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Anatomical and Physiological changes in pediatrics

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Pediatric anatomical and Physiological changes ..

Several anatomical and physiological changes impact the effects and techniques of anesthesia administration. Pediatric patients can be divided into four groups based on age:

1. Newborn: from birth to the first 24 hours.
2. Neonate: from 1 to 30 days of life.
3. Infant: from 1 month to 12 months of age.
4. Child: from 1 year to the onset of puberty.

Cardiovascular Physiology..

Cardiac output for a neonate is 30-60% greater than an adult. This helps meet the increased oxygen consumption requirements. Cardiac output in the pediatric patient is dependent on heart rate. Monitoring of the pediatric patient's heart rate can be accomplished with a precordial stethoscope, ECG, and pulse oximetry. Prompt recognition and treatment of bradycardia are critical.

Bradycardia..

(a)less than 120 beats per minute in neonates.

(b)less than 100 beats per minute in infants aged 1-12 months.

(c) less than 80 in children 1-8 years.

The most common cause of bradycardia in pediatrics is:

1. Hypoxia
2. Vagal stimulation (suctioning, surgical traction, etc.).
3. An overdose of anesthetic medications.
4. Hypothermia.
5. Increased intracranial pressure.

The blood volume of the pediatric patient is highest as a neonate and declines with age. Knowledge of the approximate blood volume is important when calculating total blood volume and estimated blood loss. e.g., a 4 kg neonate's total blood volume would be calculated as follows: 4(kg) X 85 (ml/kg) = 340 ml total blood volume.

Age	Newborn	Neonate	Infant	Child
Blood volume	90-100	85	80	75

Pulmonary Physiology and Airway Anatomy

functional reserve capacity is much smaller in infants and neonates, during anesthesia, airway obstruction can result in hypoxia very quickly. For this reason, pulse oximetry is essential. Induction and emergence are especially critical periods to monitor for these complications. Oxygen consumption for a neonate is two times greater than that of an adult.

The anatomy of the pediatric airway is different compared to an adult:

*The pediatric patient is prone to airway obstruction related to a proportionally larger head, short neck, and large tongue.

*Infants and neonates exchange air primarily through their nasal airways. The larynx is higher in the infant and child (cervical vertebrae 3-4) than in the adult (cervical vertebrae 5-6).

*The epiglottis is large, stiff, and U-shaped. The trachea is short, and the right main bronchus is less angled. This increases the risk of a right mainstream intubation.

*Choosing the correct-size endotracheal tube and approximate length of insertion is important. This can also be accomplished by simple calculation The equation that can be used (4 + Age/4)

*The calculation for the correct endotracheal tube depth insertion is to multiply the diameter of the endotracheal tube by 3.

Temperature Regulation..

Neonates and infants can rapidly lose heat, even in warm environments. They are at greater risk for hypothermia than adults due to:

*Relatively high surface-to-volume ratio.

* High metabolic rate.

*Insufficient body fat for insulation.

Infants less than 3 months do not shiver to generate heat. It is important to take steps to minimize heat loss including a warm operating room, warm blankets, or a heating blanket. Monitoring the patients' temperature before, during, and after the anesthesia is important to detect abnormal drops or increases in temperature.

Pharmacology in Pediatrics.

Pediatric patients respond differently to anesthetic medications when compared to adults. This is due to physiological differences that include:

*Increase extracellular fluid.

*Decrease skeletal mass.

*Increase metabolic rate.

* Decrease renal function

*Receptor maturity.

Inhaled Anesthetics..

Uptake, distribution, and potency of volatile anesthetics are different in neonates and infants than in adults. Induction of general anesthesia occurs faster in neonates and infants. Emergence also occurs faster. The differences between adult and pediatric patients during induction and emergence are:

1. Smaller functional residual capacity (smaller lung volume).

2. Greater blood flow to the vessel-rich tissues such as the brain, heart, liver, and kidneys .

*infants and neonates, the vessel-rich tissues comprise about 22% of total body weight ,In adults, the vessel-rich soft tissue compose about 10% of the total body weight.

MAC varies according to the age of the patient..

*In general, MAC is lower in neonates than in infants. MAC increases until about 2-3 months of age, peaks during infancy, and then steadily declines.

*During puberty, there is a brief increase in MAC. After puberty, MAC will continue to decline.

Lower MAC requirements for volatile anesthetics in neonates are due to an immature central nervous system.

Agent	Neonates	Infants	Children
Halothane.	0.90	1.2–1.1	0.75
Sevoflurane.	3.2	3.2	2
Isoflurane.	1.6	1.9–1.8	1.2
Desflurane.	9–8	10–9	6

Approximate MAC 1 values for pediatric patients reported in % of an atmosphere.*

Intravenous Anesthetic Agents..

Neonates are sensitive to intravenous anesthetic agents. They have an immature blood-brain barrier and a decreased ability to metabolize medications such as opioids and barbiturates In general, lower doses of intravenous anesthetic medications are required to produce the desired effects. There are some generalized exceptions. For example, to induce general anesthesia higher doses of propofol (on an mg/kg basis) are required when compared to an adult

Nondepolarizing muscle relaxants

Neonates and infants may be more sensitive to the effects of nondepolarizing muscle relaxants. The neuromuscular junction of the infant is immature. The duration of action of nondepolarizing muscle relaxants may be prolonged due to immature renal and hepatic systems

Depolarizing muscle relaxants..

Neonates and infants require higher doses, on an mg/kg basis, of succinylcholine than the adult patient. This is due to an increased extracellular volume and volume of distribution.

Agents	Infants (mg/kg)	Children (mg/kg
Succinylcholine.	0.7	0.4
Atracurium	0.25	0.35
Cisatracurium	0.05	0.06
Rocuronium	0.25	0.4
Vecuronium	0.05	0.08

	Premature	Neonate	Infant	Toddler	Small Child	Large Child
Age	0–1 month	0–1 month	1–12 months	1–3 years	3–8 years	8–12 years
Weight (kg)	0.5–3	3–5	4–10	8–16	14–30	25–50
Tracheal (ET)[1] tube (mm i.d.)	2.5–3	3–3.5	3.5–4	4–4.5	4.5–5.5	5.5–6 (cuffed)
ET depth (cm at lips)	6–9	9–10	10–12	12–14	14–16	16–18
Suction catheter (F)	6	6	8	8	10	12
Laryngoscope blade	00	0	1	1.5	2	3
Mask size	00	0	0	1	2	3
Oral airway	000–00	00	0 (40 mm)	1 (50 mm)	2 (70 mm)	3 (80 mm)
Laryngeal mask airway (LMA#)	—	1	1	2	2.5	3

[1]ET, endotracheal tube.

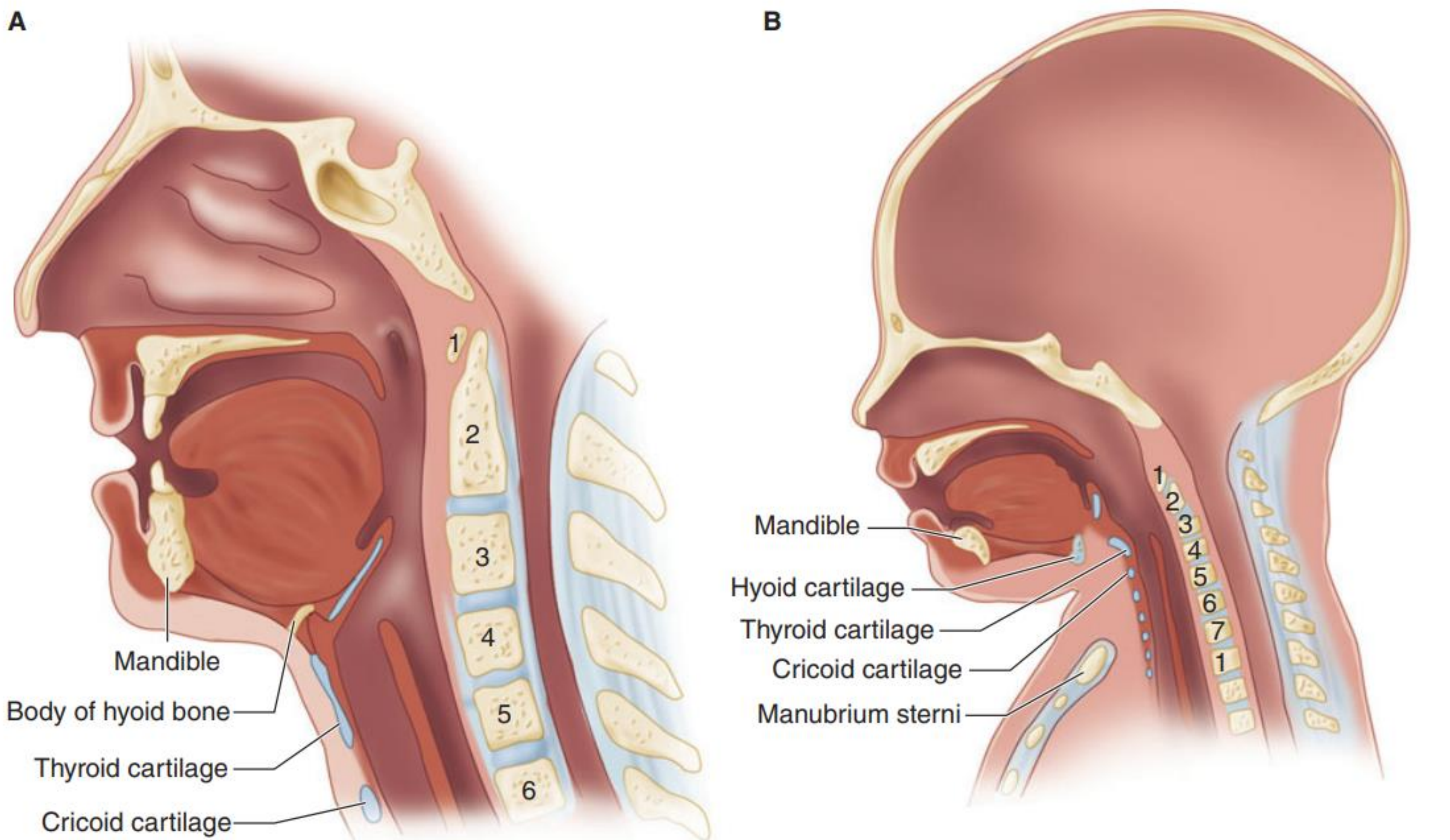

FIGURE 42–1 Sagittal section of the adult (**A**) and infant (**B**) airway. (Reproduced, with permission, from Snell RS, Katz J: *Clinical Anatomy for Anesthesiologists*. Appleton & Lange, 1988.)

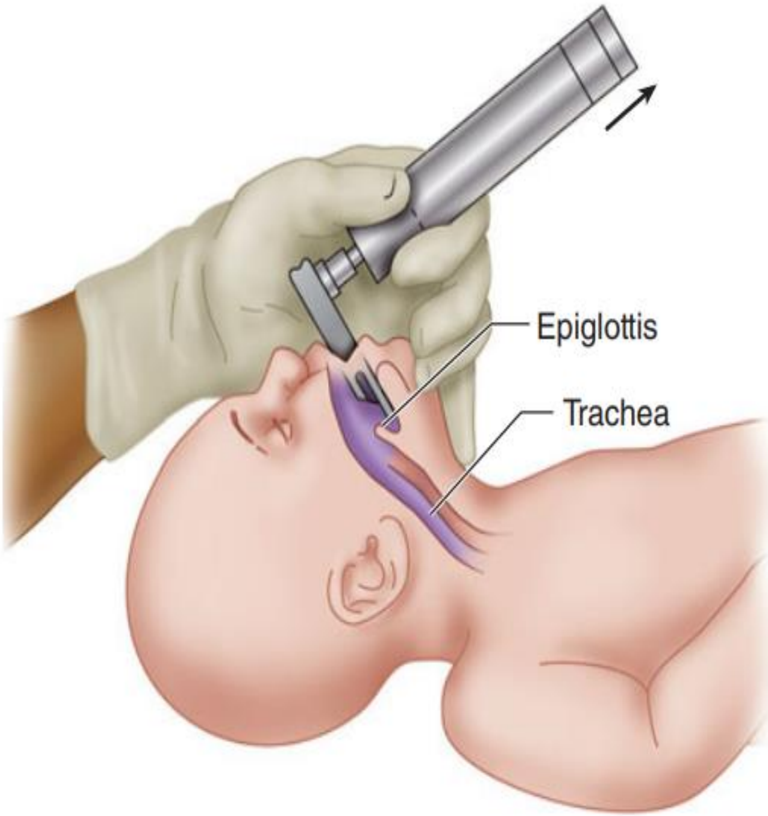

FIGURE 41–6 Intubation of the neonate. The head is placed in a neutral position, and the laryngoscope handle is held with the thumb and index finger as the chin is supported with the remaining fingers. Pressure applied over the hyoid bone with the little finger will bring the larynx into view. A straight blade such as a Miller 0 or 1

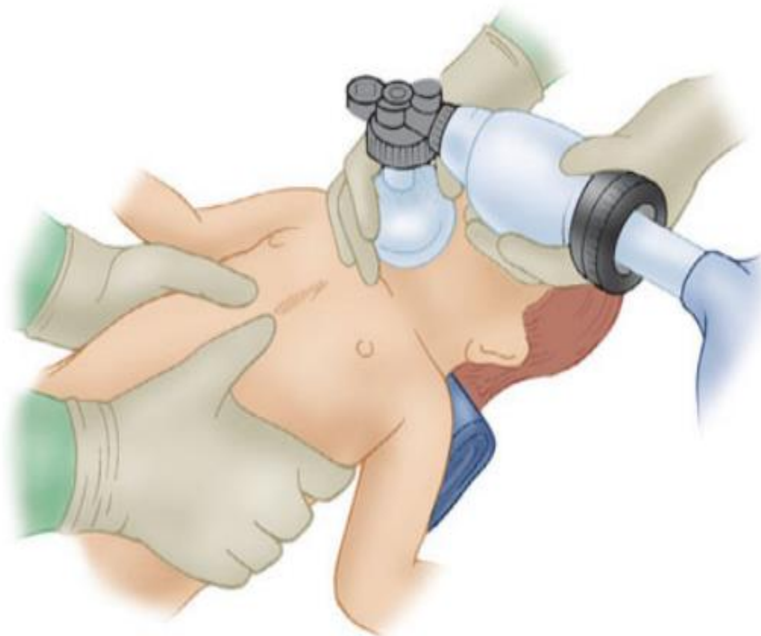

FIGURE 41–7 Chest compressions in the neonate. The neonate is held with both hands as each thumb is placed just beneath a line connecting the nipples and the remaining fingers encircle the chest. The sternum is compressed ⅓ to ¾ in. (1 cm) at a rate of 120/min. (Reproduced with permission from Rudolph CD, et al. *Rudolph's Pediatrics*. 22nd ed. McGraw-Hill; 2011.)