Anesthetic Management of Thoracoscopic Surgery in The Newborn

Essay
Submitted for partial fulfillment of the requirements of M.Sc degree in Anesthesia

By

Dr. Saif El-din Ahmed Shawky Abd El-Hamed
M.B.B.Ch
Faculty of medicine, Cairo University

Under supervision of

Prof. Dr. Foudan Fahim Shaltout
Professor of Anesthesia
Faculty of Medicine
Cairo University

Dr. Nevine Mahmoud Gouda
Assistant Professor of Anesthesia
Faculty of Medicine
Cairo University

Dr. Maha Gamil Hanna
Assistant Professor of Anesthesia
Faculty of Medicine
Cairo University

Faculty of Medicine
Cairo University
2007

Dedication

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

Acknowledgment

First and foremost, thanks to God, the most kind and merciful.

Words will never be able to express my deepest gratitude to all those who helped me during preparation of this study.

I gratefully acknowledge the sincere advice and guidance of Prof. Dr. Foudan Fahim Shaltout Professor of anesthesiology, faculty of medicine, Cairo University, for her constructive guidance and general help in accomplishing this work.

I am greatly honored to express my sincere appreciation to Ass. Prof. Dr Nevine Mahmoud Gouda ,Assistant Professor of anesthesiology, faculty of medicine, Cairo University, for her continuous support, direction and meticulous revision of this work.

I owe a particular dept of gratitude to Ass. Prof. Dr. Maha Gamil Hanna, Assistant Professor of anesthesiology, faculty of medicine, Cairo University, for her valuable help, support and guidance.

Abstract

Providing perioperative care to infants and children undergoing thoracoscopic surgery presents a great challenge to the anesthesiologist.

Minimal access surgery does not mean minimally invasive anesthesia. A thorough knowledge of the physiology of one lung ventilation, meticulous planning, continuous vigilance to detect any untoward event at the earliest and good communication between the anesthesiology and surgical teams all contribute to a safe and successful surgery.

It is important to understand the physiology of lung ventilation and perfusion during surgery, monitoring requirements, appropriate anesthetic techniques, and methods of providing single lung ventialtion safely and effectively. Methods of postoperative analgesia are also important in managing pediatric patients undergoing thoracic surgery.

Key words

Management – Thoracoscopi c - Surgery - Newborn

Abbreviations

ACT	**Activated clotting time**
BB	**Bronchial Blocker**
$CaCl_2$	**Calcium chloride**
CT	**Computerized tomography**
CCAM	**Congenital cystic adenomatoid maiformaion**
CDH	**Congenital diaphragmatic hernia**
CLE	**Congenital lobar emphysema**
CNS	**Central nervous system**
COTA	**Coarctation of the aorta**
CO_2	**Carbon dioxide**
CPAP	**Continuous positive airway pressure**
CVP	**Central venous pressyre**
DLT_S	**Double lumen endo-tracheal tubes**
EA-TEF	**Esophageal atresia and trachea-esophageal fistula**
ECG	**Electrocardiogram**
ECMO	**Extra-corporeal membrane oxygenator**
ELMA	**Eutectic mixtures of local anesthetics**
ETT	**Endotracheal tube**
FB	**Foreign body**
FRC	**Functional residual capacity**
FiO_2	**Fractional ratio of inspired oxygen**
GA	**General Anesthesia**
HPV	**Hypoxic pulmonary vasoconstriction**
ICU	**Intensive care unit**
ID	**Internal diameter**
ILD	**Interstitial lung disease**
IPA	**Intra pleural analgesia**
IMV	**Intermittent mandatory ventilation**
IM	**Intramuscular injection**
IV	**Intravenous injection**
Kg	**Kilogram**
LDP	**Lateral decubitus position**
MAC	**Minimal alveolar concentration**
MAP	**Mean arterial pressure**
Mg	**Milligram**
Ml	**Milliliter**
MmHg	**Millimeter mercury**
MmH_2O	**Millimeter water**
MR-MRI	**Magnetic resonance image**
PACU	**Post anesthetic care unit**

PaO_2	**Partial oxygen tension in the blood**
$PaCO_2$	**Partial tension of carbon dioxide in the blood**
PCA	**Patient controlled analgesia**
PDA	**Patent ductus arterisus**
PEEP	**Positive end-expiratory pressure**
PFC	**Persistent fetal circulation**
PG	**Prostaglandins**
RDS	**Respiratory distress syndrome**
SVCO	**Superior vena cava obstruction**
SLV	**Single lung ventilation**
TEE	**Trans-esophageal echo**
VATS	**Video-assisted thoracoscopy**
ZEEP	**zero end-expiratory pressure**

List of tables

List of figures

Content

Chapter 1

Special Anatomical and Physiological Features in Pediatrics

Special Anatomical and Physiological Features in Pediatrics

An anesthetic workstation to be used for pediatric anesthesia has to meet numerous requirements and must take into consideration the special physiological aspects of the various age groups of children, from premature babies to school children. Children are not simply to be considered "little adults". They differ from adults anatomically, physiologically, psychologically, and biochemically. These differences are especially marked when comparing premature infants and neonates to adults, and they only begin to recede around a child's tenth year.

Breathing and respiratory system

Anatomical Fundamentals of the Respiratory Tract

Knowing the differences between the respiratory tract of a child and that of an adult is essential for anesthetists in order for them to safely administer anesthesia.

• A child's nostrils, oropharynx and trachea are relatively narrow. Breathing can be hindered by irritation of the mucous membrane due to edema buildup in this area.

• The trachea is short – it only measures approximately 4cm from the larynx to the carina – and has a narrow diameter of 5 mm.

• The tongue is relatively large and tends to fall backwards under anesthesia.

• Neonates, infants and small children have a very soft thorax compared to their lungs. The thorax is relatively short. The ribs run horizontally and not diagonally, as is the case with adults. The intercostal muscles are immature.

• The salivary secretions of children are more pronounced than those of adults.

• The larynx of a child is more ventrally located and on level with the third to fourth (neck) vertebrae, thus about a whole vertebrae higher than that of an adult. Until the age of 8 to 10 years, the most narrow point is a very sensitive mucous membrane at the level of cricoid cartilage and not, as in the case with adults, at the glottis.

• The epiglottis is relatively large and shaped like a U.

• The size of the tonsils and the adenoid in children can complicate the intubation process.

• Infants breath through their nose until they reach an age of 5 months[1, 2].

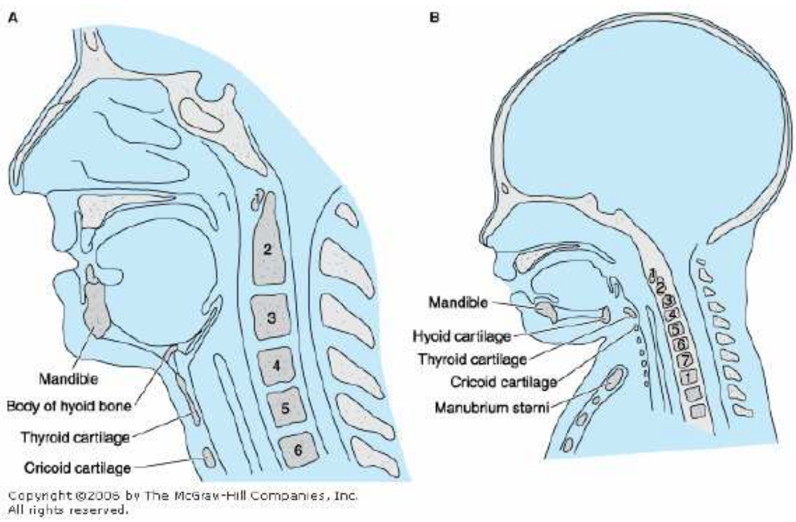

Figure 1: Sagittal section of the adult (A) and infant (B) airway[1].

Controlling the Respiratory Process

The respiratory process of both premature newborns and neonates, like that of adults, is essentially controlled by changes in $paCO_2$; paO_2 and pH. The hypoxia breathing regulation of newborns is not, however, fully developed; right after birth, the oxygen receptors and their functions are immature. The $paCO_2$ and paO_2 values of newborns and infants are lower than those of adults until the end of their first year[3].

Premature infants often experience respiratory arrest (apnea) either at regular (periodical breathing) or irregular intervals. Periodical breathing is considered an episode of 3 or more respiratory pauses of at least 3 seconds. Apnea phases can be due to a central problem (no physical breathing exertion) or, less often, caused by an obstruction (no flow despite physical breathing exertion). In addition, there are mixed forms of both. Nevertheless, these breathing abnormalities are not usually dangerous. Respiratory arrest can, however, lead to decreased O_2 partial pressure in the blood and can cause bradycardia if the length of such a phase is longer than 30 seconds[3].

Infants react to hypoxia biphasically. First there is a 30 second increase in minute volume, followed by hypoventilation or apnea. If hypothermia or hypoglycemia occurs simultaneously, hypoventilation is the immediate result. An adequate reaction to lack of oxygen on the part of the child can only be observed 2 to 4 weeks after birth[3].

The breathing regulation of premature newborns and neonates continues to be influenced by pulmonary compliance. Compliance triggers breathing reflexes via the mechanoreceptors. The most well-known reflex is the inspiratory repressive Hering-Breuer reflex which is especially noticeable in premature babies (born between the thirty-second and thirty-eight week of pregnancy) with little pulmonary compliance. This effect decreases as the neonate matures. Ventilating with high tidal volume, which may cause the lungs to overinflate, leads to an inhibition of reflexes in the central breathing system's inspiratory neurons and, thus, to an interruption and extension of the expiratory phase. It is thought that this reflex protects the system from respiratory fatigue caused by ineffective muscle work and from volutrauma[1,2].

Respiratory Mechanics

A newborn's pulmonary compliance (or elasticity) is very low and does not differ greatly from the total compliance (i.e. compliance of the lungs and thorax). A newborn's thorax is substantially more elastic than an adult's and offers little resistance to e.g. over inflation. As a child grows older, the total compliance increases (Table 1).

	Newborns	Infants	Small children	School-aged children
Age	1 to 29days	Up to 1year	2 to 5 years	6to 14years
Weight	2.5 to 5 kg	5 to 10 kg	10 to20 kg	>20 kg

Compliance (ml/mbar)	5	10 to 20	20 to 40	100

Table 1: The relationship between age and compliance[3]

In newborns and infants, the diaphragm does almost all the work expended for breathing. Abdomen hindrances, for example due to intra-abdominal pressure, can lead to insufficient spontaneous breathing[3].

Pulmonary compliance can be reduced due to many causes, for example:

- Parenchyma changes
  - Bronchopneumonia
  - Pulmonary edema
  - ARDS
  - Fibrosis
- Functional surfactant disorders
  - Alveolar pulmonary edema
  - Atelectasis
  - Aspiration
  - RDS/ARDS
- Reduced volume
  - Pneumothorax
  - Raised diaphragm[3]

Pulmonary Volumes

Relative to its size, the volume of a child's lung is equivalent to that of an adult's. An infant born after a full term pregnancy has a total lung capacity of approximately 160 ml, a functional residual capacity of 80 ml and a tidal volume of approximately 16 ml. One-third of the tidal volume is equal to the dead space volume. The proportion, dead space volume to tidal volume, remains constant for spontaneously breathing children, it can, however, increase during controlled ventilation. In order to keep total dead space volume to minimum, accessories of the anesthetic systems should be operated using the smallest