronchiectasis. These anomalies are related to defects occurring early in foetal life and often are associated with congenital heart diseases, Downs syndrome, VACTERL syndrome and tracheal stenosis.⁵

In a retrospective study done by Abakay A et al in Turkey in 2011, the prevalence of tracheobronchial variants was 4.2%. 68% were males and 32% were females. TBVs were most frequently identified in the Right upper lobe (33%). The most frequent TBV was the upper lobe bifurcation. The second frequent TBV was two segmental bronchi in lower lobe of left lung.³

Another prospective study by Rodrigues L V et al in Portugal in 2011 on 181 patients found TBVs in 43% of patients. Variations were more frequently found within the RUL (16.6%). Middle lobe and lingula presented no variations. The most frequent was bifurcate pattern of RUL.²

Similarly in our study 342 bronchoscopies were done, TBVs were noted in 12% patients. Male predominance was observed (69%) and bilateral variants was seen in 9%. Most frequent variants were seen in RUL (64%). Bifurcation of the upper lobe was the most common variant.

TBVs can be found routinely during bronchoscopy, they are not given much attention. Bronchial variations may have important implications for bronchoscopy both diagnostic and interventions, brachytherapy, pulmonary resections and intubation.

5. Conclusion

The anatomical variations in trachea bronchial tree were found in 12% of the cases with majority involving right upper lobe. Bifurcation of upper lobe bronchus was the most common variant. TBVs have important implications during diagnostic and therapeutic bronchoscopy guided procedures.

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