

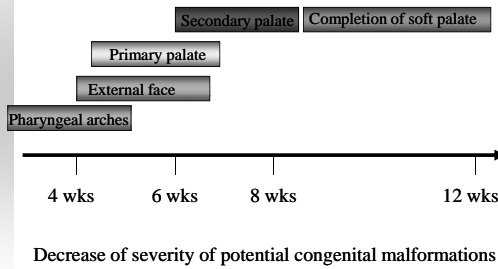
## Facial and palatal development

L.Moss-Salentijn

**Craniofacial malformations are involved in three quarters of all congenital birth defects in humans.**

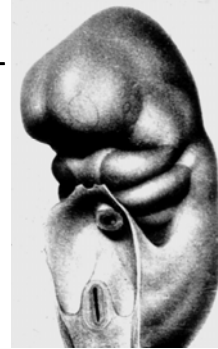
Chai Y & Maxson RE (2006) *Develop Dynamics* 235: 2353-2375

## Timeline for development

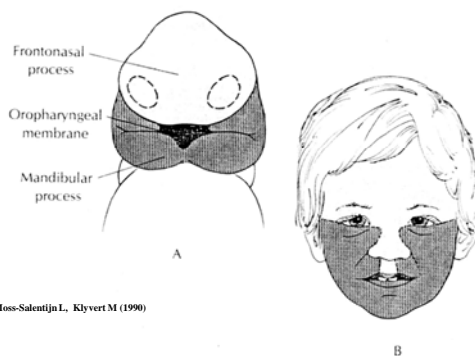


## Contributions to the external face

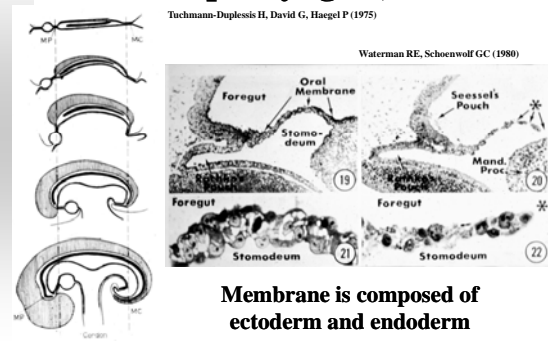
- **Periprosencephalon:** ectoderm and mostly nc-derived mesenchyme surrounding the forebrain. Frontonasal process.
- **First pharyngeal (mandibular) arch.** Mandibular and maxillary processes.



## Contributions to external face

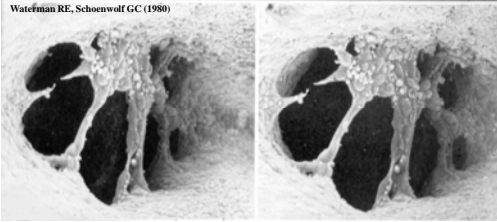


## Oropharyngeal membrane (buccopharyngeal, oral)



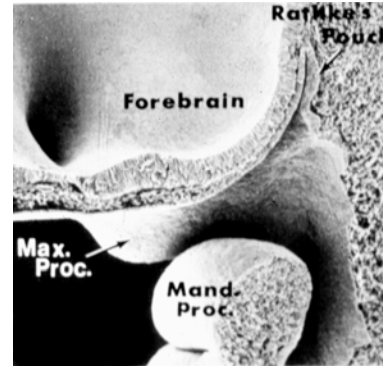
## Disintegration of oropharyngeal membrane

Waterman RE, Schoenwolf GC (1980)



Communication between foregut and amniotic cavity at approximately 4 weeks of development

## Stomodeum at 4 weeks



Waterman RE, Schoenwolf GC (1980)

## Facial processes (prominences)



Sulik K, Johnston M et al (1980)

**Bilaterally:**  
**Lateral nasal**  
**Medial nasal**  
**Maxillary**  
**Mandibular**

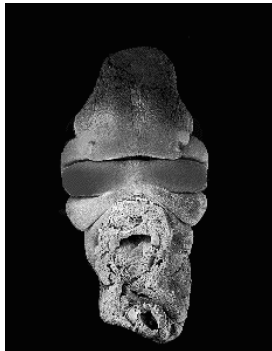
## Face development animation 1



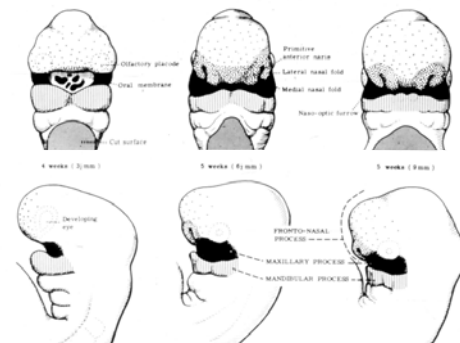
Watt, Marie A, and Sanders, Colin

## Face development – animation 2

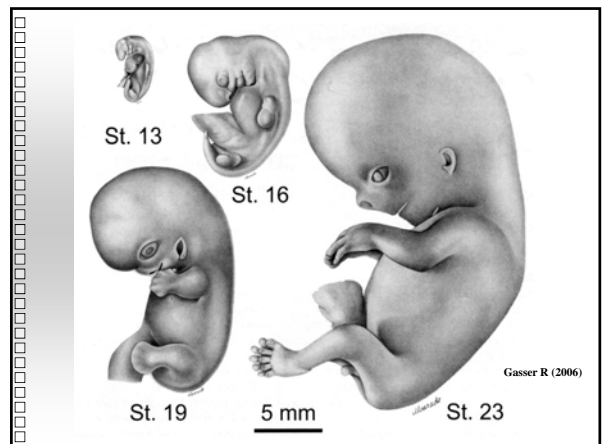
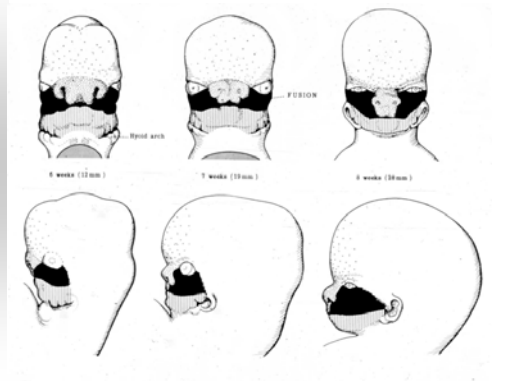
Watt, Marie A, and Sanders, Colin



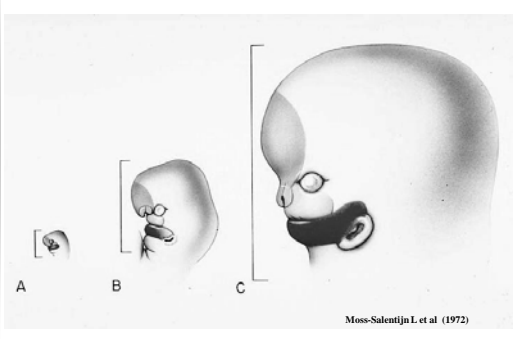
## Development external face (4-5 wks)



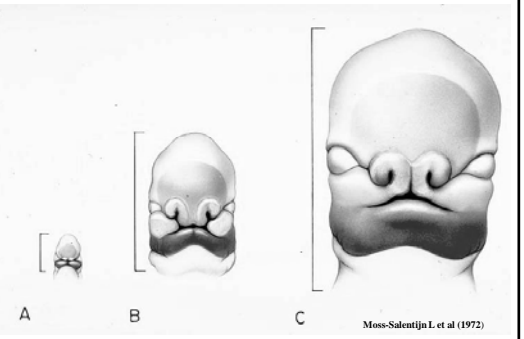
**Development external face (6-8 wks)**



**Dimensional changes (4-6 wks)**

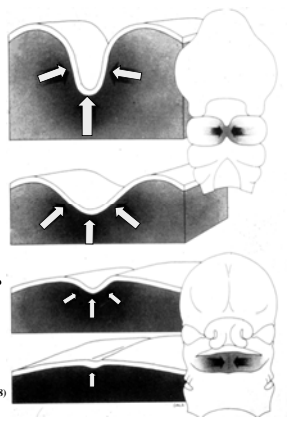


**10-fold linear increase in size !**



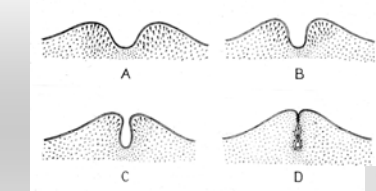
**Merging**

**Differential mesenchymal proliferation. Elimination of groove.**



**Merging with epithelial inclusion**

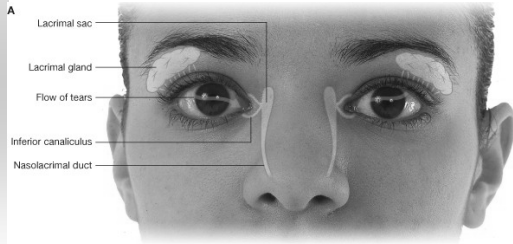
**May result in facial cleft.**



**May be normal between LNP and maxillary process where enclosed epithelium gives rise to part of nasolacrimal duct epithelium.**

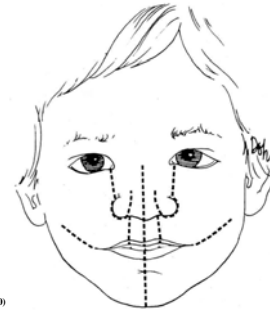


## Nasolacrimal duct between maxillary and lateral nasal processes



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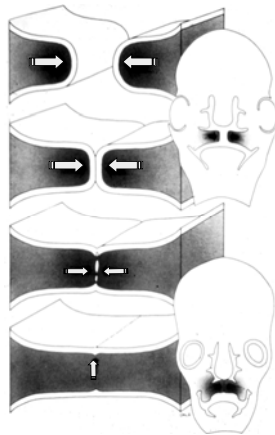
## Sites of potential facial clefts



Moss-Salentijn L, Klyvert M (1990)

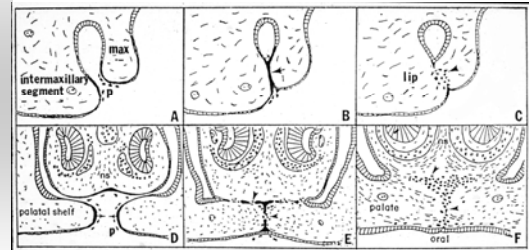
## Fusion

Contact and fusion of epithelium-covered surfaces. Removal of epithelium



Ten Cate AR (1988)

## Fusion in primary and secondary palate development

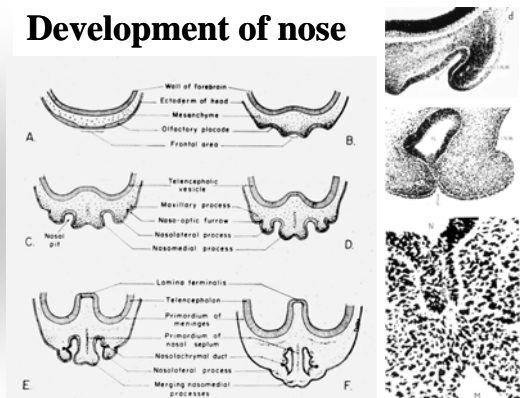


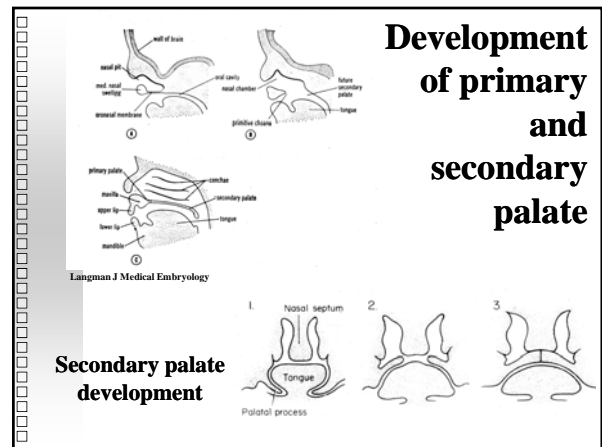
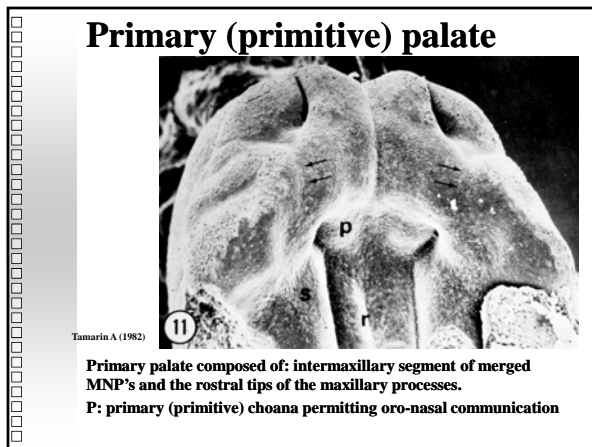
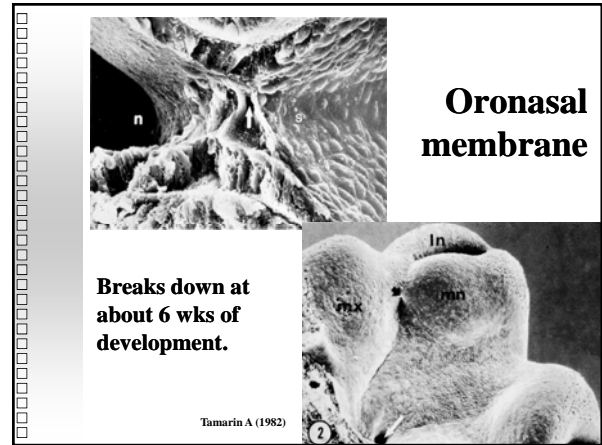
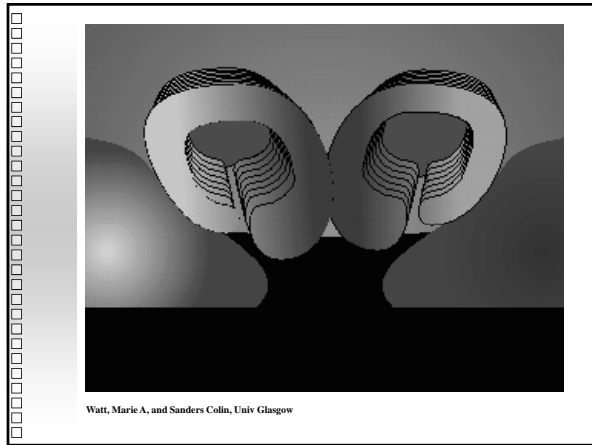
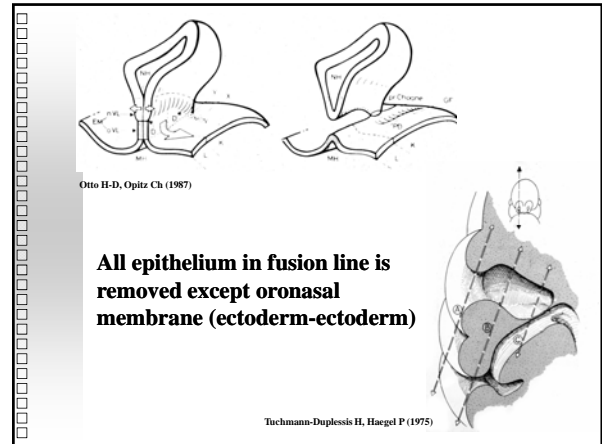
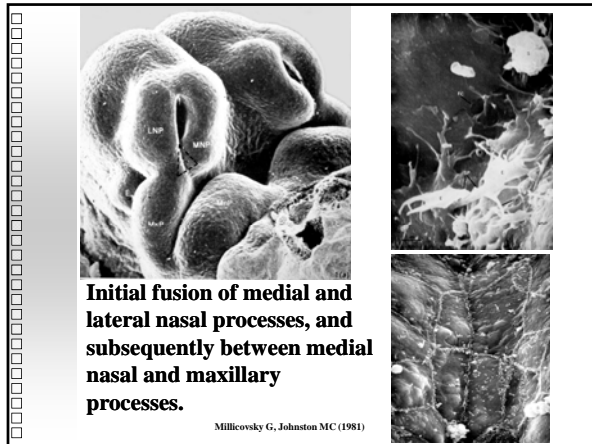
Sun D, Baur S, Hay ED (2000)

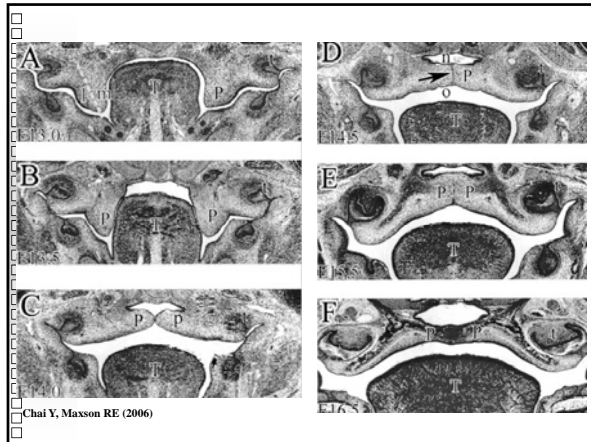
## Fate of fused epithelium

- Non-proliferating epithelium in rapidly growing environment: passive stretch and incorporation in nearby surface epithelia
- Apoptosis and phagocytosis
- Epithelial-mesenchymal transformation

## Development of nose



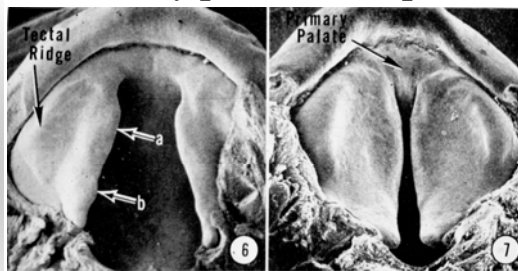




### Intrinsic factors in the successful development of the secondary palate: increase in size of palatal processes

- Mesenchymal cell proliferation – ceases hours before palatal processes become horizontal
- ECM production increasing volume of palatal processes
- Hydration of ECM – major increase in volume and turgor just prior to horizontalization

### Secondary palate development



Waterman RE, Meller SM (1974)

Palatal processes develop on the oral surfaces of the maxillary processes: initially vertically oriented, they assume horizontal orientation during eighth week of development.

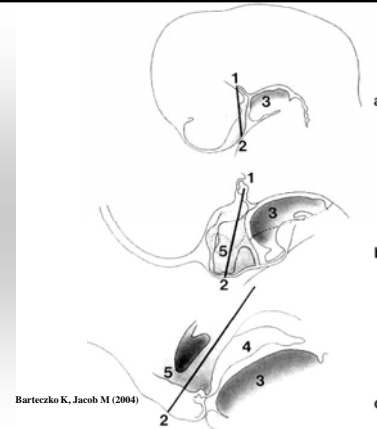
### Horizontalization of palatal processes



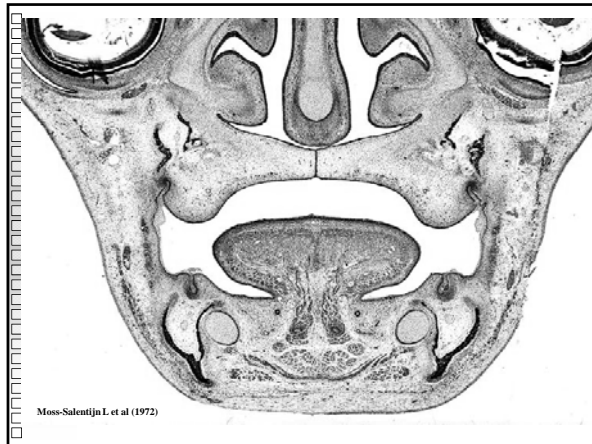
Watt, Marie A, and Sanders, Colin

### Factors contributing to the horizontalization of the palatal processes

- Turgor in the palatal processes
- Movements of the tongue – primitive swallowing- allowing tongue to move out of the way
- Downward and forward growth of lower jaw complex – providing space for the secondary palate
- Straightening of the cranial base – providing mechanical conditions for horizontalization

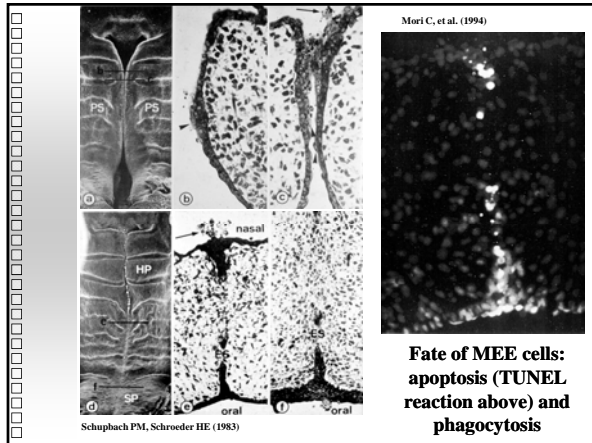


Barteczko K, Jacob M (2004)

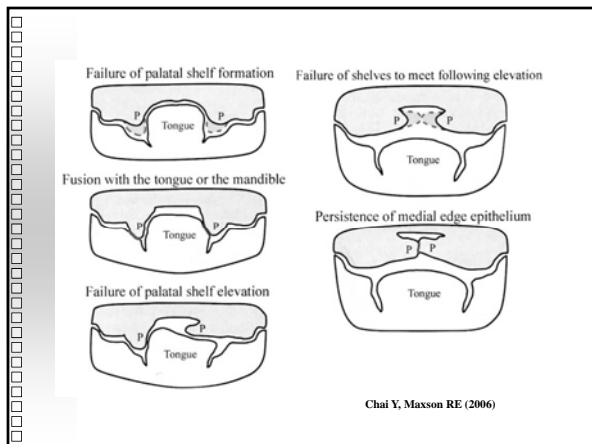
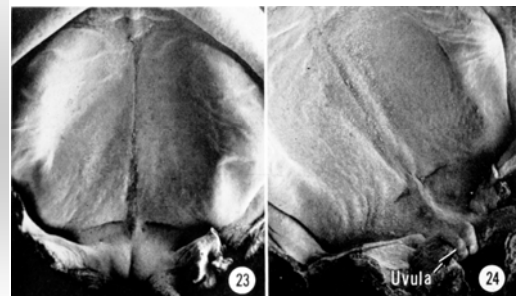


### Factors contributing to the successful fusion of the secondary palate: the medial edge epithelium (MEE)

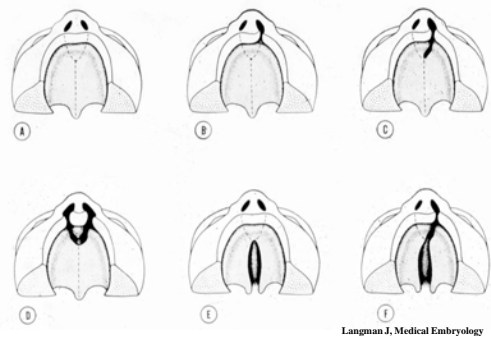
- Apoptosis of MEE surface cells immediately prior to fusion
- Development of temporary glycoprotein membrane coating, enabling adhesion between MEE cells of opposing palatal processes
- Successful removal of MEE from fusion line

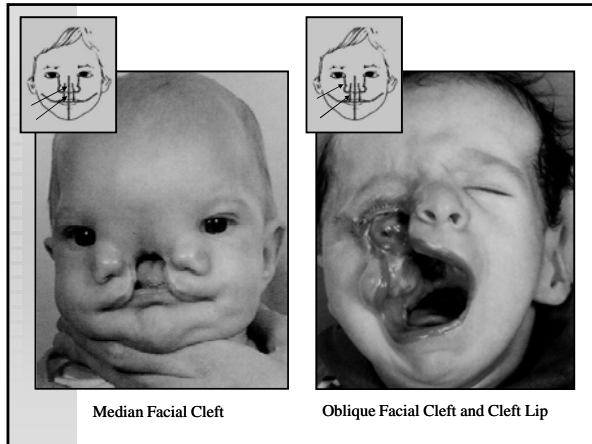


### Completion of palate formation



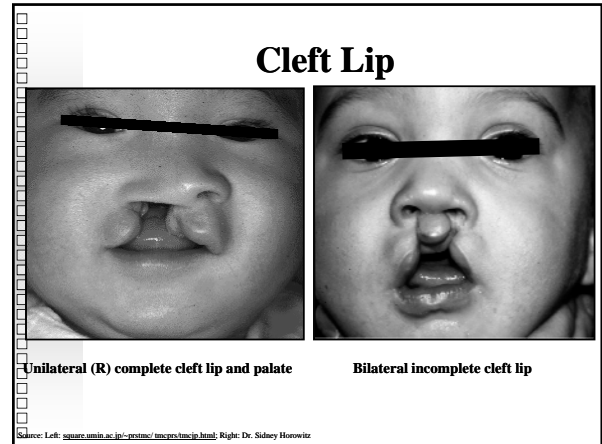
### Sites of potential palatal clefts





Median Facial Cleft

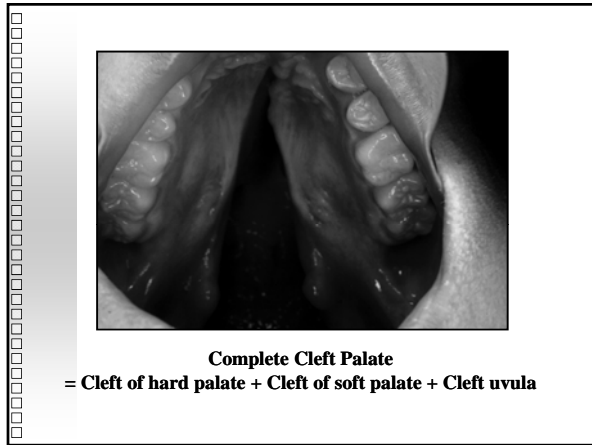
Oblique Facial Cleft and Cleft Lip



Unilateral (R) complete cleft lip and palate

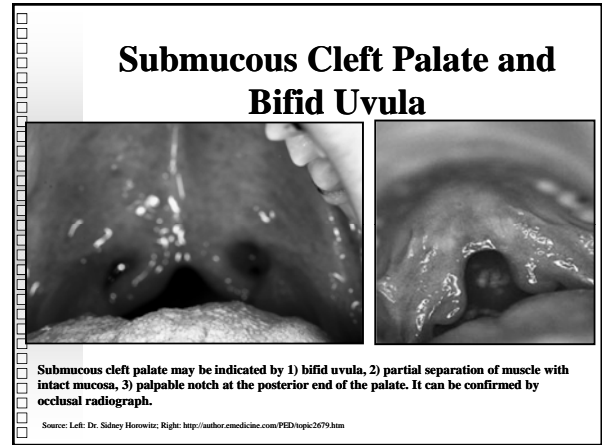
Bilateral incomplete cleft lip

Source: Left: [www.nlm.nih.gov/ncicprtc/mcgr/mcgr.htm](http://www.nlm.nih.gov/ncicprtc/mcgr/mcgr.htm); Right: Dr. Sidney Horowitz



**Complete Cleft Palate**

= Cleft of hard palate + Cleft of soft palate + Cleft uvula



Submucous cleft palate may be indicated by 1) bifid uvula, 2) partial separation of muscle with intact mucosa, 3) palpable notch at the posterior end of the palate. It can be confirmed by occlusal radiograph.

Source: Left: Dr. Sidney Horowitz; Right: <http://author.emedicine.com/PED/topic2679.htm>