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An Assessment of the Tracheobronchial Branching Anomalies in 1000 Adult Patients: A Computed Tomography-based Population Study

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ABSTRACT

Objective: The tracheobronchial tree has several anatomical variants, many of which are asymptomatic and are not identified until adulthood. This study demonstrated tracheobronchial branching anomalies in adult patients using chest computed tomography (CT).

Methods: Thorax CT examinations of 1000 adult patients were retrospectively evaluated. Frequencies, localizations, and types of the tracheal diverticulum, tracheal bronchus, accessory cardiac bronchus, upper lobes, and right middle lobe branching anomalies, sub superior and supra superior bronchus, right and left isomerism, and situs inversus and bridging bronchus were evaluated.

Results: Tracheobronchial branching anomalies were detected in 102 of 1000 patients (491 females, 509 males). An isolated anomaly was observed in 92 patients, whereas five patients had two separate anomalies. Preeparterial bronchi in 8 patients, left prehyparterial bronchi in 2 patients, right suprasuperior bronchi in 9 patients, right subsuperior bronchi in 33 patients, left subsuperior bronchi in 38 patients, and accessory cardiac bronchi in 7 patients were observed. A single right tracheal bronchus, posteparterial bronchus, right tracheal diverticulum, upwardly displaced middle lobe bronchus, and situs inverse were observed. Of the detected congenital tracheal bronchial anomalies, 11 were displaced and 82 were supernumerary.

Conclusion: Radiological assessment of branching anomalies is crucial because of their potential clinical consequences. CT is a successful imaging method in the evaluation of tracheobronchial branching anomalies. Using lobe-based classification will facilitate the detection and classification of these anomalies.

Keywords: Tracheobronchial branching, tracheobronchial tree, branching anomalies, chest CT

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INTRODUCTION

Several congenital variations in the number, length, diameter, and placement of the bronchi have been reported previously. Data regarding tracheobronchial branching anomalies are mostly based on bronchoscopy, bronchography, and cadaver studies. A limited number of studies have been conducted to identify tracheobronchial branching abnormalities assessed by chest computed tomography (CT). The prevalence of tracheobronchial anomalies in the general adult population is reported to be 0.1-12% (1,2). The majority of these abnormalities were discussed without CT guidance (1), and further anomalies have subsequently been identified (3,4).

The preferred screening technique for examining congenital tracheobronchial tree anomalies is CT. It often enables a thorough and accurate assessment of abnormal tracheobronchial structures and any accompanying abnormalities. Routine chest CT may detect all congenital branching defects affecting the trachea, major bronchi, and intermediate bronchus; however, they are usually overlooked in typical CT scans. Adequate knowledge of the CT features of the primary congenital bronchial abnormalities and comprehensive visibility of the tracheobronchial tree can help detect further incidental anomalies. Thus, the increasing use of CT for the analysis of congenital anomalies of tracheobronchial branching patterns has improved the determination of these anomalies (5,6).

The bronchial tree, with its intricate network of airways, plays a pivotal role in maintaining respiratory homeostasis. Any structural abnormalities can significantly impact respiratory physiology, leading to complications that vary in severity in affected individuals. Understanding the mechanisms underlying these complications is crucial for optimizing patient management and improving outcomes. There are some risks associated with the tracheal bronchus. These risks include respiratory failure resulting from inadvertent intubation of the tracheal bronchus and lobar or segmental atelectasis caused by luminal tube occlusion. Accidental intubation into the tracheal bronchus is far more dangerous than occlusion of the lumen of the tracheal bronchus, as this can lead to inadequate ventilation of most of the respiratory system (7,8). Knowledge of the distance between the tracheal bronchus and the carina, the diameter of the tracheal bronchus, and the angle between the tracheal bronchus and the trachea are important factors for anesthesiologists to avoid complications of intubation (2). Additionally, the tracheal bronchus may be the cause of stridor, atelectasis, recurrent infections, and bronchiectasis due to the stenosis and retained secretions (9). Although the accessory cardiac bronchus (ACB) rarely causes symptoms, this blind-ending airway could act as a potential reservoir for pathogenic materials. Clinical symptoms in these cases are believed to be related to retained secretions causing inflammation, hypervascularity, and hemoptysis (10). Several hospitals routinely perform video-assisted thoracoscopic surgery (VATS) for lung cancer patients. However, the left eparterial bronchus may make VATS procedures challenging, and lower lobectomy may cause damage to the bronchovascular system. Consequently, the risk of harm to the left eparterial bronchus increases if its presence is unknown during surgery (11). In addition to the risk of injury mentioned above, obstructive emphysema has been reported in one patient with left eparterial bronchus because of close contact between the left pulmonary artery and eparterial bronchus (12).

Given that routine chest CT is not specifically examined for branching patterns, this study aimed to determine the frequency and types of tracheobronchial branching anomalies in Turkish adult patients who underwent thoracic CT for any clinical indication.

METHODS

Adult patients who underwent chest CT examinations from July 2020 to November 2020 were included in this retrospective study. Patients whose tracheobronchial branching pattern could not be evaluated because of consolidation, atelectasis, endobronchial pathologies, motion, respiratory artifacts, or surgical procedures were excluded. This study was approved by the local ethics committee.

Chest CT examinations were performed on multislice CT scanners (Aquilion, Toshiba Medical Systems Europe, Zoetermeer, The Netherlands and GE Revolution EVO, GE Medical Systems, Milwaukee, WI, USA). All examinations were performed in the supine position during deep inspiration covering the area from the thoracic inlet to the diaphragm. CT scanning parameters were as follows: rotation time, 0.5-0.6 s; 120 kV; 50-500 mA; slice thickness, 1.25 mm; section interval, 1.25 mm; pitch, 1.375-1.388.

All images were evaluated on a workstation (GE Advantage Workstation, General Electric Medical Systems, Milwaukee, Wisconsin) by two radiologists (with 3 and 8 years of experience respectively) who were in consensus. The tracheobronchial branching pattern was evaluated on axial, coronal, and sagittal images at the lung parenchyma window (window width 1500 HU, level -600 HU), minimum intensity projection (MinIP), three-dimensional, and curved multiplanar reconstruction images. Boyden's nomenclature and a lobe-based classification scheme proposed by Chassagnon et al. (3) were used to describe segmental bronchial anatomy and tracheobronchial branching anomalies. Branching anomalies were classified as displaced or supernumerary (1,3). The term displaced bronchus was used to describe a bronchus with an abnormal origin when the normal bronchus was absent. The term supernumerary describes an abnormal bronchus that coexists with the normal corresponding bronchus (2).

The following anomalies were evaluated:

1. Tracheal diverticulum and tracheal bronchus,

2. ACB and its subtypes (blind ending, ventilated lobulus, soft tissue mass, cystic degeneration),

3. Branching anomalies of the bilateral upper and right middle lobes,

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4. Subsuperior and suprasuperior bronchi in the lower lobes,
5. Right isomerism, left isomerism, and situs inversus,
6. Bridging bronchus.

Ethics Approval

This study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Scientific Research Ethics Committee of Karadeniz Technical University Faculty of Medicine (no: 24237859-44, date: 11.01.2021).

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (Inc. Chicago, USA). Frequencies and percentages were used for categorical variables. Mean ± standard deviation and minimum and maximum values were used for continuous variables. Frequencies of anomalies in male and female subjects were compared using the chi-square test. A p-value of 0.05 was considered statistically significant.

RESULTS

One thousand adult patients were retrospectively evaluated in this study. Of these patients, 509 were male and 491 were female. The mean age of the patients was 55±17.5 years (range 18-99 years). A total of 102 tracheobronchial branching anomalies were found in 97 patients (Table 1). Five patients had two anomalies: a right tracheal bronchus and a left subsuperior bronchus in one patient, bilateral subsuperior bronchi in one patient, a prearterial bronchus and a right subsuperior bronchus in one patient, and a right suprasuperior bronchus and a left subsuperior bronchus in two patients. Forty-four female and 53 male patients had tracheobronchial branching anomalies. There was no statistically significant difference between male and female patients in terms of the frequency of tracheobronchial branching anomalies (p=0.223).

One male patient had a right tracheal bronchus, which was a supernumerary apical bronchus (Figure 1). One female patient had a tracheal diverticulum localized on the right posterolateral side of the proximal trachea.

Preeparterial bronchus was found in 8 patients (4 females and 4 males). They ventilated the apical segment partially or totally. In 7 patients, the apical bronchi were displaced (Figure 2), whereas a supernumerary apical segment bronchus was found in one patient. A posteparterial bronchus was detected in one male patient. It was displaced anterior (B2) segment bronchus stemming from the middle lobe bronchus (MLB) (Figure 3). The left prehyparterial bronchus was observed in 2 male patients (Figure 4). One of them was a supernumerary B1+3 bronchus and the other was a displaced B1+3 bronchus. Both ventilated the apicoposterior segments.

The right supernumerary suprasuperior bronchus was observed in 9 patients (5 females and 4 males) (Figure 5). The most common

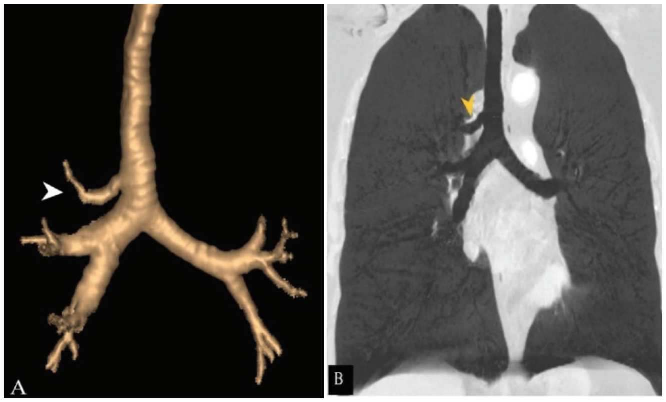

Figure 1. A 65-year-old male patient, A) 3D reformatted and B) coronal MinIP images show the right tracheal bronchus (arrowhead), which is the supernumerary apical bronchus

Table 1. The distribution of the congenital tracheobronchial anomalies

	All patients		Female patients		Male patients	
Tracheobronchial anomaly	**Number**	**%**	**Number**	**%**	**Number**	**%**
Right tracheal bronchus	1	0.1	-	-	1	0.2
Preeparterial bronchus	8	0.8	4	0.8	4	0.8
Posteparterial bronchus	1	0.1	-	-	1	0.2
Left prehyparterial bronchus	2	0.2	-	-	2	0.4
Right suprasuperior bronchus	9	0.9	5	1	4	0.8
Right subsuperior bronchus	33	3.3	16	3.2	17	3.3
Left subsuperior bronchus	38	3.8	14	2.8	24	4.7
Accessory cardiac bronchus	7	0.7	3	0.6	4	0.8
Right tracheal diverticulum	1	0.1	1	0.2	-	-
Gross upward displacement of the MLB	1	0.1	-	-	1	0.2
Situs inversus anomaly	1	0.1	1	0.2	-	-
Total	**102**	**10.2**	**44**	**8.9**	**58**	**11.4**

MLB: middle lobe bronchus

tracheobronchial branching anomaly detected in this study was the subsuperior bronchus. The right subsuperior bronchus was found in 33 patients (16 females and 17 males). One was displaced bronchus, and the others were identified as supernumerary bronchi (Figure 6). The left subsuperior bronchus was detected in 38 patients (14 females and 24 males), and all were supernumerary bronchi.

ACB was found in 7 patients (3 females and 4 males). Five of them originated from the bronchus intermedius (Figure 7) and two from the left main bronchus. All anomalies were blind-ending subtypes and were not associated with ventilated or rudimentary lung tissue. Situs versus was detected in one female patient. The right MLB was displaced from its normal location to the superior in one male patient. The MLB originated just inferior to the right upper lobe bronchus (RULB) orifice (Figure 8).

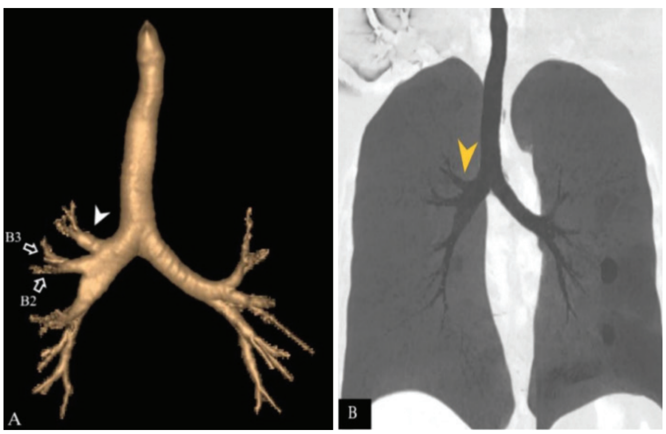

Figure 2. A 51-year-old female patient, A) 3D reformatted and B) coronal MinIP images show the preeparterial bronchus (arrowhead). The anterior (B2) and posterior (B3) segment bronchi originate from the right upper lobe bronchus, while the apical segment bronchus (arrowhead) arises from the right main bronchus separately

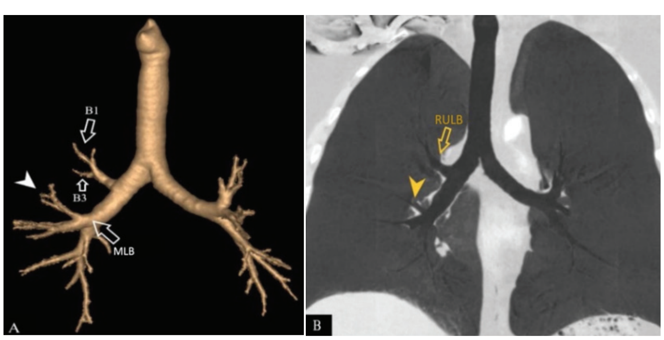

Figure 3. A 46-year-old male patient, A) 3D reformatted and B) coronal MinIP images show a posteparterial bronchus (arrowhead). The apical (B1) and posterior (B3) segment bronchus originates from the RULB, while the displaced anterior (B2) segment bronchus originates from the MLB as a posteparterial bronchus

MLB: middle lobe bronchus, RULB: right upper lobe bronchus

In total, 11 branching anomalies were displaced, and 82 were supernumerary. The segments most frequently ventilated by the abnormal bronchi completely or partially were the superior segments of the lower lobes (Table 2).

DISCUSSION

The prevalence of tracheobronchial branching anomaly was found to be 10.2% in our study, which is similar to others in the literature. Most of these anomalies are asymptomatic and are detected incidentally. Although anomalies such as situs versus and tracheal bronchus can be easily recognized on thoracic CT, other tracheobronchial branching anomalies are often overlooked (5,6,13).

Kurt et al. (14) reported a prevalence of tracheal diverticulum of 2.38%. They found that 97.1% of the diverticula were right posterolateral (14). Similar retrospective CT studies stated the prevalence of paratracheal air cysts as 3.7-6.5%. According to their

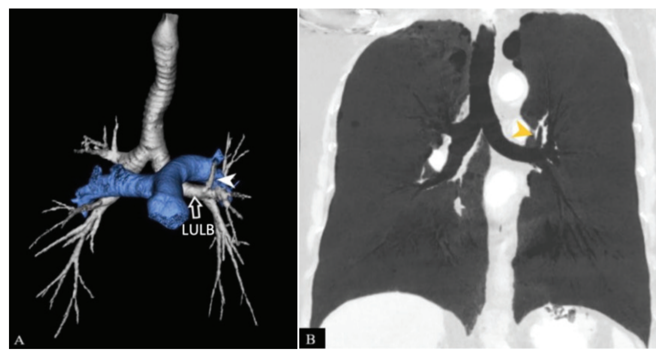

Figure 4. A 76-year-old male patient, A) 3D reformatted and B) coronal MinIP images show a left prehyparterial bronchus (arrowhead). It arises between the LULB and the level where the left pulmonary artery crosses the left main bronchus

LULB: left upper lobe bronchus

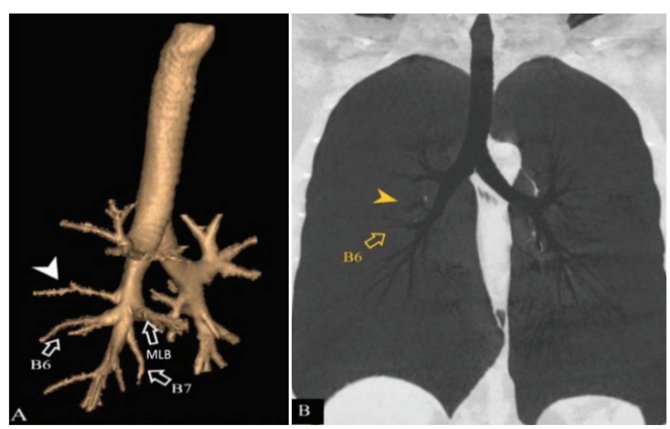

Figure 5. A 30-year-old female patient, A) 3D reformatted and B) coronal MinIP images show a supernumerary right suprasuperior bronchus (arrowhead). The normal superior bronchus (B6) originates from the lower lobar bronchus at the level of the MLB origin

MLB: middle lobe bronchus

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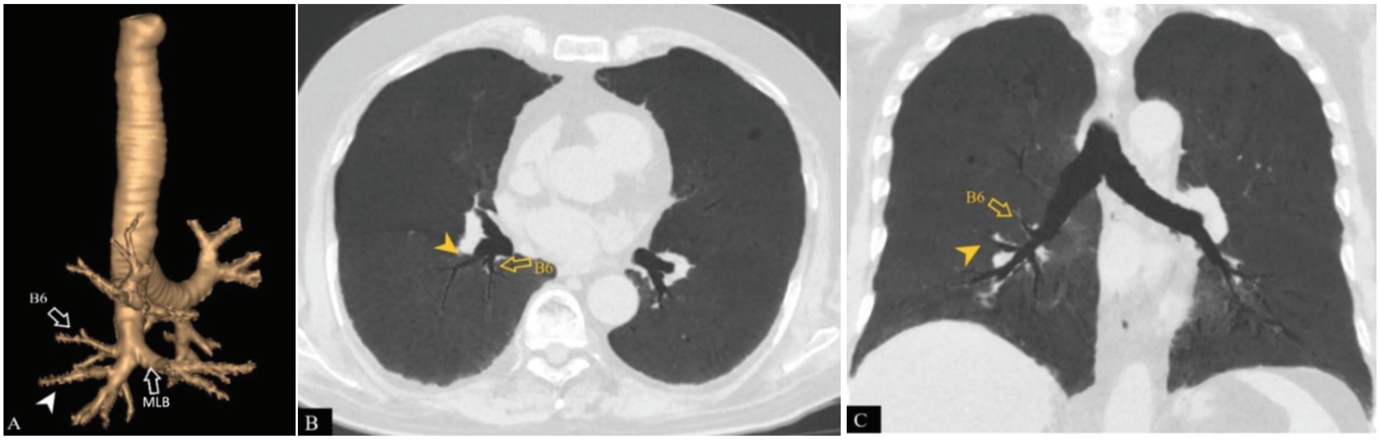

Figure 6. A 71-year-old female patient, A) 3D reformatted, B) axial MinIP and C) coronal MinIP images show a supernumerary right subsuperior bronchus (arrowhead). The right superior bronchus (B6) originates from the lower lober bronchus at the level of MLB origin
MLB: middle lobe bronchus

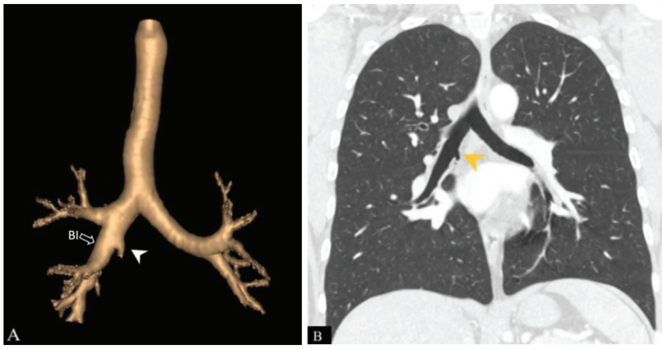

Figure 7. A 35-year-old male patient, A) 3D reformatted, B) coronal reformatted images show a blind-ending type ACB (arrowhead) originating from the bronchus intermedius (BI)
ACB: accessory cardiac bronchus

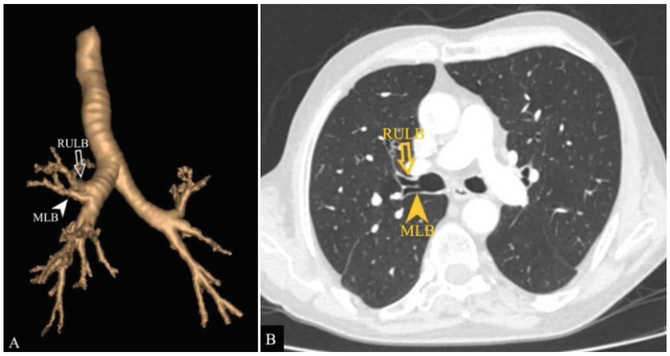

Figure 8. 74-year-old male patient, A) 3D reformatted B) axial thorax CT images shows MLB originating just inferior of the RULB
MLB: middle lobe bronchus, RULB: right upper lobe bronchus, CT: computed tomography

results, the tracheal diverticulum was detected more frequently in women and almost all of these anomalies were located on the right (15,16). However, no congenital acquired distinction

Table 2. The distribution of the segments ventilated by the abnormal bronchi

Ventilated segments	Number of patients	Percentage (%)
Right upper lobe apical segment	9	0.9
Right upper lobe anterior segment	1	0.1
Right middle lobe medial segment	1	0.1
Right lower lobe superior segment	42	4.2
Left upper lobe apicoposterior segment	2	02
Left lower lobe superior segment	38	3.8
Total	**93**	**9.3**

was made for tracheal diverticulum, and most of the cases considered as tracheal diverticula were acquired in these studies. In our study, we did not include acquired paratracheal air cysts as tracheobronchial branching anomalies. Therefore, the prevalence of congenital tracheal diverticulum (0.1%) was lower than that in previous studies.

The prevalence of the tracheal bronchus has been reported as 0.1-2% in several studies (2,17-20). McLaughlin et al. (17) evaluated children who underwent bronchoscopy for respiratory symptoms, and the prevalence of the tracheal bronchus was stated as 2%. The retrospective study of Akoglu et al. (20) found the prevalence of tracheal bronchus to be 0.2% in the bronchoscopy assessment of 6732 cases. Fifteen of 16 cases were on the right side (20). Ruchonnet-Metrailler et al. (19) examined bronchoscopy data of 5970 children with respiratory symptoms and found 57 cases of tracheal bronchus (0.9%). The bronchoscopy data of 1000 children evaluated by Doolittle and Mair (2) showed that the prevalence was 0.5%. Displaced B1 tracheal bronchus was detected in 1 (0.42%) of 238 patients who underwent CT by Wang et al. (18). The prevalence of tracheal bronchus was 0.1% in our study. This was similar to the study of Akoglu et al. (20), but lower than the other studies. Studies by Ruchonnet-Metrailler et al. (19) and Doolittle

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and Mair (2) are based on data from symptomatic pediatric patients. This may be the reason for the higher prevalence of tracheal bronchus in these studies. Because Doolittle and Mair (2) specified tracheal diverticulum as a subtype of tracheal bronchus, this can be considered another reason for the high prevalence (18,19).

Previously, the tracheal bronchus is mostly associated with the apical segment, which is more common on the right side and in males. The tracheal bronchus detected in our study was located on the right side of the distal trachea and was associated with the apical segment in one male patient. Our results were in accordance with the findings in previous studies in terms of its side and location. However, it was supernumerary bronchus, not a displaced one, which is more common in the literature (6,21).

Our study revealed preeparterial bronchus associated with apical segments in 8 patients (0.8%), and seven of them had displaced bronchi, in line with previous data. The prevalences of preeparterial and tracheal bronchus were found to be 0.9% and 0.4%, respectively, by Atwell (5) in 1200 bronchograms. Ulusoy et al. (22) detected a displaced type of pre-eparterial bronchus in two (0.5%) of 400 patients who underwent CT. In another study by Ghaye et al. (23), 25 preeparterial bronchi were reported, 20 displaced, and 5 supernumerary bronchi.

Studies investigating the posteparterial bronchus anomaly are limited. The right posteparterial bronchus originating from the bronchus intermedius was found in one case (0.04%) of 2773 bronchoscopy reports (24). Ghaye et al. (23) reported displaced posteparterial bronchus in two cases (0.01%). One arose from the bronchus intermedius and the other from the right lower lobe bronchus (23). We detected posteparterial bronchus in one patient (0.1%). It was displaced B2 bronchus originating from the MLB.

Despite the relatively high prevalence in anatomical and bronchographic studies, the number of cases of left eparterial bronchus detected by CT is low. This may suggest that this anomaly is overlooked in CT. The left eparterial and prehyparterial bronchus were grouped under the title of displaced left ULB by Oshiro et al. (11). They found accessory fissures in seven of the ten cases. In this study, 8 of 10 displaced left superior bronchus cases diagnosed during surgery were seen in retrospective CT evaluation (9,22).

Ghaye et al. (23) reported 5 cases of eparterial bronchus and 3 cases of prehyparterial bronchus. All of the eparterial bronchi were displaced, whereas the prehyparterial bronchus was supernumerary. An accessory fissure was observed in two of the three prehyparterial bronchus cases in their study (23). In our study, two patients had prehyparterial bronchus. One was a supernumerary subtype, and the other was a displaced subtype. Both were associated with the apicoposterior segment. The prevalence of left eparterial bronchus has been reported to be 1% in anatomical studies and 0.3-0.5% in bronchographic studies (11,23,25). However, we did not detect any left eparterial bronchi.

Upward-displaced MLB is a very rare anomaly. The appearance may be confused with left isomerism, but the RULB is eparterial in this anomaly. Chassagnon et al. (3) found upward displaced MLB in two cases of congenital heart disease. We observed an upward displacement of MLB in one male patient. Its origin was inferior to the ULB.

Anomalies involving the lower lobes are the suprasuperior and subsuperior bronchi, which are associated with the superior segment. Boyden reported 6 cases of displaced suprasuperior bronchus (1). Sabri et al. (26) reported a suprasuperior bronchus in 3 (6%) of 50 patients who underwent thoracic CT for various reasons. We found 9 right suprasuperior bronchi (0.9%). All of them were supernumerary. Two of the cases had both the right suprasuperior and left subsuperior bronchus. No suprasuperior bronchus was detected on the left side.

Ghaye et al. (23) observed subsuperior bronchus at a rate of 56% on the right and 26% on the left. The rate of subsuperior bronchus was found to be 19.4% in 67 cases by Martín-Ruiz et al. (27) 16.4% of them were on the right side. Nagashima et al. (28) reported the prevalence of subsuperior bronchus as 20.4% by assessing 270 CT examinations. We found the right subsuperior bronchus in 33 cases and the left subsuperior bronchus in 38 cases. According to our results, the prevalence of subsuperior bronchus (7.1%) was lower than that in the above-mentioned studies. This conflicting result may be explained by the identification differences in the subsuperior bronchi. In our study, we only defined the bronchi that ventilate the superior segments of the lower lobes as subsuperior bronchi. However, the bronchi originating from the inferior of the superior bronchus origin and ventilating basal segments were also accepted as subsuperior bronchi in other studies.

The ACB is the only bronchus originating from the medial wall of the main bronchus or bronchus intermedius. Ghaye et al. (23) reported the prevalence of ACB as 0.08%. The accessory bronchus was blind-ended in ten cases and the parenchyma was ventilated in four cases (23). Akoglu et al. (20) retrospectively evaluated 6732 bronchoscopy cases and found ACB in 4 cases. The prevalence of ACB was found to be 0.2% in CT examinations of 5790 patients by Unlu et al. (29). The anomalies were detected in seven male and five female patients, all of whom originated from the bronchus intermedius. Blind-ending diverticulum was detected in six patients, whereas fusiform ACB and multi cystic appearance of rudimentary lung tissue were observed in three patients. Lobules ventilated by ACB were detected in three cases (29). ACB was found in two of 400 CT examinations by Ulusoy et al. (22) and those that ended blindly. The prevalence of ACB was 0.7% in our study. This was similar to the prevalence reported by Ulusoy et al. (22) and higher than that reported in other studies. Five of the ACBs originated from the bronchus intermedius, which is consistent with the literature, and two of them originated from the left main bronchus. All of them ended blindly. Cases missed during bronchoscopy and diagnosed with CT were also reported (30). This may explain the lower incidence of anomalies observed in bronchoscopic studies.

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Situs inverse is a rare anomaly and is seen in 0.0005-0.01% of the general population (31). Situs inversus was found in one patient in our study. There was no accompanying congenital heart disease. Bronchiectasis was observed in the lower lobes, consistent with primary ciliary dyskinesia.

Situs ambiguous (or heterotaxy) and bridging bronchus are both rare anomalies and have been frequently reported as case reports in the literature. Situs ambiguous includes abnormalities in the arrangement of the cardiac atria, lungs, liver, stomach, and spleen that cannot be categorized as situs solitus or situs inversus. The most reliable CT marker of the bronchial situs is the relationship of the ULB with the ipsilateral pulmonary artery (32). Bridging bronchus is the most common tracheobronchial malformation (78%) in patients with pulmonary artery sling (33). We did not detect bridging bronchus or ambiguous situs in our study.

Study Limitations

Our study has some limitations. First, the study design was retrospective. Two radiologists evaluated the CT images by reaching a consensus. Inter-reader agreement was not analyzed. A larger sample may be required to detect extremely rare anomalies such as bridging bronchus. Finally, the detected anomalies were not confirmed by bronchoscopy or histopathology. Strengths of our study include the following: radiologists experienced in chest CT and CT bronchography performed the assessments, a larger sample size than previous CT-based Turkish population studies, a wide spectrum of tracheobronchial branching anomalies was screened, and a uniform nomenclature was used as a guideline to identify anomalies.

Our results indicate that subsuperior and suprasuperior bronchi constitute the majority of the bronchial tree developmental anomalies. Detection of such tracheobronchial branching anomalies by a radiologist is important because it may have clinical consequences if overlooked. Knowing these tracheobronchial anomalies facilitates the procedure and prevents complications before intubation, bronchoscopy, bronchoalveolar lavage, endobronchial treatment, lung transplantation, or resection.

CONCLUSION

Congenital tracheobronchial branching defects affecting the trachea, main bronchi, and intermediate bronchus may be categorized thoroughly using a lobe-based categorization method. The assessment of clinicians performing bronchoscopy and radiologists evaluating CT scans depends on their understanding of bronchial anatomy and abnormalities. CT screening is a practical, reliable, and accessible method to further assess the tracheobronchial tree, determine the type of bronchial anomaly, and rule out intraluminal diseases.

Ethics Committee Approval: Approval was granted by the Scientific Research Ethics Committee of Karadeniz Technical University Faculty of Medicine (no: 24237859-44, date: 11.01.2021).

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Peer-review: Externally and internally peer-reviewed.

Author Contributions: Surgical and Medical Practices - M.F.D.; Concept - S.A.; Design - S.A.; Data Collection and/or Processing - M.F.D.; Analysis and/or Interpretation - S.A.; Literature Search - M.F.D., S.A.; Writing - M.F.D., S.A.

Conflict of Interest: The authors have no conflict of interest to declare.

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REFERENCES

1. Boyden E. Segmental anatomy of the lungs. New York, NY: McGraw-Hill 1955.
2. Doolittle AM, Mair EA. Tracheal bronchus: classification, endoscopic analysis, and airway management. Otolaryngol Head Neck Surg 2002; 126: 240-3.
3. Chassagnon G, Morel B, Carpentier E, Ducou Le Pointe H, Sirinelli D. Tracheobronchial Branching Abnormalities: Lobe-based Classification Scheme. Radiographics 2016; 36: 358-73.
4. Wells TR, Gwinn JL, Landing BH, Stanley P. Reconsideration of the anatomy of sling left pulmonary artery: the association of one form with bridging bronchus and imperforate anus. Anatomic and diagnostic aspects. J Pediatr Surg 1988; 23: 892-8.
5. Atwell SW. Major anomalies of the tracheobronchial tree: with a list of the minor anomalies. Dis Chest 1967; 52: 611-5.
6. Kubik S, Muntener M. [Bronchus abnormalities: tracheal, eparterial, and pre-eparterial bronchi]. Fortschr Geb Rontgenstr Nuklearmed 1971; 114: 145-63.
7. O'Sullivan BP, Frassica JJ, Rayder SM. Tracheal bronchus: a cause of prolonged atelectasis in intubated children. Chest 1998; 113: 537-40.
8. Wong DT, Kumar A. Case report: Endotracheal tube malposition in a patient with a tracheal bronchus. Can J Anaesth 2006; 53: 810-3.
9. Middleton RM, Littleton JT, Brickey DA, Picone AL. Obstructed tracheal bronchus as a cause of post-obstructive pneumonia. J Thorac Imaging 1995; 10: 223-4.
10. McGuinness G, Naidich DP, Garay SM, Davis AL, Boyd AD, Mizrachi HH. Accessory cardiac bronchus: CT features and clinical significance. Radiology 1993; 189: 563-6.
11. Oshiro Y, Murayama S, Ohta M, Teruya T. CT findings of a displaced left upper division bronchus in adults: its importance for performing safe left pulmonary surgery. Eur J Radiol 2013; 82: 1347-52.
12. Remy J, Smith M, Marache P, Nuyts JP. [Pathogenetic left tracheal bronchus. A review of the literature in connection with four cases (author's transl)]. J Radiol Electrol Med Nucl 1977; 58: 621-30.
13. Evans JA. Aberrant bronchi and cardiovascular anomalies. Am J Med Genet 1990; 35: 46-54.
14. Kurt A, Sayit AT, Ipek A, Tatar IG. A multi detector computed tomography survey of tracheal diverticulum. Eurasian J Med 2013; 45: 145-8.
15. Buterbaugh JE, Erly WK. Paratracheal air cysts: a common finding on routine CT examinations of the cervical spine and neck that may mimic pneumomediastinum in patients with traumatic injuries. AJNR Am J Neuroradiol 2008; 29: 1218-21.
16. Cheng HM, Chang PY, Chiang KH, Huang HW, Lee CC. Prevalence and characteristics of paratracheal air cysts and their association with emphysema in a general population. Eur J Radiol 2012; 81: 2673-7.
17. McLaughlin FJ, Strieder DJ, Harris GB, Vawter GP, Eraklis AJ. Tracheal bronchus: association with respiratory morbidity in childhood. J Pediatr 1985; 106: 751-5.
18. Wang T, Meng M, Huang M, Zhao X. Variations of right bronchial tree: a study with multi-detector CT. Surg Radiol Anat 2018; 40: 955-8.
19. Ruchonnet-Metrailler I, Abou Taam R, de Blic J. Presence of tracheal bronchus in children undergoing flexible bronchoscopy. Respir Med 2015; 109: 846-50.
20. Akoglu S UE, Celik G, Sener G, Sevinc C, Kılınc O, Itil O. Tracheobronchial anomaly and variants detected by bronchoscopy. Toraks Dergisi 2006; 7: 84-7.
21. Barat M, Konrad HR. Tracheal bronchus. Am J Otolaryngol 1987; 8: 118-22.
22. Ulusoy M KA, Uysal II, Karabulut AK, Paksoy Y, Fazliogullari Z. Developmental Anomalies of Bronchial Tree: A Multidetector Computerized Tomography Study. Int J Morphol 2013; 31: 1049-55.

23. Ghaye B, Szapiro D, Fanchamps JM, Dondelinger RF. Congenital bronchial abnormalities revisited. Radiographics 2001; 21:105-19.
24. Gonlugur U, Efeoglu T, Kaptanoglu M, Akkurt I. Major anatomical variations of the tracheobronchial tree: bronchoscopic observation. Anat Sci Int 2005; 80: 111-5.
25. LE ROUX BT. The bronchial anatomy of the left upper lobe. J Thorac Cardiovasc Surg 1962; 44: 216-24.
26. Sabri YY, Yamamah HGAEN, Taymour TA. Role of multislice computed tomography in evaluation of congenital tracheobronchial branching anomalies. EJRNM 2018; 49: 1003-8.
27. 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 2021; 235: 151677.
28. Nagashima T, Shimizu K, Ohtaki Y, Obayashi K, Nakazawa S, Mogi A, et al. Analysis of variation in bronchovascular pattern of the right middle and lower lobes of the lung using three-dimensional CT angiography and bronchography. Gen Thorac Cardiovasc Surg 2017; 65: 343-9.
29. Unlu EN, Yilmaz Aydin L, Bakirci S, Onbas O. Prevalence of the Accessory Cardiac Bronchus on Multidetector Computed Tomography: Evaluation and Proposed Classification. J Thorac Imaging 2016; 31: 312-7.
30. Ghaye B, Kos X, Dondelinger RF. Accessory cardiac bronchus: 3D CT demonstration in nine cases. Eur Radiol 1999; 9: 45-8.
31. Strife J BG, Burrows P. Practical Pediatric Imaging: Diagnostic radiology of infants and children. Philadelphia: Lippincott-Raven 1998.
32. Schallert EK, Danton GH, Kardon R, Young DA. Describing congenital heart disease by using three-part segmental notation. Radiographics 2013; 33: E33-46.
33. Medina-Escobedo G, Lopez-Corella E. Sling left pulmonary artery, bridging bronchus, and associated anomalies. Am J Med Genet 1992; 44: 303-6.