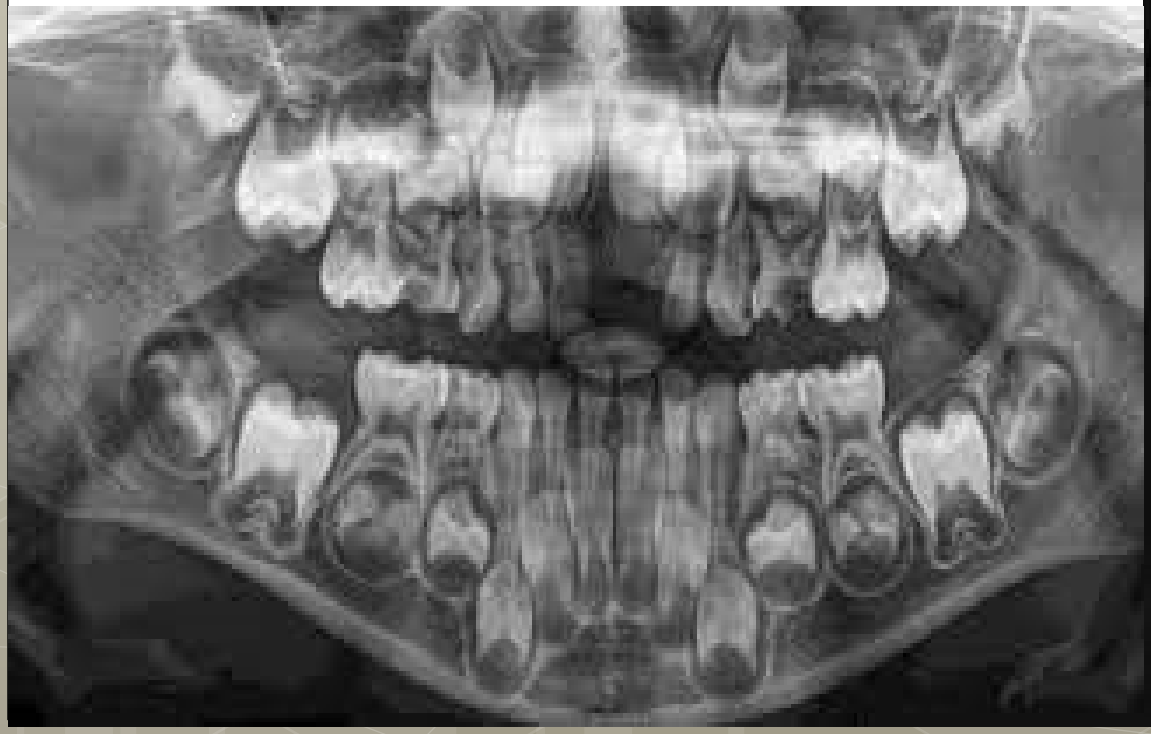

بسم الله الرحمن الرحيم


Fetal Growth From 4 to 40 Weeks
4
8
12
16
20
24
28
32
36
40
shutterstock.com · 551553847



AGE ESTIMATION

Learning objectives

- Describe ossification of bones.
- Discuss foetal age determination.
- Describe age estimation in human skeleton.
- Describe age estimation from miscellaneous data.
- Discuss medico legal importance of age.

Age determination

- Determination of age pre requires understanding of the life span of human beings. Age span begins with conception within the womb and after birth passing through stages, ends with death.
- Age span has three clear phases, two of activity and one of rest, (static phase) being in the middle.

Phases of age

- Proliferative phase
- Static phase
- Retrogressive phase

Proliferative phase

- It is the first biologically active period showing development in the human body.
- Every part of body increases in size. It has two distinct stages an intrauterine followed by an extrauterine, starting from birth to attainment of about twenty five years.

- Biological changes in the proliferative phase are increase in size of every part, length and Weight of a person and other diverse changes in complexity of the body. These changes correspond to an established chronology having relation with time.
- Advantage is taken of this record of events in order of time that age can be estimated with a degree of reasonable accuracy.

Static phase

- It is the second and biologically inactive periodic from twenty five years to about forty four years during which there is no change in the body.

- Afterward in retrogressive phase changes in most parts of the body do occur but their appearance is erratic and age estimation is only an approximation.

Retrogressive phase

- It is the third and again biologically active period from forty- four years showing degenerative changes in almost every part of the body.

- Factors affecting the age are sex, race nutrition and climate. In bony and dental data scales, females end up in advance of males. It is generally seen that puberty ensues much earlier in the hot climate.

Age estimation

- Age of a person is an essential factor in establishing the personal identity, and it can be determined by the following factors/parameters;
- Height and weight data
- Morphological characteristics
- Dentition(Teeth)
- Ossification of bones; and
- Miscellaneous data

Foetal age

- The age of a fetus in IUL can be assessed by studying;
- Length and weight of the foetus
- The developmental morphology
- Appearance of Ossification centers in skeletal bones
- Germination of teeth

Hasse’s rule

- This enables the estimation of the age of the fetus in lunar months from the crown-heel length(in cm)of the fetus. Accordingly, until the fetal length is 25 cm, square root of the length determines the age of the fetus in months and when the length is more than 25cm,age is derived by dividing the length by 5.

Morphological development

Age	Length	Features
1st month	1.25 cm	Embryo formed,showing limb buds
2nd month	2.5 cm	Head formed showing ears
3rd month	9 cm	Placenta formed. Nails appearing
4th month	15 cm	Sex clear, hairs appearing on head.
5th month	25 cm	Fetus, 350---450 gm weight
6th month	30 cm	Fetus, 700---900 gm weight
7th month	35 cm	Fetus, 1.2---1.4kg weight
8th month	40 cm	Fetus, 1.5---2.0 kg weight
9th month	50 cm	Fetus, 2.5---3.5 kg weight

Ossification of bones

- The bones of human skeleton develop from separate ossification centers.
- From these centers, ossification progresses till the bone is formed.
- These changes can be studied by means of x-rays.
- It is therefore possible to determine the approximate age of an individual by radiological examination of bones till ossification is complete.

- While the time of ossification gives a good indication of age it should be noted that;
- There are variations due to dietetic, geographic, hereditary and other factors
- Union of epiphysis in cartilaginous bones takes place earlier in female than in male; except in case of skull sutures where obliteration sets in a little later and
- Under tropical conditions, ossification is observed earlier than in temperate areas.

Chronology of Ossification Data

- At birth : lower end of femur(talus and calcaneum; cuboid,upper end of tibia and head of humerus)shows centre of ossification.
- By 1 ½-2 years : the anterior fontanelle closes(also metopic suture).
- By end of 2 years : condylar portions of the occipital bone fuse with the squama.
- Between 2 and 6 years : the number of carpal bones on x-ray represents the approx. age in years(example ,four carpal bones-4years).

- By 4 years in females and 6 years in males, centre of ossification appears in medial epicondyle of humerus.

- By about 6 years : condylar portions of occipital bone fuse with the basi-occiput.
- By 7-8 years : the rami of pubis and ischium unite(sacral vertebrae seperated by cartilage.
- By 8-10 years : centre of ossification appears in olecranon.
- By 10-12 years : pisiform ossifies.

- By 18-20 years : all epiphyses at wrist, knee, crest of ileum and lateral end of clavicle should be united.
- The acromion process should be united to scapula.
- Soon after 20th year : the articular facets of ribs should be united.
- By 21-22 years ischial tuberosity should be fused in females.

- By 13-14 years : lateral epicondyle of humerus unites with trochlea and capitulum.
- By 15-16 years : epiphysis of calcaneum joins the bone;tri-radiate cartilage of acetabulum fuses;coracoid process should unite to the scapula;olecranon should be united to the ulna; heads and ends of metacarpals unite with their respective shafts.
- By 16-18years : all epiphyses at elbow, head of femur, lower end of tibia join the respective shafts.
- In females,the epiphyses at elbow join their respective shafts by 13-14 years.

- By 22 years : the inner epiphysis of clavicle fuses.
- By 18-22 years : the basi-occiput should be fused with basi-sphenoid.
- By 23 years : sacral vertebrae should be united with one another from below upwards.

- The four middle pieces of the sternum fuse with one another from below upwards between 14 and 25 years of age.
- If all the epiphyses are united, the person is above 25 years of age. From these data, it is seen that the probable age can be determined within a year or so before puberty, and within a range of two years thereafter, until the consolidation of the skeleton at 22 to 25 years

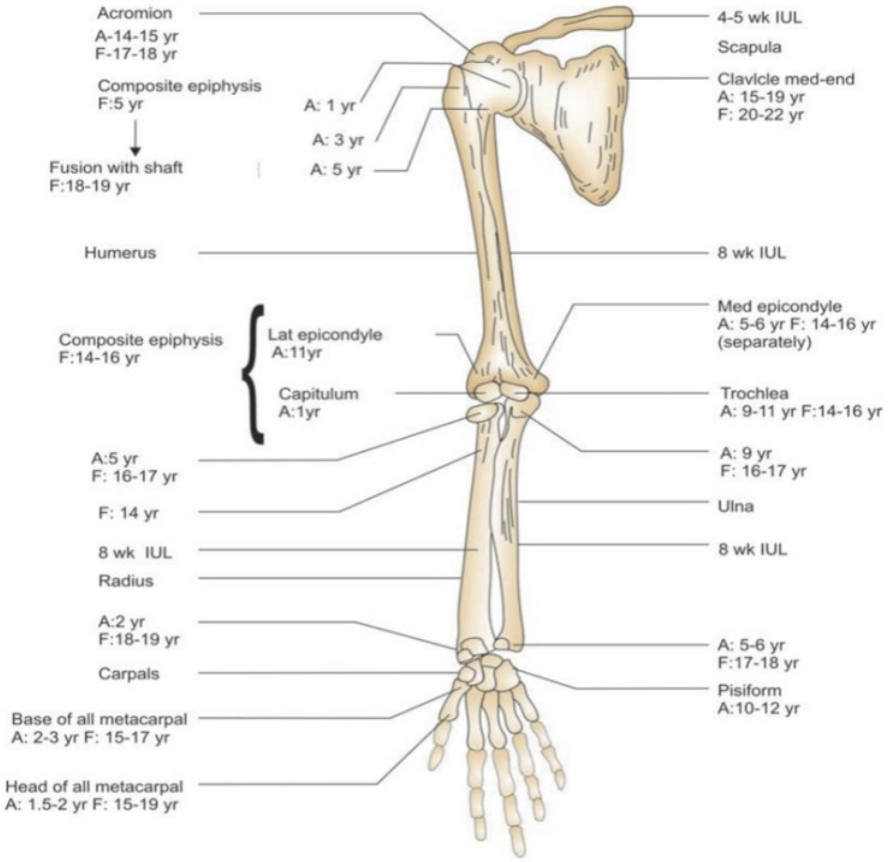


Fig. 11.5: Scheme of ossification of bones of upper extremity[11]

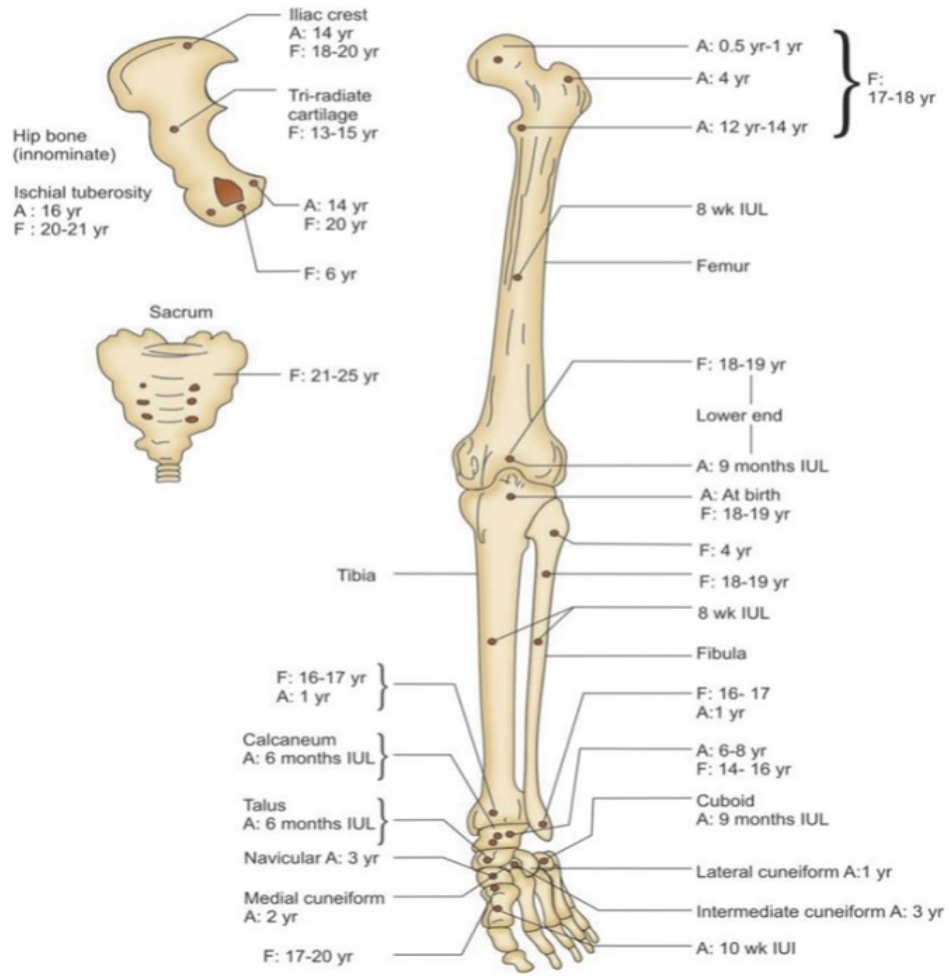
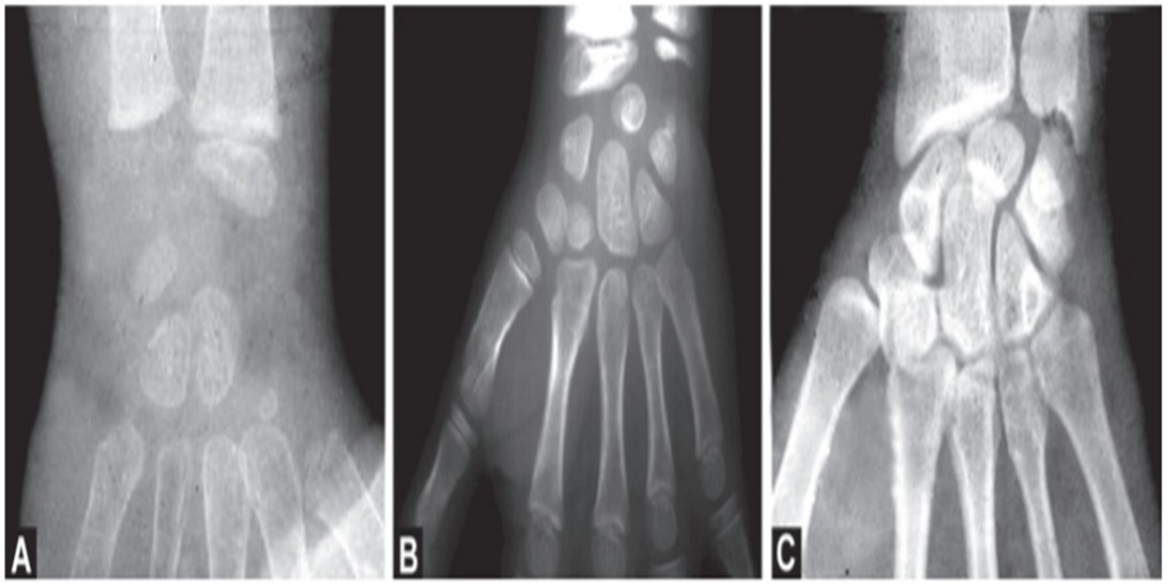


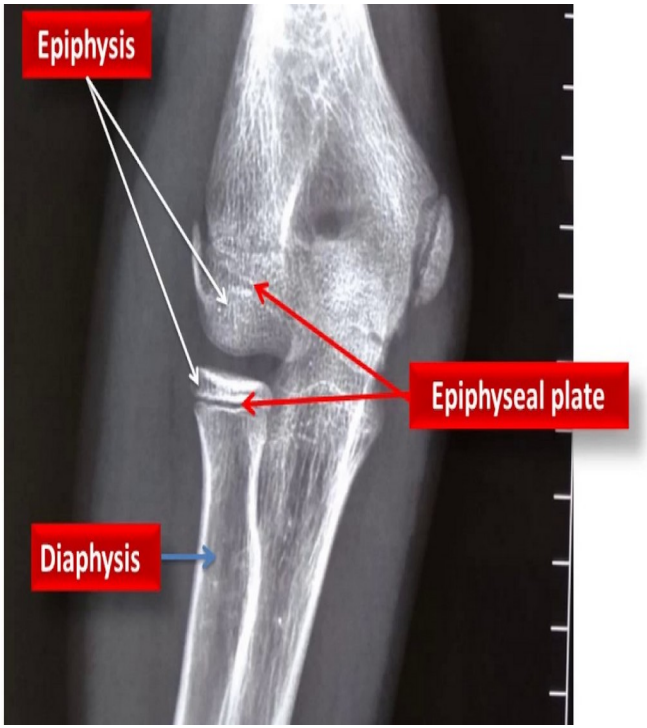
Fig. 11.6: Scheme of ossification of bones of lower extremity[11]

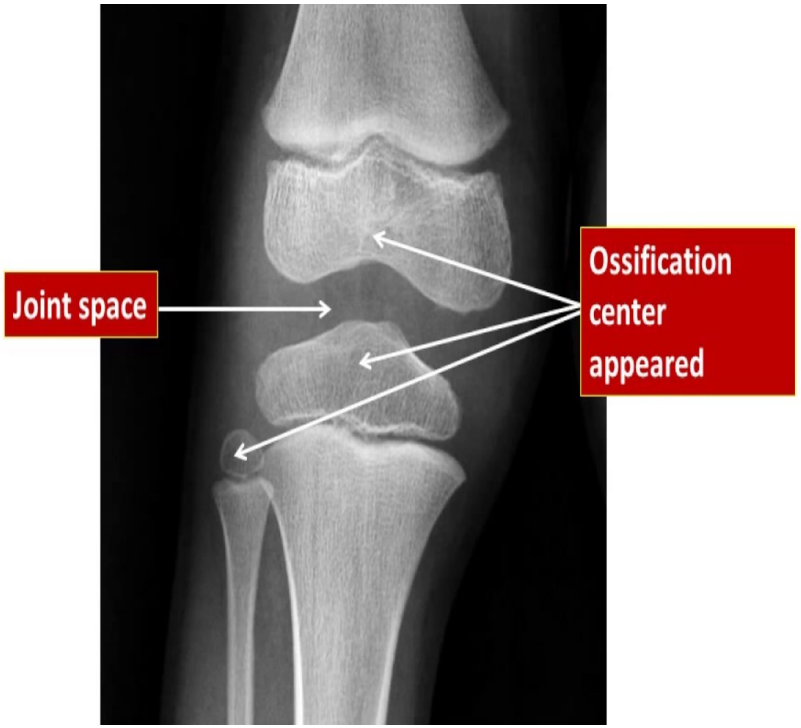
Routinely X-rayed Areas

- The areas which are routinely X-rayed to determine the age of a person are;
- Wrist and hand in children
- Elbow, shoulder, pelvis and knee in adults; and
- Skull, vertebrae, and sternum in old people



Figs 11.15A to C: *AP views of wrists of age groups:* (A) 2-6 years (Reasons—Lower end of radius appeared: >2 years; Lower e of ulna not appeared: <6 years); (B) 10-17 years (Reasons—Pisiform appeared: >10 years; Base of first metacarpal not fused <17 year (C) More than 18 years (Reason—Lower end of radius fused)


Epiphysis
Epiphyseal plate
Diaphysis


Joint space
Ossification center appeared

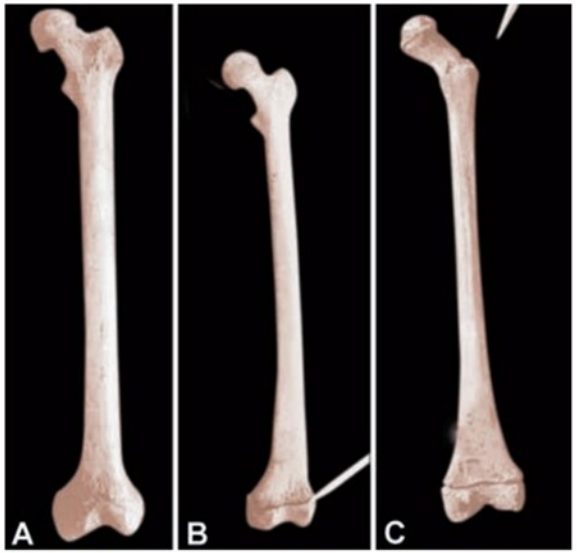

1st Rib
Superior Angle Scapula
Superior Border Scapula
Acromioclavicular Joint
Acromion Process
Head of Humerus
Clavicle
Anatomical Neck
Greater Tubercle
Intertubercular Groove
Lesser Tubercle
Coracoid Process
Surgical Neck
Glenoid Fossa

Union of Epiphyses at Different Ages

- The indication of age is based on the union of epiphyses,with a range of six months on either side;

Region	Girls	Boys
Elbow	13-14	15-17
Wrist	16-17	18-19
Shoulder	17-18	19-20
Crest of ilium	18-19	20-21
Ischial tuberosity	21-22	23-24
Inner end of clavicle	21-22	23-24

Fig. 11.13: Iliac crest—not fused



Figs 11.12A to C: *Femur:* (A) All centres fused, (B) Lower end not fused, (C) Upper end greater and lesser trochanter centres not fused (missing) and lower end not fused

Age Determination after 25years

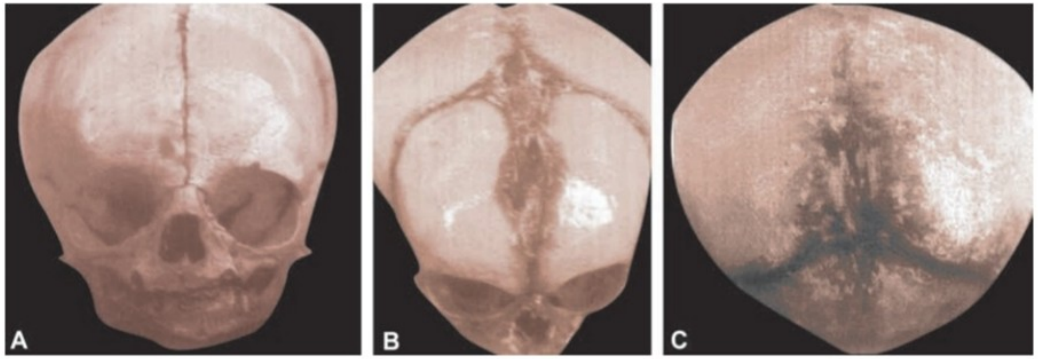
- After 25 years, some indication of age may be obtained from the following data;
- The xiphoid process unites with the body of the sternum at about 40 years and the manubrium unites with the body in old age,at about 60 years.
- The absence of closure of any suture of the skull indicates that the age does not exceed thirty years.An exception to this general rule is the basilar suture;the fusion between the basi-occiput and basi-sphenoid is complete by 18-22 years

- The lipping of lumbar vertebrae occurs after the age of 40 years.The osteophytic outgrowths from the anterior and lateral margins of the intervertebral discs rarely become prominent before 40 years.The disc undergoes by about 40-45 years.
- The greater cornu of the hyoid unites with its body between 40-60 years.
- In old age, laryngeal and costal cartilages ossify. General rarefaction of bones also occurs.

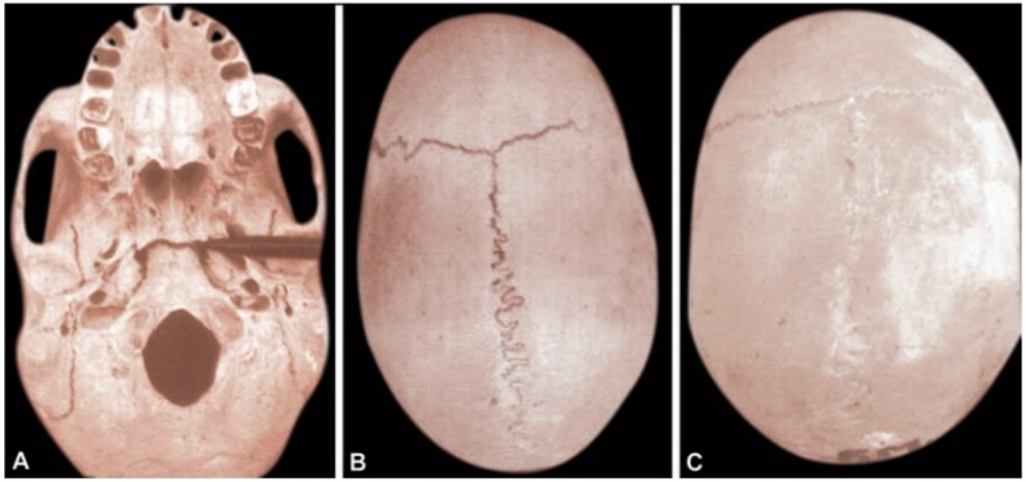
Age by Closure of Skull Sutures

- Generally, evidence of commencing union of sutures is first seen on the inner and then outer surface, the inner surface closing several years before the outer.
- The closure starts with the
- saggital (30-35 years),
- coronal(35-40 years),
- and lambdoid sutures(45-50 years)

- followed by parieto-mastoid
- and squamous sutures(55-60 years),
- and the spheno-parietal suture which closes by about 70 years.
- The palate suture closes at 45-50 years



Figs 11.10A to C: *Foetal skull:* (A) Frontal suture not fused, (B) Anterior fontanelle not closed, (C) Posterior fontanelle not closed



Figs 11.11A to C: *Adult skull:* (A) Basiocciput—basi-sphenoidal suture not fused, (B) Coronal and sagittal sutures—is not fused, (C) Sagittal suture—posterior 2/3rd fused

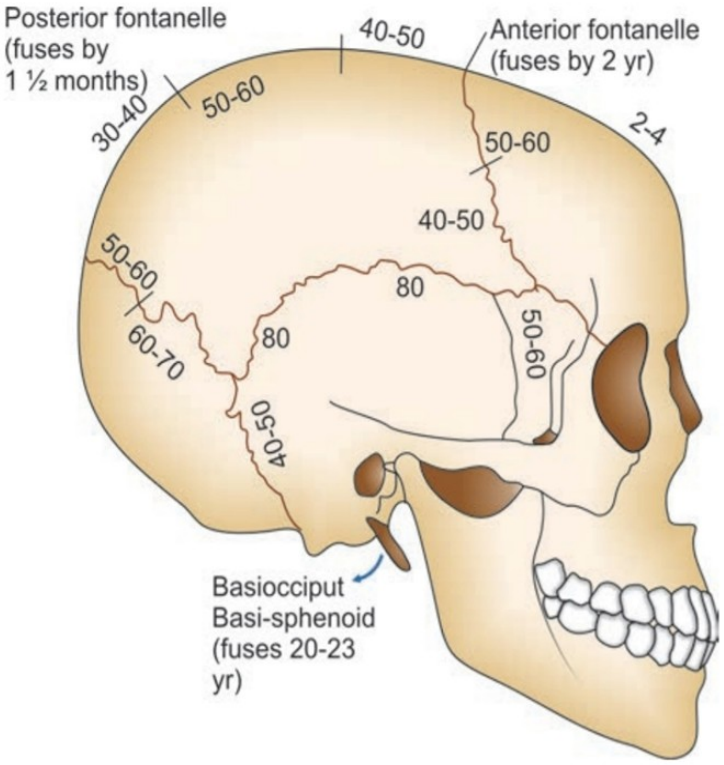
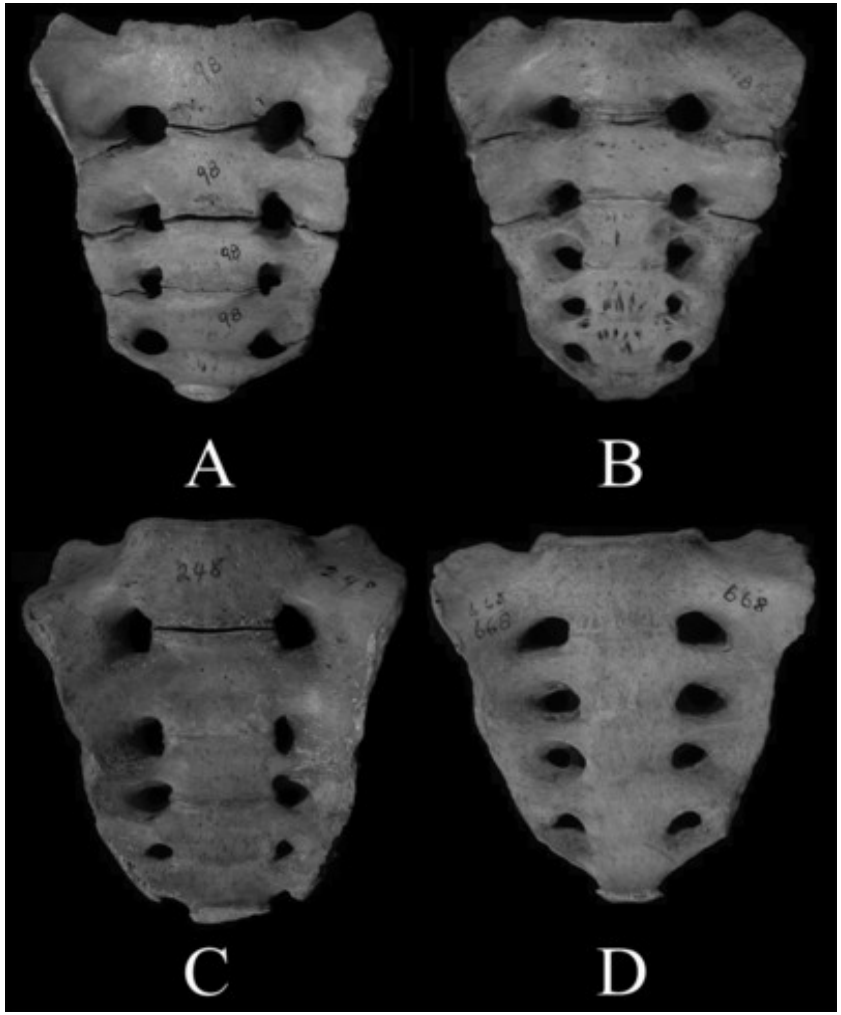


Fig. 11.7A: Scheme of ossification of skull by suture closure (Inner aspect)

Changes in Sacrum

- The five sacral vertebrae are seperated by cartilage until puberty.
- Later,fusion of epiphyses takes place and ossification of intervertebral discs extend from below upwards.
- Sacrum becomes a single bone at 21-25 years of age,leaving a gap between S1 and S2,until 32 years due to lapsed union


A
B
C
D

Changes in Vertebrae

- The immature vertebral body has series of deep radical furrows both on upper and lower surfaces.The feature increases in prominence up to the age of ten,and then gradually fades between 21 and 25 years.
- Later on,due to osteo-arthritic changes,lipping of vertebra are seen after the age of 45 years.

Lipping of Lumbar Vertebrae

Fig. 11.7D: Lipping of lumbar vertebrae

Skeletal Changes Occurring in Advanced Age

- Disappearance of skull sutures------after 60 years
- Union of Xiphoid process with body of sternum-------after 40 years
- Lipping of lumbar vertebra or bones of the joints of the extremities-----after 45 years
- Union of greater cornu of hyoid bone with body.

- Rarefaction of bone i.e. senile osteoporosis--------after 60 years
- Age by changes in the articular surface of the pubic symphysis
- Calcification of costal(30 years)and laryngeal cartilage(50 plus minus 12.7 years)

However, it may be noted that all these methods are not very reliable.

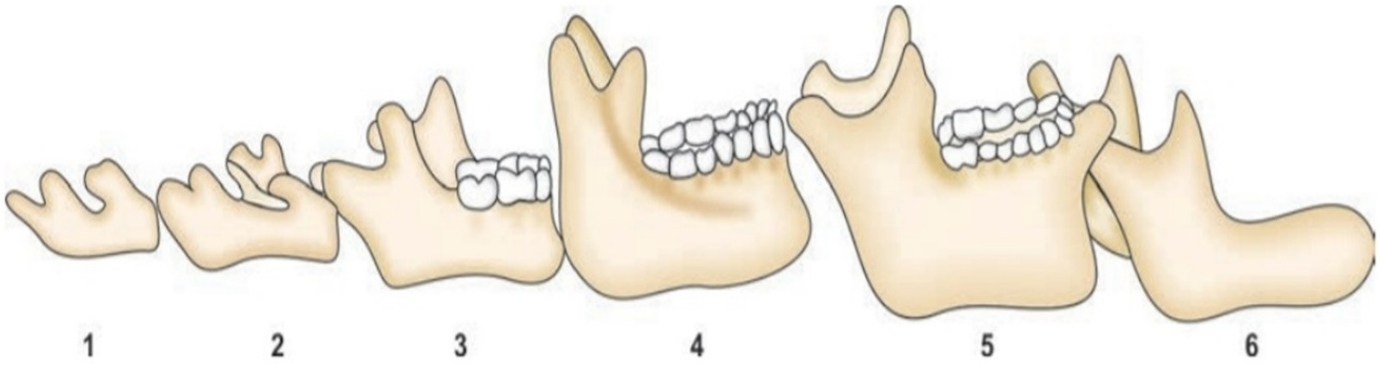


Fig. 11.8: Age changes in the mandible

Age by Changes in the Pubic Symphysis

Table 11.12: Age by changes in articular surface of the pubic symphysis (*Refer Fig. 11.9*)

Changes noticed	*Age*
Markedly irregular and uneven with transverse ridges	20 yr
Ridges disappear, resulting in granularity and formation of the ventral and dorsal margins	24-38 yr
Symphyseal face becomes oval and smoothening of its upper and lower extremities	50 yr
Beaded rimmed margin	5th decade
Erosion of surface and break down of ventral margin	6th decade
Irregularly eroded surface	7th decade

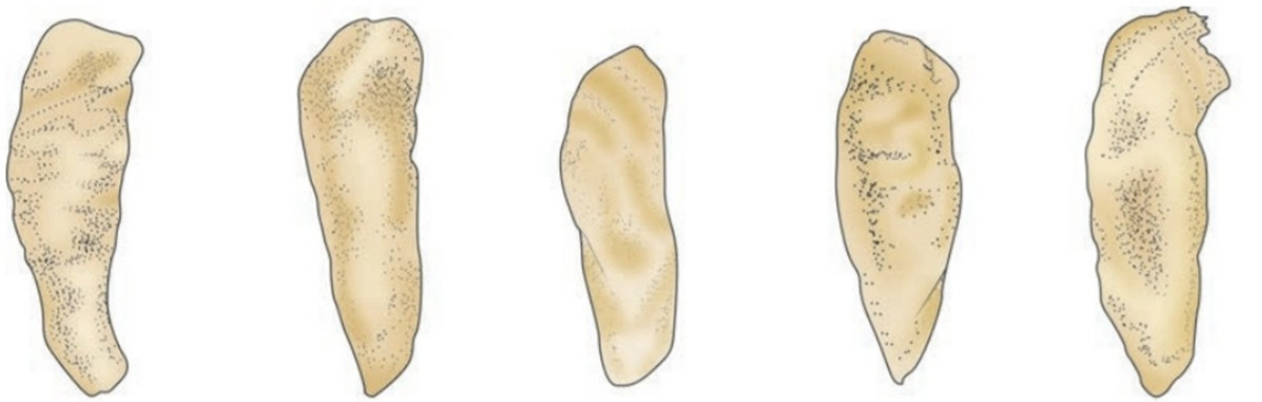


Fig. 11.9: Age changes of symphysis pubis (Refer Table 11.12)

Miscellaneous Data

Various other data that may be worth mentioning and beneficial in determining the age of an individual are;

- Birth record
- Changes occurring at puberty,and
- Changes due old age

Birth Record

- It provides legal proof of identity, age, nationality, parentage, and civil status of an individual.

Changes Occurring at Puberty

- In males,fine downy hair begin to appear on the pubis by about 14 years, on the axilla by about 15 years, and on the chin and upper lip between 16 to 18 years.
- In about a year or two, the fine hair become thick and the color darker.
- The voice becomes deeper and Adam’s apple more prominent by about 16 to 18 years.

- In females, breasts begin to develop by about 13 years and fine downy hair appears on the mons veneris.
- By about 14 years menstruation starts,fine pubic hair bcomes thick and dark,and fine hair appears in the axilla becoming darker in about a year.

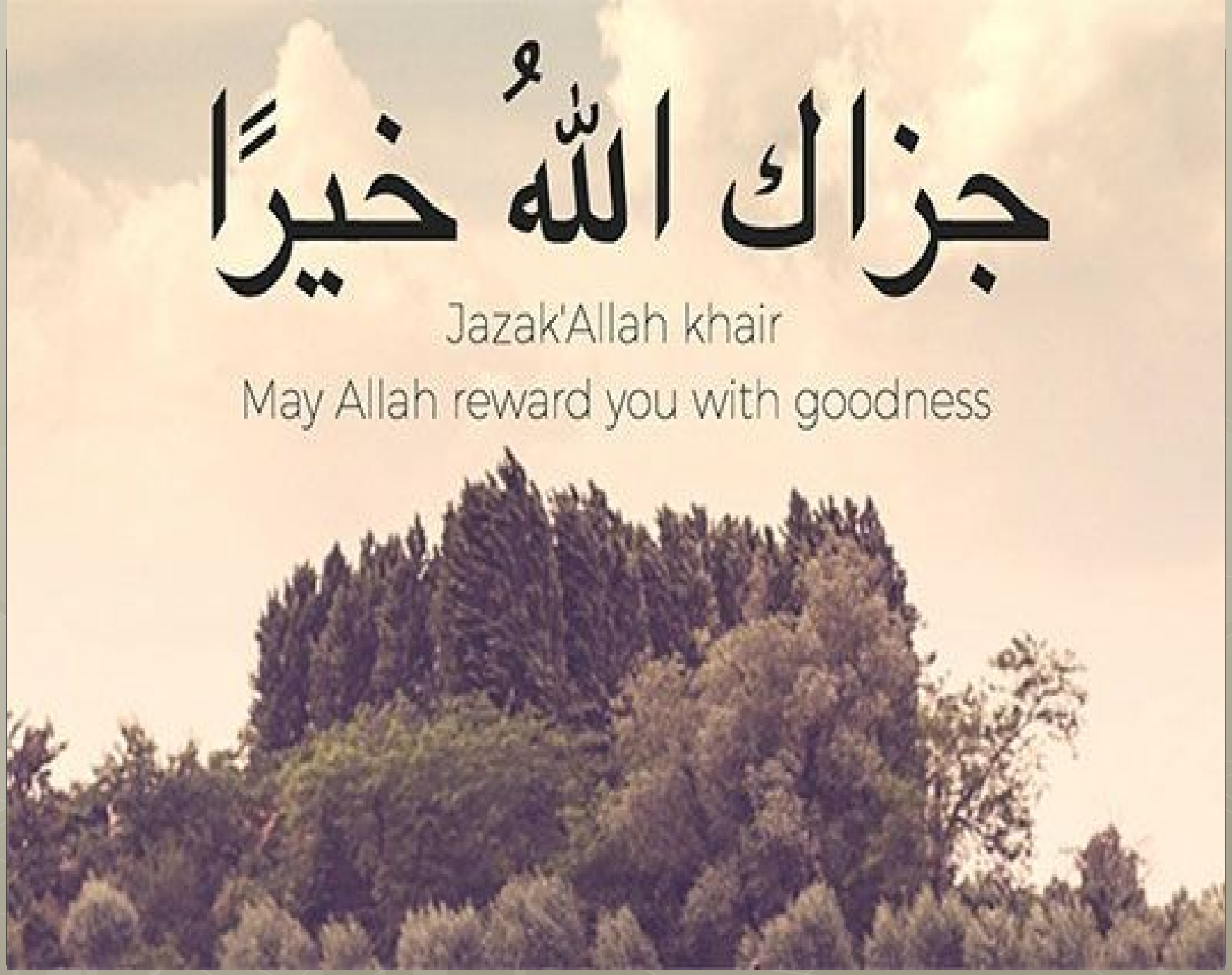
Changes due to Old Age

- Wrinkles : on the face appear after 40 years.
- Arcus senilis : a ring of opacity in the opacity in the peripheral part of the cornea may also appear after 40 years but is seldom complete before 60.
- Hair in auditory meatus : rarely begins to appear before 50 years.
- Greying of hair : starts on the scalp at about 40 years first at the temples,followed later by beard and moustache,and still later the chest.
- Density of hair : scalp hair becomes less dense in the male and there is loss of axillary hair in the female.
- Teeth : also begin to fall out in old age.

Medicolegal importance of age

- Criminal responsibility
- Judicial punishment
- Kidnapping
- Rape
- Marriage
- Attainment of majority
- Employment

- Infanticide
- Criminal abortion
- Impotence and sterility
- Competency as a witness, and
- identification


جزاك اللهُ خيرًا
Jazak'Allah khair
May Allah reward you with goodness