General Anesthesia for Pediatric Laparoscopic Surgery

Essay

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Wadah Ahmed Ata Mohamed

Contents

List of Abbreviations

Abbr.	Full term
ASA	: American Society of Anesthesiologists
CNS	: Central nervous system
CO_2	: Carbon dioxide
ECF	: Extracellular fluid
ETco2	: End-tidal CO_2
FRC	: Residual capacity
GI	: Gastrointestinal
IAP	: Intra-abdominal pressure
ICF	: Intracellular fluid
ICP	: Intracranial pressure
IVC	: Inferior vena cava
LMA	: Laryngeal mask airway
NPO	: Nothing by mouth
PEEP	: Positive end-expiratory pressure
PICU	: Pediatric Intensive Care Unit
PONV	: Postoperative nausea and vomiting
REE	: Resting energy expenditure

List of Tables

List of Figures

Figure No.	Title	Page No.

Abstract

Background: Although laparoscopy has been available since it was first described by Kelling in 1923, only in the last decade it has found applications in pediatric surgery. **Aims of the essay:** to present an overview on pediatric laparoscopy, to display the physiological changes during pediatric laparoscopy, to review the anesthetic management and complications during pediatric laparoscopy. There is a perception associated with an improved cosmetic result, reduced postoperative hernias, less wound infections, a lower incidence of postoperative ileus, and less postoperative pain. The premature and term neonates present the greatest differences in anatomy and physiology from adults. Children also have different psychological needs. This assay describes the physiological changes produced by laparoscopy in children and the anaesthetic considerations for laparoscopic procedures in the paediatric patient population. Once the diagnosis is made, laparoscopic techniques can help to treat the condition (e.g., unwinding adnexal torsion, appendectomy, adhesiolysis, resection of Meckel's diverticulum, or even removal of a pheochromocytoma. Anaesthetic management is complicated by the major physiologic effects of the pneumoperitoneum and patient positioning. Modifications in anaesthetic technique might be required to allow this novel operation to be performed safely.

Key words: laparoscopy, pneumoperitoneum, anaesthetic technique, premature and term neonates

Introduction

Although laparoscopy has been available since it was first described by Kelling in 1923, only in the last decade it has found applications in pediatric surgery. As expertise and equipment have improved, an increasing number of young children now present for laparoscopic intervention ***(Harrison, 2006).***

As in adults, the laparoscopic approach to pediatric surgery has been marketed through claims of reducing hospital costs, allowing earlier discharge and a more rapid return to normal diet and full activity**.** There is a perception associated with an improved cosmetic result, reduced postoperative hernias, less wound infections, a lower incidence of postoperative ileus, and less postoperative pain ***(Holcomb et al., 2001; Newman et al., 2001; Sigman et al., 2001).***

Laparoscopy permits inspection of the abdominal and pelvic organs and the intraperitoneal space with cameras without disturbing the anatomic relationships of these structures. The premature and term neonates present the greatest differences in anatomy and physiology from adults. Children also have different psychological needs ***(Goel, 2005).***

In addition to the routine anaesthetic considerations for the individual patient, the choice of the anaesthetic technique in these patients should consider changes in haemodynamic and respiratory functions induced by the pneumoperitoneum and carbon dioxide (CO_2) insufflation. This assay describes the physiological changes produced by laparoscopy in children and the anaesthetic considerations for laparoscopic procedures in the paediatric patient population ***(Bannister et al., 2003).***

Laparoscopy can be a diagnostic procedure in children (e.g., to evaluate the undescended testis, as part of the evaluation of intersex, in the diagnosis of the acute abdomen, and in staging pediatric cancer). Once the diagnosis is made, laparoscopic techniques can help to treat the condition (e.g., unwinding adnexal torsion, appendectomy, adhesiolysis, resection of Meckel's diverticulum, or even removal of a pheochromocytoma ***(Clements et al., 2009)***.

Small controlled studies of laparoscopic appendectomy and fundoplication in children have been published ***(Sfez et al., 2005).*** These have helped to identify the benefits and drawbacks of this surgical technique ***(Lejus et al., 2006).***

With the laparoscope, even large, solid intra-abdominal masses such as the kidney or spleen can be removed after the tissue has been morcellated. As experience has increased, a variety of more sophisticated procedures are now possible (e.g., colectomy, "pull-through" for Hirschsprung's disease, pyeloplasty, and treatments for, " vesicoureteral reflux, gut malrotation, and choledochal cysts) ***(Georgeson, 2008).***

Anaesthetic management is complicated by the major physiologic effects of the pneumoperitoneum and patient positioning. Modifications in anaesthetic technique might be required to allow this novel operation to be performed safely. As more procedures are performed laparoscopically, knowledge of these physiologic changes and how to deal with has become fundamental to safe practice, especially when they are applied to sicker patients ***(Clements et al., 2009)***.

Aim of the Study

The aims of this essay are to present an overview on pediatric laparoscopy, to display the physiological changes during pediatric laparoscopy, to review the anesthetic management and complications during pediatric laparoscopy.

Chapter (1)
Anatomical and Physiological Differences between Adults and Pediatrics

A) Respiratory system:

(1)The upper airway:

In infants, the tongue is relatively large compared with the rest of the airway (figure 1). Infants usually are described as having an anterior, cephalic-displaced glottis, with the airway forming an inverse cone (figure 2).

The narrowest segment of the airway is at the cricoid cartilage and remains so until puberty.

The epiglottis in small children is relatively larger, longer, more curved (omega shaped), and floppy compared with that in adults. Maturation begins to occur at age 2 years, and the adult configuration is achieved sometime near puberty ***(Steward and Lerman, 2001).***

These anatomic differences in the airway have a major effect on which intubation techniques will be useful in children. For example, a straight laryngoscope blade (e.g., Miller blades) that can lift directly the epiglottis out of the larynx during glottic visualization is useful in children ***(Steward and Lerman, 2001).***

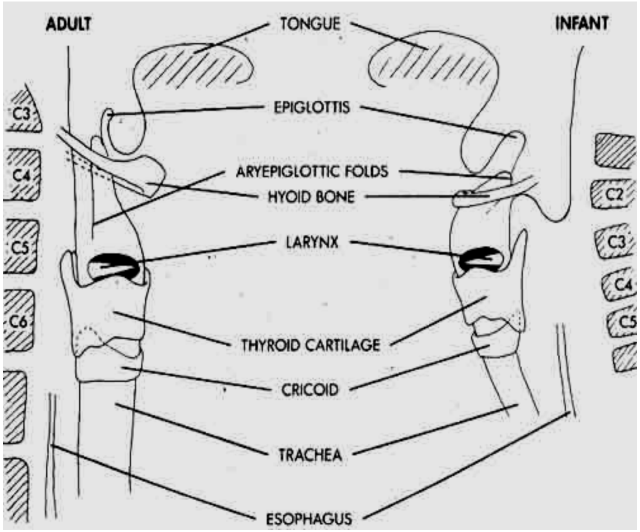

Figure (1): Diagram of a coronal section through the airway of an infant. Areas where there are important differences from adults are shown ***(Greg and Joy, 2005).***

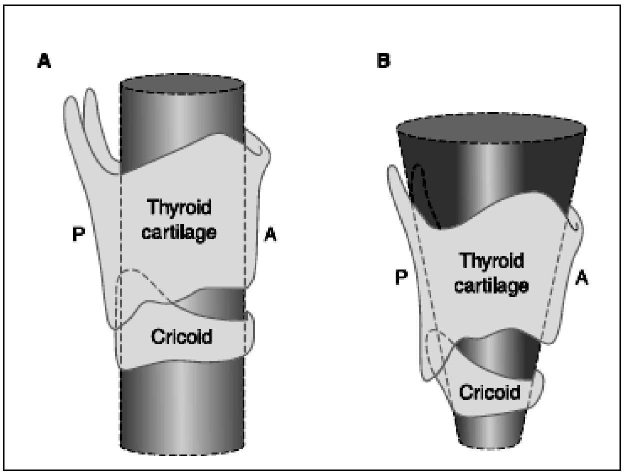

Figure (2): Schematic of an adult (**A**) and infant (**B**) airway. Note the comparison between the cylindrically shaped airway with uniform diameters in the adult and the conically shaped airway of the child with the narrowest region at the cricoid. A, anterior; P, posterior ***(Randall, 2007).***

(2) Airway caliber:

Airway caliber undergoes continuous developmental change from the nares to the small airways. Although airway branching has been completed by birth, the caliber of the airways continues to increase.

Airway resistance decreases approximately 15 times from infancy to adulthood, with a dramatic change occurring near age of 8 years. This decrease in resistance with increasing age largely results from an increase in diameter of the small airways ***(Stoll and Kliegman, 2004).***

(3) Respiratory mechanics:

The airway of an infant is highly compliant and poorly supported by surrounding structures. The chest wall is also highly compliant, so the ribs provide little support for the lungs; that is, negative intrathoracic pressure is poorly maintained. Thus, each breath is accompanied by functional airway closure ***(Cote, 2005).***

(4) Respiratory muscle characteristics:

Respiratory muscle does not reach the adult pattern of distribution until approximately 2 years old.

In neonates, oxygen consumption is double that seen in adults. Increased oxygen consumption is the major cause of the rapidity of desaturation in infants and small children ***(Greg and Joy, 2005).***