Growth and Development I

The term growth usually refers to an increase in size or number while the term development will be used to refer to an increase in complexity. Growth is largely an anatomic phenomenon, whereas development is physiologic and behavioral, which means a progress toward maturity.

Why should a dentist or orthodontist be interested in development?

1. Knowledge of general and facial growth provides a background to the understanding of the etiology and development of malocclusion, playing an important part of the diagnosis and treatment planning process.

2. At regular intervals of the growing child, all dentists should be able to identify abnormal or unusual patterns of skeletal growth (e.g. posterior rotational growth of the mandible may lead to skeletal open bite)...

3. The dentist will be able to identify abnormal occlusal development at an early stage in order to undertake suitable interceptive orthodontic treatment (e.g. premature contact may lead to sever skeletal class III)

4. Poorly timed extractions performed by the dentist during growth may have unfortunate consequences on the developing occlusion.

5. Many malocclusions are resulted from skeletal discrepancies between the jaws (maxilla and mandible). Such discrepancies are usually due to differences in the comparative growth of the jaws.

6. Orthodontic treatment may make use of growth spurts (maximum growth period) and other trends. The timing of treatment in relation to these may be important.

7. Most orthodontic treatments are performed in the actively growing child or adolescent and may have an effect on the favorable growth of hard and soft tissues of the area.

8. In some treatments, especially when surgery is being considered, it is important to be able to identify when the majority of facial growth has been completed. (above the age of 17th years)

9. Growth effects can have long-term effects on the stability of the occlusion after treatment. This needs to be considered when a retention regime is planned. (e.g. Class Ill needs long retention period because there is a continuous possibility of mandibular growth till 20 years of age while maxillary growth usually stopped earlier.)

Control of cranio-facial growth

Three major theories in recent years have attempted to explain the determinants of craniofacial growth as followings:

1- Bone, is the primary determinant of its own growth.

2- Cartilage is the primary determinant of skeletal growth, while bone responds secondarily and passively.

3- The soft tissue matrix in which the skeletal elements are embedded is the primary determinant of growth, and both bone and cartilage are secondary followers.

The major difference in the theories is the location at which genetic control is expressed.

- The first theory implies that genetic control is expressed directly at the level of the bone, and therefore, its locus should be the periosteum. However this theory has been largely discarded from 1960.
- The second, or cartilage, theory suggests that genetic control is expressed in the cartilage, while bone responds passively to being displaced, this theory still controversy till now. This indirect genetic control is called epigenetic.
- The third theory assumes that genetic control is mediated to a large extent outside the skeletal system, and that growth of both bone and cartilage is controlled epigenetically, occurring only in response to a signal from other tissues (as it proposed that growth of cranium occurs as a result to growth of brain).

If neither bone nor cartilage was the determinant for growth of the craniofacial skeleton, it would appear that the control would have to lie in the adjacent soft tissues. This point of view was put formally in the 1960s by **Moss**, in his "functional matrix theory" of growth, and was reviewed and updated by him in the 1990s, his theory holds that neither the cartilage of the mandibular condyle nor the nasal septum cartilage is a determinant of jaw growth. Instead, he theorizes that growth of the face occurs as a response to functional needs and is mediated by the soft tissue in which the jaws are embedded. In this conceptual view, the soft tissues grow, and both bone and cartilage react.

Moss theorizes that the major determinant of growth of the maxilla and mandible is the enlargement of the nasal and oral cavities, which grow in response to functional needs.

The theory does not make it clear how functional needs are transmitted to the tissues around the mouth and nose, but it does predict that the cartilages of the nasal septum and mandibular condyles are not important determinants of growth, and that their loss would have little effect on growth if proper function could be obtained.

From the view of this theory, however, absence of normal function would have wide-ranging effects on normal growth. This theory considered as most acceptable one now a day.

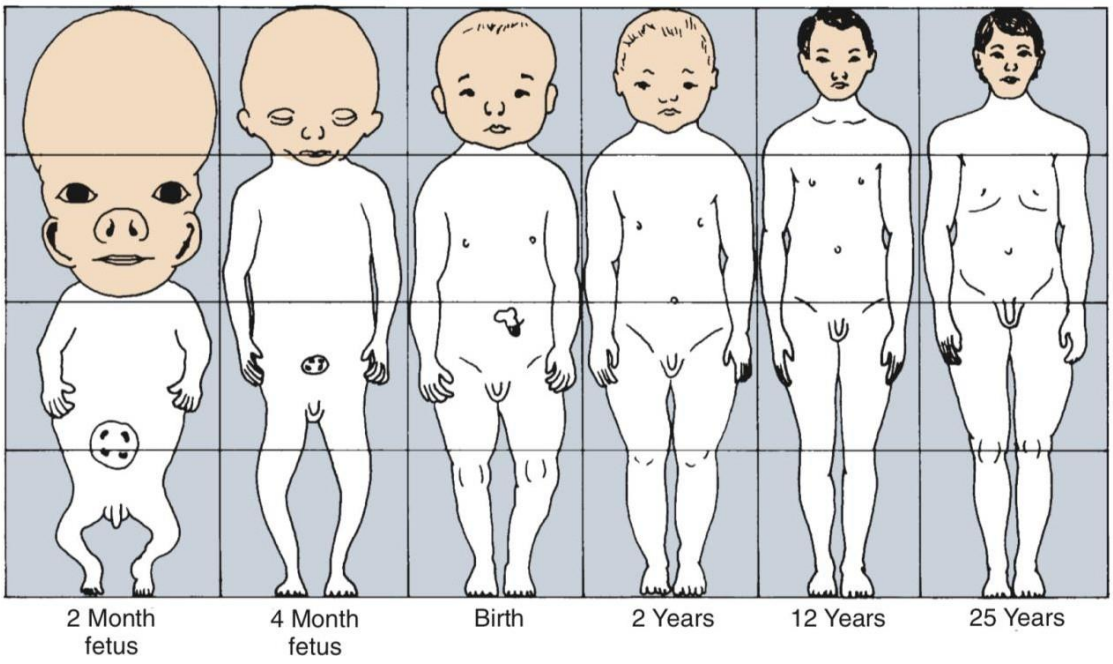
IGROWTH: PATTERN, VARIABILITY AND TIMING

1-Pattern:

In studies of growth and development, the concept of pattern is an important one. In a general sense, pattern reflects proportionality, usually of a complex set of proportions rather than just a single proportional relationship, because it refers not just to a set of proportional relationships at a point in time, but to the change in these proportional relationships over time. In other words, the physical arrangement of the body at any one time is a pattern of spatially proportioned parts.

In fetal life, at about the third month of intrauterine development, the head takes up almost 50% of the total body length. At this stage, the cranium is large relative to the face and represents more than half the total head. In contrast, the limbs are still rudimentary and the trunk is underdeveloped.

By the time of birth, the trunk and limbs have grown faster than the head and face, so that the proportion of the entire body devoted to the head has decreased to about 30%. The overall pattern of growth thereafter follows this course, with a progressive reduction of the relative size of the head to about 12% of the adult. At birth, the legs represent about one third of the total body length, while in the adult, they represent about half.



As Figure (1) illustrates, there is more growth of the lower limbs than the upper limbs during postnatal life. All of these changes, which are a part of the normal growth pattern, reflect the "cephalocaudal gradient of growth." This simply means that there is an axis of increased growth extending from the head toward the feet.

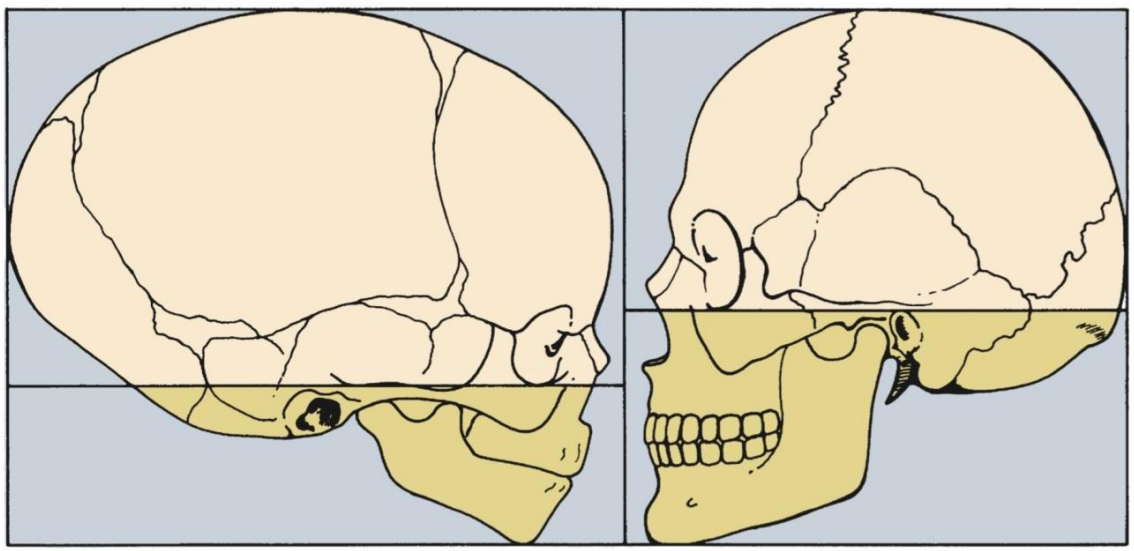


Fig (2): At birth, the face and jaws are relatively underdeveloped compared with their extentin the adult, there is much more growth of facial than cranial structures postnatally.

As the face enlarges it grows downward and forwards away from the cranium, the growth of the face involving many growth processes in the mandible, mid face, cranial base, all of these are going on at the same time, and the overall pattern of growth result from the interplay betweenthem.

Even within the head and face, the cephalocaudal growth gradient strongly affects proportions and leads to changes in proportion with growth, so when the skull of a newborn infant is compared proportionally with that of an adult (fig. 2), it is easy to see that the infant has a relatively much larger cranium and a much smaller face.

When the facial growth pattern is viewed against the perspective of the cephalocaudal gradient, it is not surprising that the mandible, being farther away from the brain, tends to grow more and later than the maxilla, which is closer, and this is considered as advantage in treatment of skeletal Class II and disadvantage in treatment of skeletal Class III.

Different systems of body have different growth patterns in terms ofrate and timing and four main types are recognized:

1- Lymphoid growth

2- Genital growth

3- Neural growth: Determined by the growth of the brain, and the calvarium follows this pattern of growth, in other words the bones grows in response to the growth of another structure. There is rapid growth of cranium in the early years of the life, but this slows until about 8 years, growth is almost complete. The orbits follow the neural growth pattern.

4- Somatic growth: Is that followed by most of body structures. It is seen in the long bones leading to increase in the body height, This growth is fairly rapid in the early years but slows in the pre-pubertal period, while the pubertal growth spurt (11years in girls, 13 years in boys) is a time of very rapid growth, which followed by further slower growth.

The maxilla and mandible follow a pattern of growth that is intermediate between neural and somatic growth, with the mandible- following the somatic growth curve more closely than the maxilla, which has a more neural growth pattern. Thus different parts of the skull follow different growth patterns, with much of the growth of the face occurring later than the growth of the cranial vault. As a result the proportions of the face to the cranium change during growth, and the face of the child represents a much smaller proportion of the skull than the face of the adult.

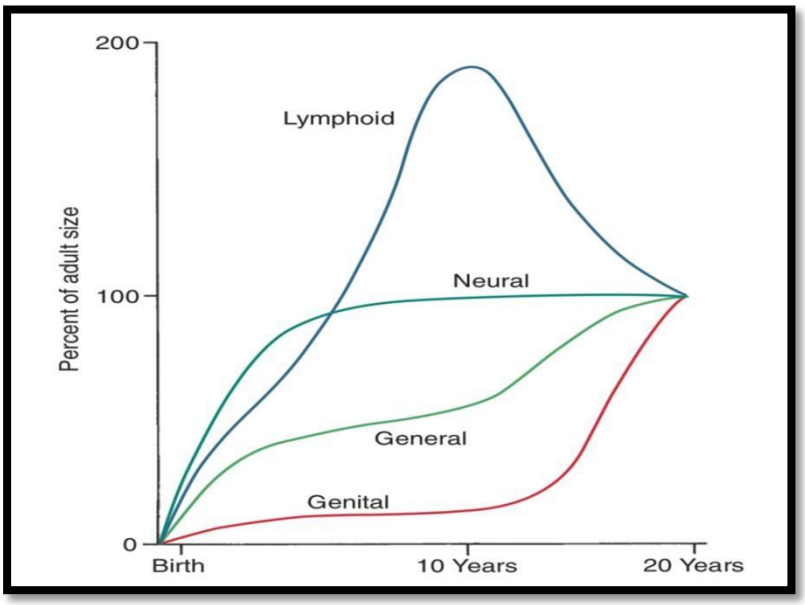


Fig. (3) **Scammon's curves** for growth of the four major tissue systems of the body. As the graph indicates, growth of the neural tissues is nearly complete by 6or 7 years of age. Genera body tissues, including muscle, bone, and viscera, showan S shaped curve, with a definite slowing of the rate of growth during childhoodand an acceleration at puberty. Lymphoid tissues proliferate far beyond the adult amount in late childhood, and then undergo involution at the same time that growth of the genital tissues accelerates rapidly.

CLINICAL SIGNIFICANCE OF THE GROWTH SPURTS

1- To differentiate whether growth changes are normal or abnormal.

2- Treatment of skeletal discrepancies (e.g. Class II) is more advantageous if carried out in the mixed dentition period, especially during the growth spurt.

3- Pubertal growth spurt offers the best time for majority of cases in terms of predictability, treatment direction, management and treatment time.

4-Orthognathic surgery should be carried out after growth ceases.

5-Arch expansion is carried out during the maximum growth period

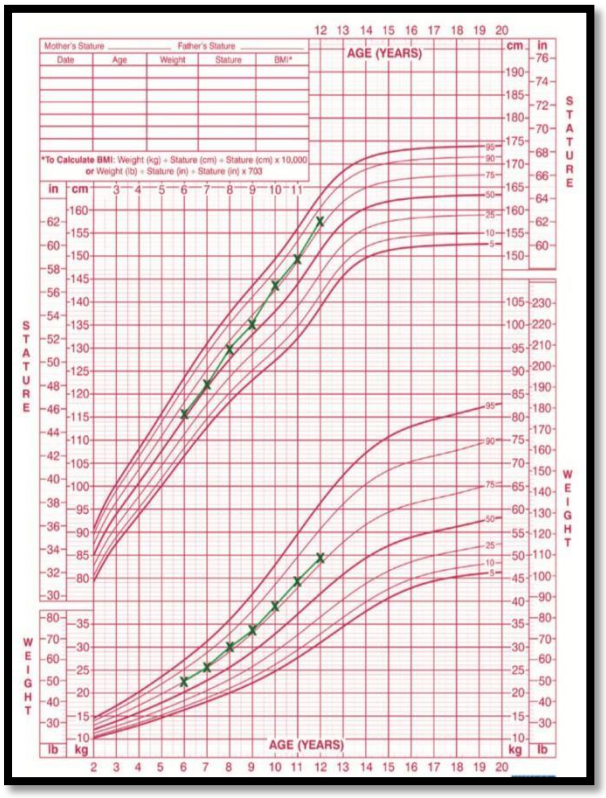
2- Variability:

Obviously, everyone is not alike in the way that they grow, as in everything else. 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. Rather than categorizing people as normal or abnormal, it is more useful to think in terms of deviations from the usual pattern and to express variability quantitatively.

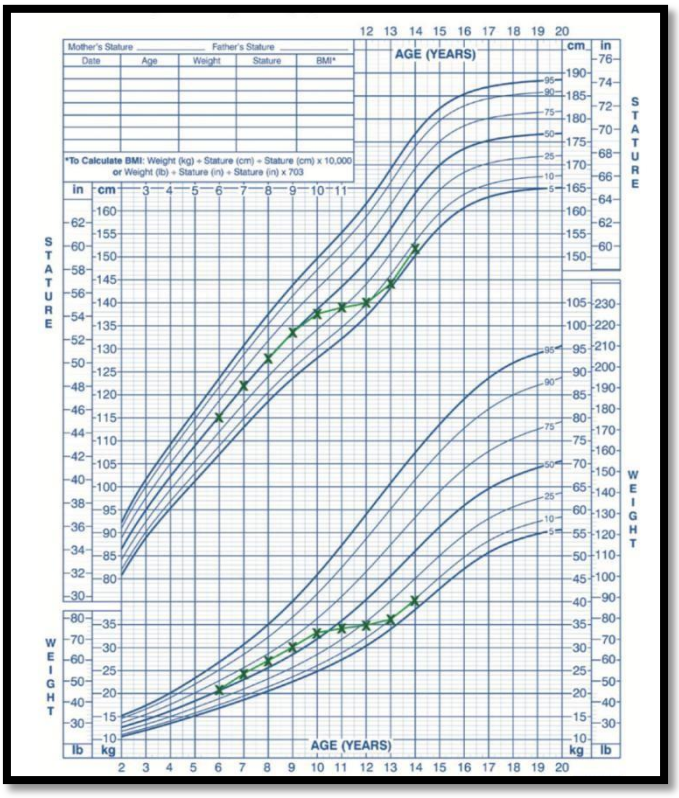
One way to do this is to evaluate a given child relative to peers on a standard growth chart which can be used in two ways to determine whether growth is normal or abnormal.

a-The location of an individual relative to the group can be established.

b-More importantly, growth charts can be used to follow a child were evaluate whether there is an unexpected change in growth pattern.



Normal growing girl



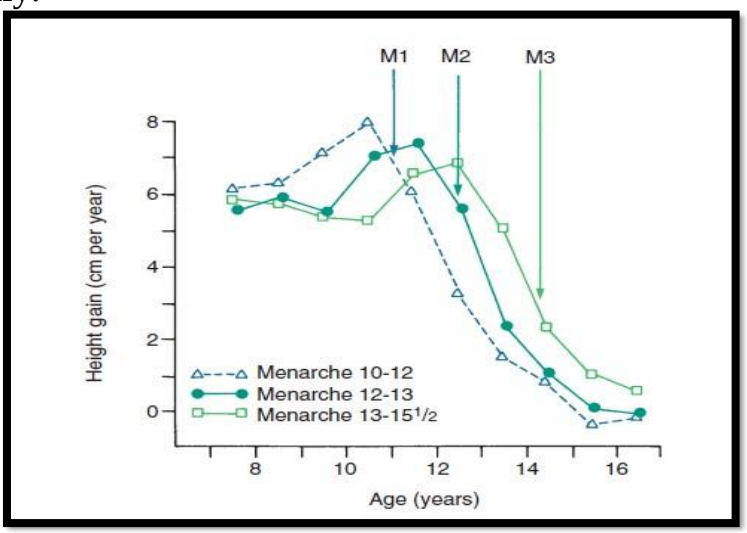
Sick growing boy

4- **Timing:**

Variation in timing arises because the same event happens for different individuals at different times-or, viewed differently, the biologic clocks of different individuals are set differently.

Variations in growth and development because of timing are particularly evident in human adolescence. Some children grow rapidly and mature early, completing their growth quickly and thereby appearing on the high side of developmental charts until their growth ceases and their contemporaries begin to catch up. Others grow and develop slowly and so appear to be behind, even though, given time, they will catch up with and even exceed children who once were larger. All children undergo a spurt of growth at adolescence, but the growth spurt occurs at different times in different individuals.

Growth effects because of timing variation can be seen particularly clearly in girls, in whom the onset of menstruation, often referred to as menarche, gives an excellent indicator of the arrival of sexual maturity. Sexual maturation is accompanied by a spurt in growth. When the growth velocity curves for early average-, and late-maturing girls are compared in (Figure 4), the marked differences in size between these girls during growth are apparent. At age 11, the early-maturing girl is already past the peak of her adolescent growth spurt. Whereas the late- maturing girl has not even begun to grow rapidly.



Growth velocity curves for early-, average-, and late-maturing girls.

The **earlier** the adolescent growth spurt occurs, the **more** intense it appears to be. The marked differences in size among these girls during growth are apparent. At age 11, the early-maturing girl is already past the peak of her adolescent growth spurt, whereas the late-maturing girl has not even begun to grow rapidly.Obviously, at age 11 or 12, an early-maturing girl would be considerably largerthan one who matured late.