# Pediatric Trauma

# Objectives

- Review ATLS from the pediatric perspective
- Convince you that children aren't simply little adults (especially when it comes to trauma)
- Impress you with my Power Point mastery

# Epidemiology (source Health Canada)

- In kids aged 1-4, up to **50%** of all deaths are due to trauma
- Children aged 15-19 contribute to the greatest number of deaths/yr.
- 1,280 total childhood deaths were related to trauma (1996)
- More than 60% of all trauma deaths are from MVC's
- The head is the most often injured structure
- Head injury almost always coexists with thoracoabdominal trauma (about 80% assoc.)
- 25-35% of trauma deaths are secondary to abuse

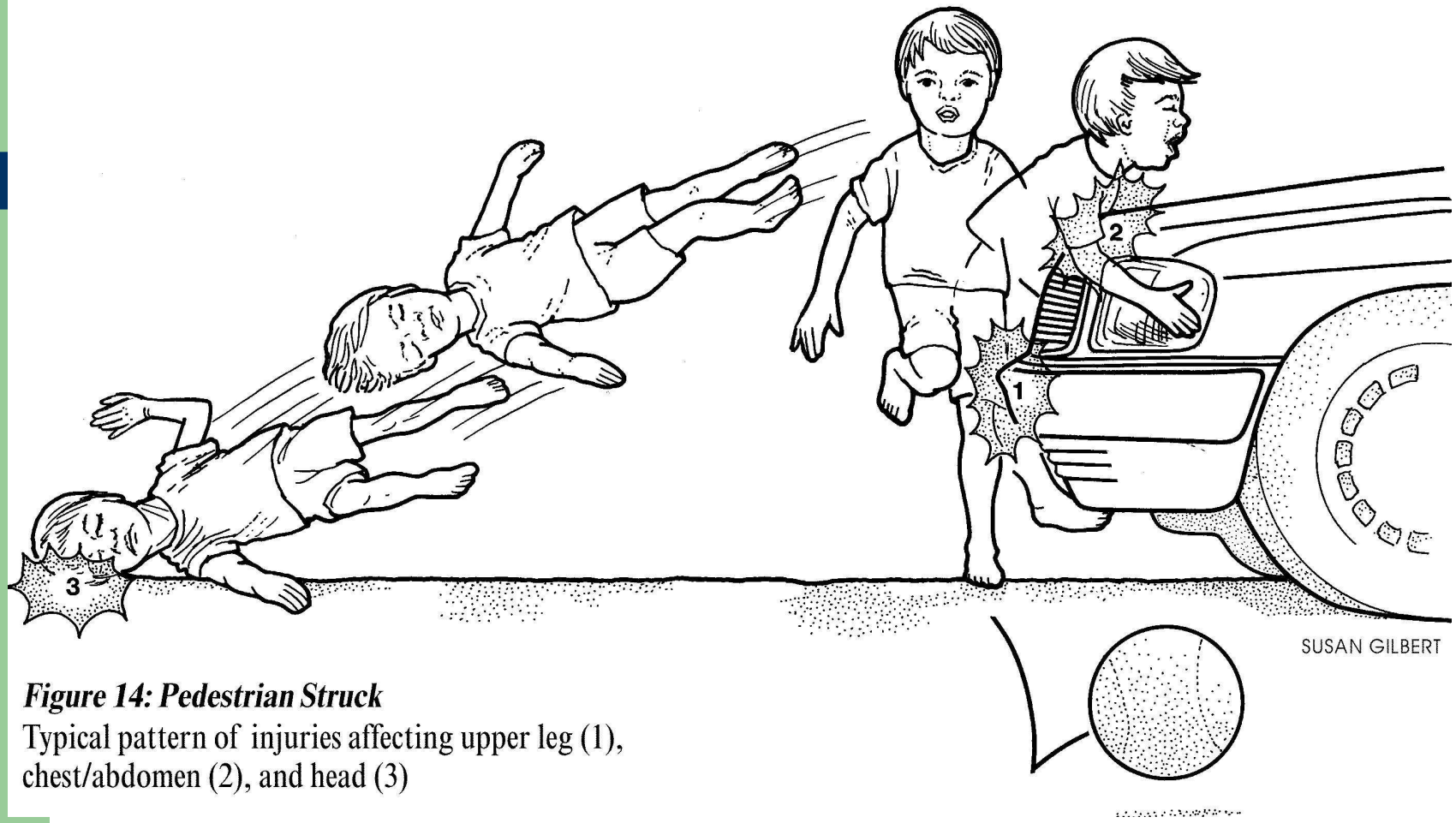



***Figure 14: Pedestrian Struck***
Typical pattern of injuries affecting upper leg (1), chest/abdomen (2), and head (3)

# ATLS Protocol

- Primary Survey
  (ABCDEF)
  -adjuncts to prim. survey
- Secondary Survey
  -adjuncts to sec. survey
- Tertiary Survey

# Pediatric Vital Signs

INFANTS:

- HR: 140-160 bpm
- BP: 60-80 mmHg (SBP)
- RR: 40-60 breaths/min.

PRESCHOOL:

- HR: 120 bpm
- BP: 90 mmHg (SBP)
- RR: 20 breaths/min.

# Pediatric Vital Signs

Approximating normal blood pressure:

Normal SBP = 80 + 2(age)

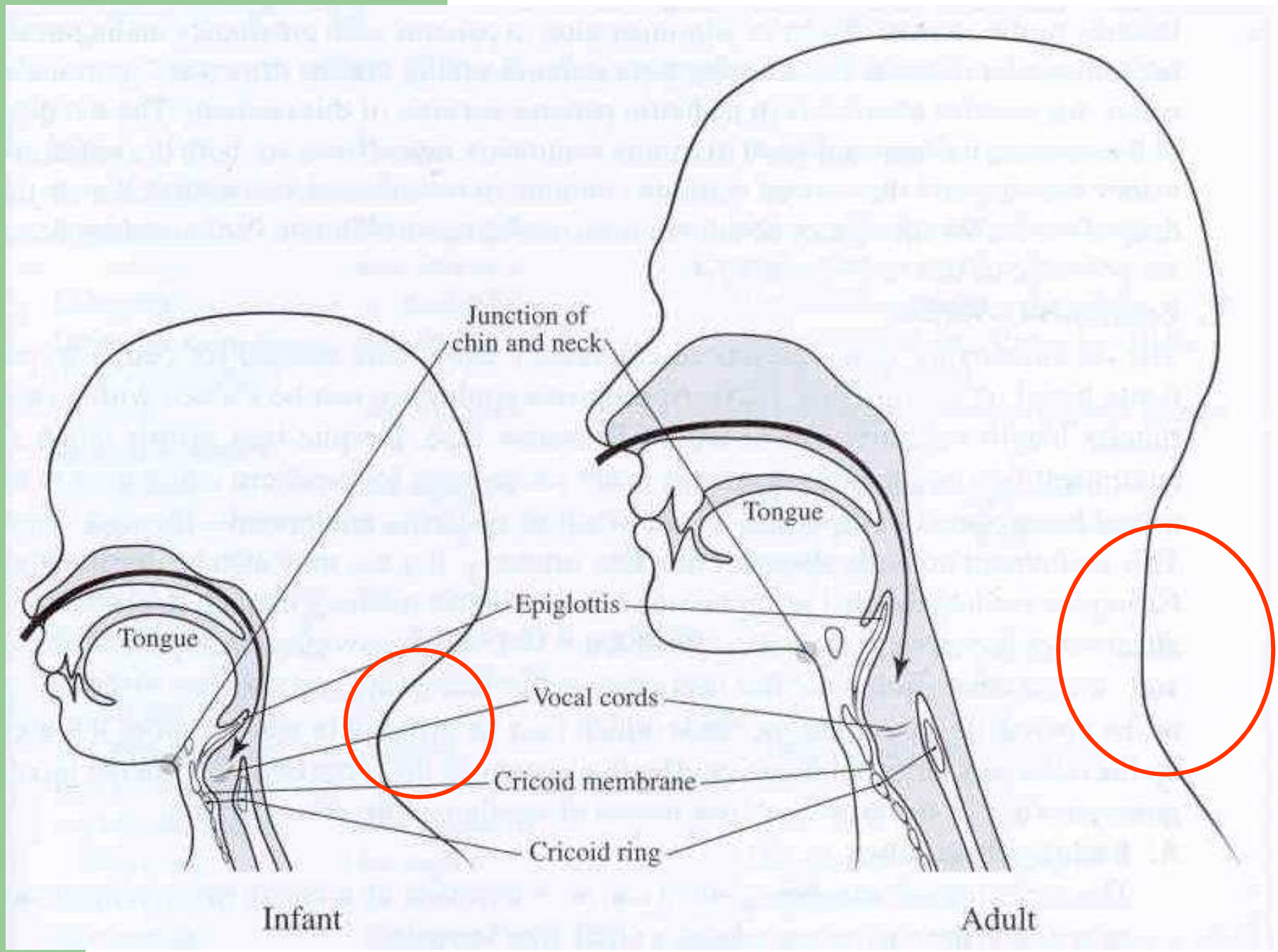
Normal DBP = 2/3(SBP)

# Airway and C-spine Stabilization

- Assess and manage the airway
- Maintain C-spine stabilization
- Recognize the differences in the pediatric airway (compared to adults)

# The Child’s Airway

- Younger than 2 yrs old: airway quite different
- Older than 8 yrs old: airway looks like ours
- 2-8 yrs. old: the “transition period”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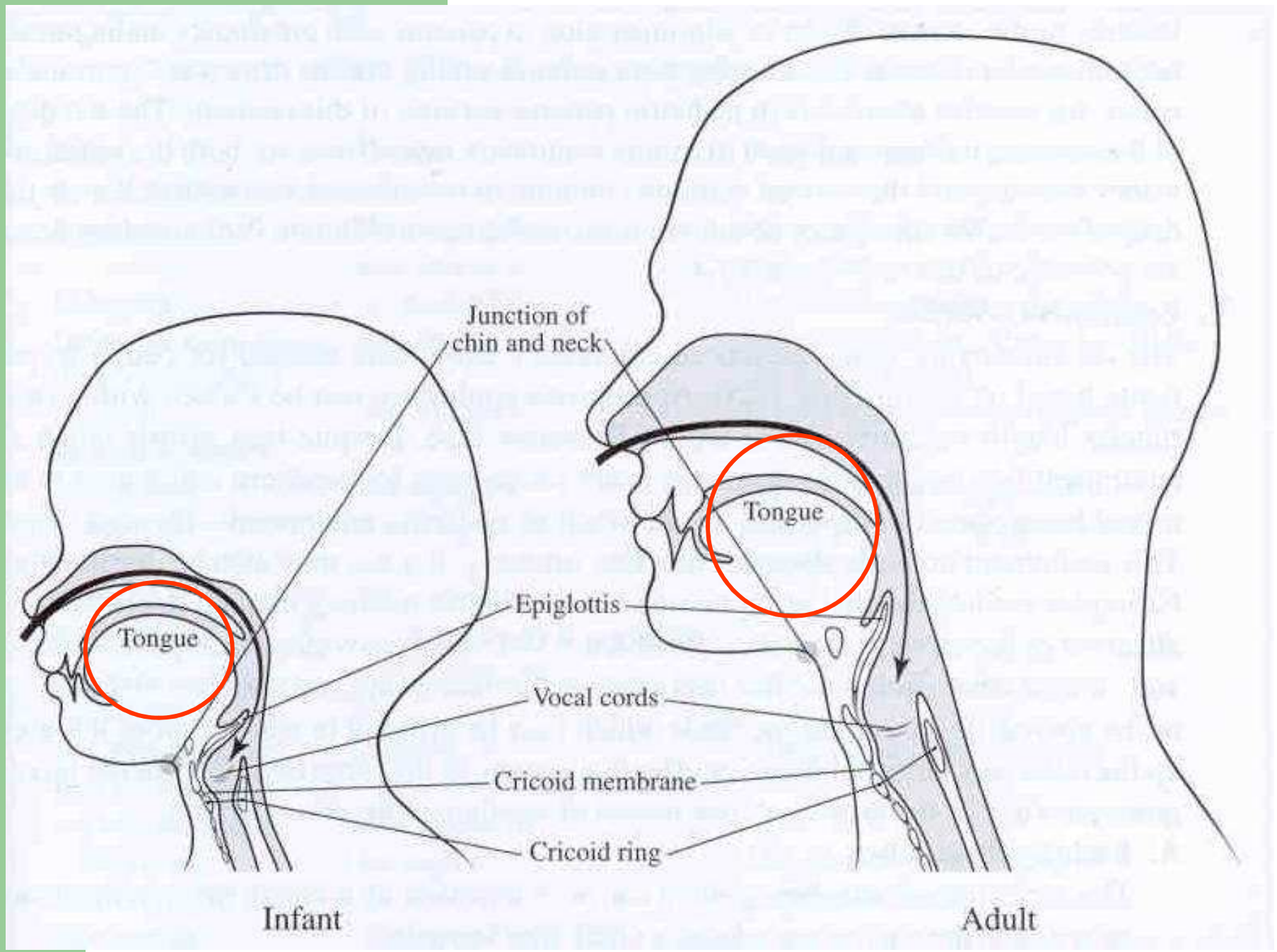
Tongue
Epiglottis
Vocal cords
Cricoid membrane
Cricoid ring
Tongue
Infant
Adult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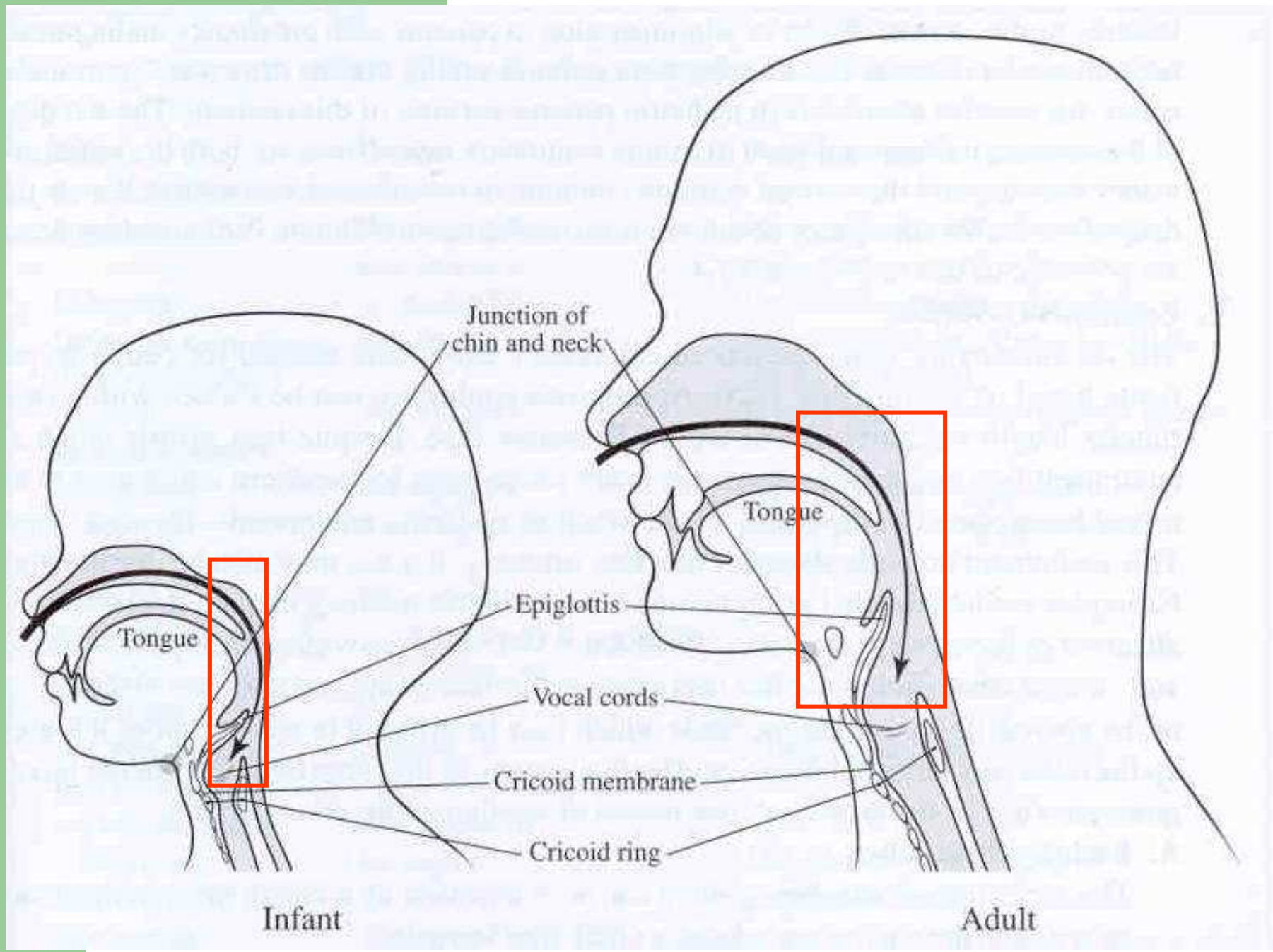
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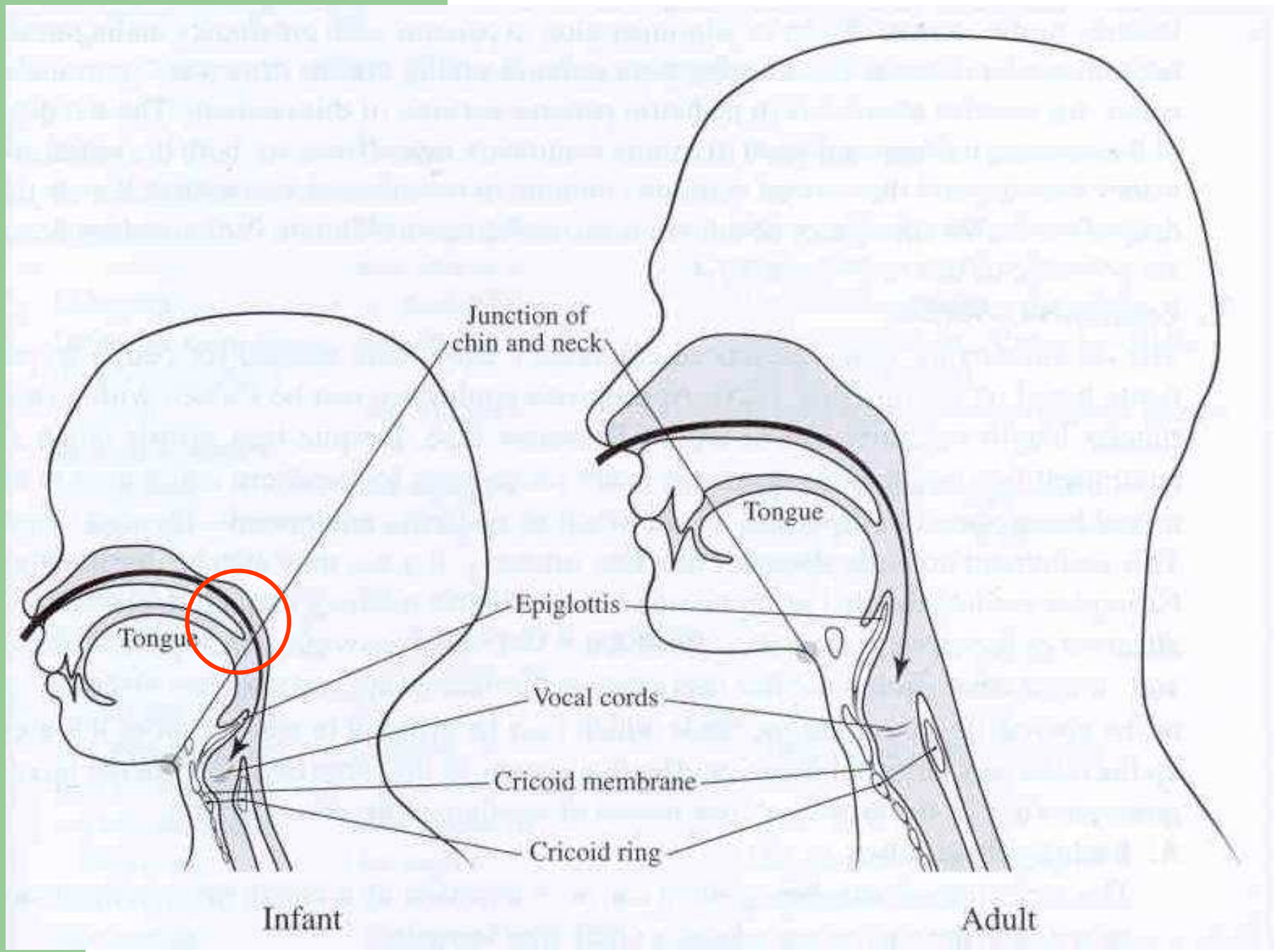
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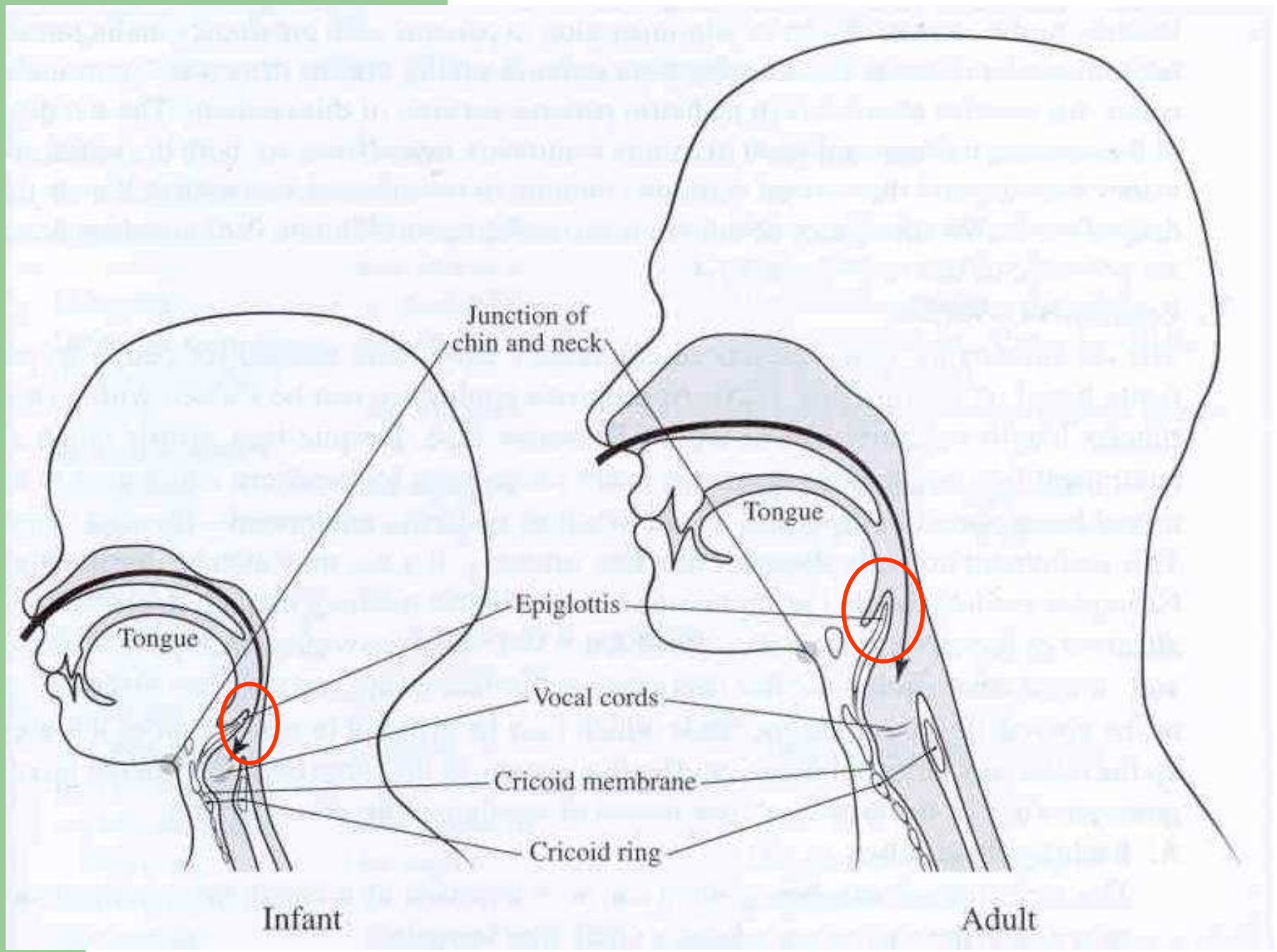
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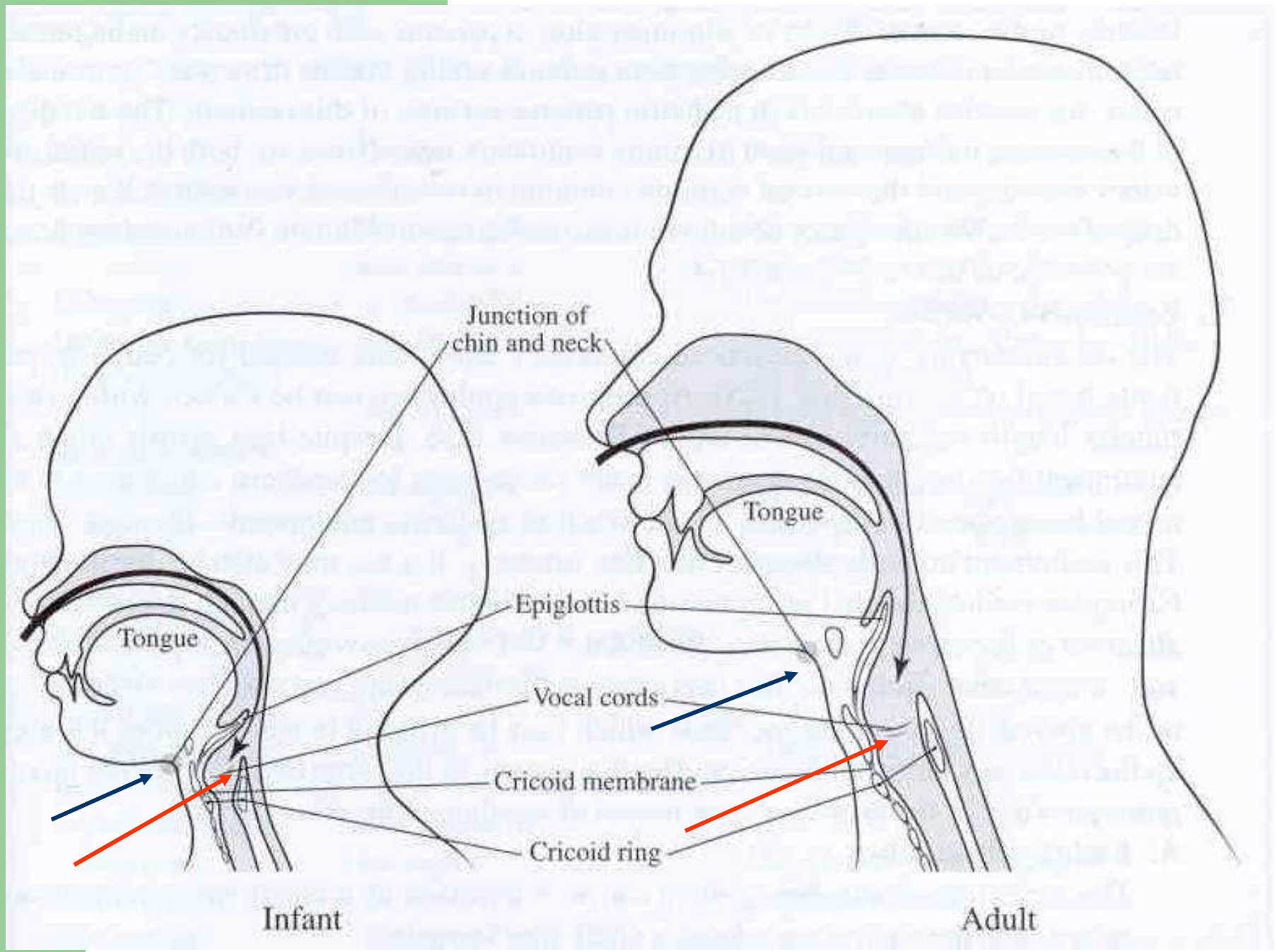
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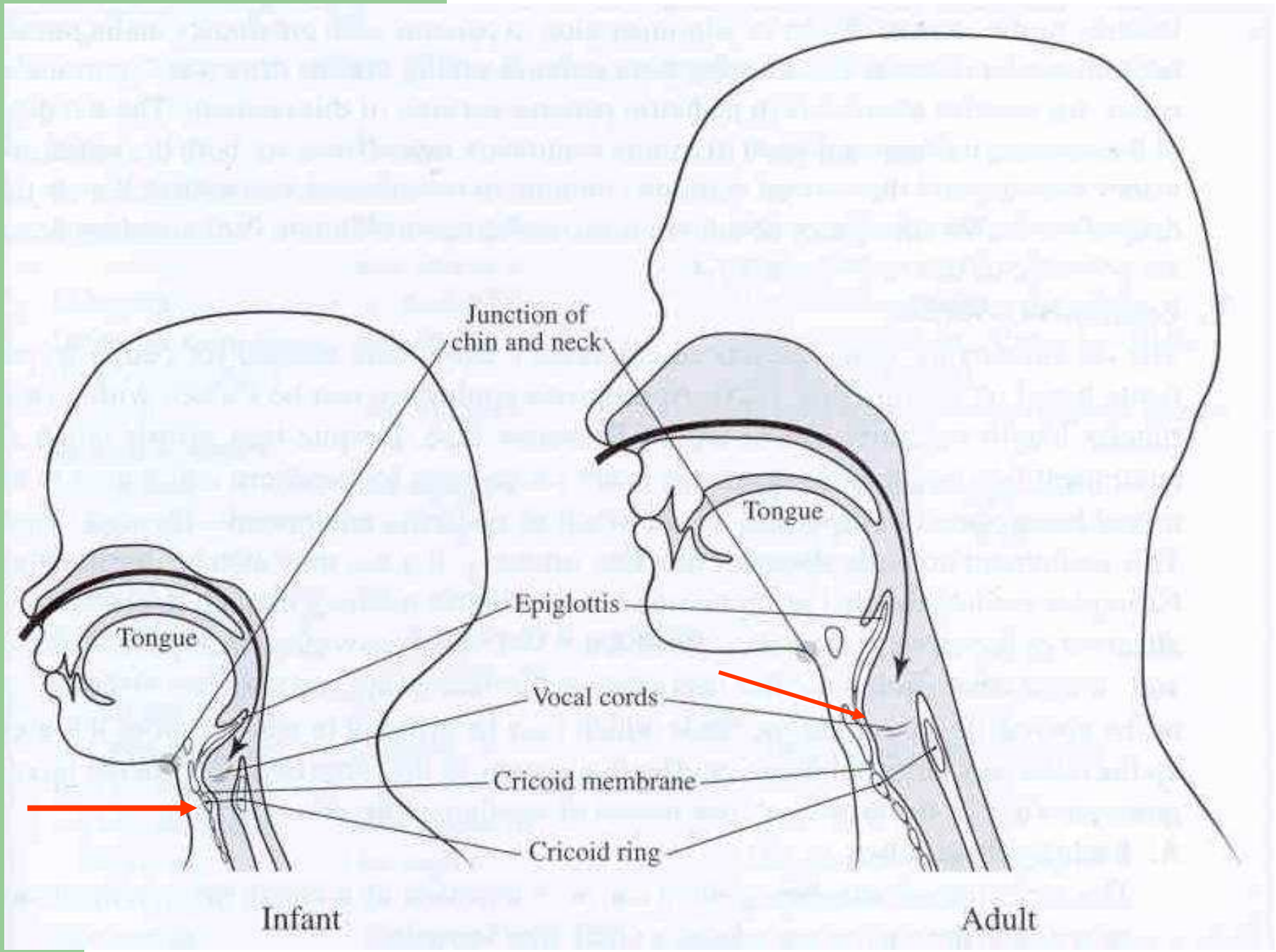
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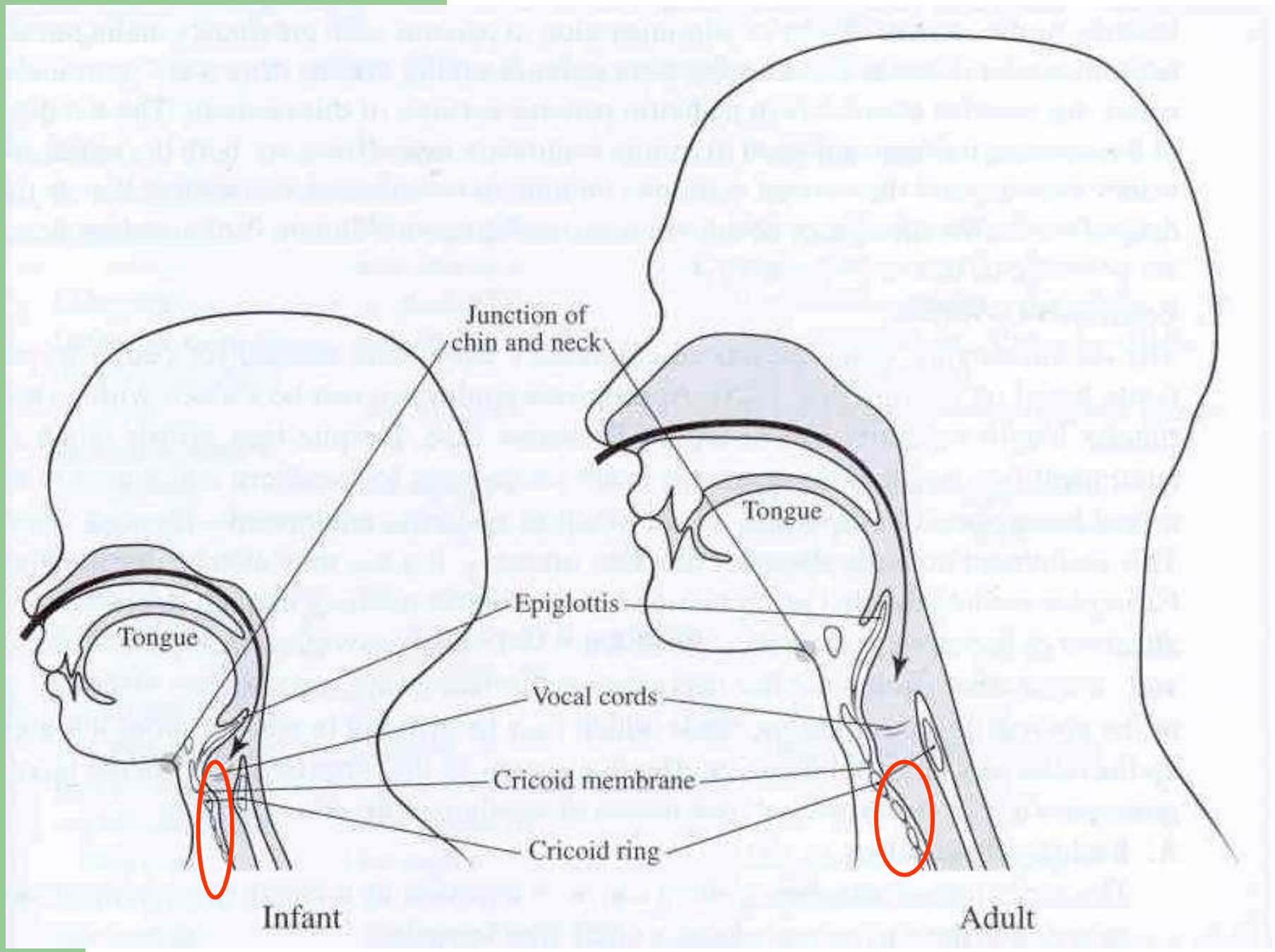
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Adult

# The Pediatric Airway

**Box 17.2.** Physiologic differences

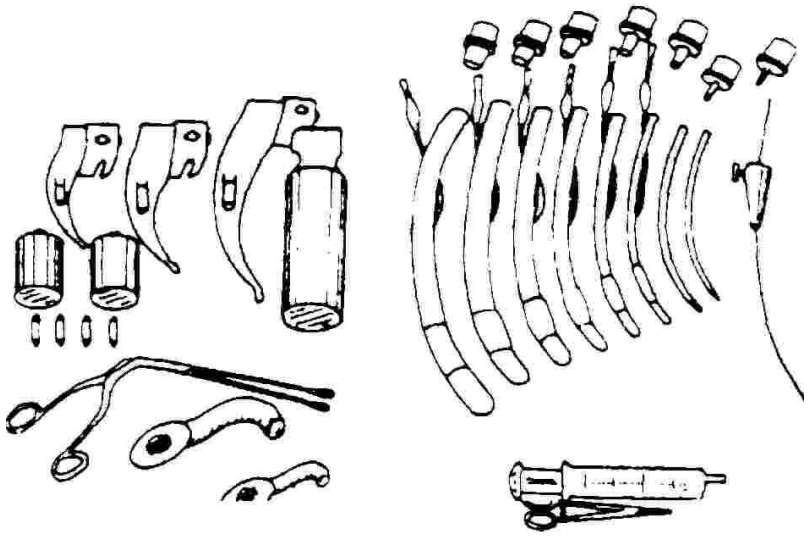
| Physiologic difference | Significance |
| --- | --- |
| Basal $O_2$ consumption is twice adult values (>6 ml/kg/min). Proportionally small FRC as compared with adults. | Shortened period of protection from hypoxia for equivalent preoxygenation time as compared with adults. Infants and small children often require BVM ventilation and cricoid pressure to avoid hypoxia. |

# Dealing with the Airway Equipment

Estimating ETT diameter:

- Age/4 + 4
- Broselow tape
- Pinky finger circumference or nostril

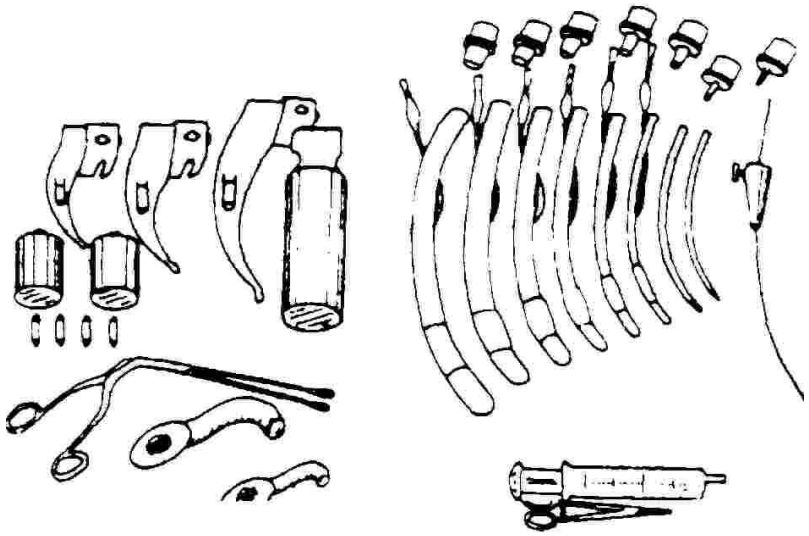
# Airway Equipment



Why use an uncuffed tube in the younger pediatric age group?

- These tubes fit snugly in the narrowest portion of the airway, the cricoid ring

# Airway Equipment



How far down does the tube go?

2 approaches:

- 3(ETT dia.,mm)= x cm
- Length-based chart

# Medications for RSI

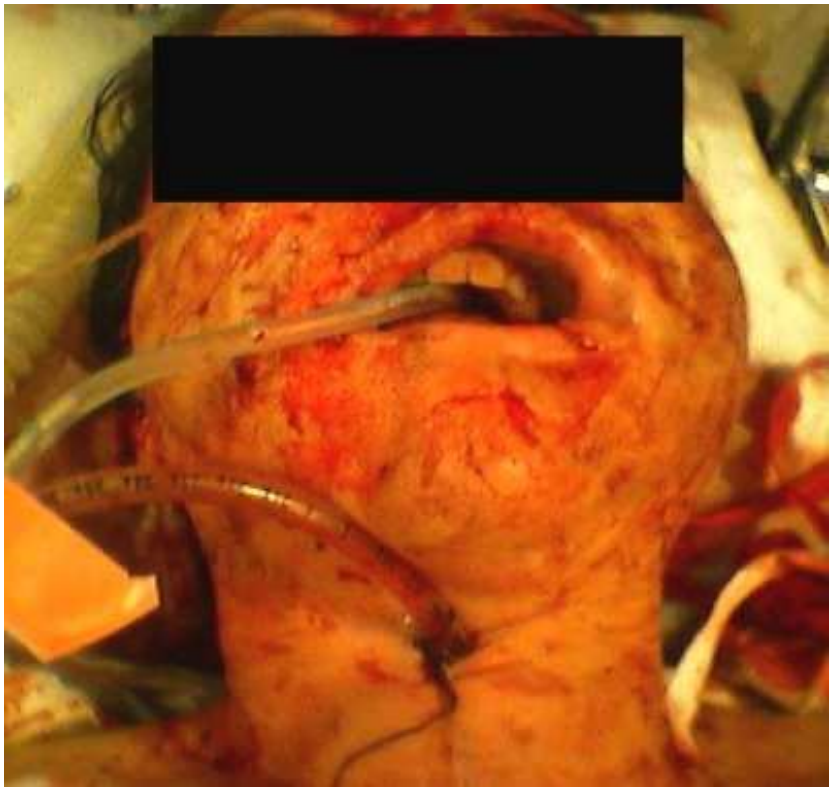

What should all kids get for premedication?

- Atropine, 0.02 mg/kg

What dose of SCh should be used?

- SCh, 2.0 mg/kg, ivp

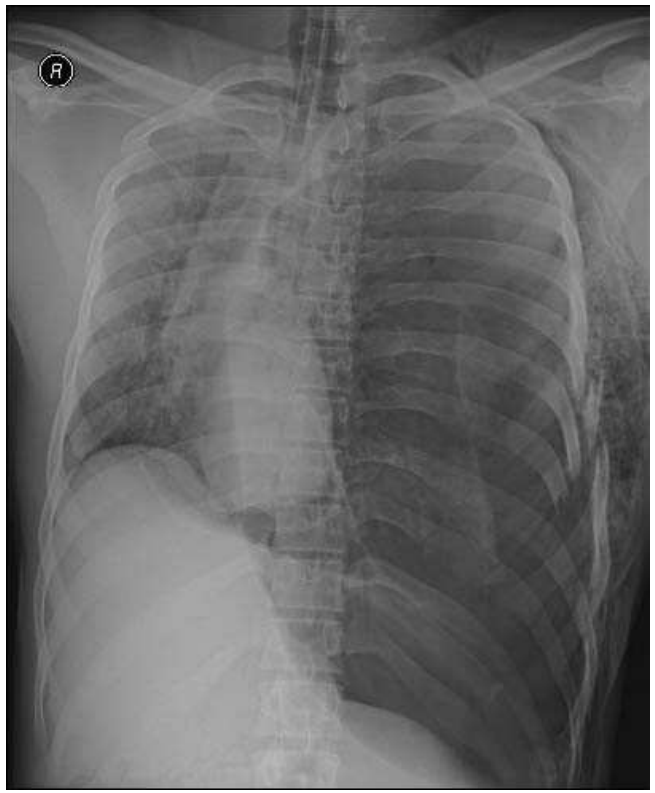
# The Difficult Airway



What happens if you encounter a difficult airway?

# Breathing

- Normal inspiration seen in the lower chest and upper abdomen
- Pay attention to the vital signs relative to the age of the pt.
- What if you have to insert a chest tube?



# Circulation

Assessing adequate circulation in the child:

- Pay attention to the vital signs- or should you?
- Children may lose up to 25% of blood volume before they develop hypotension
- Normal blood volume estimated at 80 cc/kg
- Tachycardia and poor skin perfusion may be the only subtle signs (along with clues from the history)

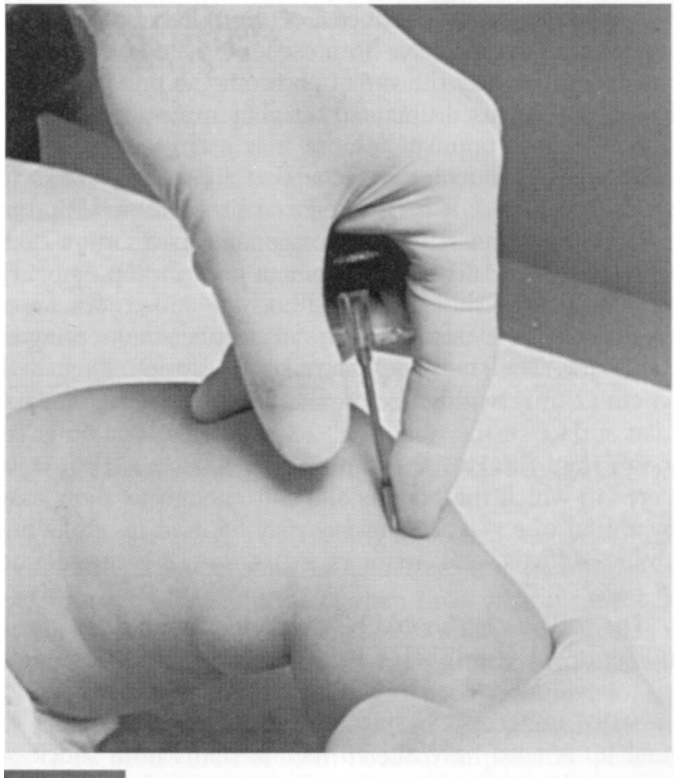
# Establishing Venous Access

- Start with peripheral sites using lg. bore catheters
- Consider CVC
- If this fails, consider “rescue” devices (e.g.: IO lines, FAST-1 lines, cut downs, etc.)
- Bolus 20 cc/kg

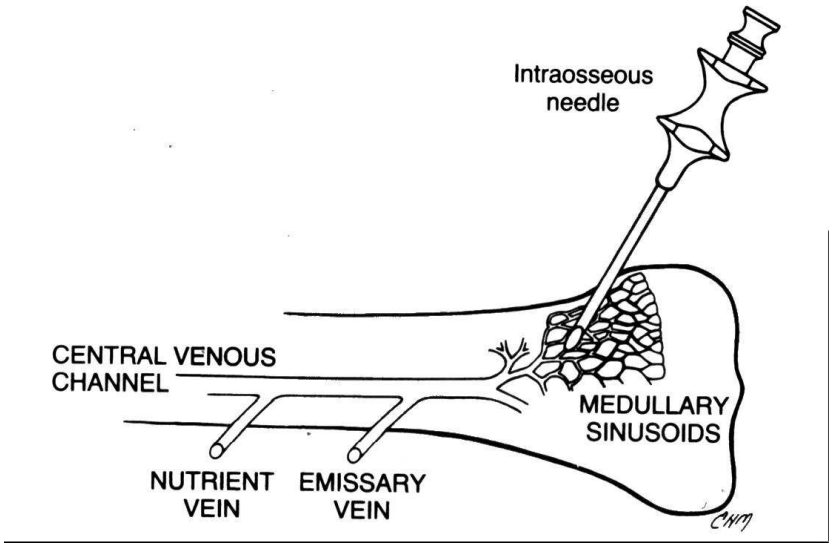
# Intraosseus Infusions (IO)

Background:

- First used in 1934 to treat pernicious anemia
- Became popular in the U.S. in 1940



# Anatomy and Physiology




- Long bones are richly vascular
- Medullary sinusoid acts as a patent vein
- Blood leaves the bone via emissary and nutrient veins

# Uses of IO Access

- Provide fluids during resuscitation
- Infusion of meds and iv contrast
- Sampling of blood for electrolytes, blood type (not suitable for CBC determinations)
- Provides estimate of acid-base status

# Does IO access take time to achieve??

- Retrospective chart review showed the following mean times to achieve vascular access:

Venous access: 7.9 min.

IO access: 4.7 min.

# How successful is IO access??

- Retrospective study showed the following success rates:

IO access: 83%

Surgical cutdown: 81%

Central venous catheterization: 77%

# Other Features of IO Access

- Almost every med can be given through IO
- Infusion rates in animals:

10-17 ml/min. (by gravity)

Up to 42 ml/min. (by pressure)

# Indications for IO Access

- Inability to establish rapid venous access to provide fluids and meds
- IO is intended to be used as a temporizing measure until venous access can be established

# Contraindications of IO Access

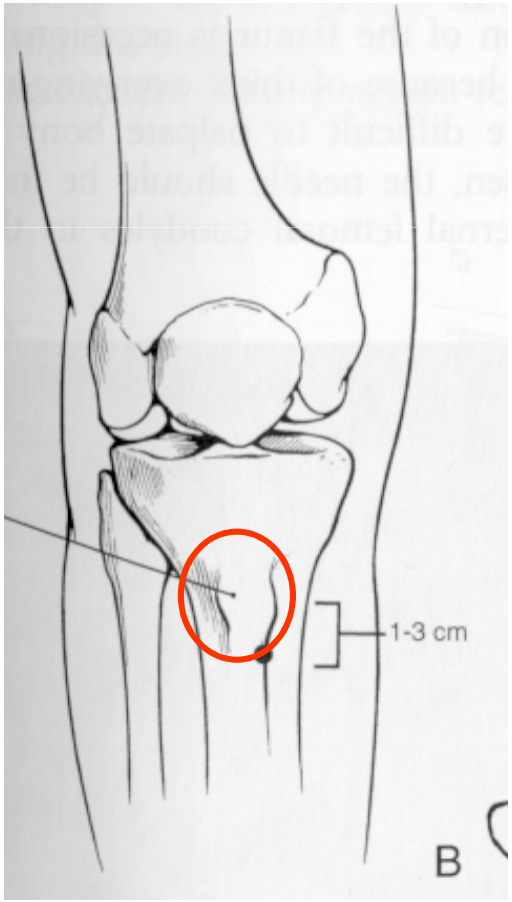
1. Fracture at the IO site

Osteoporosis and Osteogenesis Imperfecta may add potential complications to the procedure.

# IO Equipment

- Obtain the usual sterile vascular access equipment
- Obtain specially designed IO needles
- Regular iv tubing can be used

# IO Placement Technique

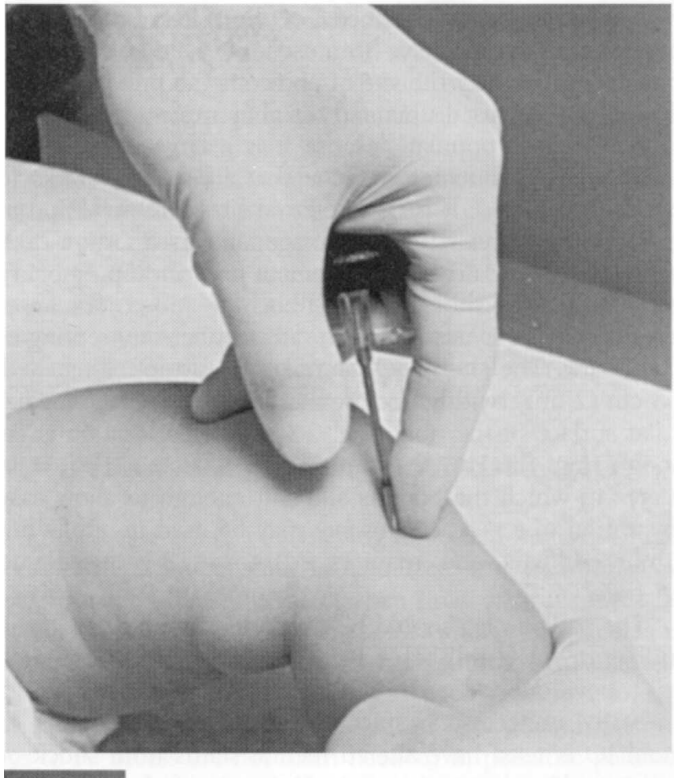



- Proximal tibia most popular

1. Locate the tibial tuberosity

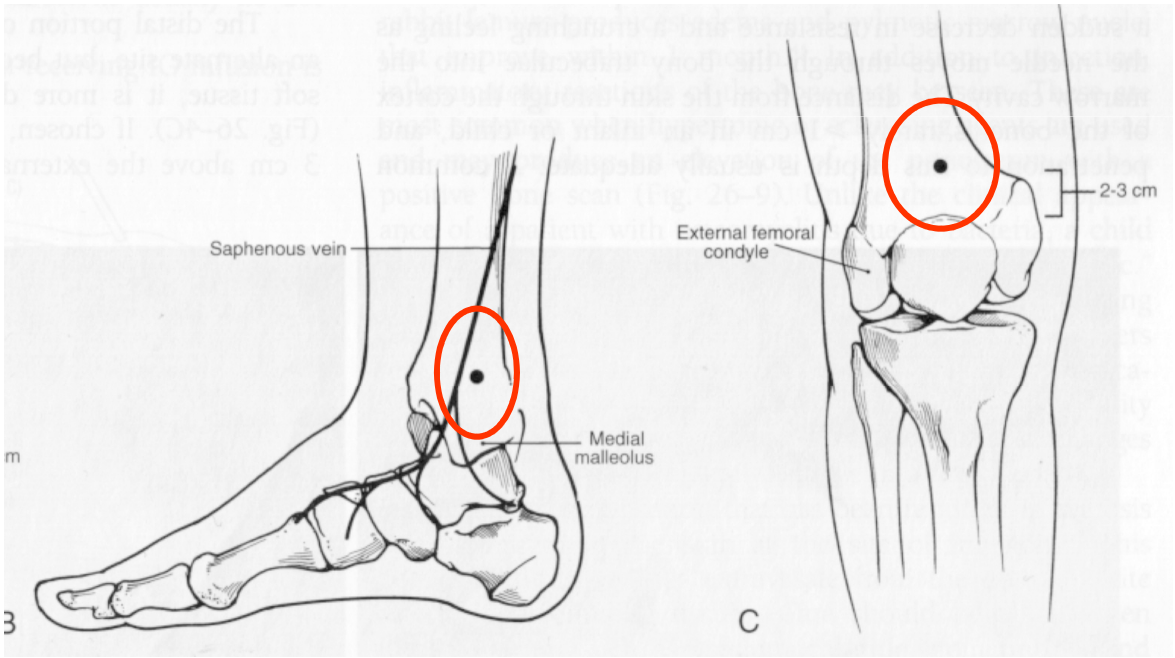
2. The landmark is approx. 2 fingerbreadths inferior and medial (1-3 cm)- this location is away from the growth plate

# Now the fun begins!!!



- Bend the pt's knee
- Stabilize proximal tibia
- Insert needle either perpendicular to long axis, or slightly caudad
- Use twisting or rotatory motion
- Don't push in too far!!!

# Alternative Sites of IO Access




1. Distal tibia
2. Distal femur

# Complications of IO Insertion

- Extravasation- most common complication
- Infection:

  - reported rates of osteomyelitis range from 0.6- 3% (depending on the study)
- Potential for growth plate injury
- Others: fat embolism, compartment syndrome, site necrosis

# Experimental techniques (FAST-1)

# Back to the primary survey (Disability)

**Table 32-2.** Glasgow Coma Scale Modified for Pediatric Patients

**Eye opening response**

| Score | > 1 year | < 1 year |
|---|---|---|
| 4 | Spontaneous | Spontaneous |
| 3 | To verbal command | To shout |
| 2 | To pain | To pain |
| 1 | None | None |

**Motor response**

| Score | >1 year | <1 year |
|---|---|---|
| 6 | Obeys commands | Spontaneous |
| 5 | Localizes pain | Localizes pain |
| 4 | Withdraws to pain | Withdraws to pain |
| 3 | Abnormal flexion to pain (decorticate) | Abnormal flexion to pain (decorticate) |
| 2 | Abnormal extension to pain (decerebrate) | Abnormal extension to pain (decerebrate) |
| 1 | None | None |

**Verbal response**

| Score | >5 years | 2-5 years | 0-2 years |
|---|---|---|---|
| 5 | Oriented and converses | Appropriate words and phrases | Babbles, coos appropriately |
| 4 | Confused conversation | Inappropriate words | Cries but is consolable |
| 3 | Inappropriate words | Persistent crying or screaming to pain | Persistent crying or screaming to pain |
| 2 | Incomprehensible sounds | Grunts or moans to pain | Grunts or moans to pain |
| 1 | None | None | None |

Total score key: Severe: <9, Moderate: 9-12, Mild: 13-15.

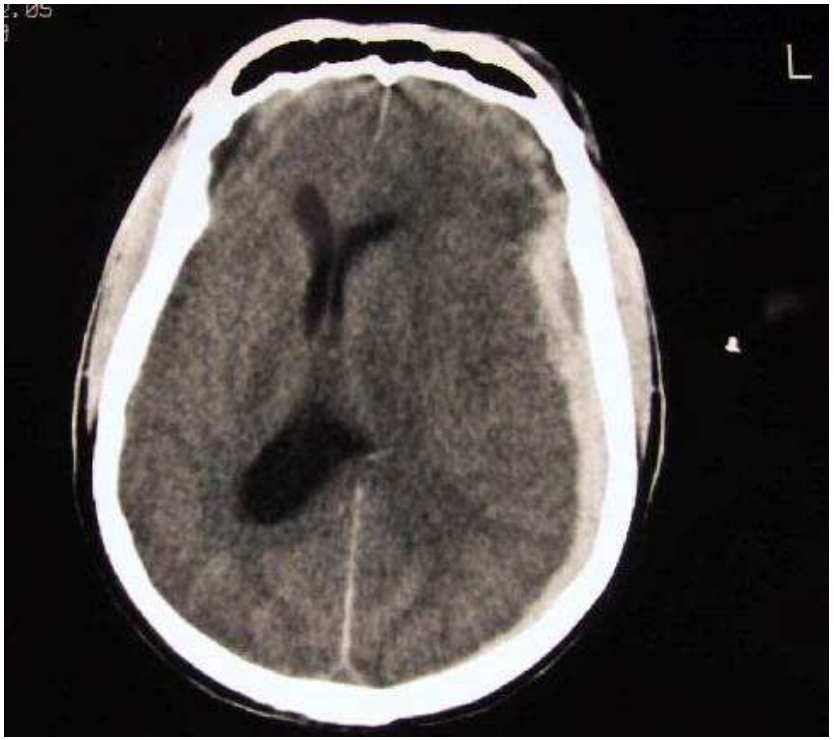
# Exposure and prevent hypothermia

- Remember in children, the relatively larger head and relatively large TBSA

# The “F” in the primary survey


Manitoba
BIENVENUE AU
MANITOBA
WELCOMES YOU
EXPLORE
MANITOBA
CANADA

# Head Injury in Children




- Recall, this is the leading cause of trauma mortality
- Cranial vault is proportionately larger and heavier in children
- Pediatric brain is also less myelinated

# Traumatic Seizures in Children

Difference between an “impact” seizure and a post-traumatic seizure:

- Onset relative to head injury
- Implications for treatment

# Assessing Head Injuries in the Infant

Increased ICP in the infant:

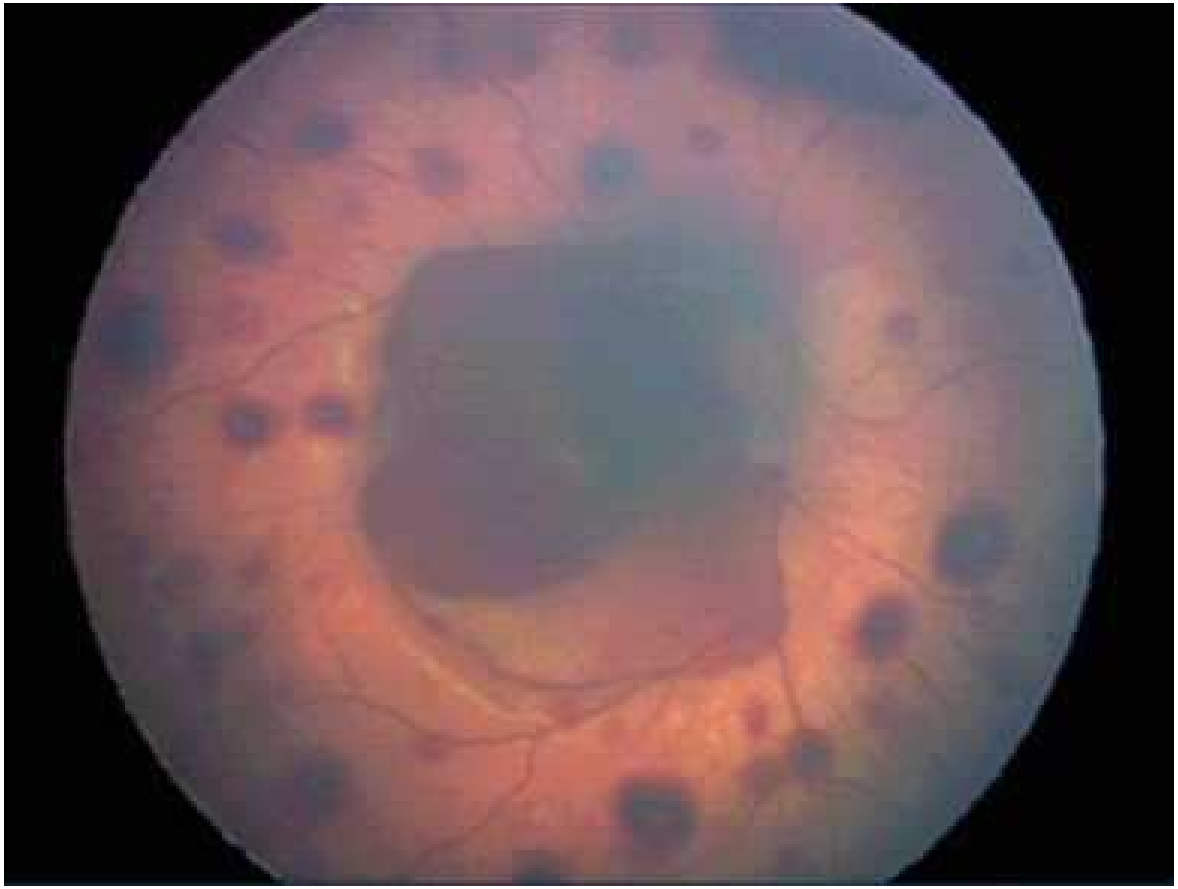
Signs:

- Full fontanel
- Split sutures
- “setting sun” sign

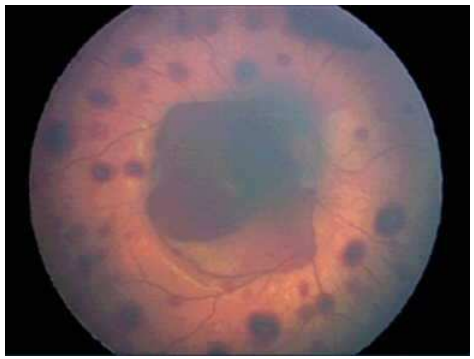
Symptoms:

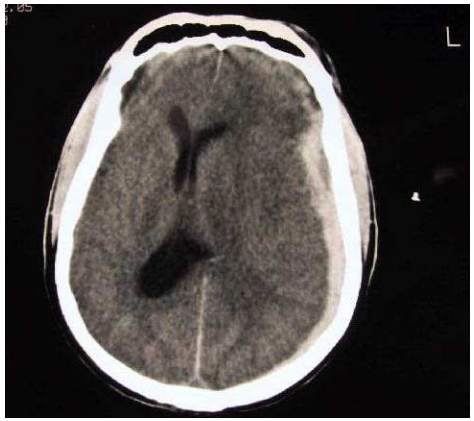
- Persistent emesis
- Irritability (or lack of it)

# What is this? (what is it associated with?)



# Shaken Baby Syndrome





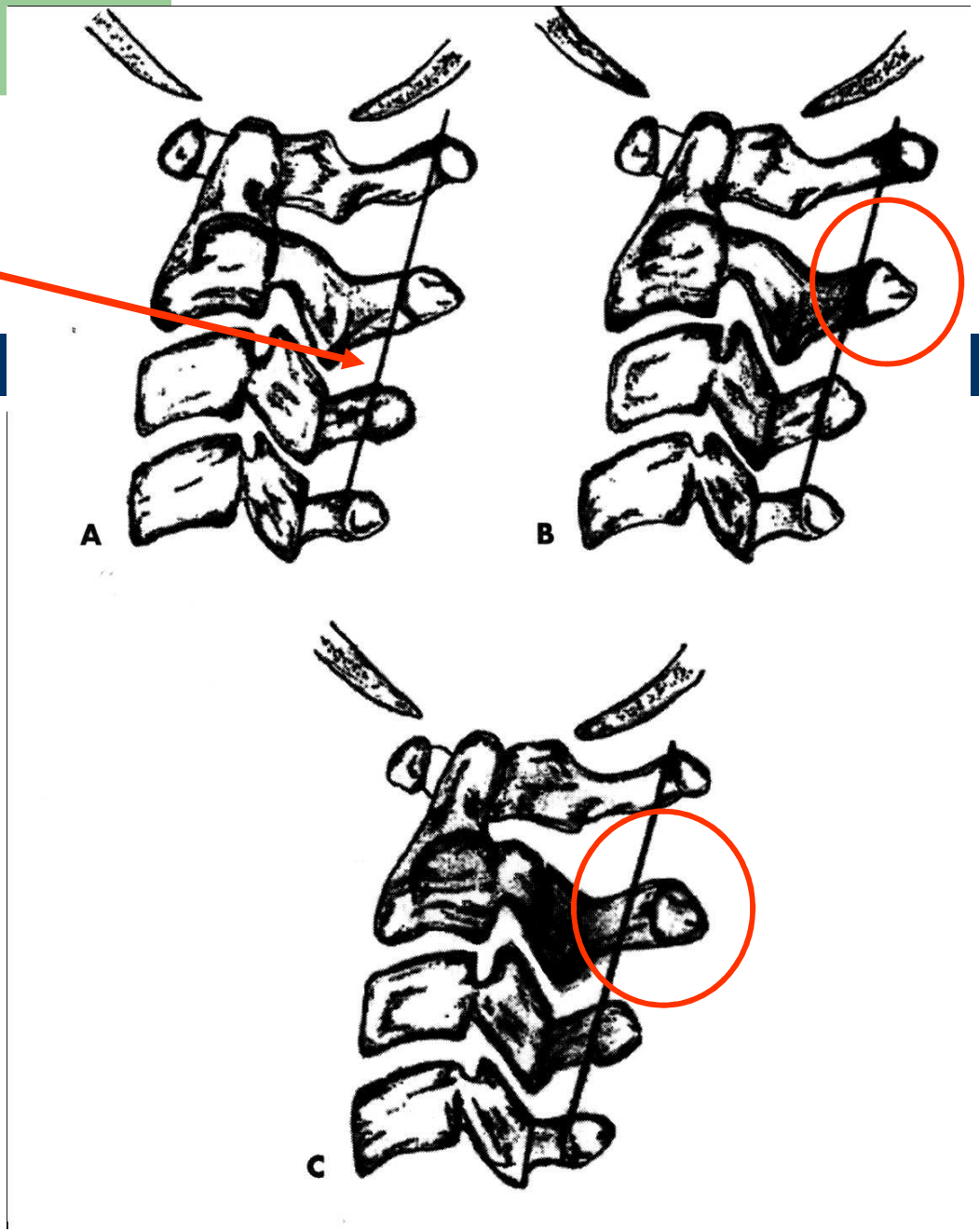
- Up to 22% of abused children have CNS damage
- Results from accel./decel. Of the brain within the skull
- Presents with vomiting, FTT, ALOC, seizures, etc.
- Retinal hemorrhages found in 75% of cases
- Look for other signs of abuse

# C-spine Injury

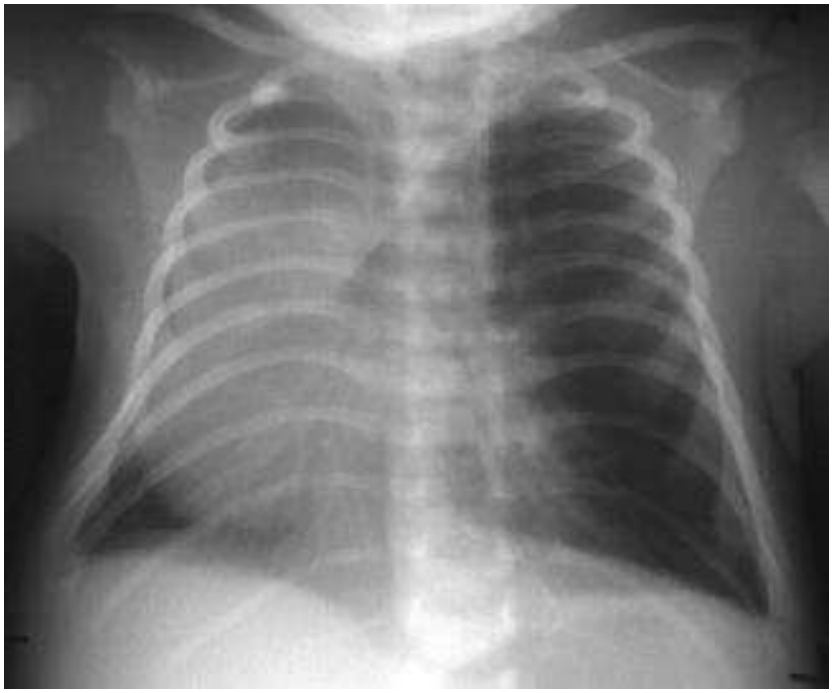
- “SCIWORA” found in 25-50% of spinal cord injuries in kids < 8 y.o.
- Key differences exist between the adult and pediatric C-spine

# C-spine Anatomical Differences

1. Relatively larger head size
2. Ligaments and joint capsules more elastic
3. Facet joints more horizontal
4. “Anatomic fulcrum” at C2,3
5. Posterior arch of C1 fuses at 4 y.o.
6. Anterior arch fuses at 7-10 y.o.
7. Pseudosubluxation of C2,3 seen in 40% of children

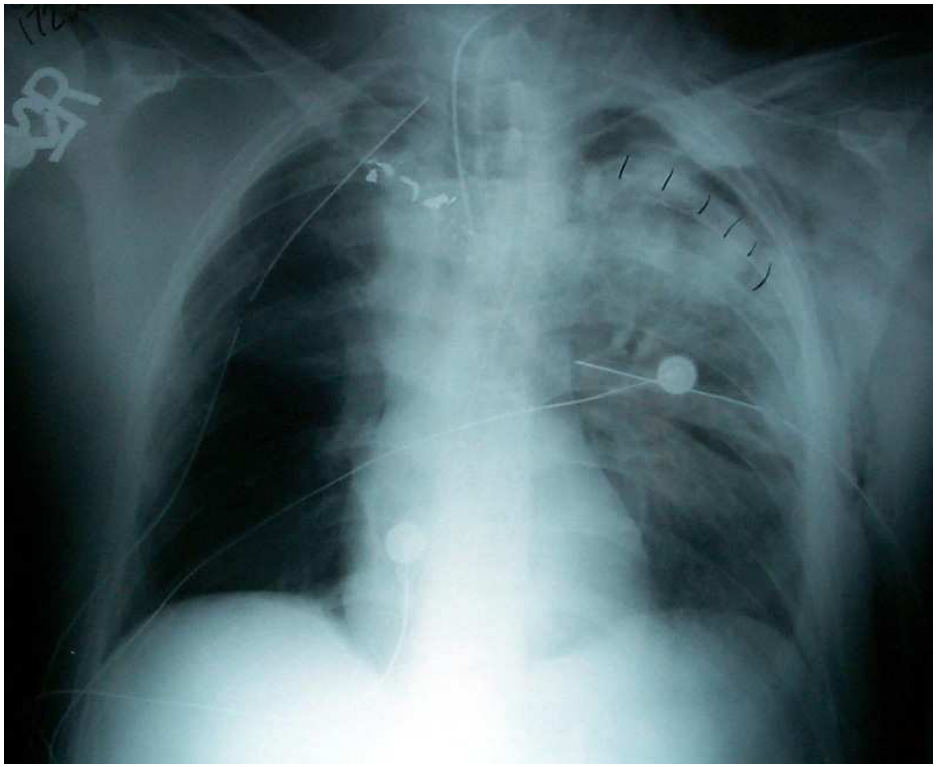

A
B
C

# Chest Trauma



- 83% due to blunt trauma
- Pediatric rib cage is very compliant
- Mediastinum relatively more mobile

# Chest Trauma



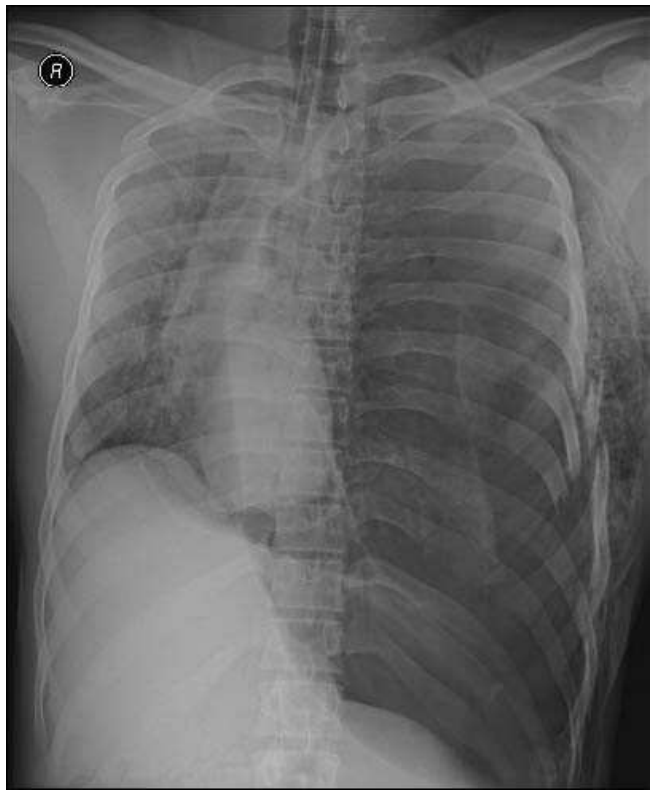
What's the abnormality?

- Pulmonary contusion (together with rib fractures constitutes the most common sequela of blunt chest trauma)

# Assessing for Tension Pneumothorax

The pitfalls:

- Short neck, relatively more soft tissue (makes assessment of trachea difficult)
- Transmission of breath sounds throughout thorax

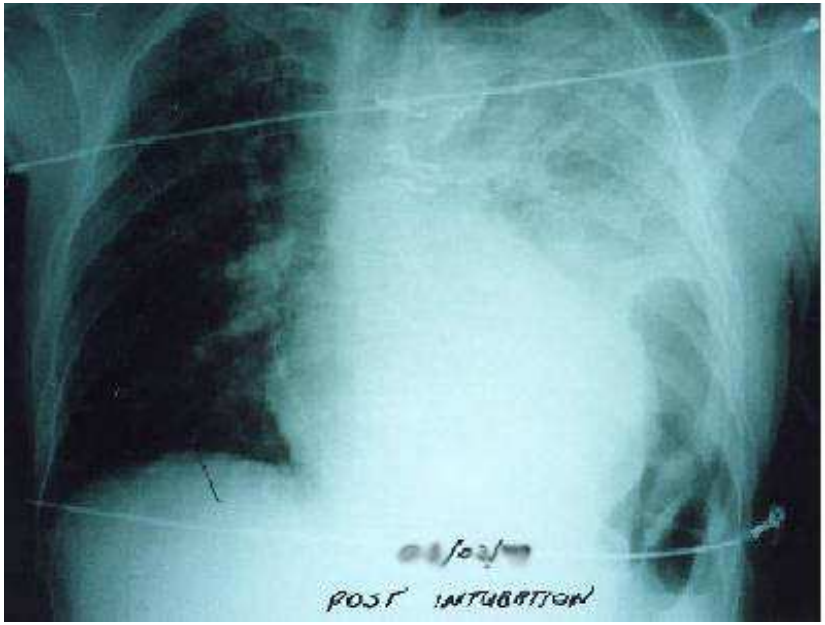


# Assessing for Tension Pneumothorax

Add the following to your assessment:

- Presence of tachycardia
- Skin changes
- Mechanism of injury

# Thoracic injuries caused by indirect forces

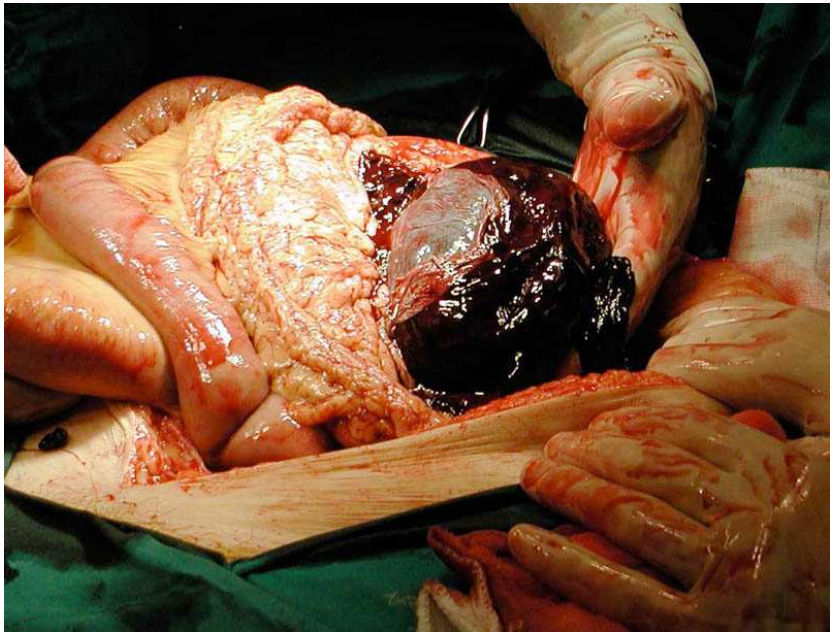



What is the abnormality?

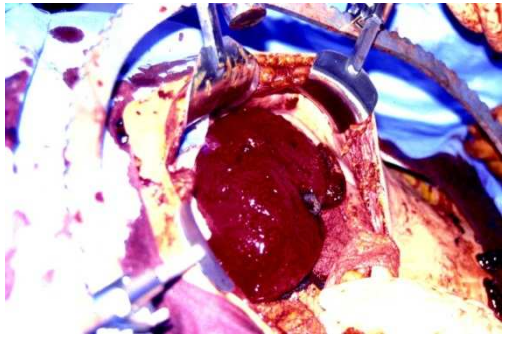
- Ruptured left hemidiaphragm
- Associated with lap belt use
- Increase in abdominal pressure transmitted through the diaphragm

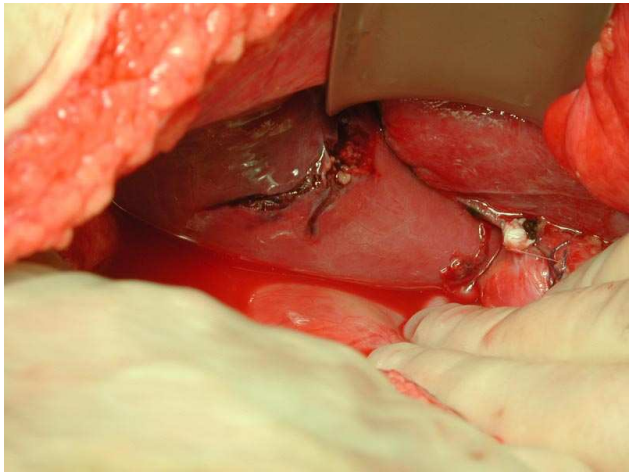
# Abdominal Trauma

- Third leading cause of trauma deaths (after head and thoracic trauma)
- Most common cause of **unrecognized** fatal injury in children
- MVC's contribute the most



# Abdominal Trauma



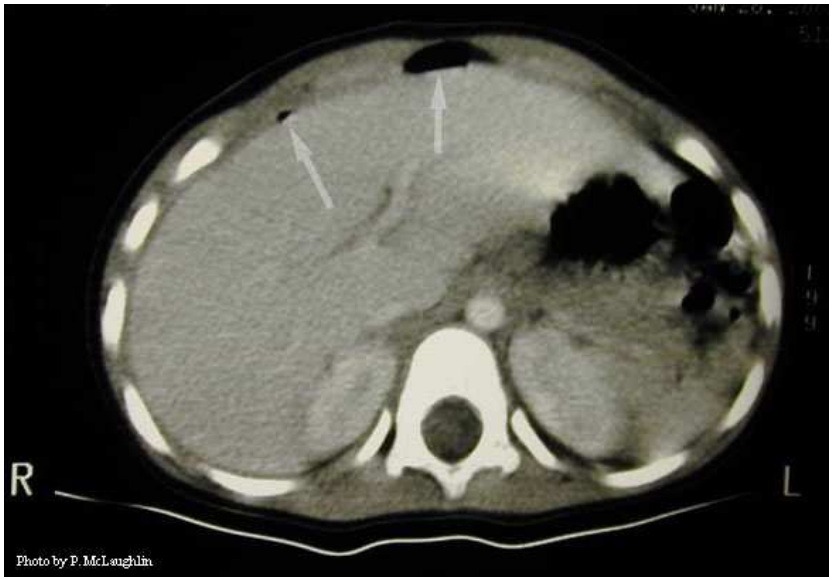


- Kids have prop. larger solid organs, less musculature and less fat
- Spleen is most often injured solid organ
- Liver lacerations are the leading cause of death in abdominal trauma

# Diagnostic Tests in Abdominal Trauma

1. Abdominal CT
2. Ultrasound
3. DPL

# Abdominal CT:




- Utility: for the hemodynamically stable child with blunt trauma or non-GSW penetrating trauma
- Drawback: time wasted if the pt. is in shock from abdominal injuries

# Abdominal Ultrasound

Abdominal U/S (FAST):

- Utility: rapid, noninvasive means of looking for free fluid in the abdomen
- To detect free fluid in the hypotensive pt.: sensitivity: 100%, specificity: 96%

# FAST Ultrasound Continued

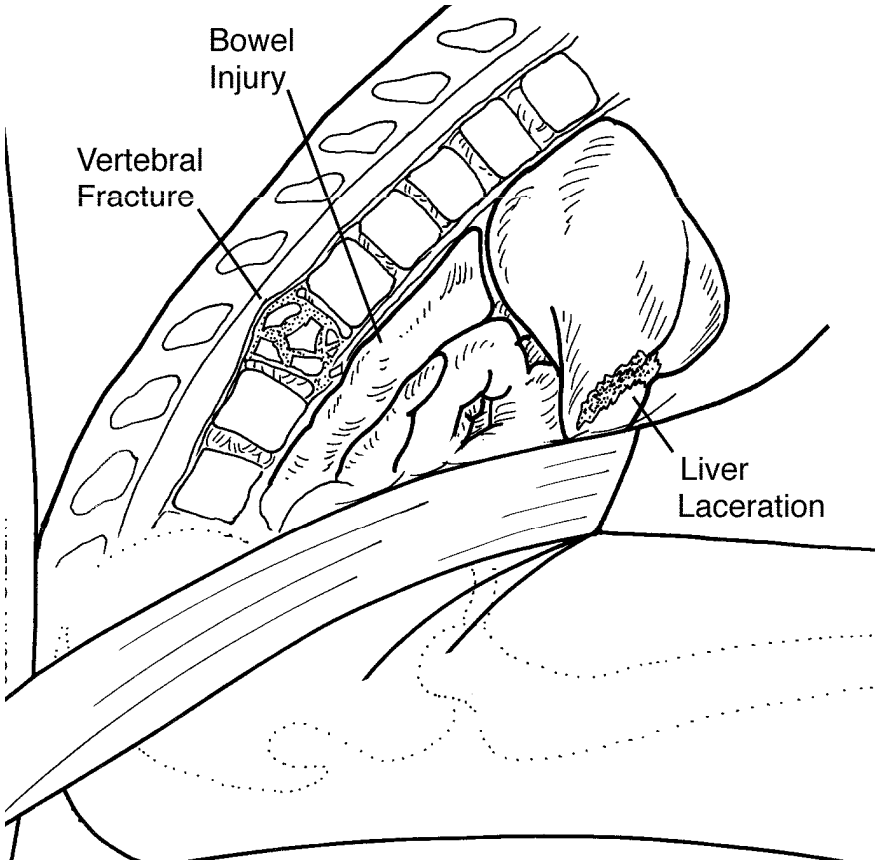
- To detect free fluid in all types of abdominal trauma: sensitivity: 98%, specificity: 94%
- Drawback: limited studies done in children; still also limited in studying solid organ pathology

# Diagnostic Peritoneal Lavage

- Utility: high specificity and sensitivity
- Drawback: very time consuming, invasive

# What is this? What structures may be injured?

# Seat Belt Syndrome



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# Pediatric Chance Fractures: Association with Intra-abdominal Injuries and Seatbelt Use

A. B. REID, M.D., R. M. LETTS, M.D., F.R.C.S.(C.), AND G. B. BLACK, M.D., F.R.C.S.(C.)

**Seven cases of Chance fractures of the spine in children are presented, with their association to intra-abdominal injuries secondary to seatbelt use. A discussion and review of the literature suggest an increasing frequency of this particular injury with a high association given the clinical sign known as the "seatbelt sign." Also reviewed is the association of intra-abdominal injuries secondary to seatbelt restraints, and particular attention is paid to the concurrence of intra-abdominal injury with Chance fractures of the spine. The unique features of the pediatric anatomy in relation to the design of the adult seat restraint as it relates to the vertebral fracture and intra-abdominal injuries are noted. A review of the literature discusses the development of a classification for this flexion-distraction type of vertebral injury, and supports our experience of the increasing frequency of these particular injuries with increasing seatbelt use.**

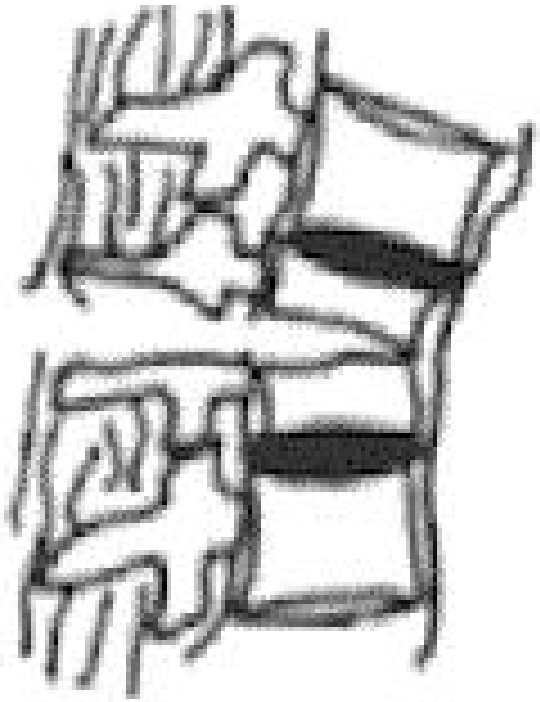
- Retrospective chart review conducted at HSC in Winnipeg (Reid, Letts, and Black, J Trauma, 1990)

# The Seat Belt Syndrome

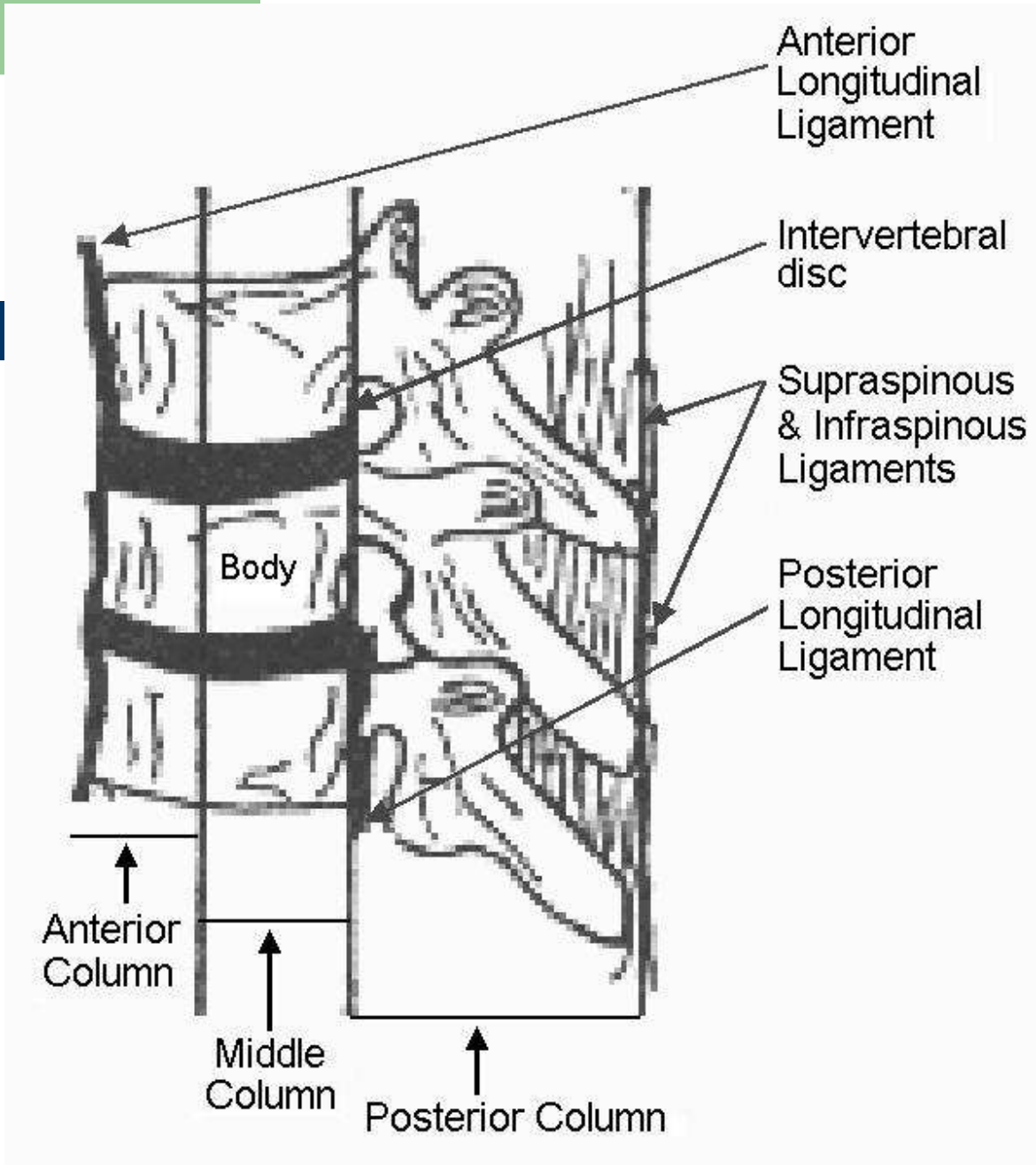
- Association of the seat belt sign and Chance Fractures: approx. 20%
- Association of the seat belt sign with intra-abdominal injuries: approx. 60-80%

# Chance Fractures


- Fracture of upper lumbar vertebra
- Flexion of vertebral spine about an axis **anterior** to the vertebral bodies
- Compression of ant. column, with distraction of the post. column

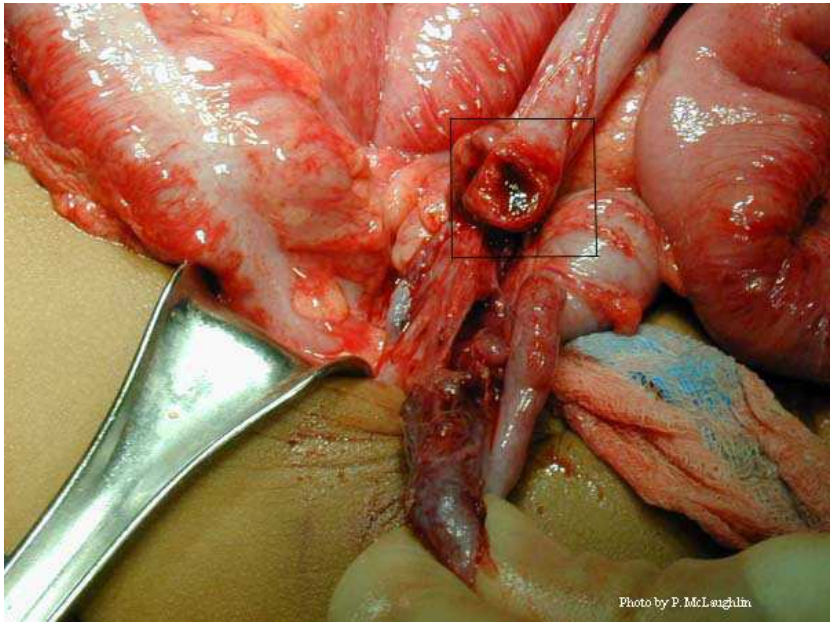


Chance Fracture


Anterior Longitudinal Ligament
Intervertebral disc
Supraspinous & Infraspinous Ligaments
Posterior Longitudinal Ligament
Body
Anterior Column
Middle Column
Posterior Column

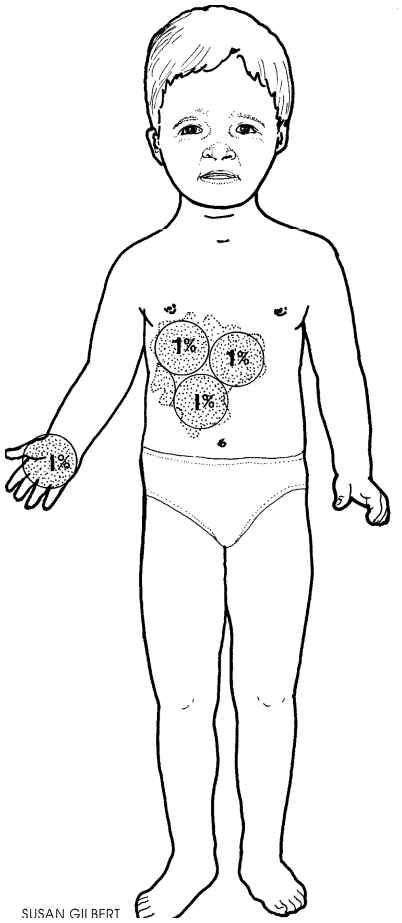
# Associated Intra-abdominal Injuries

- Jejunum and ileum most frequently injured
- Cecum and duodenum next most frequently injured
- Can also see aortic dissection and renal injuries



# Children and the Seatbelt Syndrome

- Big floppy head
- Arms tend to flail out more in deceleration injuries
- Overall: maintain a high index of suspicion for associated injuries when the seat belt sign is seen



# Take Home Message

1. Peds trauma is “same same, but different.”
2. Trauma is the number 1 cause of death in children
3. Anatomical differences predispose children to certain injuries
4. Always assume multiple injuries in the peds trauma patient.