International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(3.3):6901-05. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2019.252

Original Research Article

VARIATIONS IN BRANCHING PATTERN OF SEGMENTAL BRONCHI IN LUNGS USING CONVENTIONAL DISSECTION METHOD

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ABSTRACT

Introduction: The anatomical knowledge of tracheobronchial tree and its variations will be useful in case of many interventional treatments. Hence we undertook the present study to document the variation in branching pattern of segmental bronchi and its clinical implication.

Materials and Methods: The Study was done on 30 right & 30 left formalin fixed adult lungs obtained from the cadavers in the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore. The lung was dissected along the primary bronchi to expose the branching pattern, till the segmental bronchi. Ramification of bronchial tree was observed and photographed.

Results: Regular pattern of B1 to B10 was found to be more on right side (76.6%), Absence of B7 was also more on right side. The pattern B7, B8+9+10(6.6%), was seen only on right side, whereas the patterns, B1+B2,B3, B7+8,B9+10, B7,B8,B9+10 and B7+8, B9,B10 was seen only in the left lungs. Two left lungs exhibited an accessory bronchus after lingual division and three left lungs had three bronchi in lingual division.

Conclusions: The knowledge of anatomical variability of branching pattern will be useful for interventional radiologist, which would help to diagnose or predict many adverse outcomes of chest diseases at earlier stage and surgeons for planning segmental resections or pulmonary lobectomy.

KEY WORDS: Bronchopulmonary segments, Bronchial disease, lobectomy, segmentectomy, resection of lung.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research**
	ICV for 2016 90.30
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2019.252	**Article Information**
	Received: 14 Jun 2019 Accepted: 05 Aug 2019
	Peer Review: 14 Jun 2019 Published (O): 05 Sep 2019
	Revised: None Published (P): 05 Sep 2019

INTRODUCTION

The Trachea or the windpipe through which air enters the lung, is divided into principal bronchus (right and left) which further divides into lobar bronchi, three for right lung (superior, intermediate and inferior) and two for left lung (superior and inferior). Finally, each lung consists of ten bronchopulmonary segements [1]. The branching pattern of tracheobronchial tree of lungs have not received appropriate clinical attention although it serves a major role in respiration until the recent decades. Routine anatomical and morphological evaluations of lungs are restricted for assessment of fissures and lobes. In the extensive review of literature,

we encountered many studies on tracheobronchial tree upto primary bronchi. There is enough information in previous studies about the normal branching pattern of primary bronchi [2-6]. But there is paucity in literatures regarding the branching pattern of segmental bronchi especially using conventional dissection method [7-9].

The preoperative knowledge of tracheobronchial anatomy and its variations will be useful in case of interventional treatments like intubation and other operative procedures like brachytherapy, postural drainage, bronchial thermoplasty, segmental lung resection and laser therapy. Hence we undertook the present study to document the variation in branching pattern of segmental bronchi and its clinical implication.

MATERIALS AND METHODS

The Study was done on 30 right & 30 left formalin fixed adult lungs irrespective of their sex, obtained from the cadavers in the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore. Gross dissection of the thorax was done by following the guidelines of Cunningham's Manual of Practical Anatomy, fifteen editions. Anterior thoracic wall was cut with costotomy and elevated. The lungs were extracted out carefully. Mutilated specimens, with malformation and deformities were excluded.

The lung was dissected along the primary bronchi to expose the branching pattern, till the segmental bronchi. Ramification of bronchial tree was observed and photographed. The segmental bronchi according to lobes were labeled as follows.

Right Upper Lobe (RUL) & Right Middle Lobe (RML): RUL has three segmental bronchi such as apical, posterior and anterior which was labeled as B1, B2 and B3 respectively. RML has two segmental bronchi i.e. lateral and medial which were labeled as B4 and B5 respectively.

Left Upper Lobe (LUL): Five segmental bronchi was renowned in LUL designated as apical (B1), posterior (B2), anterior (B3), Superior lingular (B4) and Inferior lingular (B5).

Right Lower Lobe (RLL) & Left Lower Lobe (LLL): The lower lobe segmental bronchi on both sides are similar and were labeled as follow, superior (B6), medial basal (B7), anterior basal (B8), lateral basal (B9) and Posterior basal (B10).

Accessory segmental bronchi: was represented as Bx.

RESULTS

Table 1 and 2 shows the incidence of variation in the branching pattern of segmental bronchi. Regular pattern of B1 to B10 was found to be more on right side (76.6%) whereas variations were found in 7 lungs which accounts for 23.4%. Out of 7 lungs, the incidence of absence of B7 and the pattern B7, B8+9+10 were observed in 5 lungs (16.7%) and in 2 lungs (6.7%) respectively (Figure 1& 2).

Table 1: The incidence of patterns of segmental bronchi in left upper, right upper and right middle lobes.

Pattern of Segmental bronchi	Right Lungs		Left Lungs	
	No	%	No	%
B1,B2,B3	30	100	28	93.3
B1+B2,B3	--	--	2	6.7
B4, B5 superior & inferior lingular	--	--	25	83.3
B4, B5 medial &lateral	30	100	--	--
An extra bronchus after lingular division	--	--	2	6.7
Three bronchi in the lingular division	--	--	3	10

Table 2: The incidence of patterns of segmental bronchi in right lower and left lower lobes.

Pattern of Segmental bronchi	Right Lungs		Left Lungs	
	No	%	No	%
B6	30	100	30	100
B7 absent	5	16.7	--	--
B7,B8, B9,B10	23	76.6	13	43.3
B7+8, B9+10	--	--	2	6.7
B7,B8, B9+10	--	--	4	13.3
B7+8, B9,B10	--	--	11	36.7
B7, B8+9+10	2	6.7	--	--

Fig. 1: The right lung shows the absence of B7.

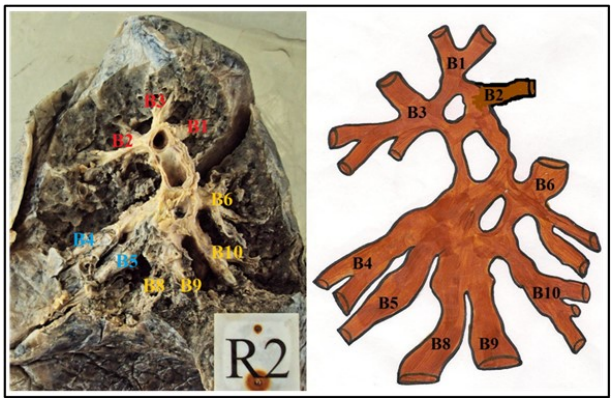
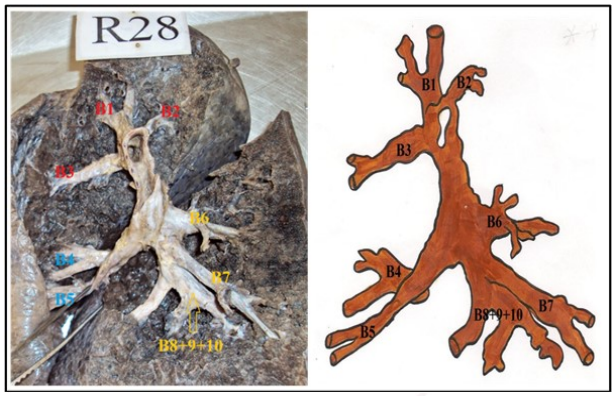


Fig. 2: The right lung shows the B7, B8+9+10.



The incidence of variability in pattern of B1 to B10 was found to be more in left side. In left upper lobe (LUL), the variability of segmental pattern B1+B2, B3 and lingular segmental pattern i.e. B4 and B5 were observed in 2 lungs (6.7%) and in 5 lungs (16.7%) respectively. Out of the 5 lingular segmental patterns, two left lungs (6.7%) exhibited an accessory bronchus after lingular division (Figure 4) and three left lungs (10%) had three bronchi in lingular common trunk (Figure 5).

In case of left lower lobe (LLL), variability in segmental pattern was 17 lungs which accounts for 56.7%. The patterns like i) B7+8,B9+10, ii) B7,B8,B9+10 and iii) B7+8, B9,B10 was observed in 2 (6.7%) , 4 (13.3%) and 11 (36.7%) lungs respectively (Figure 3).

Fig. 3: Shows the variation of branching pattern in left lungs. A) B1+2, B3 pattern B) B7+8, B9+10 pattern C) B7, B8, B9+10 pattern D) B7+8, B9, B10 pattern. A1, B1, C1 & D1 shows the schematic representation.

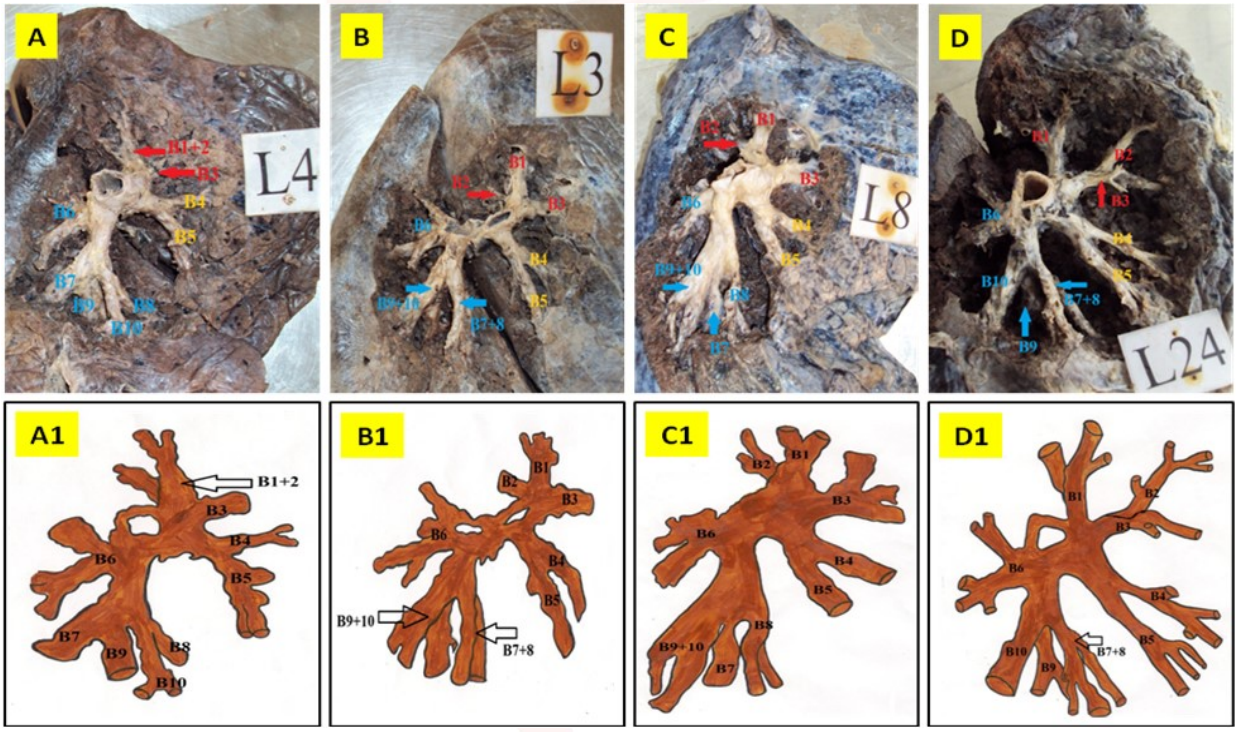


Fig. 4: shows extra bronchus after common lingular trunk (X).

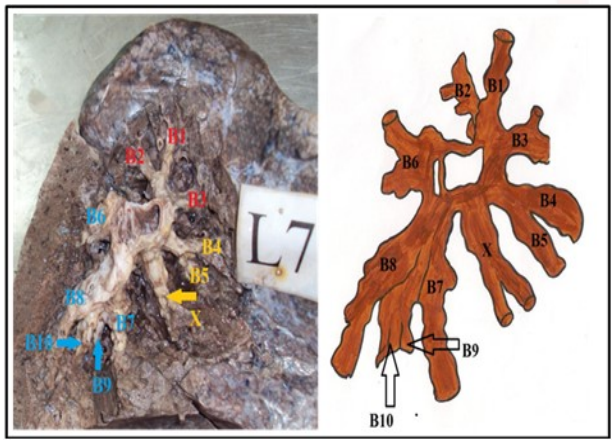
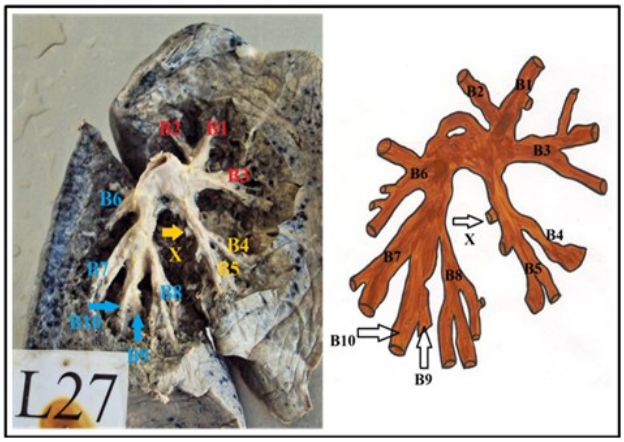


Fig. 5: Shows the three bronchi in lingular trunk (X).



DISCUSSION

Table 3: Shows the incidence of variation in branching pattern of right middle, right and left upper lobes in different authors.

Authors	Right Lung			Left Lung		
	B1,B2,B3	B1,B2,B3, X	B4 and B5 Medial , Lateral	B1,B2,B3	B1+2,B3	B4 and B5 Superior, Inferior Lingular
Boyden & Scannell (1948) [8]	46%	14%	100%	-	-	-
Ghaye (2001) [10]	30%	-	23%	83%	17%	100%
Cenk Kilic (2010) [9]	86.70%	13.33%	6.70%	40%	60%	60%
Present Study (2019)	100%	-	100%	93.30%	6.70%	83.30%

Several studies in the review of literature have documented the morphology of lungs especially lobes and fissures. Many authors reported the normal as well as abnormal branching pattern of primary bronchi [2-6]. Very few studies using radiological or luminal casting methods have reported and focused on variability of branching pattern of segmental bronchi [7-9]. This is therefore the first proper conventional dissection methods without any dye or cast injection.

Right Middle, Right and Left Upper Lobes: Our data on right upper and middle lobe, the branching pattern of segmental bronchi slightly differed from previous data. In the present study, the normal pattern of B1, B2, B3 and B4, B5 was found to be in 100%. But on the contrary, Boyden et al and Cenk Kilic et al had reported the abnormal branching pattern in right upper lobe with the incidence of 14% and 13.33% respectively [8,9]. The lowest incidence of normal pattern of B1, B2, B3 in the right upper lobe was documented by Ghaye et al which accounts for 30% [10] and similarly, the lowest incidence of normal pattern of B4, B5 in right middle lobe was observed by Cenk Kilic et al which accounts for 6.7% [9].

In the present study, the incidence of normal pattern of B1, B2, B3 was found to be the highest (93.3) in left upper lobe followed by Cenk Kilic et al and Ghaye et al which accounts for 40% and 83% respectively [9,10]. We also found the incidence of an accessory bronchus in relation to common lingular trunk. An accessory bronchus may arise either separately as extra bronchus or as additional branch in the common lingular trunk. We acknowledged an extra bronchus in two lungs (6.7%) which exhibited as an accessory bronchus after lingular division andfound the common lingular trunk exhibiting three divisions in three lungs (10%). Comparison of incidence of accessory bronchi in relation to common lingular trunk with Cenk Kilic was described in table 4.

Table 4: Shows the incidence of accessory bronchi in relation to common lingular trunk in different authors.

Authors	B4 and B5 lingular bronchi	
	An extra bronchus	Three bronchi
Cenk Kilic (2010) [9]	13.33%	46.70%
Present Study (2019)	6.70%	10%

Right and Left Lower Lobes: Pattern variability was more in lower lobes than upper and middle lobes. Authors like Smith et al [11] and Ferry et al [12] conducted their study only on right lower lobe and Berg et al [13] conducted on left lower lobe only, whereas Cenk kilik et al [9], Ghaye et al [10], and Naidich et al [14] conducted studies on both right and left lower lobe (table 5).

Table 5: The incidence of variation in branching pattern of left and right lower lobes in different authors.

Authors	B7 absent		B7, B8, B9, B10		B7+8, B9+10		B7, B8, B9+10		B7+8, B9,B10		B7, B8+9+10	
	R	L	R	L	R	L	R	L	R	L	R	L
Berg (1949) [13]	-	3%	-	0%	-	67%	-	0%	-	13%	-	-
Smith & Boyden (1949) [11]	14%	-	-	-	-	-	-	-	-	-	-	-
Ferry & Boyden (1951) [12]	20%	-	-	-	-	-	-	-	-	-	-	-
Naidich (1999) [14]	-	<5%	15%	35%	-	45%	60%	-	-	15%	-	-
Ghaye (2001) [10]	10%	-	6%	0%	3%	76%	68%			10%	10%	-
Cenk Kilic (2010) [9]	13.33%	6.70%	20%	0%	6.70%	53.33%	53.33%	-		26.66%	6.70%	-
Present Study (2019)	16.70%	0%	76.60%	43.30%	0%	6.70%	0%	13.30%	0%	36.70%	6.70%	0%

Limitation of study is that our study was confined only to the variability to branching pattern of segmental bronchi B1 to B10. The present study can be correlated with other methods like luminal casting and tracheobronchial imaging. The knowledge of anatomical variability of branching pattern is important for the radiologist and surgeons for planning segmental resections or pulmonary lobectomy.

CONCLUSION

In the present study, irregular pattern was found to be more on left side. The patterns like B1+B2,B3(6.7%), B7+8,B9+10(6.7%), B7, B8, B9+10 (13.3%) and B7+8, B9,B10(36.7%) was seen only in the left lungs, whereas the pattern B7, B8+9+10(6.7%), was seen only on right side. The incidence of absence of B7 pattern was found only on right side (16.7%). We acknowledge and conclude form previous as well as present study, that branching pattern of tracheobronchial tree is not constant and knowledge of variability is useful for interventional radiologist and cardiothoracic surgeons. With the advancement of imaging technology, it is now possible to study the normal tracheobronchial anatomy and its variant, which helps to diagnose or predict many adverse outcomes of chest diseases at earlier stage.

Conflicts of Interests: None

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How to cite this article:

Umesh. S.N, Khizer Hussain Afroze. M, Sangeeta. M. VARIATIONS IN BRANCHING PATTERN OF SEGMENTAL BRONCHI IN LUNGS USING CONVENTIONAL DISSECTION METHOD. Int J Anat Res 2019;7(3.3):6901-6905. **DOI:** 10.16965/ijar.2019.252