Bronchial segmentation of right bronchial tree and its variation: A Bronchoscopic Study

Srijana Thapa[1], Binay Thakur[1], Sagar Khatiwada[1], Manoj Tiwari[1], Shachee Bhattarai[1], Ashish Kharel[1], Mahesh Mani Adhikari[1], Sandeep Sapkota[1], Laxmi Shrestha[2], Dipti Poudel[2]

[1]Department of Surgical Oncology. BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal.

[2]Department of Nursing, Endoscopy unit. BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal.

Abstract

Background: Bronchoscopy is of paramount importance in the field of thoracic surgery. Over the years it has evolved as an important diagnostic and therapeutic tool. The aim of our study was to describe the frequency of right sided segmental bronchial variation identified during bronchoscopy.

Methods: A meticulous examination of both right and left bronchial tree was done during bronchoscopy in 60 patients. Indications for bronchoscopy was part of suspected malignancy work up. Segmental as well as the subsegmental bronchi (B1-10) were properly identified. Any accessory bronchus in the tracheobronchial tree was also noted.

Results: Our results show that there are no significant differences in the incidence of variations by sex. The highest recorded variations of 80.8% was found in the right lower lobe followed by right upper lobe with frequency of 40.4%whereas RML had no variation.

Conclusion: Significant segmental bronchial variations do exist in the general population. Bronchoscopy is also an important tool to delineate and confirm the segmental bronchial variations.

Keywords: Bronchoscopy, Segmental bronchial variation, Right bronchial tree

Introduction:

Bronchoscopy has evolved as an essential tool in the medical field especially in thoracic surgery, pulmonology and in the field of anesthesia. With the advent of high resolution video bronchoscopy, diagnostic (Bronchoalveolar lavage, Fine Needle Aspiration Biopsy, Staging of the tumor by endobronchial ultrasound EBUS) as well as therapeutic (Coiling in asthma, emphysema, COPD, laser for tumor ablation, pulmonary toileting postoperative and in trauma) ability has broadened.[1]

The human lung has classically 10 segments on the right and 8-9 segments on the left.[2] Kramer and Glass defined the term "Bronchopulmonary segment" in 1932.[3] In 1943 first study was conducted by Jackson and Huber about the segmental bronchi according to their spatial orientation and established the first nomenclature.[4] Boyden in 1949 then published the most prevalent patterns on the bronchial tree.[5] He reported the frequent pattern of the right bronchial tree as trifurcation in the Right Upper Lobe (RUL) and RLL. He was also the discoverer of the accessory subsuperior bronchus(B*) in the lower lobe. Subsequently, another anomaly: accessory cardiac bronchus was established by Brock in 1954.[6]He also noted that RUL had the highest frequency of displaced

Corresponding Author
Dr Srijana Thapa, FCPS Thoracic Surgery, Dept. of Surgical Oncology (Thoracic Unit), BP Koirala Memorial Cancer Hospital Bharatpur, Nepal. Email: Thsrijana@yahoo.com, Phone: +977 9843343661.

and supernumerary bronchus.

To understand the variations of the right bronchial tree it is necessary to know the normal pattern during the bronchoscopy and the possible variations that we may encounter as well. The other alternative and non-invasive way generally practiced is 3D CT with reconstruction applying some softwares. Ghaye et.al in 2001 to identify abnormalities and variations of the bronchial tree.[7]

The aim of this bronchoscopic study was to determine the frequency of the variation in the right bronchial tree in Nepalese population.

Methods:

Patients:

A prospective study within 6 months, from 2024 september-2025 February was conducted in BPKMCH Surgical Oncology (thoracic unit). Ethical clearance from institutional review committee was taken. All the patients undergoing bronchoscopy for various indications (mostly suspected malignancy, undiagnosed tuberculosis, staging of esophageal/ lung cancer) were included in the study.

Procedure:

A written informed consent was taken from the patient prior to the procedure. Videobronchoscopy was performed in the endoscopy suite. Olympus fiberoptic bronchoscope with 6 mm external diameter was used for the procedure. Monitoring was done by continuous pulse oximetry, electrocardiography and sphygmomanometry. Pre oxygenation was done via face mask with oxygen at 6L/min or nasal cannula to achieve oxygen saturation of >90%.

In supine position local anesthesia was given via transtracheal route or 'spray-as-you-go' technique using 1% lidocaine. In the transtracheal route, 10 ml of 1% lidocaine was taken and 8ml was injected directly into trachea via cricothyroid membrane and remaining 2ml was flushed in bilateral nostrils (1ml each nostrils). 15% lidocaine spray was used to anesthetize oropharynx and laryngopharynx.

Tracheobronchial tree including bronchial segments B1-B10 was examined thoroughly and nomenclature was recorded as per Collin's classification.

Variations recorded:

We aimed to record the data for the variations in the right bronchial tree while performing bronchoscopies for suspicion of carcinoma or during its workup. Table 1. shows the general and the common pattern found in the right bronchial tree. Any pattern other than the one mentioned below was confirmed and photos or video was captured and reviewed among the investigators and recorded as the variation in our data.

Table 1. General pattern of bronchial segmentation seen in the right bronchial tree.

Level	Right Lung
Right Upper Lobe	Trifurcation(B1;B2;B3)
Right Middle Lobe	Bifurcation (B4;B5)
Right Lower Lobe	B6; B7;B8;B9;10

Statistical Analysis: The data was entered into the Statistical Package for the Social Sciences (SPSS-26) for analysis

Fig 1. Right Upper Lobe showing the three segments in trifurcation

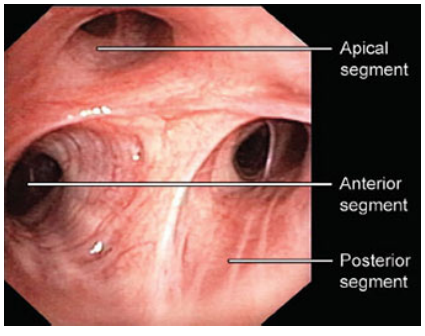
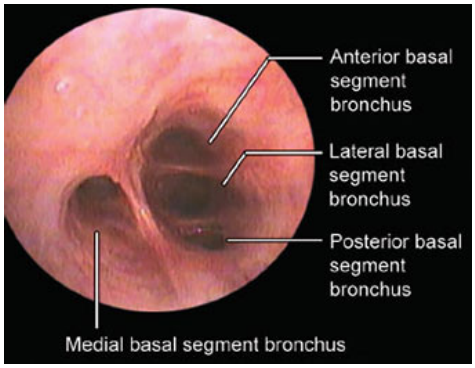


Fig 2. Right Lower Lobe showing the most common pattern in the general population (B6 is not seen)



Results:

A total of 60 patients underwent vidoebronchoscopy. 8 patients had growth in the right bronchial tree so were excluded and only 52 patients were analyzed.

Frequency of variations in the RUL and RLL are mentioned in the table 2 and 3 respectively. In RML (B4;B5) bifurcation pattern was noted and no variation was observed.

Table 2. Frequency of variations of RUL

RULB		
Variations	Frequency	Percent
B1;B2;B3	31	59.6
B1+2;B3	10	19.2
B1+3;B2	5	9.6
B1;B2+3	6	11.5
Total	52	100

Table 3. Frequency of variations of RLL

RLLB		
Variations	Frequency	Percent
B6;B7;B8;B9;B10	10	19.2
B6;B7+8;B9+10	6	11.5
B6;B7;B8;B9+10	12	23.1
B6;B7;B8;B9+10,B*	3	5.8
B6;B7;B8+9;B10	16	30.8
B6;B7;B8+9+10	2	3.8
B6;B7;B8+9,B10,B*	3	5.8
Total	52	100

Similarly, the variations and its frequency noted in the RUL and RLL according to the gender are given below in table 4. and table 5.

Discussion:

The present study represents one of the first prospective studies in the Nepalese population which aims to identify the frequency of normal and possible variations in the right bronchial tree. The prevalence of anatomical variations of bronchial segment are varied in different literature. Similar bronchoscopic study carried out by Kumar et.al, total of 548 patients were included.[8]we aimed to evaluate the type and frequency of tracheobronchial variations (TBVs Highest variations was noted on the right side (81.5%). Due to reasons of the variations being most common on the right side we have conducted our study to check the prevalence of variations on the right bronchial tree.

In the data collected, 51.9% were male and 48.07% female and there was no significant difference noted in incidence of variations by gender. Comparing RUL, RML and RLL, RLL had the highest number of variations whereas the RML had no variation. In a study where autopsy combined with bronchoscopy was done by Silvia martin et.al they observed that most variations were noted in RLL(25.4%) similar to our finding.[9] The RML had bifurcation pattern (i.e. B4;B5) which is the predominant pattern in the general population. However, trifurcation of the middle lobe is also a established variation.[10]

In the RUL, trifurcation (B1;B2;B3) was the most common pattern with frequency of 59.6% followed by B1+2;B3 pattern(19.2%). We did not come across the tracheal bronchus[11] or Accessory Cardiac Bronchus(ACB) during our study. The ACB also called as the supernumerary bronchus arises from the inner wall of Right Main Bronchus (RMB) or Bronchus Intermedius (BI) towards the pericardium.[6]

Table 4. Variation pattern in RUL with gender.

		Male	%	Female	%	Total
RULB	B1;B2;B3	15	28.8	16	30.7	31
	B1+2;B3	7	13.46	3	5.7	10
	B1+3;B2	2	3.8	3	5.7	5
	B1;B2+3	3	5.7	3	5.7	6
Total		27	51.9	25	48.07	52

Table 5. Variation pattern in RLL with gender.

		Male	%	Female	%	Total
RLLB	B6;B7;B8;B9;B10	7	13.46	3	5.7	10
	B6;B7+8;B9+10	3	5.7	3	5.7	6
	B6;B7;B8;B9+10	7	13.46	5	9.6	12
	B6;B7;B8;B9+10;B*	22	42.30	1	1.9	3
	B6;B7;B8+9;B10	7	13.46	9	17.3	16
	B6;B7;B8+9+10	1	1.9	1	1.9	2
	B6,B7,B8+9;B10;B*	0	0	3	5.7	3
Total		27	51.9	25	48.07	52

In the RLLB we came across a total of seven different variations of the segmental bronchi. The most common variation was B6;B7;B8+9;B10 with frequency of 30.8%. Second most common pattern was that of 5 separate segmental bronchi (B6;B7;B8;B9;B10) arising from the basal trunk accounting 19.2% of the total RLLB variation. This is the usual textbook pattern of bronchial segments that we generally study. The subsuperior bronchus or B* is the commonest variation that has been studied so far.[12] It is almost always oriented outwardly and posteriorly and lies between the superior segment (B6) and basal segments (B9+10). A total of 11.6% of the patients were identified with B* of which 5.8% had B* bronchus between B6 and B9+10. Rest of them had B* bronchus associated with B6;B7;B8+9;B10;B*

Conclusion:

Our study showed that the right lower lobe has the highest percentage of variation in the right bronchial tree followed by right upper lobe. Knowing the variations of the bronchial tree is essential as these segments have their own pulmonary arterial and pulmonary vein required when performing segmentectomy.

Limitations: Small sample size and it was a single center study.

References:

1. Shah P. Atlas of Flexible Bronchoscopy [Internet]. 0 ed. CRC Press; 2011 [cited 2025 Mar 17]. Available from: https://www.taylorfrancis.com/books/9781444149500
2. Terminologia-Anatomica-2nd-Ed-2019.pdf [Internet]. [cited 2025 Mar 18]. Available from: https://neuron.mefst.hr/docs/katedre/anatomija/medicina/Terminologia%20anatomica/Terminologia-Anatomica-2nd-Ed-2019.pdf
3. Sealy WC, Connally SR, Dalton ML. Naming the bronchopulmonary segments and the development of pulmonary surgery. Ann Thorac Surg. 1993 Jan;55(1):184–8.
4. Foster-Carter AF. The anatomy of the bronchial tree. Br J Tuberc. 1942 Jan;36(1):19–39.
5. Boyden EA. A Synthesis of the Prevailing Patterns of the Bronchopulmonary Segments in the Light of Their Variations. Dis Chest. 1949 Jun;15(6):657–68.
6. The anatomy of the bronchial tree : with special

reference to the surgery of lung abscess. | The University of Adelaide [Internet]. [cited 2025 Mar 17]. Available from: https://librarysearch.adelaide.edu.au/discovery/fulldisplay/alma9916319101811/61ADELAIDE_INST:UOFA
7. Ghaye B, Szapiro D, Fanchamps JM, Dondelinger RF. Congenital Bronchial Abnormalities Revisited. RadioGraphics. 2001 Jan;21(1):105–19.
8. Beder S, Küpeli E, Karnak D, Kayacan O. Tracheobronchial variations in Turkish population. Clin Anat. 2008 Sep;21(6):531–8.
9. Martín-Ruiz S, Gutiérrez-Collar C, Forcén Vicente De Vera E, Bernabé-Barrios MJ, De Blas CS, Konschake M, et al. The bronchial segmentation and its anatomical variations. A clinical-anatomic and bronchoscopy study. Ann Anat - Anat Anz. 2021 May;235:151677.
10. K. S. Anatomical arrangement of the lobar bronchi, broncho-pulmonary segments and their variations. Int J Res Med Sci. 2016;4928–32.
11. Barat M, Konrad HR. Tracheal bronchus. Am J Otolaryngol. 1987 Mar;8(2):118–22.
12. Zhou D, Gao Y, Wang H, Xin H, Zhao J, Zhu X, et al. Prevalence and anatomical characteristics of subsuperior segment in lung lower lobe. J Thorac Cardiovasc Surg. 2023 Mar;165(3):864-872.e1.