My notes - The Anatomy of the Child

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Until delivery, the foetus lives a parasitic existence. The placenta "breaths, digests and excretes" for the foetus and permits the vital functions of respiration and digestion to remain latent.

At the moment of delivery, the infant is launched on an independent existence and assumes these vital functions or dies. This necessitates profound physiological changes in the infant, often based on anatomical alterations, immediately following the traumatic experience of birth.

Changes in Respiratory System at Bihth

The initiation of respiration is probably induced by a stimulation of the Respiratory centre during labour by the relative anoxia in the placental circulation due to uterine contractions.

After birth the body of the baby can uncoil so that the spine is straightened and the shape of the chest and position of the diaphragm facilitates repiration.

The fall in body surface temperature after delivery probably also serves as a stimulus to respiration.

With successive respiratory movements the thoracic cage expands and creates a negative intrapleural pressure. Air in the bronchial tree is at atmospheric pressure and so the foetal lung expands by entry of air into the elveoli, overcoming the surface tension between the alveolar walls.

Changes in Foetal circulation at birth

1) The umbilical cord dessicates, and the left umbilical vein closes by aseptic thrombosis. Blood in the ductus venosus clots, and the duct atrophies and disappears. These two venous channels persist later on as the ligamentum teres and ligamentum venosum respectively. The umbilical arteries show retrograde closure.

2) There is a drop in pressure in the right side of the heart due to expansion of the lungs and opening of pulmonary circulation. So there is overlap and adherence of flanges of cardiac muscle closing the Foramen ovale in the interatrial septum, and persisting as a shallow Fossa Ovalis. This closure results in separation of systemic and pulmonary circulation.

3) The Ductus Arteriosus serves in the foetus to short — circuit blood from entering the airless lungs. It links the left branch of pulmonary trunk to the aorta distal to the origin of the arteries going to supply the head and upper limbs. It conveys chiefly deoxygenated blood that is coming from the head and that enters the stream of oxygenated blood conveyed into right atrium by the ductus venosus and inferior vena cava. This mixture is thought to be prevented by the Intervenous tubercle of Lower which eventually goes to form the semilunar valve of the inferior vena cava. The ductus arteriosus is usually anatomically obliterated by end-arteries after one or two months.

General Features of the Newborn.

In the Newborn, some organs and structures are well developed and even of full adult size e.g. internal ear; while others differ in size or have yet to develop e.g. cerebrospinal tracts to be medullated; teeth to erupt; secondary sex characters to appear.

Relative to the adult, the newborn is much more fully developed at its head end than at its tail end. The head and shoulders are large; the abdomen, buttocks and lower limbs small. The edentate jaws and shallow maxillae produce a face that is short vertically and the cheeks bulge forwards to accomodate their tissues. This is lost at seven years of age by the eruption of the permanent teeth and growth of the maxillary air sinus. The newborn has no visibe neck, and must elongate before flexion, extension and rotation are possible. The abdomen is not prominent. The 'Pot - Belly' is due to the large liver andsmall pelvis. The Pelvic organs lie in the abdominal cavity. Later these pelvic organs and many coils of intestine sink into the pelvis and the rate of growth of the abdominal wall out-paces that of the liver.

The limbs are disproportionately developed.

a) The upper limb is well-developed but movements are ill-controlled and ataxic. Fingers can be flexed and hyperextended, and there is a very powerful grasping reflex. The hand takes several months to become the chief tactile organ, until which time the lips are used for feeling, and the hand is merely prehensile, carrying things to the mouth for examination.
b) The buttocks and the short legs are ill-developed.

Features of the newborn skull and its growth.

1. The cranium is very large relative to the skeleton of face. Due to this underdevelopment of the face, the foetal skull is round.
2. In the foetal skull, the vertical diameter of the orbit is equal to the vertical height of the maxilla and mandible, whereas in the adult skull, that of the orbit is equal to a third of the height of the maxilla and mandible. This is due to (a) growth of the maxillary sinus, and (b) growth of alveolar bone around the permanent teeth.
3. The bones of the skull vault and of the face are developed by ossification in membrane wheras those of the base of the skull develop by endochondral ossification. Most of the separate bones of the skull and face are ossified by the time of birth but are mobile on each other, mostly in the vault where the overlap permits moulding of the cranium during parturition.
4. The bones of the vault are separated by the linear attachments of fibrous tissue and the edges of bones are not serrated. The fibrous tissue is continuous with the pericranium outside the bone, and the endocranium (outer layer of dura mater) on the inside. At the

corners the bones of the vault are separated by large areas of fibrous tissue called Fontanelles:—

a) Anterior fontanelle, diamond - shaped, closes at about 18 months.

b) Posterior fontanelle, triangular, closes 16 months.

c) Anterolateral fontanelle at Pterion closes by the end of the first year as does the

d) Posterolateral Fontanelle, at Asterion.

Sutural bones may develop at any fontanelle.

5. Other features of the newborn skull are:—

a) Thinness of vault bones.

b) Prominence of frontal and parietal eminences.

c) Frontal suture (which persists up to sixth year).

d) Occipital bone is in 4 parts joined by cartilage to the sphenoid bone.

e) Sphenoid bone is in 3 parts.

f) Temporal bone is in 4 parts.

g) There is no mastoid process. Hence the danger of damaging the facial nerve as it emerges from the stylomastoid foramen during forceps delivery.

h) Stylomastoid foramen, tympanic ring and membrane, and mastoid antrum are close to the lateral surface of the skull.

i) The Mandible is in two halves; its angle is very obtuse; the coronoid process is higher than the head of the condyloid process; the mental foramen lies at the lower border of mandible.

j) The alveolar parts of the mandible and the maxilla are undeveloped.

k) The vertical height of maxilla, ethmoid and palatine bones is much smaller than in adult.

l) All the paranasal air sinuses except frontal sinus are present but rudimentary.

6. Growth of the vault of the skull occurs by:

a) Appositional growth—that is deposition of bone at suture lines so that separate bones come to interdigitate with each other.

b) Interstitial or growth in thickness (i.e. addition by osteoblasts to the outside) accompanied regular throughout by resorption on the inside, causing moulding of each bone, by osteoclasts. In the vault, only compact bone is present at birth. With subsequent growth, the interior of the bones becomes excavated into cancellous bone (Diplöe) and red bone maddow fills the interstices therein. Growth of the vault is most rapid in the 1st year; decreases in rate up to the seventh year, and further decreases until the 16th year when growth ceases. Several parts of the skull have adult size by 7 years:- orbits, body of sphenoid, posterior part of temporal bone and foramen magnum. There is some growth of jaws during eruption of decidious (6th month to 2nd year) and permanent (6th to 12 year) teeth. During 7th year and puberty the paranasal air sinuses (especially frontal and maxillary) grow considerably, increasing size of the face and frontal region of the skull.

7. Temporal bone and ear.

The Temporal bone develops in four parts; squamous and tympanic which ossify in membrane and petromastoid and styloid process which ossify in cartilage. The Tympanic part at birth is a C-shaped tympanic ring applied to the under surface of the petrous and squamous parts. It encloses the tympanic membrane which is slotted into it.

The external Auditory meatus of the newborn is wholly cartilaginous. The Tympanic membrane is of adult size but lies more obliquely.

The tympanic ring elongates by growth from the lateral rim of its whole circumference, thus forming the bony part of the external auditory meatus and pushing the cartilaginous part larerally.

Growth of bone from the C-shape tympanic ring is at first more rapid anteriorly and posteriorly than inferiorly. The growing anterior and posterior flanges of bone join and enclose an irregular foramen of Huschke which persists up to the 5th year but becomes obliterated by subsequent growth of bone. The petromastoid part contains internal ear and tympanic antrum, all of adult size at birth. At birth the tegmen tympani roofing the middle ear is not fully grown, and it does not cover the geniculate ganglion of the facial nerve, which is thus in contact with the dura of the middle cranial fossa. Later the tegmen tympani of the petrous temporal bone grows across the geniculate ganglion and curves down to form the lateral wall of the canal for tensor tympani. Its growing edge "peeps out" from the medial part of the squamo-tympanic fissure dividing it into: petrosquamous and petrotympanic fissures. Thus in the newborn, the chordatympani nerve emerges from the skull in the squamotympanic fissure, but later emerges in the petrotympanic fissure. At birth, the mastoid antrum is covered by 3mm of petrous temporal bone; at 12 years of age this covering has thickened to 15mm of petrous temporal bone. At birth the bony part of the external auditory meatus is the tympanic ring. In the adult the external auditory meatus is $\frac{2}{3}$ bony and $\frac{1}{3}$ carilaginous.

Classified changes of the skull with age.

In the 6th month (lower and, soon after upper) central incisor (deciduous) tooth.

In the 8 — 9 month lateral incisor (deciduous) tooth.

In the 1st year:

(a) Anterolateral and posterolateral fontanetelles disappear.

(b) During 1st year, most rapid growth of skull vault.

(c) 1st molar (deciduous) tooth eruption.

(d) 4 parts of temporal bone have united.

(e) 2 halves of mandible have united.

In the 15th month: Canine (deciduous) tooth erution.

In the 16th month: Posterior Fontanelle disappears.

In the 18th month: Anterior Fontanelle disappears.

In the 20th month: 2nd molar (deciduous) tooth eruption.

In the 2nd year:

(a) Mastoid process develops with growth of the sternomastoid muscle as the child starts to move the head, and the aircells grow into it from the mastoid antrum. The mastoid process is this aerated during 2nd year.

(b) Frontal sinus (paranasal) appears but is still rudimentary.

In the 3rd year: squaomus part of occipital and condylar parts of occipital bone have united.

In the 5th year:

(a) Condylar parts of occipital and basilar parts of occipital bone have united and,

(b) the foramen of Huschke disappears.

In the 6th year:

(a) 1st molar (permanent) tooth eruption.

(b) Frontal (metopic) suture almost disappeared.

In the 7th year:

(a) Up to 7th year growth of vault of skull is quite rapid.

(b) Central incisor (permanent) tooth eruption.

(c) Growth of paranasal air-sinuses.

In the 8th year: lateral incisor (permanent) eruption.

In the 9th year: first premolar.

In the 10th year: second premolar.

In the 11th year: Canines erupt.

In the 12th year:

(a) 2nd "factory" molar.

(b) After ossification of petrosquamous fissure, new bone from squamous part flows down over the developing mastoid process, and at a rate of 1mm per year buries mastoid antrum more deeply. This growth stops at 12 years, with antrum 15mm. from the surface. At puberty there is rapid growth of paranasal air-sinuses.

At the 16th year; growth of skull vault ceases after being very slow from 8th to 16th years.

25th year: Complete fusion of sphenoid body with basilar part of occipital bone.

Between 20th and 30th years saggital suture closes

Between 25th and 30th years coronal suture closes.

Between 25th and 40th years Lambdoid suture closes.

In late life:

(a) The bone of skull become thinner and lighter.

(b) Enlargement of sinuses.

(c) As teeth fall out, the alveolar part of mandible and maxilla are absorbed.

(d) Sphenoidal air-sinus may grow into basilar part of occipital bone.

Changes in the Mandible

1. In the foetus, the mental foramen lies at the lower border of the body of the mandible. With tooth eruption, it lies midway between upper and lower border and as teeth fall out and the alveolar margin of the mandible degenerates, the mental foramen comes to lie at the uppr border of the body of the mandible.

2. (a) The Angle of mandible is very obtuse in the newborn and the head of the condyloid process lies in line with the upper border of the body of the mandible with the coronoid process at a higher level.

   (b) After eruption of teeth the angle is nearly a Right Angle and the well developed condyle lies higher than the coronoid process.

   (c) In the edentate mandible, the angle is slightly more obtuse, but gradual moulding of the neck ultimately depresses the condyle to a lower level than the coronoid process.

The Face

The maxilla at birth is shallow and full of developing teeth. Eruption of the deciduous teeth allows room for excavation of the antrum beneath the orbital plate but the maxilla grows slowly until the permanent teeth begin to erupt at 6 years, when there is a rapid increase in the size of the antrum, and growth of the alveolar bone increasing the depth of maxilla.

The hard palate grows back to accomodate the extra teeth but the forward growth of the base of the skull at the occipital sutures outstrips it and prevents the hard palate form approaching the Cervical vertebrae. Thus the nasopharyngeal isthmus is kept open and in fact, enlarges. Growth of the base of skull can continue at the basisphenoidal suture (which fuses at 25 years). Growth of the face occurs by growth of all face bones. Growth at the sutures forces the face downwards and forwards away from the base of the skull.

There is overall growth of the mandible by a process of moulding with harmonious deposition of new bone and resorption of old bone. An "epiphysis" at the neck of the mandible allows ready moulding of the condyle for accomodation with the changing size and direction of the articular cartilage and temporal bone.

The tongue is relatively large at birth and has a blunt tip that cannot be extruded. The newborn is tongue-tied and only slowly does the tip of the tongue elongate. The hard palate is high and the orifice of the Eustachian tube (tubal Elevation) lies at the same level. As the nasal septum grows in height, the palate descends and leaves the tubal orifice above it in the nasopharynx.

As with lymphoid tissues elsewhere in the body, the palatine and nasopharyngeal tonsils (adenoids) tend to be exuberant in the child.

The Neck

The newborn has no visible neck. The left Innominate vein crosses the trachea so high in superior mediastinum that it may encroach above the sternal notch into the neck, especially if it is engorged and the head extended. So care is taken in performing tracheostomy on infants.

The shortness of the neck of the newborn involves a higher position of the viscera. The Epiglottis and larynx lie nearer to base of tongue and their descent is slow. They reach adult levels after the 7th year. The larynx and trachea are of small bore at birth. The vocal cords are 5mm long by the end of the 1st year. Laryngitis and tracheitis in infancy thus carry far more risk of respiratory obstruction than later. At puberty the male larynx inreases in size and the vocal cord elongate from 8 to 16mm causing "breaking of the voice". Castration or failure of testicular hormone prevents this change.

The Thorax

In the child, the rib cage is more Barrel - Shaped. The large thymus extends from the lower part of the

neck through the superior and anterior mediastina. The thymus atrophies at puberty. The ribs lie more nearly horizontal so that the cage is set at a higher level than in the adult. Hence the shortness of the neck. Due to the high thorax, there is a higher diaphragm and hence increase in abdominal volume. Descent of the thoracic cage as the ribs take up their adult obliqiuty is the chief cause of the elongation of neck.

The Abdomen

1. At birth the liver is twice its relative adult size and its inferior border is palpable below the costal margin.
2. The suprarenal is enormous at birth, nearly as large as the kidney itself.
3. The kidneys are always highly lobulated at birth and grooves on the surface of the adult organ frequently persist as a visible sign of the orignal foetal lobulation.
4. The caecum is conical and the appendix arises from its apex in the foetus and this is still present at birth. During infancy and early childhood, the lateral wall of the caecum balloons out and the base of the appendix comes to lie posteromedially.
5. The appendiceal mucosa is packed with massed lymphoid follicles in the child. These become more sparse in later life.
6. The pelvic cavity is small at birth and the fundus of bladder lies above the symphysis pubis.

The Upper Limb

1. At birth, the upper limb is more fully developed than the lower limb.
2. Grasping reflex of the hand is very pronounced.
3. Growth in length occurs more at the shoulder and wrist than at the elbow. Thus, amputation through humerus in the young requires a very generous flap of soft tissue lest the growing bone should later protrude through the stump.

The Lower Limb

At birth, it is poorly developed and is flexed for the first 6 months. Later it grows stronger and is extended and medially rotated.

The inverted foot of the newborn gradually becomes everted.

Growth of lower limb proceeds more rapidly at the knees than at the hip and ankle. It is not symmetrical across the lower Epiphysis of the femur and "Knock-Knee" (genu valgum) is normal in the child.

Ther Vertebral Column.

Until birth, the column is C — Shaped. The cervical curve opens up into a ventral convexity when the infant holds up its head and the lumbar curve opens up into a ventral convexity when the infant walks. The extension of the hip that accompanies walking tilts the pelvis forwards, so that the axis of the pelvic cavity is no longer in line with that of abdominal cavity. This forward tilt of pelvis necessitates a high degree of forward curvature (lordosis) of the spine in order to keep the body vertical in the standing position. The spinal cord extends to the level of S3 at birth and does not rise to the level of lower border of L3 until adult years.