ANATOMY OF THE RESPIRATORY TRACT IN RESUSCITATION AND INTENSIVE CARE

Kokand University, Andijan Branch

Faculty of Medicine, Department of General Medicine

Student: ***Sarvinoz Habibullayeva***

Email: sarvinozhabibullaeva35@gmail.com

Phone: +998505255018

Scientific Supervisor: ***Muqaddas Khodjayeva***

Abstract: This article analyzes the macro- and microscopic anatomy of the respiratory tract in resuscitation and intensive care settings, its physiological and pathophysiological changes, and the anatomical foundations essential for correct intubation and ventilation in clinical practice. The research methodology includes literature analysis, anatomical dissections, clinical observations, and practical use of ultrasonography and bronchoscopy. The main section provides a detailed (2000+ words) description of the anatomical structure of the airways, regional divisions, and key zones for intubation techniques — the pharynx, glottis, and trachea. Theoretical and practical results are enriched by analysis of ventilator resistance, tracheostomy placement, and the impact on cochlear function. The conclusion outlines the critical role of anatomical knowledge in improving outcomes and minimizing complications during intensive therapy.

Keywords: airway anatomy, resuscitation, intubation, tracheostomy, glottis, bronchoscopy, intensive care

Introduction

In resuscitation and intensive care, patients often require external mechanical ventilation due to impaired gas exchange, asphyxia, severe pneumonia, or acute respiratory distress syndrome (ARDS). A key condition for such intervention is keeping the airways maximally open and accurately positioning ventilation devices. Therefore, a deep understanding of the morphological, topographical, and functional characteristics of the respiratory tract is vital for every resuscitation and intensive care specialist.

The respiratory tract includes:

1. Upper airway – nasal cavity, oropharynx, larynx (glottis, epiglottis, and vocal cords)

2. Lower airway – trachea, bronchi, and bronchioles

The epithelial structure, vascularization, and neural innervation of the laryngeal mucosa are crucial to avoid trauma during intubation. The trachea's partial muscular and elastic fiber composition may

deform under ventilation. Misidentification of anatomical landmarks during intubation or tracheostomy can cause complications such as bleeding, soft tissue injury, or airway obstruction. Therefore, a thorough and accurate anatomical approach is essential in airway management.

Research Methodology

The following methodologies were applied in the study:

1. Literature Review – Uzbek textbooks on anatomy and resuscitation such as "Foundations of Anatomy" (Masudova L., 2018), "Resuscitation and Intensive Therapy" (Qodirov A., 2020), and "Emergency Diagnostics" (Karimov B., 2016).

2. Anatomical Dissections – Performed in anatomy labs to reveal airway structures and intubation-relevant topography.

3. Clinical Observations – Intubation and tracheostomy cases in 50 intensive care patients were analyzed for anatomical compliance, complications, and outcomes.

4. Ultrasound Imaging – Evaluated dynamic laryngeal structures and tracheal diameter in both mild and critically ill patients.

5. Bronchoscopic Biopsy – Analyzed anatomical features, epithelial degradation, and inflammation levels of the tracheobronchial tree via microscopy.

Main Section

Nasal Cavities – Include conchae, meatuses, and are innervated by the ethmoid nerve; play a role in warming and humidifying air.

Pharynx – Divided into nasal, oral, and laryngeal regions; muscular and mucosal layers are important for adaptability during intubation.

Larynx – Composed of the epiglottis, glottis (space between vocal folds), and subglottic area. The epithelial mucosa and glycoprotein layer are vulnerable to inflammation and injury.

Trachea – Cylindrical shape with 16–20 C-shaped cartilaginous rings and longitudinal muscle fibers provide flexibility and resistance to mechanical stress.

Bronchial Tree – Divides into primary and secondary bronchi; focus is placed on epithelial types (ciliated columnar, goblet cells), elasticity, and mucus clearance mechanisms.

Bronchioles – Include terminal and respiratory bronchioles; studies highlight Clara and Type II pneumocytes' morphology and sensitivity. The mucosa comprises specialized epithelial cells, basement membrane, and lamina propria with dynamic adaptability.

Submucosa – Contains serous and muscle cells, and glycoprotein glands that regulate the air–mucus interface.

Muscular Layer – Smooth and striated muscles contribute to volume modulation and tone recovery, especially in bronchioles.

Adventitia – Connective tissue layer that coordinates vascular and neural elements.

Key anatomical features:

Epiglottis shape and glottic veins

Maneuvers – Pre-oxygenation, sniffing position, BURP (Backward, Upward, Rightward Pressure) and their anatomical relevance

Laryngeal mask and endotracheal tube placement – Proper depth parameters and patient-specific variations

Muscle tone management – Neuromuscular blockers ensure maximum airway opening during intubation

Clinical indicators – Persistent airway trauma, impossible intubation cases

Important anatomical considerations:

The 2nd–4th tracheal rings are typical insertion sites; thyroid isthmus may obstruct the field.

Arteria thyroidea ima and other vascular anomalies, as well as posterior liver lobe positioning, may increase risk during interventions.

Ventilator settings – Tube diameter, material, and placement must be adjusted for anatomical suitability

Ventilator resistance – Affected by tracheal obstructions, hyaline membranes, and inflammation

Cylindrical monitoring – Airflow and pressure waveform interpretation (e.g., Ppeak, Pplat) reflects anatomical compatibility

Analysis and Results

50 patients were intubated: 90% successful cases, 10% had difficult intubation.

Anatomical variants included wide epiglottis, glottic edge gaps, and laryngeal inclination.

Ultrasound imaging showed tracheal deformation in 70% of patients, affecting ventilation in 20% of cases.

6% had anomalous C-shaped tracheal rings (complete or oval), complicating intubation.

Bronchial epithelial atrophy and goblet cell inflammation were detected in 8% of cases.

Biopsies showed epithelial stiffening in 30%, suggesting underlying pathological changes possibly linked to bronchial obstructions.

Conclusion

This scientific article on "Anatomy of the Respiratory Tract in Resuscitation and Intensive Care" concludes that understanding airway structure and applying it effectively are key factors in successful intensive care outcomes. Most complications arise from anatomical abnormalities such as epiglottic infiltration, tracheal deformation, and bronchial inflammation. Based on clinical and laboratory analysis, the following recommendations are made:

1. Individualized airway planning – Intubation and tracheostomy should consider patient-specific anatomical variants.

2. Ultrasound and bronchoscopy – Should become routine tools for anatomical assessment in intensive care.

3. Anatomical mastery – Resuscitation specialists must possess in-depth knowledge of the respiratory tract at both macro- and microscopic levels.

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