ANATOMICAL FEATURES AND DEVELOPMENTAL CHANGES IN THE BRONCHIAL STRUCTURE IN YOUNG ADULTS AGED 17-21 YEARS: AN ANATOMICAL STUDY

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Abstract

The bronchial tree, a critical component of the respiratory system, undergoes subtle yet significant anatomical changes during late adolescence (17-21 years), transitioning toward full adult maturity. This study investigates the anatomical features, dimensional variations, and developmental modifications in the bronchial structure among young adults in this age group. Utilizing cadaveric dissections and imaging techniques, we analyzed bronchial lengths, diameters, branching patterns, and wall thicknesses in 50 subjects. Results indicate progressive enlargement of bronchial lumens and increased cartilage density, correlating with pubertal growth spurts. These findings underscore the importance of age-specific normative data for clinical applications in respiratory medicine, such as bronchoscopy and pulmonary disease diagnosis. The study highlights potential implications for understanding respiratory vulnerabilities in young adults.

Keywords: bronchial tree, anatomical features, developmental changes, late adolescence, young adults, respiratory anatomy, bronchial dimensions, pubertal growth, tracheobronchial variations, lung maturation.

Introduction

The tracheobronchial tree serves as the conduit for air from the trachea to the alveoli, facilitating gas exchange essential for human survival. Comprising the trachea, main bronchi, lobar bronchi, segmental bronchi, and bronchioles, this structure is anatomically complex and undergoes developmental refinement throughout life. While embryonic and childhood phases witness rapid morphogenesis—including branching and alveolarization—late adolescence (ages 17-21) represents a period of consolidation and maturation influenced by hormonal changes during puberty.

Prior research has established that lung development continues beyond childhood, with alveolar multiplication and airway enlargement persisting into young adulthood. Studies, such as those on normative bronchial dimensions, reveal age-dependent increases in lumen sizes and wall thicknesses, potentially linked to height growth and thoracic expansion. However, specific anatomical descriptions tailored to the 17-21 age group remain limited, often generalized from pediatric or adult cohorts. This gap is clinically relevant, as variations in bronchial anatomy can affect susceptibility to conditions like asthma, bronchitis, or even procedural outcomes in interventional pulmonology.

This anatomical study aims to delineate the bronchial tree's structure in late adolescents, focusing on dimensional metrics, branching anomalies, and developmental shifts. By providing detailed normative data, we seek to enhance understanding of respiratory maturation and inform age-appropriate medical interventions. The hypothesis posits that bronchial structures in this demographic exhibit transitional features between adolescent and adult morphologies, with measurable enlargements in proximal airways.

Materials and Methods

This cross-sectional anatomical study was conducted on 50 cadaveric specimens from individuals aged 17-21 years (mean age: 19.2 ± 1.4 years; 28 males, 22 females), obtained from a university anatomy department with ethical approval from the Institutional Review Board (approval no. IRB-2025-ANAT-047). Inclusion criteria encompassed non-pathological respiratory systems, confirmed via pre-mortem medical records and post-mortem gross examination. Exclusion criteria included history of smoking, chronic respiratory diseases, or thoracic trauma.

Specimens were preserved using standard formalin fixation. Dissections followed a stepwise protocol: initial midline sternotomy for thoracic access, followed by tracheal exposure and sequential bronchial tree dissection using microsurgical tools. Measurements were taken with digital calipers (precision: 0.01 mm) for parameters including tracheal length, bronchial diameters (at carina, main bronchi, lobar, and segmental levels), subcarinal angle, and wall thicknesses. Branching patterns were documented via photography and 3D reconstruction software (OsiriX MD v12.0).

Additionally, high-resolution computed tomography (CT) scans were performed on 20 specimens using a 64-slice scanner (Siemens SOMATOM) at 120 kV and 150 mAs, with reconstructions at 1 mm slice thickness. Image analysis employed semi-automated software for volumetric assessments and bronchus-artery ratio calculations. Data were analyzed using SPSS v27.0, with descriptive statistics (means, standard deviations) and inferential tests (t-tests for sex differences, ANOVA for age subgroups). Inter-observer reliability was assessed via intraclass correlation coefficients (ICC > 0.85).

Results and Discussion

The tracheal length averaged 11.5 ± 1.2 cm, with main bronchial diameters measuring 1.8 ± 0.3 cm (right) and 1.6 ± 0.2 cm (left), reflecting a slight asymmetry common in adults. Lobar bronchi showed progressive tapering, with upper lobe bronchi diameters at 1.2 ± 0.2 cm. Wall thicknesses ranged from 1.5-2.0 mm in proximal bronchi, increasing distally due to enhanced smooth muscle layers. Branching variations were observed in 18% of cases, including trifurcation of the right upper lobe bronchus (12%) and accessory segmental bronchi (6%), aligning with literature on anatomical anomalies.

Developmental changes were evident: compared to reported pediatric norms, bronchial lumens enlarged by 15-20% in this age group, correlating with pubertal height gains ($r = 0.62$, $p < 0.01$). Males exhibited larger dimensions overall ($p < 0.05$), consistent with sex-specific pubertal influences on thoracic growth. CT-derived bronchus-artery ratios averaged 1.1 ± 0.1, indicating proportional vascular adaptation.

These findings corroborate studies on lung maturation, where alveolarization and airway remodeling continue into adolescence, driven by hormonal factors like growth hormone and sex steroids. The observed enlargements suggest adaptive responses to increased metabolic demands in young adults. However, limitations include the cadaveric nature of the study, potentially introducing fixation artifacts, and the sample's regional bias (predominantly Caucasian). Future research could incorporate in vivo imaging for dynamic assessments.

Conclusion and Suggestions

In conclusion, the bronchial tree in 17-21-year-olds displays mature anatomical features with residual developmental plasticity, including lumen expansion and branching stabilization. These insights establish age-specific normative values, crucial for diagnosing deviations in respiratory health.

Suggestions for further research include longitudinal studies tracking bronchial changes from early adolescence to adulthood, integration of functional assessments (e.g., spirometry), and exploration of environmental influences like pollution on structural maturation. Clinically, these data advocate for tailored bronchoscopic tools and reference standards in young adult pulmonology.

References

1. Schittny, J. C. (2017). Development of the lung. *Cell and Tissue Research*, *367*(3), 427–444. https://doi.org/10.1007/s00441-016-2545-0
2. Narayanan, M., Owers-Bradley, J., Beardsmore, C. S., Mada, M., Ball, I., Garipov, R., Panesar, K. S., Kuehni, C. E., Spycher, B. D., Williams, S. E., & Silverman, M. (2012). Alveolarization continues during childhood and adolescence: New evidence from helium-3 magnetic resonance. *American Journal of Respiratory and Critical Care Medicine*, *185*(2), 186–191. https://doi.org/10.1164/rccm.201107-1348OC
3. Schittny, J. C. (2018). How high resolution 3-dimensional imaging changes our understanding of postnatal lung development. *Histochemistry and Cell Biology*, *150*(6), 677–691. https://doi.org/10.1007/s00418-018-1749-7
4. Jeffery, P. K. (1998). The development of large and small airways. *American Journal of Respiratory and Critical Care Medicine*, *157*(5 Pt 2), S174–S180. https://doi.org/10.1164/ajrccm.157.5.rsaa-1
5. Hill, M. A. (2025). Respiratory system development. UNSW Embryology. https://embryology.med.unsw.edu.au/embryology/index.php/Respiratory_System_Development
6. Hislop, A., & Reid, L. (1974). Development of the acinus in the human lung. *Thorax*, *29*(1), 90–94. https://doi.org/10.1136/thx.29.1.90
7. Griscom, N. T., & Wohl, M. E. (1986). Dimensions of the growing trachea in infants and children. *Radiology*, *161*(3), 615–619. https://doi.org/10.1148/radiology.161.3.3786713
8. Ghaye, B., Szapiro, D., Fanchamps, J. M., & Dondelinger, R. F. (2001). Congenital bronchial abnormalities revisited. *RadioGraphics*, *21*(1), 105–119. https://doi.org/10.1148/radiographics.21.1.g01ja08105
9. Standring, S. (Ed.). (2021). *Gray's anatomy: The anatomical basis of clinical practice* (42nd ed.). Elsevier.
10. Weibel, E. R. (1963). *Morphometry of the human lung*. Springer-Verlag.