Intraoperative Respiratory Problems Associated With General Anesthesia

Essay

Submitted for the complete fulfillment of the
Master degree (M.Sc.) in

Anesthesiology

By

Asmaa Mohamed Idres Hassan

(M.B., B.Ch.)

faculty of medicine ,cairo university

Under the Supervision of

Prof. Dr. Nadia Youssef Hamed Helmi

Professor of Anesthesiology

Faculty of Medicine , Cairo University

Prof. Dr. Nesrine Abd El-Rahman El-Refai

Professor of Anesthesiology

Faculty of Medicine , Cairo University

Dr.Ahmed Abd-Allah Mohamed

Lecturer of Anesthesiology

Faculty of Medicine, Cairo University

Faculty of Medicine

Cairo University

2009

Abstract

Despite recent advances in anesthesia and surgical care, perioperative respiratory morbidity is still a common problem. Pulmonary complications are a major source of morbidity in surgical patients, second only to cardiovascular events as a cause of perioperative death

The safety of patients does not depend solely on the application of standards of practice, the purchase of new equipment and the institution of new monitoring techniques.

Safety can be increased only by combining the use of modern technology with improvement in education, training, supervision, attitudes, standards of clinical practice, audit and vigilance.[1]

Therefore, this essay aimed to discuss the most important intraoperative respiratory problems occurring under general anesthesia.

Key words: airway problems- aspiration pneumonia- pulmonary edema

Acknowledgments

First and for ever, thanks to Allah, the creator of continuosly developing human mind.

I would like to present my sincere gratitude and deepest appreciation to **Prof. Dr. Nadia Youssef Hamed Helmi** , Professor of Anesthesiology Faculty of Medicine Cairo University for her generous assistance and help.

I am also grateful to **Prof. Dr. Nesrine Abd El-Rahman El-Ref** Assistant Professor of Anesthesiology Faculty of Medicine , Cairo University for her continuous guidance and explanations.

I would like to extend my indebtedness and gratitude to **Dr.Ahmed Abd-Allah Mohamed** Lecturer of Anesthesiology Faculty of Medicine, Cairo University for his valuable and remarkable observations.

Asmaa idres
2009

Contents

List of Abbreviations

- ABGs: Arterial blood gases.
- ABP: Arterial blood pressure
- AFE: Amniotic fluid embolism.
- ARDS:Acute respiratory distress syndrome
- ASA: American association of anaesthiologists
- C.V.S: cardiovascular system
- CC: Closing capacity
- CHF: Congestive Heart Faliure.
- CO: cardiac output
- COPD: chronic obstructive pulmonary disease
- CPAP: continuous positive airway pressure
- CPE: Cardiogenic Pulmonary Edema.
- CVP: Central Venous Pressure.
- DLCO: Diffusing capacity of the lung for carbon monoxide
- DVT: Deep Venous Thrombosis.
- E.T.T: Endotracheal tube.
- ERV: Expiratory reserve volume
- FEV1: Forced exhaled volume in 1 second
- FRC: Functional residual capacity
- GA: General anesthesia
- GIT: Gastro-intestinal tract
- I.U.: International Unit.
- IC: Inspiratory capacity
- ICU: Intensive care unit
- IMV: Intermittent mandatory ventilation
- IRV Inspiratory reserve volume

- LMA: Laryngeal Mask airway
- LV: Left Ventricle.
- MAC: Minimum alveolar concentration
- NPE: Non Cardiogenic Pulmonary Edema
- NPO: Nill per Os
- PA: Pulmonary artery.
- $PaCo_2$: Partial pressure of arterial carbon dioxide
- PCWP: pulmonary capillary wedge pressure
- PEEP: Positive end-expiratory pressure
- PVR: peripheral vascular resistance
- RV: Residual volume
- S.c. : Subcutaneous
- SVR: systemic vascular resistance
- TEE: Trans-esophageal echocardiography
- TLC: Total lung capacity
- TURP: TransUretheral Prostatectomy.
- V/Q ratio: ventilation perfusion ratio
- VC: Vital capacity
- V_T : Tidal volume

List of figures

List of tables

Introduction

Despite recent advances in anesthesia and surgical care, perioperative respiratory morbidity is still a common problem. Pulmonary complications are a major source of morbidity in surgical patients, second only to cardiovascular events as a cause of perioperative death

The safety of patients does not depend solely on the application of standards of practice, the purchase of new equipment and the institution of new monitoring techniques.

Safety can be increased only by combining the use of modern technology with improvement in education, training, supervision, attitudes, standards of clinical practice, audit and vigilance.[1]

Therefore, this essay aimed to discuss the most important intraoperative respiratory problems occurring under general anesthesia. accordingly, the essay will focus on the following items:

- **Airway problems.**
- **Aspiration pneumonia.**
- **Bronchospasm**
- **Hypoxia & hypercapnia.**
- **Pneumothorax.**
- **Pulmonary embolism**
- **Pulmonary oedema.**

Chapter 1

Anatomical and physiological considerations of respiration

Chapter 1

Anatomical and physiological considerations of respiration

Anatomy of the respiratory system:

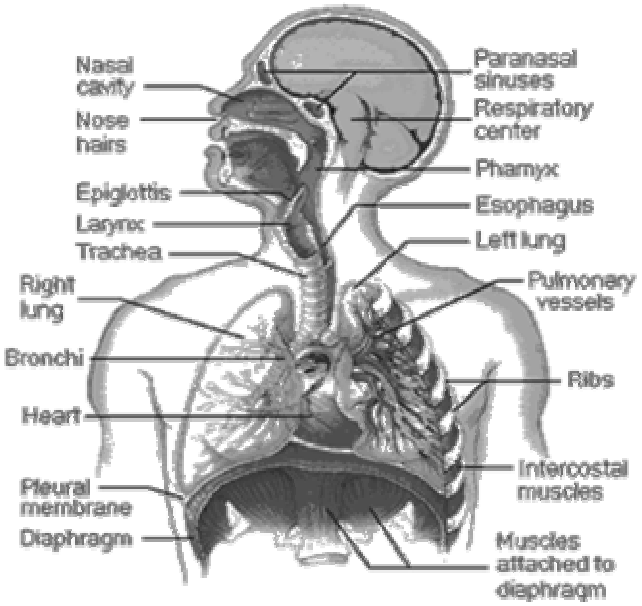

Figure 1:Anatomy of respiratory system
(from Stoelting RK, Hiller SC., the lungs in: pharmacology and anatomy in anesthetic practice .4th ed. Philadelphia, Lippincott Williams & Wilkins, 2006:770)

- **Nose:**

The normal airway begins functionally at the nares. As air passes through the nose, the important functions of warming and humidification occur. The nose is the primary pathway for normal breathing unless obstruction by polyps or upper respiratory infection is present. During quiet breathing the resistance to air flow through the nasal passages accounts for nearly two-thirds of the total airway resistance**.**

The resistance through the nose is nearly **twice** that associated with mouth breathing, this explains why mouth breathing is utilized when high flow rates are necessary as with exercise.

The **sensory innervation of the nasal mucosa** arises from two divisions of the trigeminal nerve: - The anterior ethmoidal nerve supplies the anterior septum and lateral wall whereas the posterior areas are innervated by nasopalatine nerves from the sphenopalatine ganglion. **Local anesthesia** can be produced by blocking anterior ethmoidal and maxillary nerves bilaterally; however, simple topical anesthesia is usually quite effective.[1]

- **Pharynx:**

The pharyngeal airway extends from the posterior aspect of the nose down to the cricoid cartilage, where the passage continues as the esophagus. An upper area, the nasopharynx, is separated from the lower oropharynx by the tissue of the soft palate. The principal impediments to air passage through the nasopharynx are the prominent tonsillar lymphoid structures. The tongue is the principal source of oropharyngeal obstruction during anesthesia usually because of **decreased tone** of the genioglossus muscle. [2]

The latter contracts to move the tongue forward during inspiration and thus act as a pharyngeal dilator.[2]

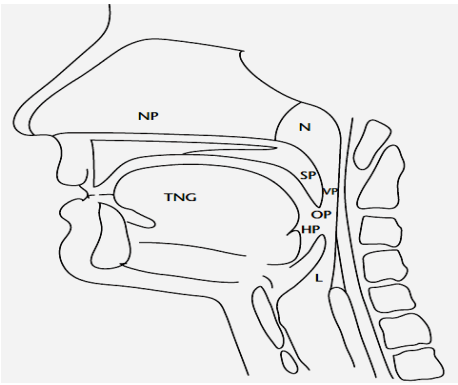

Figure 2:Anatomy of the upper airway. (NP: nasopharynx;TNG: tongue; SP: soft palate; VP: velopharynx; OP:oropharynx; HP: hypopharnyx; L: larynx).
(from core topics in airway management **2005:p24)**

- **Larynx**

The larynx, which lies at the level of the **third** to **sixth** cervical vertebrae, serves as an organ of phonation and as a valve to protect the lower airways from the contents of the alimentary tract. The structure consists of muscles, ligaments, and a framework of cartilages. These include the thyroid, cricoid, arytenoids, corniculates, and the epiglottis. The latter, a fibrous cartilage, has a mucous

membrane covering that reflects as the glossoepiglottic fold onto the pharyngeal surface of the tongue. On either side of this fold are depressions called valleculae. These areas provide the site for placement of the curved Macintosh laryngoscope blade. The epiglottis projects into the pharynx and overhangs the laryngeal inlet. However, it is not absolutely essential for sealing off the airway during swallowing.[3]

The laryngeal cavity extends from the epiglottis to the lower level of the cricoid cartilage. The inlet is formed by the epiglottis, which joins to the apex of the arytenoid cartilages on each side by the aryepiglottic folds. Inside the laryngeal cavity one first encounters the vestibular folds, which are narrow bands of fibrous tissue on each side. These extend from the anterolateral surface of each arytenoid to the angle of the thyroid where the latter attaches to the epiglottis. These folds are referred to as the false vocal cords and are separated from the true vocal cords by the laryngeal sinus or ventricle. The true vocal cords are pale white ligamentous structures that attach to the angles of the thyroid anteriorly and to the arytenoids posteriorly. [3]

The triangular fissure between these vocal cords is termed the glottic opening, which represents the narrowest segment of the laryngeal opening in adults. In young children (less than 10 years old), the **narrowest** segment lies just below the cords at the level of the cricoid ring. The mean length of the relaxed open glottis is about 23 mm in males and 17 mm in females.[3]

Innervation of the larynx:

Sensory innervation

- Glossopharyngeal nerve (posterior tongue & pharynx)
- Superior laryngeal nerve (epiglottis; larynx to level of false vocal cords)
- Recurrent laryngeal nerve (vocal cords; upper trachea)

Motor innervation:

Recurrent laryngeal nerve; superior laryngeal nerve innervates the cricothyroid muscle.[3]

Table 1: laryngeal innervation

Nerve	Sensory	Motor
Superior laryngeal (internal division)	Epiglottis, base of tongue	None
	Supraglottic mucosa	
	Thyroepiglottic joint	
	Cricothyroid joint	
Superior laryngeal (external division)	Anterior subglottic mucosa	Cricothyroid (adductor, tensor)
Recurrent laryngeal	Subglottic mucosa	Thyroarytenoid
	Muscle spindles	Lateral cricoarytenoid
		Interarytenoid (adductors)
		Posterior cricoarytenoid (abductor)

(From miller anesthesia 6th edition 2000:p 432)

- **Trachea:**

The trachea is a tubular structure that begins opposite the **sixth** cervical vertebra at the level of the thyroid cartilage. It is flattened posteriorly and supported along its 10 to 15cm length by 16 to 20 horseshoe-shaped cartilaginous rings until bifurcating into right and left main bronchi at the level of the **fifth** thoracic vertebra. The cross-sectional area of the trachea is considerably larger than that of the glottis and may be more than 150 mm^2 and as high as 300 mm^2.

There are a number of receptors in the trachea that are sensitive to mechanical and chemical stimuli. Slowly adapting stretch receptors are located in the trachealis muscle of the posterior tracheal wall. These are involved in regulating the rate and depth of breathing, but they also produce dilation of upper airways and the bronchi by decreasing vagal efferent activity. Other rapidly adapting irritant receptors lie all around the tracheal circumference. These are usually considered to be cough receptors, although their other reflex actions consist of broncho-constriction. Studies of topical anesthesia in dogs suggest that the latter receptors are more readily blocked by local anesthetics than are the slowly adapting stretch receptors.[2]

- **Bronchus**

The bifurcation of the trachea at the carina gives rise to the right & left main stem bronchus the right main stem bronchus extends approximately 2.5 cm before its initial division into the bronchus to the right upper & middle lobes with a continuation as the right lower lobe bronchus , The left main stem bronchus extends approximately 5 cm before its initial division.[1]

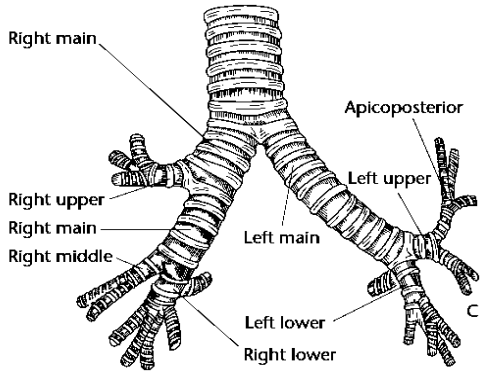

Figure 3 : main lobar segmental bronchi
(from core topics in airway management 2005:p6)

- **Thoracic cage:**

The thoracic cage is composed of 12 thoracic vertebral bodies the ribs and the sternum. The suprasternal notch is in the same horizontal plane as the midportion of the 2nd thoracic vertebra.[1]

Mechanics of breathing:

Diaphragm:

The diaphragm is the principal muscle of breathing accounting approximately to 75% of the air that enters the lungs during spontaneous inspiration.

It causes gas flow into the chest by decreasing the intrathoracic pressure to less than atmospheric pressure.

Motor innervation of the diaphragm is via the phrenic nerve C3, 4, and 5. [2]

Intercostal muscle muscles:

During quiet breathing the contribution of intercostals muscle contraction to inspiration is small.