Management of Postoperative Complications after Pneumonectomy

An essay
Submitted for the Partial Fulfillment of Master Degree
General intensive care

Presented by

Haythm Mostafa Ibrahem
(M.B.B.Ch.)

Supervised by:

Dr. Omar Mohamed Taha Elsafty
Professor of Anesthesia and ICU
Faculty of Medicine-Ain Shams University

Dr. Waleed Abd Elmged Eltaher
Assistant Professor of Anesthesia and ICU
Faculty of Medicine-Ain Shams University

Dr. Hanaa Mohamed AbdAllah Elgende
Lecturer of Anesthesia and ICU
Faculty of Medicine-Ain Shams University

Faculty of Medicine
Ain Shams University
2013

Acknowledgement

First of all, all gratitude is due to Allah for blessing this work, until it has reached its end, as a part of his generous help, throughout my life.

Really I can hardly find the words to express my gratitude to ***Dr. Omar Mohamed Taha Elsafty*** *Professor of anesthesia and intensive care department, faculty of medicine, Ain Shams University, for her supervision, continuous help, encouragement throughout this work and great effort she has done in the meticulous revision of the whole work. It is a great honor to work under her guidance and supervision.*

I am also grateful to ***Dr. Waleed AbdElmged Eltaher*** *assistant professor of anesthesia and intensive care, faculty of medicine, Ain Shams University for her guidance, continuous assistance and sincere supervision of this work.*

I would like also to express my sincere appreciation and gratitude to ***Dr. Hanaa Mohamed AbdAllah Elgende*** *lecturer of anesthesia and intensive care, faculty of medicine , Ain Shams University, for her continuous directions and support throughout the whole work.*

Last but not least, I dedicate this work to my family, whom without their sincere emotional support, pushing me forward this work would not have ever been completed.

Haythm Mostafa Ibrahem

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List of Abbreviations

ABG	:	Arterial blood gases
ALI	:	Acute lung injury
ARDS	:	Acute respiratory distress syndrome
ASA	:	American Society of Anesthesiologists
BPF	:	Bronchopleural fistula
C	:	Compliance
C.A.	:	Carbonic anhydrase enzyme
CO	:	Carbon monoxide
CO_2	:	Carbon Dioxide
CPAP	:	Continuous Positive Airway Pressure
CSF	:	Cerebrospinal fluid
CT	:	Computed tomography
DLCO	:	Diffusing capacity of the lung for carbon monoxide
DPPC	:	Dipalmitoylphosphatidylcholine
DS/TV	:	Dead space: tidal volume ratio
DVT	:	Deep Venous Thrombosis
EBUS	:	Endobronchial ultrasound-guided
ECG	:	Electrocardiogram
EGFR	:	Epidermal growth factor receptor
EPP	:	Extrapleural pneumonectomy
ERV	:	Expiratory Reserve Volume
FEV_1	:	Forced Expiratory Volume in One Second
FEV_j	:	Forced Expiratory Volume in One Second
FFP	:	Fresh frozen plasma
Fig	:	Figure
FiO_2	:	Fraction of Inspired Oxygen
FRC	:	Functional Residual Capacity
FVC	:	Forced Vital Capacity
H^+	:	Hydrogen ion
H_2CO_3	:	Carbonic acid
Hb	:	Haemoglobin
HCO_3^-	:	Bicarbonate ions
HFOV	:	High Frequency Oscillatory Ventilation

List of Abbreviations (Cont.)

HRCT	:	High-resolution computed tomography
ICU	:	Intensive Care Unit
Insp resistance	:	Mean inspiratory airway resistance
IRV	:	Inspiratory Reserve Volume
IV	:	Intravenous
MAP	:	Mean Airway Pressure
MEP	:	Maximal expiratory pressure
MI	:	Myocardial infarction
MIP	:	Maximal inspiratory pressure
MRI	:	Magnetic resonance imaging
MVV	:	Maximal voluntary ventilation
N_2O	:	Nitrous oxide
nCPAP	:	non-invasive continuous positive airway pressure
nPPV	:	non invasive positive pressure ventilation
NSCLC	:	Non-small-cell lung carcinomas
O_2	:	Oxygen
P_{50}	:	The partial pressure of oxygen in the blood at which the hemoglobin is 50% saturated
PA mean	:	Mean pulmonary arterial pressure
$PaCO_2$	:	Arterial Partial Carbon Dioxide tension
PaO_2	:	Arterial Partial Oxygen tension
PCI	:	Percutaneous coronary intervention
PE	:	Pulmonary Embolism
P_eCO_2	:	partial pressure of carbon dioxide in the expired air
PEEP	:	Positive End Expiratory Pressure
PNX	:	Pneumonectomy
PPCs	:	Postoperative Pulmonary Complications
PPE	:	Postpneumonectomy Pulmonary Edema
PPS	:	Postpneumonectomy space
Q	:	Perfusion
RV	:	Residual Volume
SaO_2	:	Oxygen Saturation

List of Abbreviations (Cont.)

SCLC	:	Small-cell lung carcinoma
TB	:	Tuberculosis
TBNA	:	Transbronchial needle aspiration
TLC	:	Total lung Capacity
TNM	:	Tumour, Node, Metastasis
TV	:	Tidal Volume
V	:	Ventilation
V/Q	:	Ventilation / Perfusion
VC	:	Vital Capacity
Vd	:	Dead space volume
VO_2	:	Oxygen Consumption
V_t	:	Tidal Volume
Δ P	:	Pressure change
Δ V	:	Volume change

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Introduction

Pneumonectomy or surgical removal of an entire lung, as well as, lobectomy are performed most frequently for management of bronchogenic carcinoma ***(Shields et al.,2005).***

It may rarely be performed for pulmonary metastases or for a variety of benign diseases, such as inflammatory lung disease, traumatic lung injury, congenital lung disease, and bronchial obstruction with a destroyed lung ***(Shields et al.,2005).***

Major lung resection causes anatomical and physiological changes with affection of lung function and consequently lung volumes. ***(Kopec et al.,1998).***

Postoperative complications after pneumonectomy are relatively frequent and significant, including cardiovascular, respiratory, pleural, gastrointestinal and other non specific complications based on the timing of occurrence and the factors that affect their incidence ***(Ferretti et al., 2009).***

A number of potential complications that involve the respiratory system, as post-pneumonectomy pulmonary edema with incidence ranging between 4% and 7% and evidence indicates that prevention is the most important therapeutic measure. Patients tend to have greater risk of pneumonia after thoracotomy, but few studies have provided a high level of evidence for the usefulness of antibiotic prophylaxis in chest surgery **(Izquierdo et al., 2005).**

Pleural space complications such as significant bleeding, empyema, bronchopleural fistula, esophagopleural fistula and pneumothorax are common **(Wolfe and Lewis., 2002).**

A number of complications involving the cardiovascular system, as postoperative arrhythmias (most common is supraventricular arrhythmias) which increase mortality, although evidence does not suggest a need for systematic prophylactic treatment of patients who will undergo lung resection **(Izquierdo et al., 2005).**

Complications after pneumonectomy require a unique approach to management, and mortality can be minimized by early detection and aggressive treatment **(Sugarbaker et al.,2004).**

Aim of the Work

The aim of the work is to highlight the postoperative complications after pneumonectomy, their detection and management.

Anatomy And Physiology Of The Respiratory System

The primary function of the respiratory system is gas exchange of oxygen and carbon dioxide which is done by the lungs ***(Ganong, 1991).***

Anatomy of the respiratory system:

The respiratory system can be divided into an upper respiratory tract (conducting zone) and a lower respiratory tract (respiratory zone)as shown in Fig.(1).

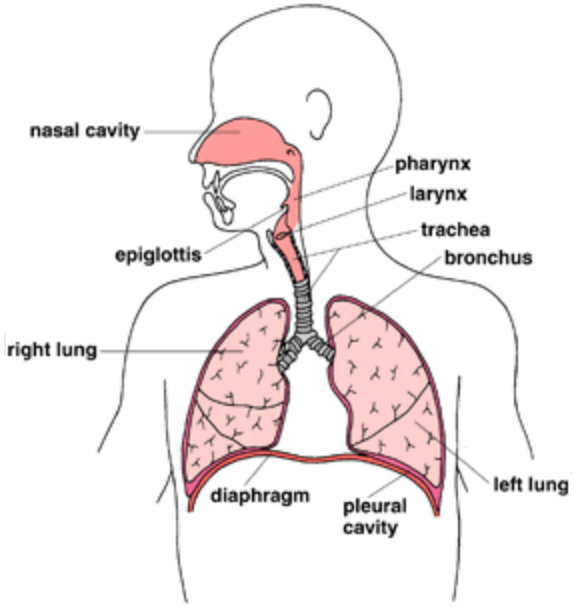

Fig.(1): Components of respiratory system.
(Widmaier et al., 2005)

Upper respiratory tract/conducting zone:

The upper respiratory tract begins with the nares (nostrils) of the nose, which open into the nasopharynx. The primary functions of the nasal passages are to filter, warm, moisten, and provide resonance in speech. The nasopharnyx opens into the oropharynx, then air entering the oropharynx passes into the laryngopharynx,the larynx, down into the trachea ***(Widmaier et al., 2005).***

Lower respiratory tract/respiratory zone:

The trachea divides at the level of the carina into the right and left main bronchi one to each lung. Each bronchus is divided into: Primary, secondary, and tertiary divisions. In total, the bronchi divide 16 times into even smaller bronchioles.

The bronchioles lead to the respiratory zone of the lungs, which consists of respiratory bronchioles, alveolar ducts, and the alveoli, the multi-lobulated sacs in which most of the gas exchange occurs ***(Widmaier et al., 2005).***

The alveolar surface is lined with different types of cells which are:

Type I pneumocyte: Also called small alveolar cell or alveolar type I cell. It is the major cell type lining the alveolar surfaces. These cells represent only 40% of the alveolar lining cells,but are spread so thinly that they cover about 90 to 95% of the surface. These cells are connected to one another by tight junctions. Gaseous exchange takes place through the type I cells.

Type II pneumocyte: It is the other major alveolar cell(also called the great alveolar cell because of its size, granular pneumocytes, alveolar type II).

Though they constitute 60% of the cells lining the alveoli, they form only 5-10% of the surface. Type II pneumocytes serve two important functions:

(i) They serve as stem cells for themselves and the type I cells. i.e. they possess proliferative power and may replace damaged types of cells.

(ii) They secrete a fluid which acts as a surfactant by reducing surface tension, and thereby prevents the collapse of the alveoli during expiration ***(Baritussio et al., 1994).***

Alveolar Macrophages:(*dust cells*) The alveolar macrophages are derived from monocytes that exit the blood vessels in the lungs. The resident alveolar macrophages can undergo limited mitoses to form additional macrophages.

Pulmonary surfactant:

Pulmonary surfactant is a surface-active lipoprotein complex (phospholipoprotein) formed by type II alveolar cells. The proteins and lipids that surfactant comprises have both a hydrophilic region and a hydrophobic region. The main lipid component of surfactant is dipalmitoylphosphatidylcholine (DPPC) ***(Hills and Brian,1999).***

Function of surfactant:

Pulmonary surfactant reduces surface tension inside the aleovli which leads to:

- Increase pulmonary compliance.
- Prevent atelectasis (collapse of the lung) at the end of expiration.
- Facilitate recruitment of collapsed airways ***(Hills and Brian,1999).***