

# Evaluation of the pediatric airways

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ORL-Unit

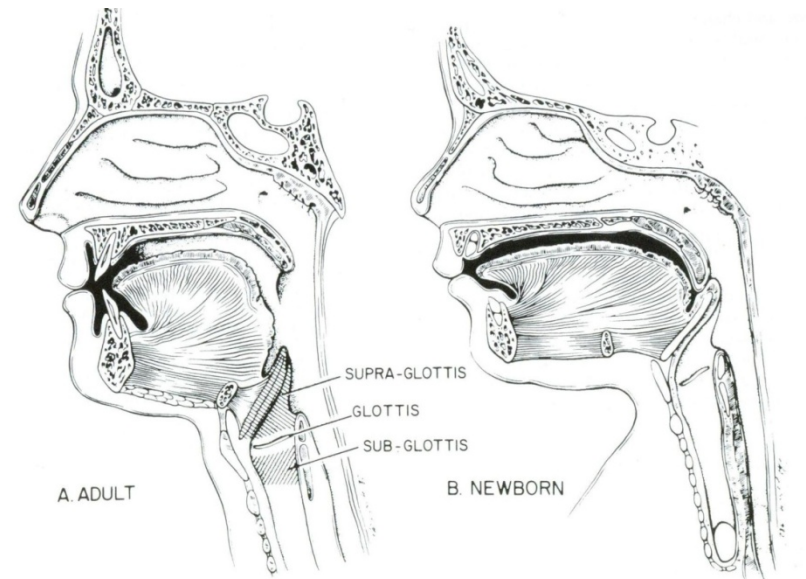
University Children's Hospital Zurich

# Pediatric airway – anatomy

- large head
- short neck
- small nares
- small mandible
- pliable trachea and chest wall
- immature alveolae
- gastric dilatation, reflux
- high metabolic rate
- friable mucosa

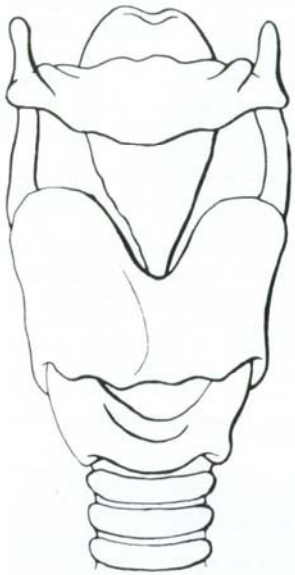
# Pediatric airway – anatomy

- high larynx  
cricoid cartilage = C4
- long epiglottis  
⇒ lies against the soft palate
- long uvula  
⇒ neonate obligate nasal breather

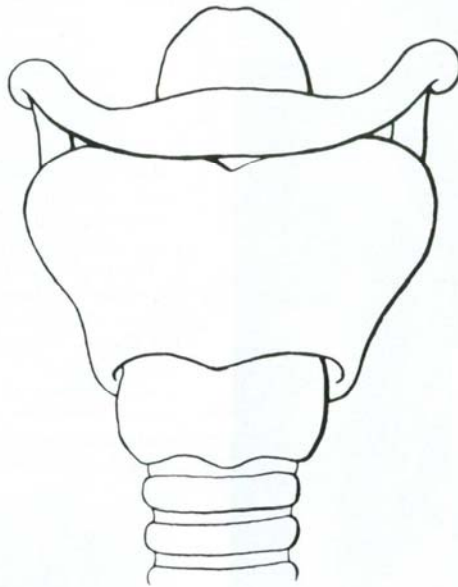


Anterior

Mature

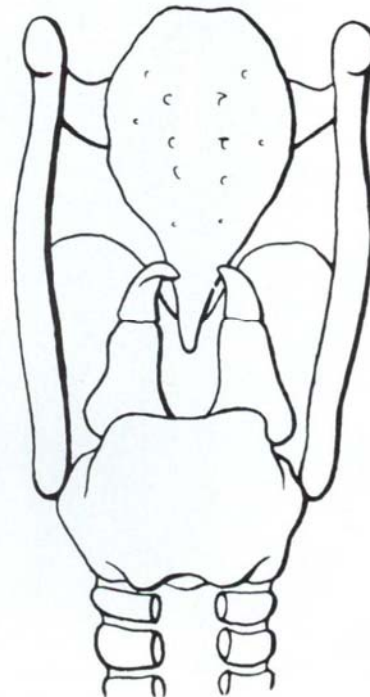


Infant

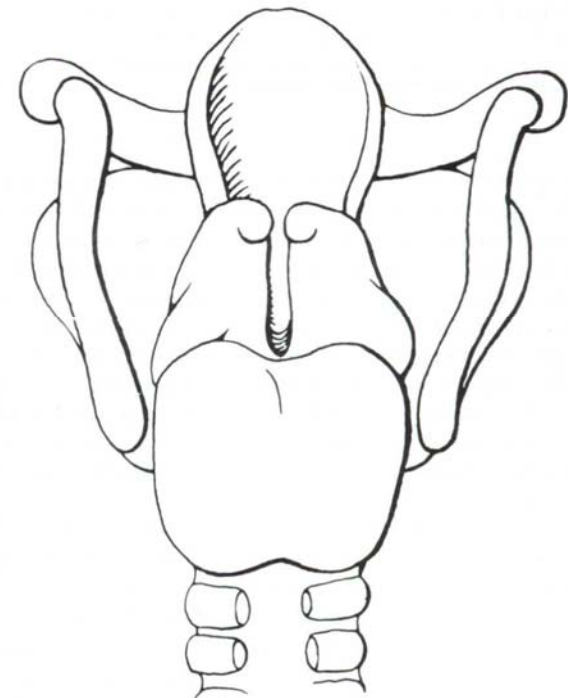


Posteriore

Mature



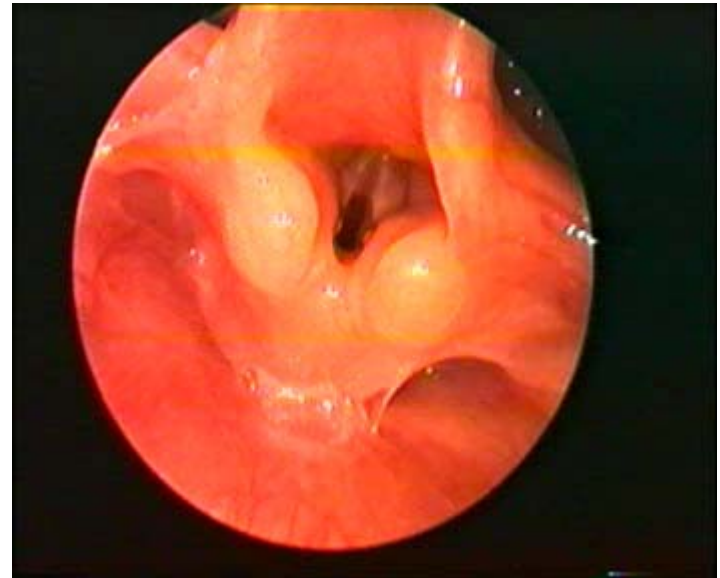
Infant



*After Bosma JF, 1986*

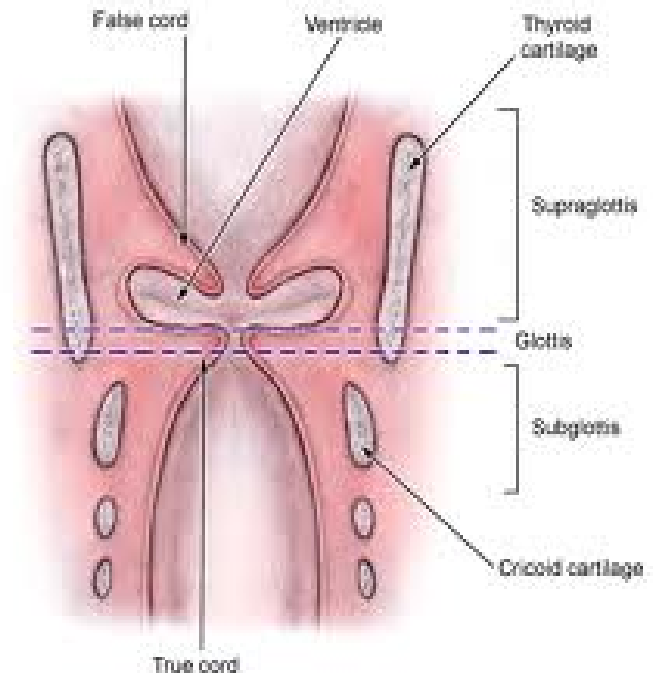
# Pediatric airway – anatomy

- supraglottis
  - short aryepiglottic folds
  - epiglottis omega-shaped
    - ⇒ tendency to collapse during inspiration
- prominent cuneiform cartilages
- more prone to submucosal edema



# Pediatric airway – anatomy

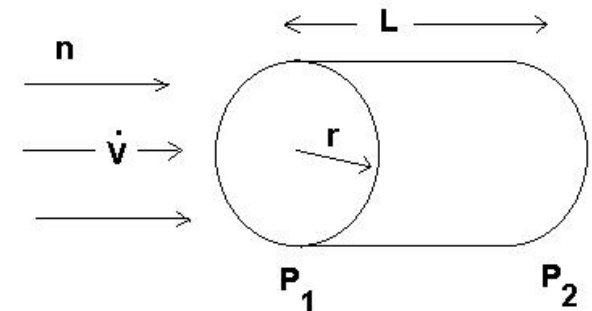
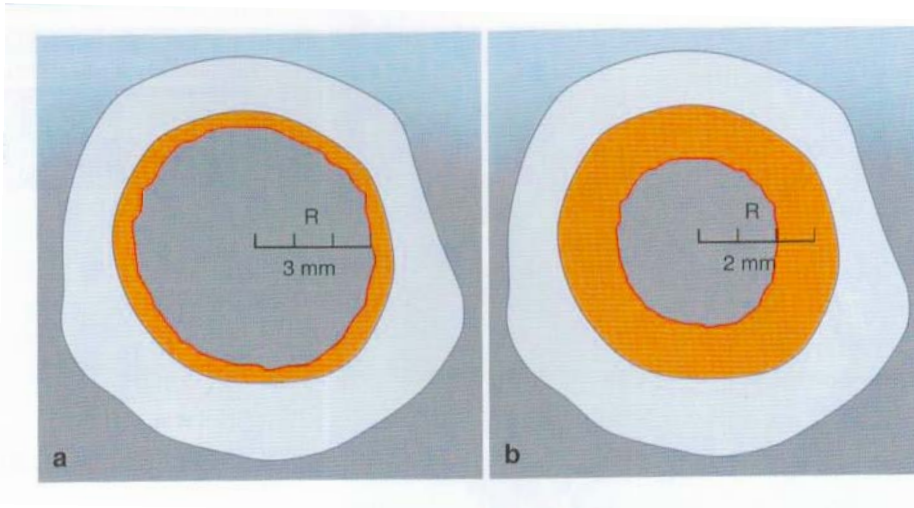
- subglottis:
  - from conus elasticus to inferior part of cricoid cartilage
  - only complete ring of the larynx and trachea
  - narrowest region of the pediatric airway
- subglottic diameter at birth:
  - cricoid cartilage: 5.5mm
  - full-term baby: 4.5-5.5mm
  - premature baby: 3.5mm



# Pediatric airway – anatomy

- ↓ diameter 1mm = ↓ surface 50%

⇒ resistance  $R = 8\mu L / \pi r^4$



$\dot{V}$	Flow	$\mu$	Viscosity
$L$	Length	$P$	Pressure
$r$	Radius		

$$P_1 - P_2 = \frac{8 \mu L}{\pi r^4} \dot{V}$$

# Pediatric airway – anatomy

	Newborn	Child	Adult
<b>Normal</b>			
subglottic diameter (mm)	4	8	14
subglottic radius (mm)	2	4	7
subglottic surface (mm <sup>2</sup> )	12	6	12
<b>1mm edema</b>			
subglottic diameter (mm)	2	6	12
subglottic radius (mm)	1	3	6
subglottic surface (mm <sup>2</sup> )	3	27	108
<b>Diminution of subglottic surface</b>	<b>75%</b>	<b>44%</b>	<b>27%</b>



# Pediatric airway – clinical approach

narrowing of the airway



abnormal flow or turbulence



noisy breathing  
(stridor/stertor)

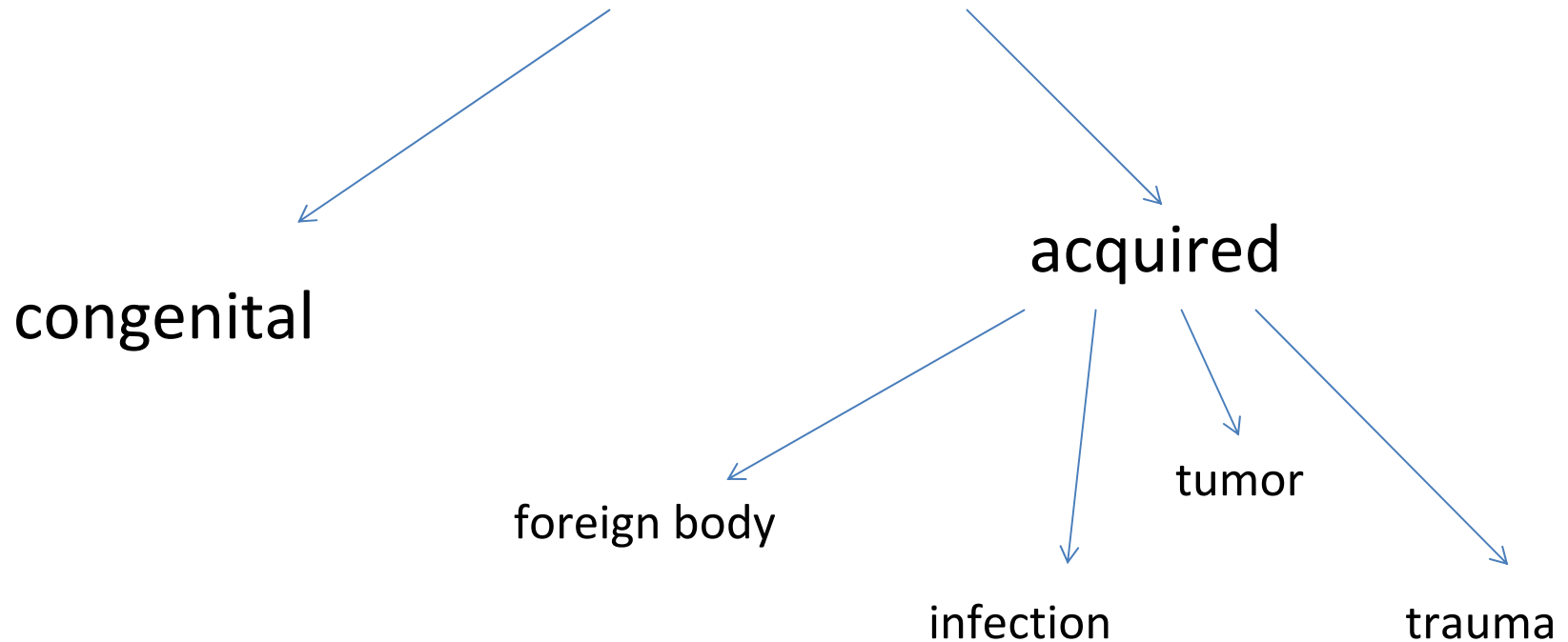
# Noisy breathing – definitions

- stertor:
  - nose, nasopharynx
  - kind of snoring
  - „low-pitched“
- stridor:
  - mostly inspiratory
  - supraglottis, glottis
  - „high pitched“
- biphasic stridor (inspiratory and expiratory):
  - subglottis

# Clinical approach

1. age at the beginning of symptoms?
2. level of obstruction?
3. what is the lesion?
4. investigations?

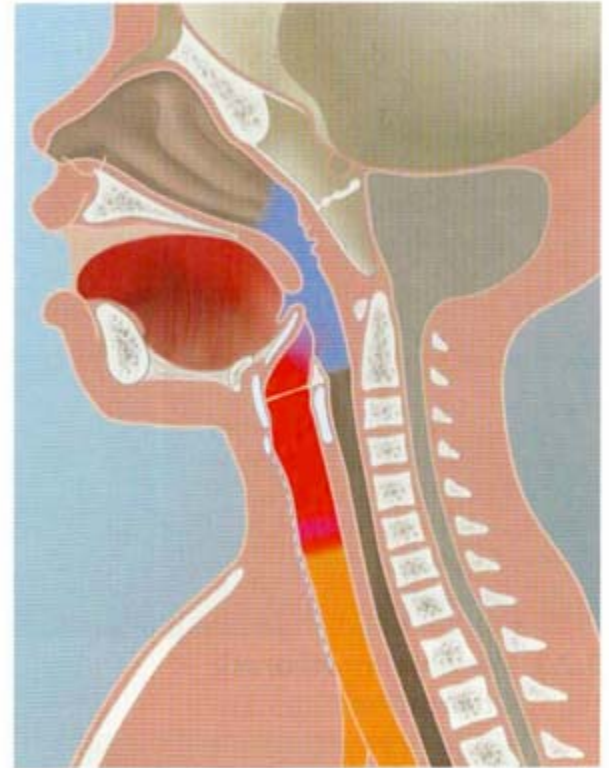
# Pediatric airway obstruction



- newborn = congenital
- 1-3 years = acquired more likely
- >3 years = acquired likely (congenital highly unlikely)

# Pediatric airway – level of obstruction

- nose
- pharynx
- larynx
- tracheobronchial tree

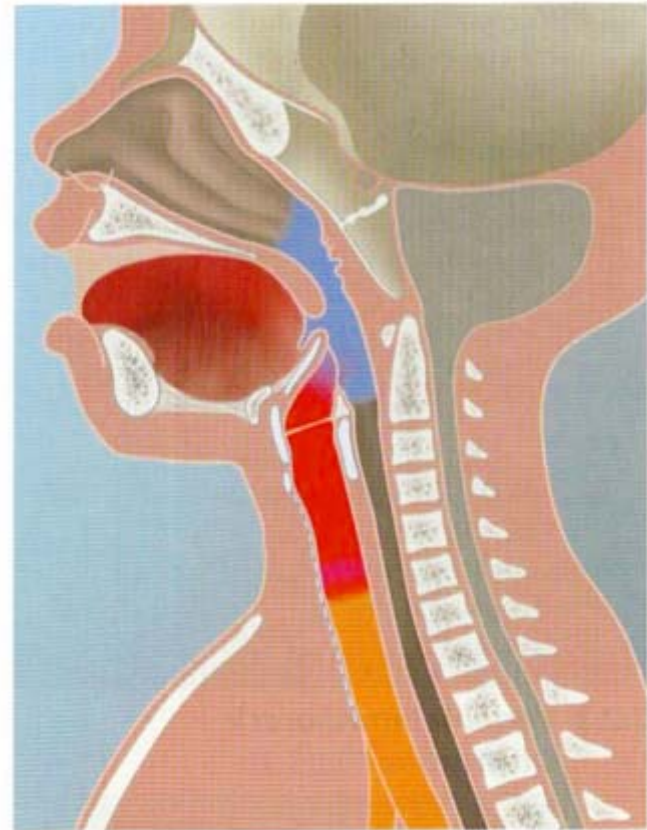


- congenital or acquired



# Clinical evaluation – noisy breathing

- **Stertor**
  - nasopharynx, oropharynx
  - ‘low-pitch’
- **Stridor**
  - larynx, trachea (extra-tracheal)
  - ‘high pitch’
  - inspiratory vs expiratory!!!
- **Wheezing**
  - trachea (intrathoracic), bronchi



# Diagnosis and age at the beginning of symptoms

- since birth:
  - bilateral vocal cord paralysis
  - congenital subglottic stenosis
  - bilateral choanal atresia
- first 2 weeks of life: laryngomalacia
- 1-3 months: subglottic hemangioma
- > 6 months:
  - pseudocroup
  - foreign body

# Pediatric airway obstruction – nose

- choanal atresia/ choanal stenosis
- piriforme aperture stenosis
- cleft lip and palate
- craniofacial malformations Treacher-Collins, Crouzon
- arrhinie (agenesia of the nose)
- proboscis lateralis
- congenital cysts
- midline deficiency Encephalocele, Meningoencephalocele
- chordoma, hamartoma



# Pediatric airway obstruction – pharynx

- craniofacial malformation:
  - Pierre-Robin sequence (retrognathia, glossoptosis, cleft palate)
  - Treacher-Collins
  - Crouzon
  - trisomy 21
- vallecular cyst
- lingual thyroid/thyroglossal duct cyst



# Pediatric airway obstruction – larynx

## congenital

- laryngomalacia
- subglottic stenosis
- bilateral vocal cord paralysis
- saccular cyst, laryngocele
- laryngeal web
- laryngeal cleft
- lymphangioma

## acquired

- subglottic stenosis
- subglottic hemangioma
- laryngeal papillomatosis
- granuloma
- angioedema
- epiglottitis
- foreign body
- trauma

# Pediatric airway obstruction – trachea

- tracheomalacia, bronchomalacia
- external compression (vascular, tumors)
- tracheoesophageal fistula
- web, stenosis (complete ring)

# Pediatric airway – evaluation

- medical history
- clinical evaluation
- radiological examination
- endoscopic evaluation



# Pediatric airway – medical history



# Pediatric airway – clinical evaluation

- noisy breathing: constant, intermittent
- dyspnoe, tachypnoe
- intercostal retraction, tracheal tugging, nasal flaring
- cyanosis
- feeding and breathing: aspiration, cough, cyanosis
- nose, mouth and oropharynx
- and the examination of larynx?

# Pediatric airway - radiology

not routinely!

- Rx-Thorax
- CT-Scan
- MRI



# Pediatric airway – endoscopic evaluation

- good collaboration with the anesthetist
- always have an iv access before endoscopy
- always have a bronchoscope in the OR

!!!no coniotomy!!!



# Pediatric airway – endoscopic evaluation

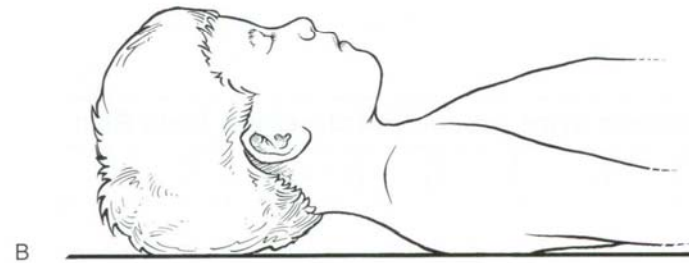
- > 4 years: endoscopy without anesthesia possible, but not under glottis
- endoscopy under general anesthesia:
  - spontaneous breathing with the flexibel scope to assess the fonction
  - rigid endoscopy to evaluate the anatomy completely, most of the time in apnea
  - always examine the whole airways!!! There may be a second lesion!!!

# Pediatric airway – endoscopic evaluation

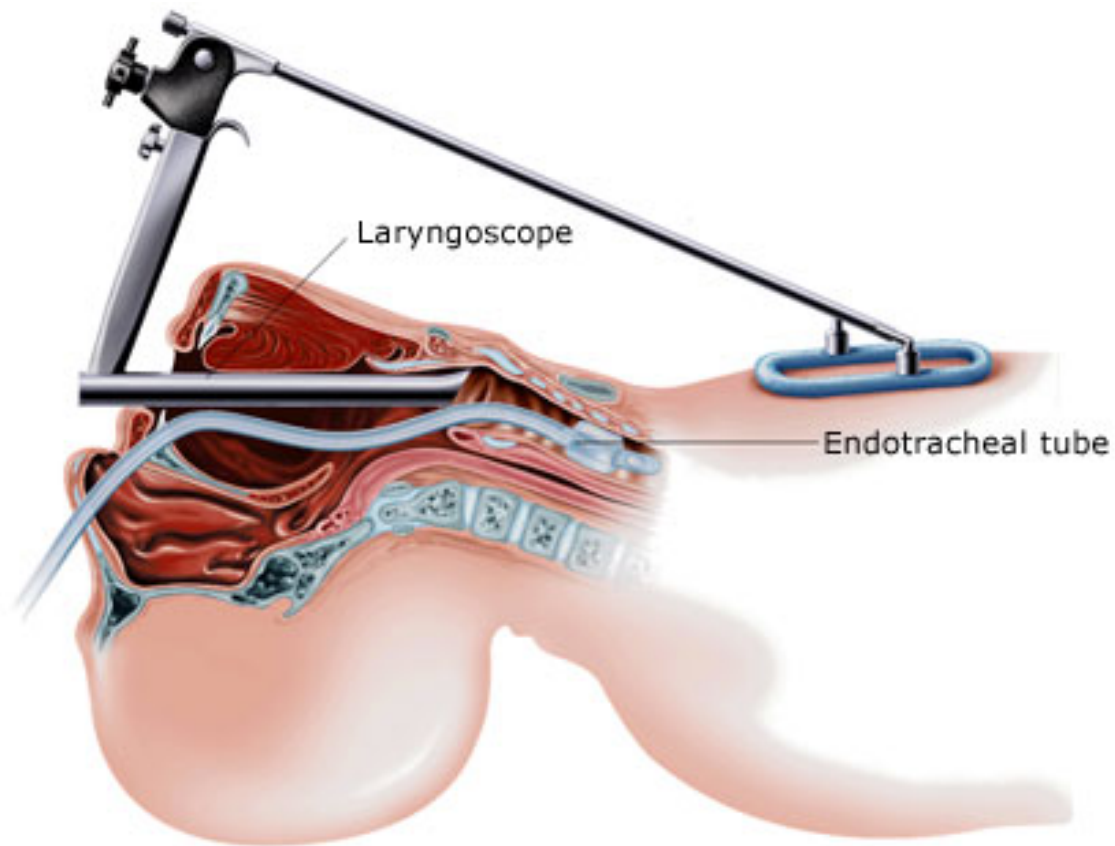
- nasopharyngolaryngoscopy
  - flexibel
  - spontaneous breathing (dynamic)
- laryngotracheoscopy:
  - rigid
  - under relaxation (anatomy)
- microlaryngoscopy
- bronchoscopy



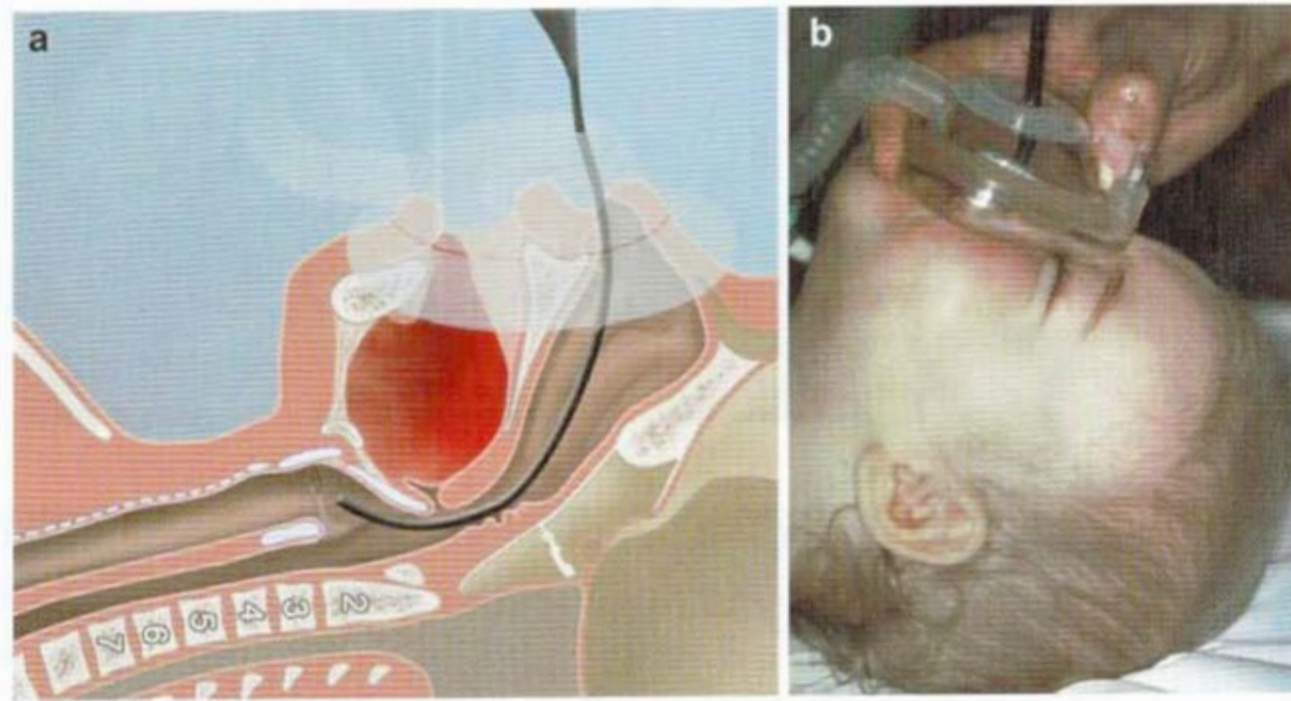
## Positioning of the patient for the endoscopy



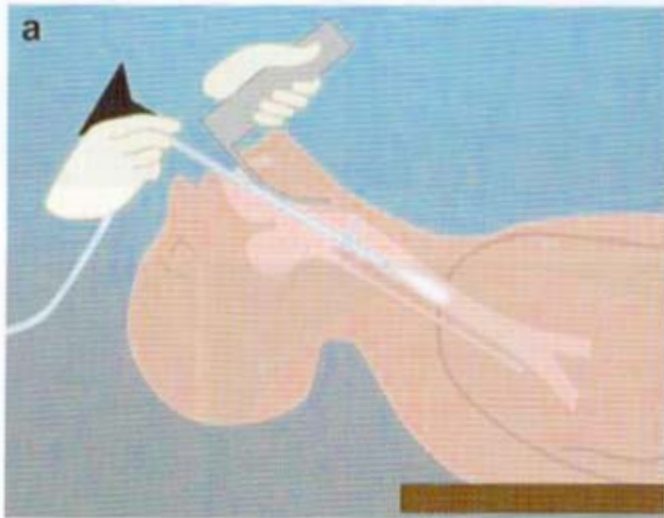
# Microlaryngoscopy



# Nasofibrolaryngoscopy



# Rigid laryngotracheoscopy



# Size of the rigid bronchoscope

Size of bronchoscope	Outer diameter (mm)	Age
2.5	4.0	premature – newborn
3.0	5.0	newborn – 6 months
3.5	5.7	6-18 months
4.0	7.0	18-36 months
5.0	7.8	3-8 years
6.0	8.2	> 8 years

Telescopes 0°/30° 20 or 30 cm length

# Pediatric airway obstruction – treatment

- endoscopy  $\Leftrightarrow$  microlaryngoscopy:
  - « cold instruments »
  - CO<sub>2</sub>-laser
- external approach
- tracheotomy



# Pediatric airway — conclusions

- there are many causes of airway obstruction in children
- the medical history and the clinical diagnosis are very helpful to orientate the diagnosis
- endoscopic evaluation is key for diagnosis, and then the whole airways must be looked at
- radiological evaluation is not used routinely
- a stridor appearing after the first weeks of life must be investigated