Introduction

Pediatric anesthesia involves patients ranging from preterm infants to teenagers, and these groups require different anesthetic equipment and techniques. Successful and safe anesthetic management in pediatric patients depends on an appreciation and clear understanding of the physiological, anatomic, pharmacological and psychological differences among the pediatric age groups and between pediatric and adult patients. Changes in the airways, cardiovascular system, renal function, central and autonomic nervous system, gastrointestinal system and thermoregulation that take place during development make anesthetic management different and extremely challenging. Pediatric anesthesia management requires an understanding and knowledge of the differences and characteristics unique to the child and infant. Infants and children have unique anatomic, physiological, pharmacological, and psychological issues relating to perioperative management [1].

Pediatric Airways

We briefly discuss the functional characteristics of the developing airway, the impact of mechanical ventilation on airway function, and the clinical assessment of airway function in neonates and children [2].

The differences in anatomy of the pediatric airway are related to the prominence and size of the occipital bone, relative macroglossia, the narrowness of the nasal passages, and anterior and cephalic larynx (at C3-C4 vertebral level), and the larger, longer and omega-shaped epiglottis. The cricoid cartilage (subglottis) is the narrowest point of the airway in children under 5 years of age. So, 1 mm of edema will have a proportionately greater effect in children because of their smaller tracheal diameter. Also, due to the shorter length of the trachea endobronchial intubation and accidental extubation with head movement are more common.
Due to the large occiput, a small pillow placed under the occiput will flex the head on the neck instead of extending it for the sniffing position. Thus it is preferable to place a pad under the neck and shoulders, with a large ring under the occiput to stabilize the head to help achieve the optimum head position for laryngoscopy.

Regarding the physiology of the respiratory system, the respiratory rate in children is three times that in adults, alveolar ventilation is high (double that in adults), and the functional residual capacity (FRC) is minor [3]. Oxygen consumption in the neonate is almost twice the adult value (newborn 4–6 ml/kg per minute, adult 2 ml/kg per minute). This is seen as increased minute ventilation (200 ml/kg per minute) in the newborn as compared to 100 ml/kg per minute at puberty. As tidal volume remains constant at 7 ml/kg through life, an increase in ventilation occurs by an increase in respiratory rate, which is approximately 30 per minute at birth progressively falling to adult values by adolescence. In young infants the FRC during complete relaxation (central apnea, general anesthesia, use of muscle relaxants) decreases to 10–15% of total lung capacity. This low FRC is caused by low closing capacity and results in atelectasias, ventilation/perfusion imbalance, and hemoglobin desaturation.

The small diameter of the airways results in high resistance. Infant airways are highly compliant and poorly supported by the surrounding structures. The chest wall is also highly compliant, so that the ribs provide little support to the lungs. Therefore negative intrathoracic pressure is poorly maintained so breathing work is approximately three times that in the adult.

Another difference concerns the composition of the respiratory muscles: type I muscle fibers which are fatigue-resistant and able to perform repeated exercise are deficient in the newborn and infant. Adult fiber configuration is reached only by approximately 2 years of age. So any factor increasing the work of breathing contributes to early fatigue of the respiratory muscles [4]. The fatigue can lead to apnea or carbon dioxide retention and respiratory failure.

Prematurely born infants, especially those with a history of apnea, are at risk (20 to 40%) of developing postoperative apnea. Apnea occurs mostly during the first 12 hours of the postoperative period, especially in the presence of certain risk factors which include postconceptual age <60 weeks, prematurity, anemia, and continuing apnea. Finally, the central coordination of breathing function is completed only after 3–5 months of extrauterine life. Neither the hypoxic nor the hypercapnic ventilatory drive is well developed in neonates and infants.

Immature respiratory control combined with an increased susceptibility to fatigue of the respiratory muscles may be responsible for the increased risk of postoperative apnea especially in preterm infants with a gestational age less than 46 weeks. For all these reasons respiratory reserve and apnea tolerance are strongly reduced and hypoxia may suddenly appear and quickly worsen.