In the name of GOD
Postnatal Facial Growth and Development

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Reference:

Contemporary Orthodontics

Chapter 2

Introduction
Pattern

- reflects proportionality
- usually a complex set of proportions
- growth pattern represent the change in proportional relationships over time
- an important aspect is its predictability
Cephalocaudal gradient of growth
Not all the tissue systems of the body grow at the same rate.

The overall pattern of growth is a reflection of the growth of the various tissues.
Within the head and face, the cephalocaudal growth pattern strongly affects proportions.
Variability

everyone is not alike in the way that they grow. It can be difficult, but clinically very important, to decide whether an individual is merely at the extreme of the normal variation or falls outside the normal range.
Normal variability is derived from large-scale studies of group of children.
These charts can be used in two ways:

• the location of an individual relative to the group can be established

• growth charts can be used to follow a child over time to evaluate any unexpected change in growth pattern
Variability arises in several ways:

- **normal** variation
- influences outside the normal experience (e.g. serious illness)
- **timing**
**Timing**

The *same event* happens for different individuals at *different times*, and the biologic clock of different individuals are set differently.

Timing variability can be reduced by using *developmental age* rather than chronologic age.
Methods for studying physical growth
Craniometry

- the **first** of the measurement approaches
- based on measurement of skulls found among **human skeletal remains**
- **precise** measurements can be made on dry skulls
- all the growth data must be **cross-sectional**
Anthropometry

• it is possible to measure skeletal dimensions on living individuals
• by using soft tissue points overlying the bony landmarks
• the measurement results affect by soft tissue thickness
• makes it possible to follow the growth of an individual directly (longitudinal data)
Cephalometric radiology

- it is considerably important not only in the study of growth but also in clinical evaluation of orthodontic patients
- the technique depends on precisely oriented the head and control of magnification
- it allows to follow direct measurements of bony skeleton over time (superimposition)
- it produces two-dimensional representation of a three-dimensional structure
Three-dimensional imaging

- allows 3-D reconstruction of the cranium and face
- CBCT significantly reducing the radiation dose
- superimposition is much more difficult than 2-D cephalometric radiographs
- MRI can be used for 3-D imaging with no radiation exposure
Data analysis

• cross-sectional
  much easier and quicker
  variability within the sample can conceal details of the growth pattern

• longitudinal
  great deal of information can be gained from a small number of subjects
  highlight individual variations particularly timing effects
Velocity curve vs. Distance curve

Velocity curve showing not total length but the increment added each time interval

Changes in the rate of growth are much more easily seen in the velocity curve
**Vital staining**

Dyes that stain mineralizing tissues (or occasionally soft tissues) are injected into an animal.

Dyes remain in the bones and teeth and can be detected later after sacrifice of the animal:

- sites of active skeletal growth at the time of injection.
Alizarin reacts strongly with calcium.
Tetracycline

An excellent vital stain

Binds to calcium at growth sites
Radioactive tracers

any radioactively labeled metabolite becomes incorporated into the tissues as a sort of vital stain

$\text{Tc} \ 99, \ \text{C-proline, 3H-thymidine}$
Implant radiography

Inert metal pins are placed in bones

Considerable increase in the accuracy of a longitudinal cephalometric analysis of growth pattern
Facial growth and development

II: Postnatal
Cranial vault

The bones that cover the upper and outer surface of brain
Cranial vault

• number of flat bones that are formed directly by *intramembranous* bone formation
• the growth process is entirely the result of *periosteal* activity at bone surfaces
• *remodeling* and growth primarily occur at the cranial *sutures*
• periosteal activity changes both the inner and outer surfaces of bones
• the *fontanelles* allow a considerable deformation of the skull at birth
• after birth, bone apposition along the edges of fontanelles *eliminates* these spaces
• the bones remain separated by a thin, periosteum-lined **suture** for many years
• apposition of new bone at sutures is the **major mechanism** for cranial vault growth
• **remodeling** of the inner (resorption) and outer (apposition) surfaces, allow for changes in **contour** during growth
Cranial base

The bony floor under the brain,

Which also is the dividing line between the cranium and the face
Cranial base

- the bones of the base are formed by endochondral bone formation
- this is particularly true of the midline sutures
- as ossification proceeds, bands of cartilage called synchondroses remain between the centers of ossification
- histologically a synchondroses looks like a two sided epiphyseal plate
- the cranial base is rather like a single long bone with multiple epiphyseal plate-like synchondroses.
Spheno-occipital synchondroses

Intersphenoid synchondroses

Spheno-ethmoidal synchondroses
Nasomaxillary complex

Nose, maxilla and associated small bones
Nasomaxillary complex

• the maxilla developed postnatally entirely by intramembranous ossification.

• growth occurs in two ways:

  1- apposition of bone at the cranial base and cranial sutures

  2- surface remodeling

• additionally the maxilla is moved forward by cranial base growth behind it

  (secondary displacement)

• the maxilla must move a considerable distance downward and forward relative to the cranium and cranial base.
• up to about age 6
  about age 7

  displacement from cranial base growth
  sutural growth
Surface remodeling + Translation
Mandible
Mandible

• both endochondral and periosteal activity are important in growth of the mandible
• displacement created by cranial base growth plays a negligible role
• cartilage covers the surface of the mandibular condyle at the TMJ, all other areas are formed and grow by surface apposition and remodeling
• the cranium as a reference → the chin moves downward and forward
• vital staining → the principal sites of growth are posterior surface of the ramus and the condylar and coronoid processes
• the chin is almost inactive growth site, it is translated downward and forward by the actual growth at the mandibular condyle and posterior surface of the ramus.

• the body of the mandible grow longer by periosteal apposition of bone on its posterior surface, while the ramus grows higher by endochondral replacement at the condyle accompanied by surface remodeling.
Facial soft tissues

Growth of the facial soft tissue does not perfectly parallel the growth of underlying hard tissue.
Lips

- the lips trail behind the growth of the jaws prior to adolescence, then undergo growth spurt to catch up
- lip incompetency is maximal during childhood and decreases during adolescence
- the lips move downward relative to the teeth during adolescence
- lip thickness reaches its maximum during adolescence, then decreases
Nose

• growth of the nasal bone is complete at about age 10, after then only the nasal cartilage and soft tissue grow (adolescent spurt)
• the nose become much more prominent at adolescent, especially in boys
• because of the nose and chin growth in adolescence and post-adolescence, the relative prominence of the lips decreases
Theories of growth control
Sites versus centers of growth

(Genetic programmed theory)

A site of growth is merely a location at which growth occurs, whereas a center is a location at which independent (genetically controlled) growth occurs.

All center of growth also are sites, but the reverse is not true.
Cartilage as a determinant of craniofacial growth

Mandible → condyle

Maxilla → nasal septum
Functional matrix theory of growth
Thanks for your attention