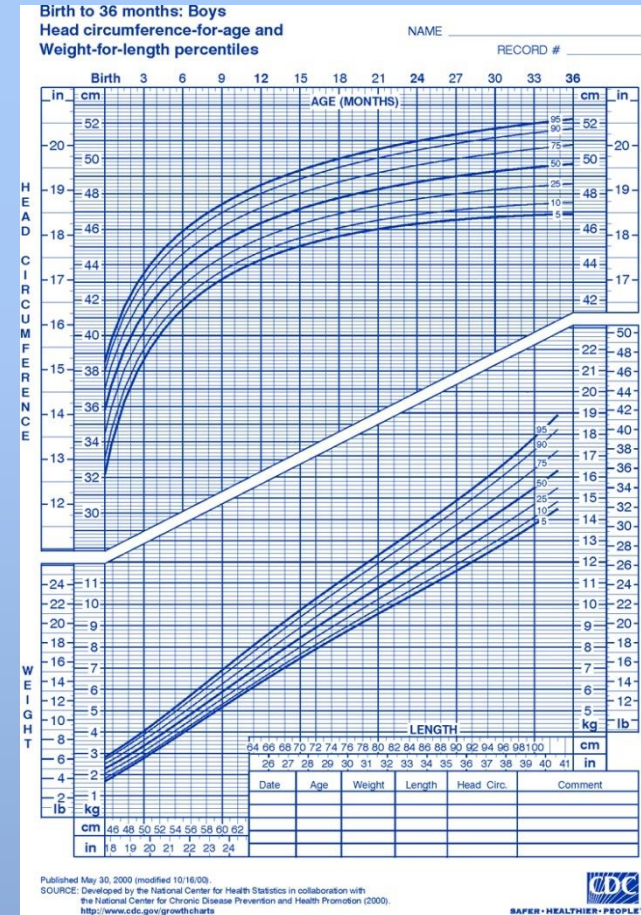
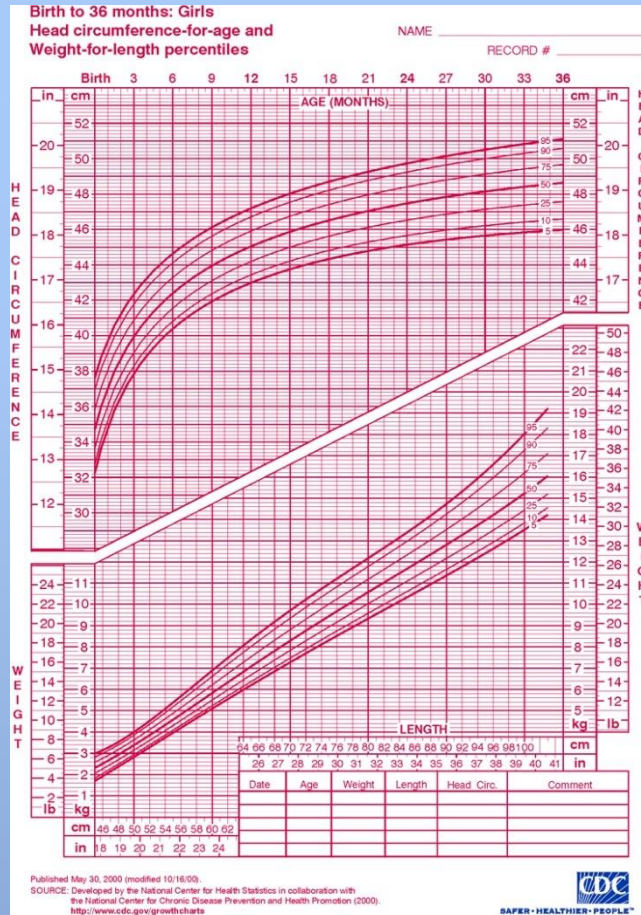


# Plagiocephaly a Modern Epidemic



**Dr Steve Williams DC, DICS, FICS,  
FRCC (paed), FBCA**

# Head Circumference Charts

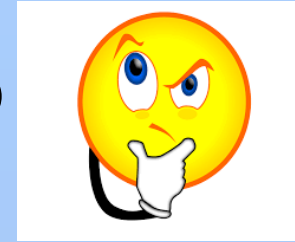


# Wonky Heads...Why?



- **Risk Factors:-**
- **Prenatal-** male gender, primiparous mother, young parents, constraint
- **Perinatal-** obstetric interventions, high birth weight, prematurity, large head circ
- **Postnatal-** supine positioning, torticollis/limited rotation, poor bottle feeding technique, little tummy time, developmental delay Linz et al [Dtsch Arztebl Int.](#) 2017 Aug; 114(31-32): 535–542

# Wonky Heads...Why?



- A 2017 review of 22 studies found the most common risk factors were male gender, supine sleep position, limited neck rotation or preference in head position, first-born child, lower level of activity and lack of tummy time De Bock et al Arch Dis Child 2017 Jun;102(6):535-542
- About 15–20% of the 4- to 6-month-old infants in industrialized societies are now affected by symmetrical or asymmetrical flattening of their posterior cranium Bialocerkowski Dev Med Child Neurol 2008; 50:577–86

# Back to Sleep

- The Back to Sleep campaign launched in the UK and USA 1991 resulted in a 60% decrease in SIDS [Duncan JR, Byard RW](#), editors. SIDS Sudden Infant and Early Childhood Death: The Past, the Present and the Future May 2018
- Supine sleeping position has to be considered the safest option Moon RW Pediatrics 2016; 138:e20162940
- But at a cost- It is exactly this developmental period (1<sup>st</sup> 6M), during which some of the babies, positioned supine....develop flattening of their posterior cranium
- Supine sleeping is changing the head shape of infants in the USA from dolchicephalic (elongated) to brachycephalic (shorter and broader). Premature infants are particularly susceptible Hummel P, Fortado D Adv Neonatal Care 2005 Dec;5(6):329-40



# Exterogestate Foetus

- Evolutionary biologists argue that the human infant is an exterogestate foetus for at least the first six months of life, dependent on maternal co-regulation for optimal physiological function
- However, infant-care practices in western industrialised societies shifted towards an emphasis on infant autonomy at the time of the Industrial Revolution. From the perspective of evolutionary biology, a misalignment between western culture and the biological expectations of the infant developed over two million years of evolution Douglas PS Med Hypotheses 2005;64(5):887-98

# DP an Evolutionary Mismatch

- Sleeping supine has been shown to be the safest option for babies
- However, this explanation cannot be correct from an evolutionary standpoint: why should safe sleep come at the cost of a misshaped head? Renz-Polster and De Bock *Evolution, Medicine, and Public Health* [2018] pp. 180–185
- They present an alternative hypothesis that is grounded on evolutionary mismatch theory and exemplifies how evolutionary reasoning can help clarify medical conditions relevant to today's public health

# DP an Evolutionary Mismatch

- Bottle feeding in the same position- would very rarely have happened
- Transport-prams and car seats supine instead of on the mum as they would have been for thousands of years
- Sleep- Starting in the 1990s infant sleep researchers have described noticeable characteristics for babies sleeping in proximity to their breastfeeding mothers—this ‘breastsleeping’ pattern is considered the evolved, species typical arrangement in humans by evolutionary biologists as well as anthropologists McKenna and Gettler *Acta Paediatr* 2016; 105:17–21

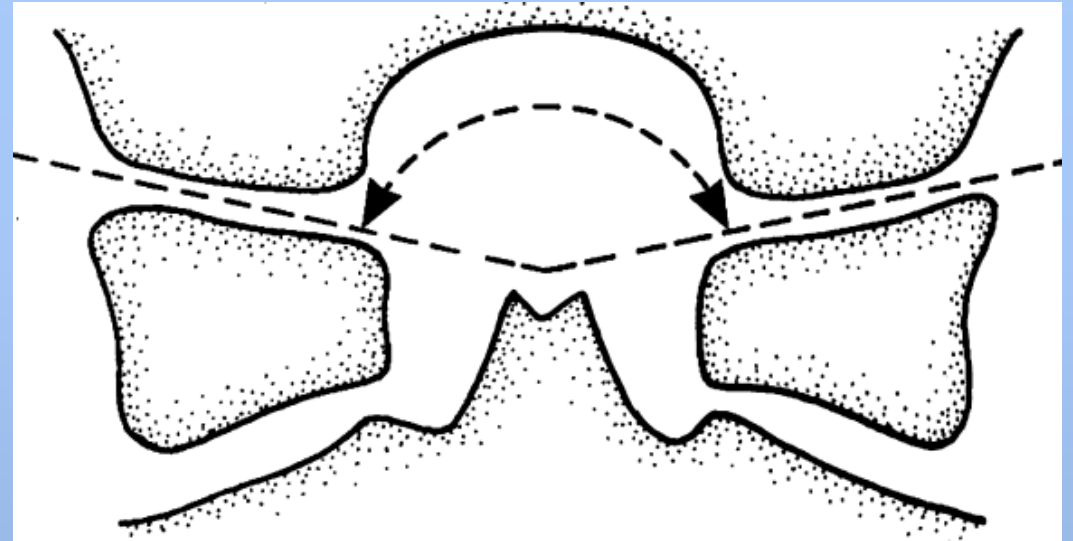


# DP an Evolutionary Mismatch

- Concomitant with the higher proportion of active sleep—marked by higher muscle tone and more frequent arousals- motor activity increases with bed sharing
- With co-sleeping babies not only have more wake periods and more frequent feeding sessions but also experience more passive re-positioning McKenna et al Pediatrics 1997; 100:214

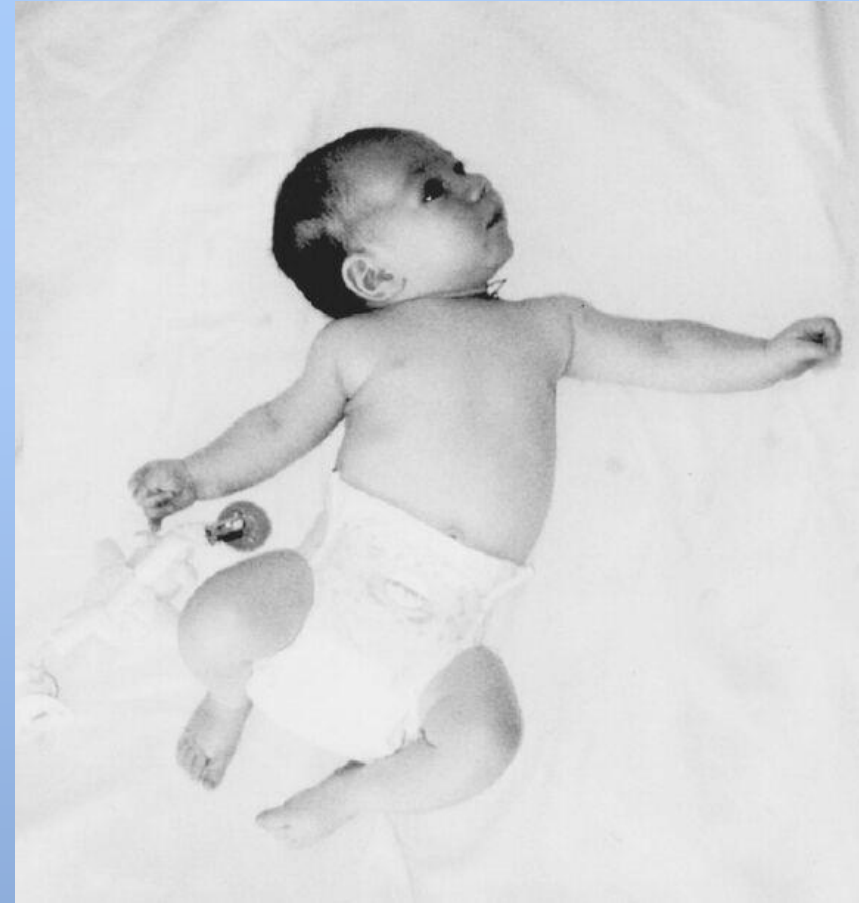
# KISS Syndrome

- Biedermann postulates that KISS syndrome is common because the frontal angle of C0-C1 is increased this leaves this area vulnerable to trauma and there is a lack of neuromotor control of these structures Biedermann H [J Manipulative Physiol Ther.](#) 2005 Mar-Apr;28(3)



# KISS 1

- **KISS I clinical markers.** Fixed lateroflexion, torticollis, unilateral microsomia, asymmetry of the skull, C-scoliosis of neck and trunk, asymmetry of gluteal area, asymmetry of motion of the limbs, retardation of motor development of one side.



## KISS 2

- KISS II clinical markers. Fixed retroflexion: hyperextension (during sleep), (asymmetric) occipital flattening, shoulders pulled up, fixed supination of the arms, cannot lift trunk from ventral position, orofacial muscular hypotonia, breast-feeding difficult on one side



# Tone

- Infants with slow development and poor tone commonly show a positional preference
- Poor body muscle tone has been linked with plagiocephaly
- Infants with deformational plagiocephaly are more likely to have altered tone but not exclusively decreased tone Fowler et al J Child Neurol 2008 Jul;23(7):742-7

# Vitamin D

- Low levels of vitamin D during pregnancy and in early infancy link to an increased risk of skull deformation Weernink et al [Matern Child Nutr.](#) 2016 Jan;12(1):177-88
- Low maternal vitamin D levels in pregnancy are associated with lower neonatal bone density and smaller size Boghossian et al [Eur J Clin Nutr.](#) 2018 Jun 12. doi: 10
- There also appears to be a relationship between maternal vitamin D status and infant neurodevelopment chi et al [J Nutr Sci Vitaminol \(Tokyo\).](#) 2018;64(2):161-167



# Microbiome

- There are a number of recent research papers linking both prebiotics and the microbiome its self to calcium absorption and bone health  
Ohlson et al [Calcif Tissue Int.](#) 2018 Apr;102(4):426-432, Whisner and Weaver [Adv Exp Med Biol.](#) 2017;1033:201-224, Fraser at al [Adv Exp Med Biol.](#) 2017; 1033: 59–94
- Perhaps the changes that the modern diet, pesticide use, drug use (antibiotics, painkillers etc) by mum and infant are creating a diminished microbiome are negatively effecting the bone health of neonates and infants

# Collagen and Glycine

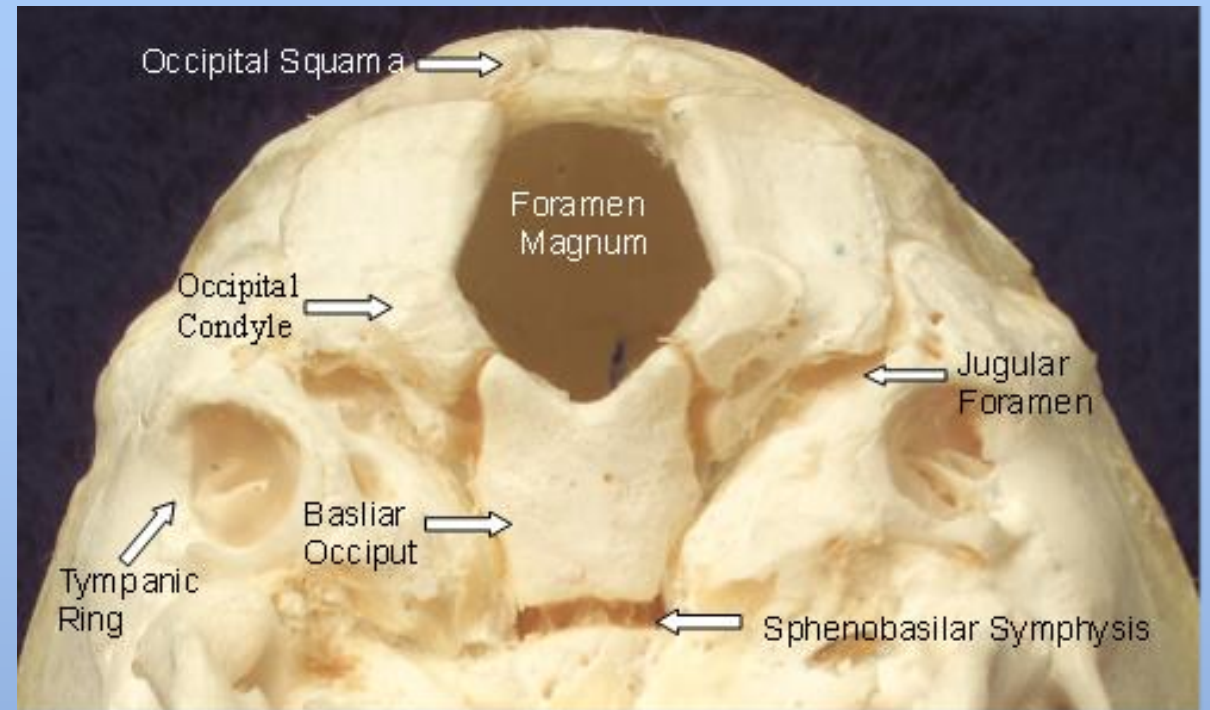
- Glycine makes up more than 1/3 of the protein content of collagen
- The best way of obtaining it in the diet is from bone broth and consuming tendons and other fibrous connective tissue
- Glyphosate may disrupt glycine homeostasis Perez-Torres et al [Mini Rev Med Chem.](#) 2017;17(1):15-32.
- Is glyphosate leading to poorer quality connective tissue.....?

# Foetal Skull Base

- The base of the skull is formed from bone derived from cartilage
- This imparts structural strength to protect the delicate neural structures
- The bones of the skull base are, however, more numerous than in the older child or adult

# The Foetal Occiput

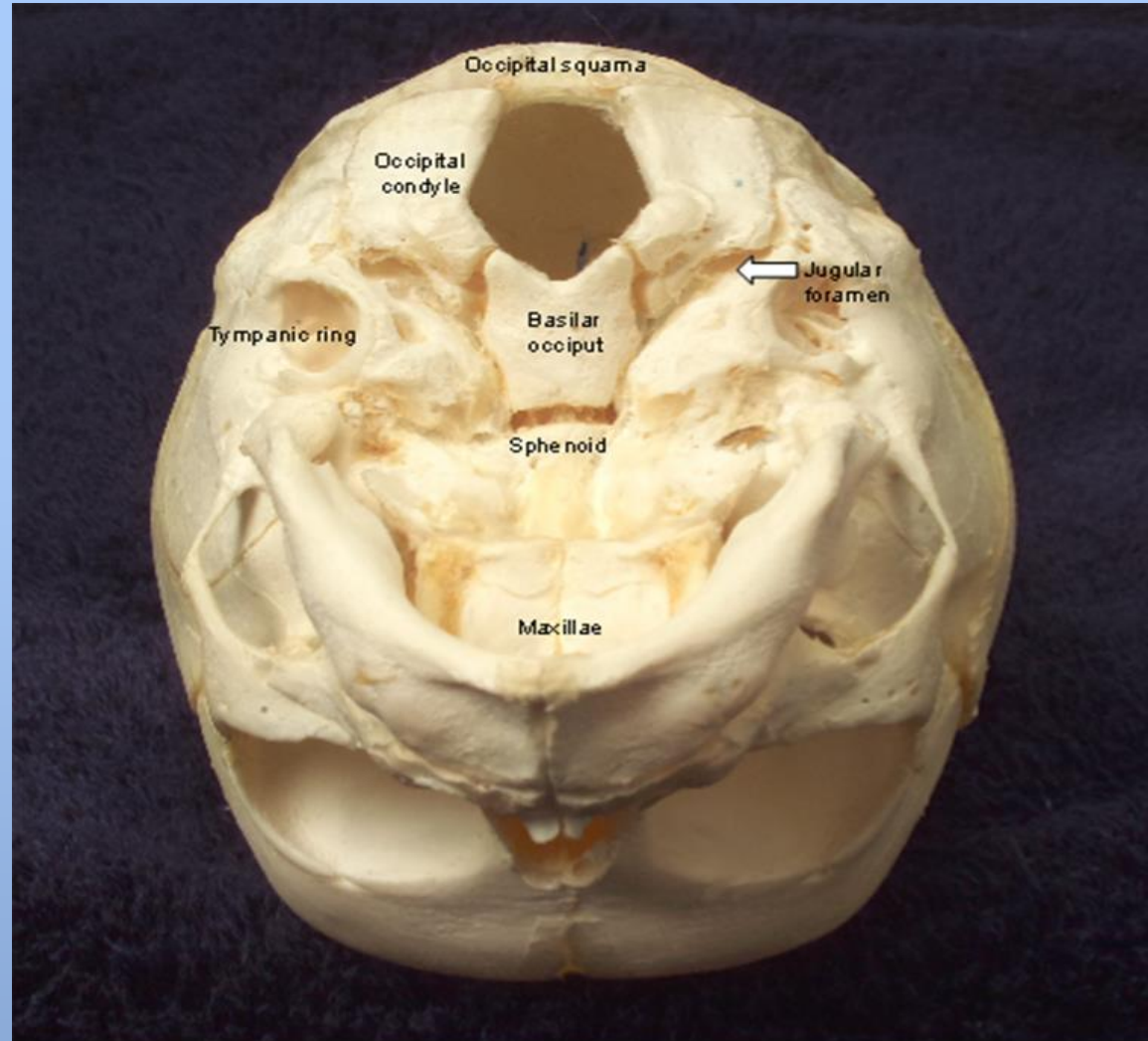
- The condylar and basilar portions are joined by a fibrocartilage matrix which is deformable
- At birth the condyles are split by a synchondrosis: 1/3 lies in the basilar process and 2/3 in the condylar portions
- Deformations of the cartilaginous bridge will cause distortions of the condyle



# The Occiput

- The cartilaginous synchondrosis in the condyles does not fuse until about 6 years of age (Carreiro JE An Osteopathic Approach to Children. 2003 Churchill Livingstone Edinburgh)
- With the occipital squama not fusing to the condylar portions until about 3 years of age, this means growth and possibly changes in shape of the foramen magnum are possible up to at least 3, and possibly 6 years of age

# Foetal Skull Base





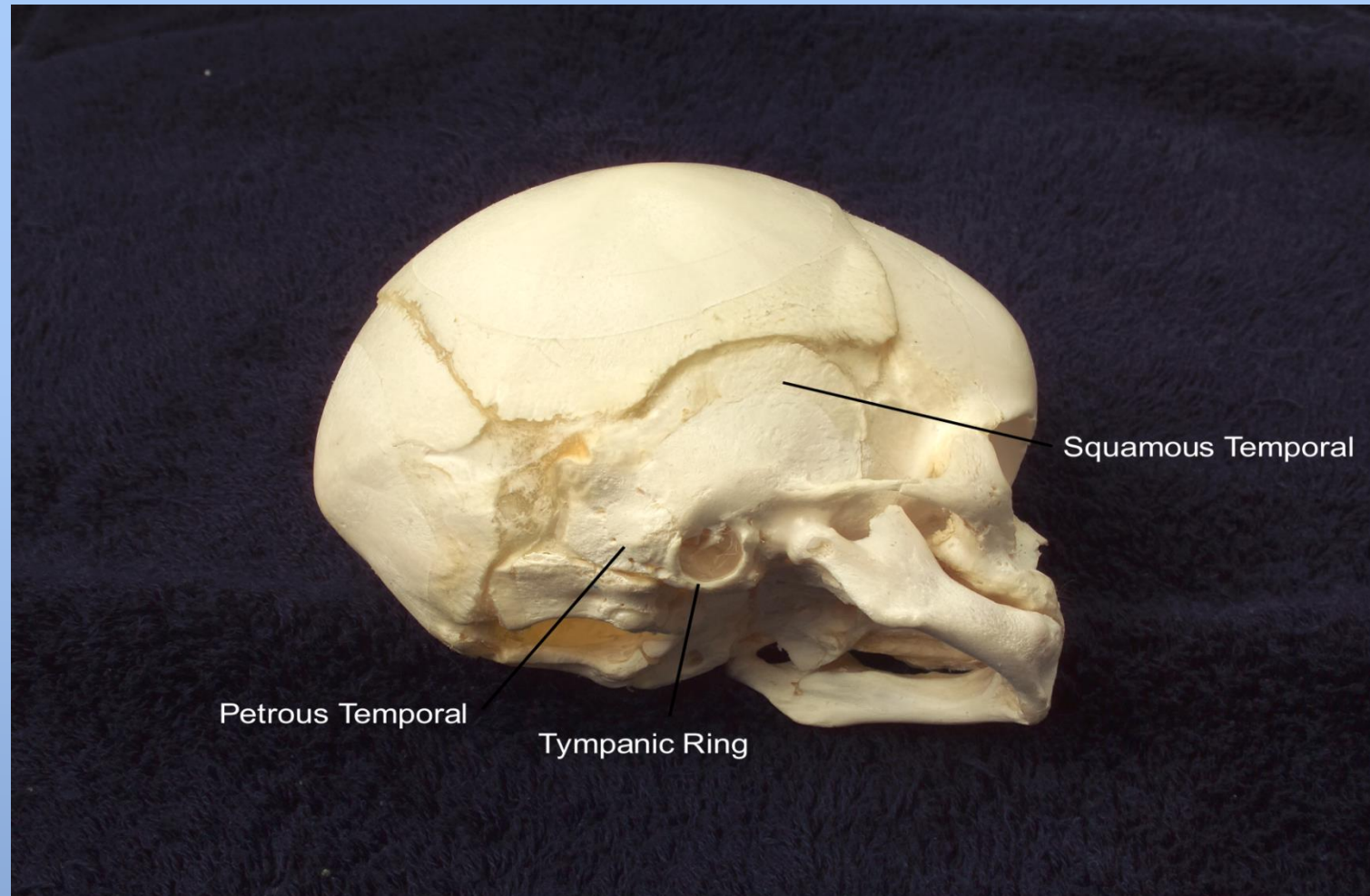
# The Sphenoid

- The sphenoid is in 3 developmental parts at birth; the body, greater wings and the pterygoid plates
- The body of the sphenoid is formed in cartilage
- The greater wings and medial pterygoid plates are membranous in origin
- Cranial nerves II, III, IV and VI pass through it into the orbital cavity

# Temporal Bones

- The temporal bones are in 3 parts in the neonate:- squama and the tympanic ring which are membranous in origin and the petrous portion which originates in cartilage
- Cranial nerves vii and viii travel through the petrous portion with vii exiting at the stylomastoid foramen
- The mastoid process is not yet formed

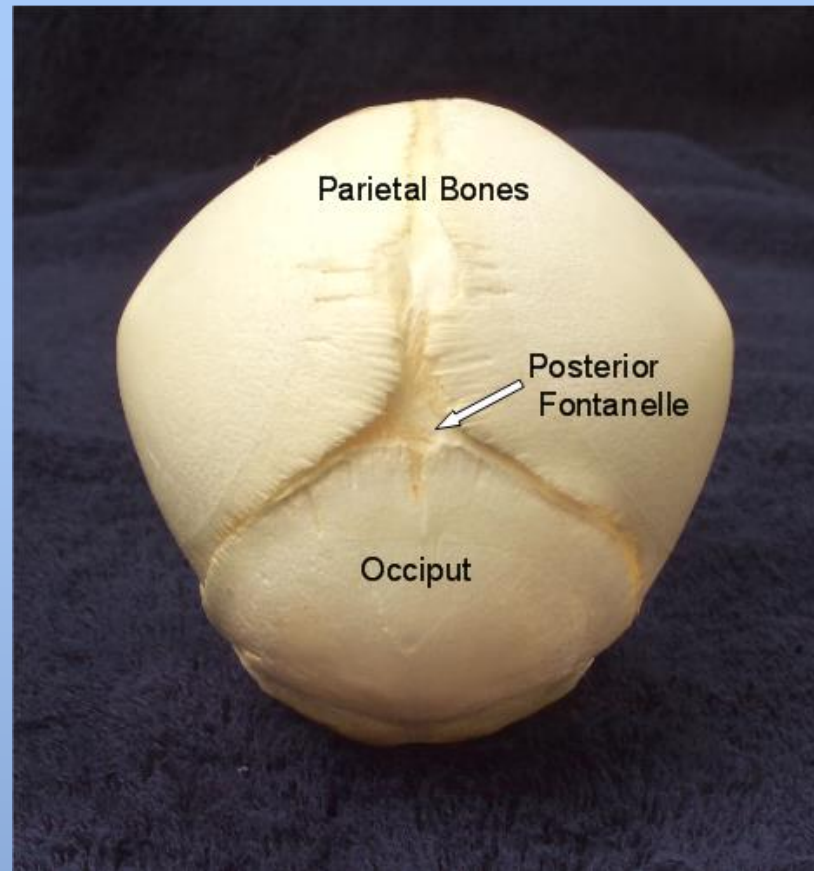
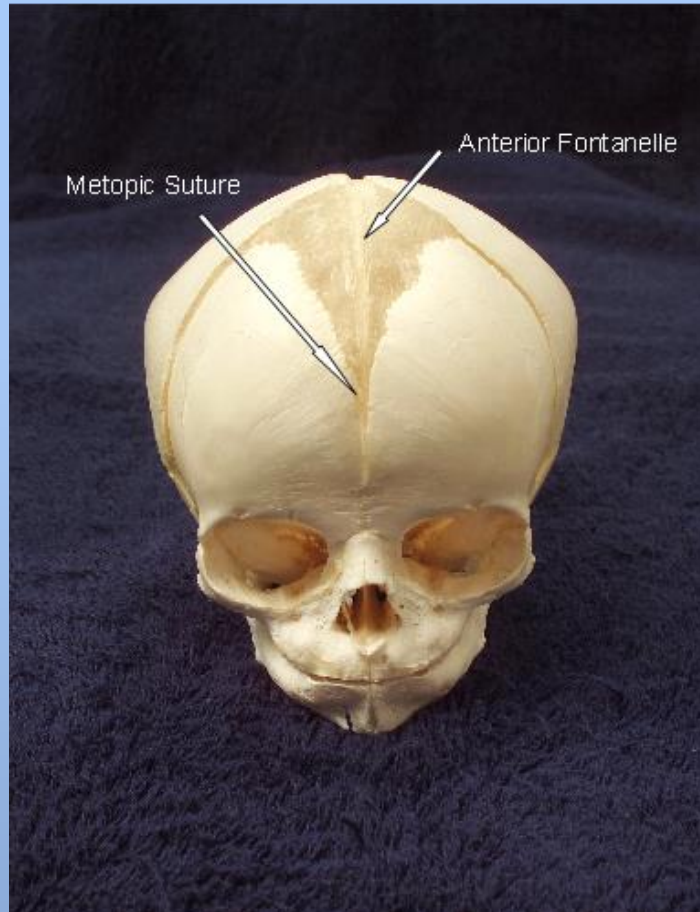
# Foetal Skull Lateral View



# The Neonatal Skull Vault

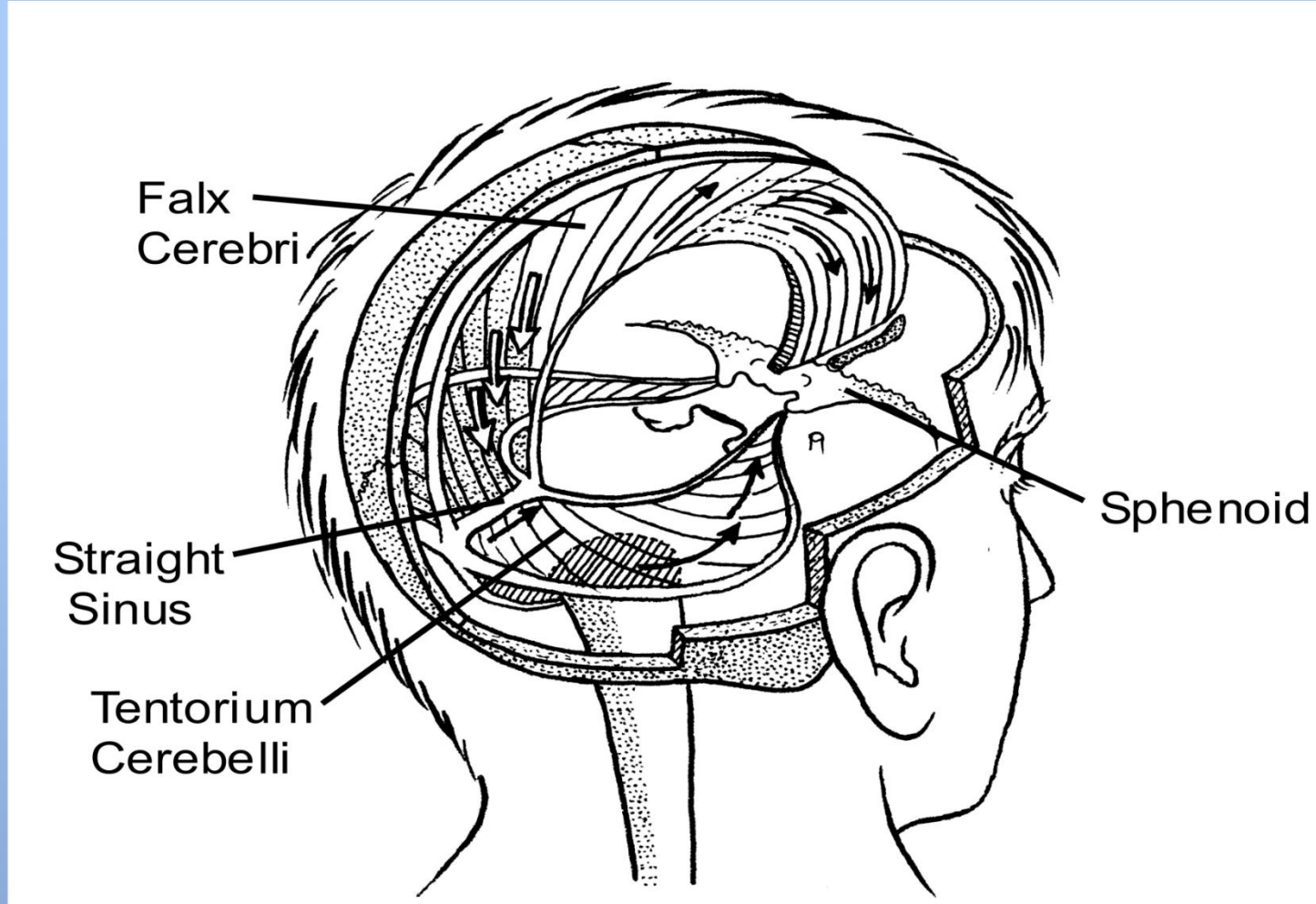
- The vault is formed from membranous bone to allow more malleability in the birth process
- The sutures do not interdigitate at all at this time
- The fontanelles allow the cranial plates to approximate, and the skull to compress and deform

# Foetal Skull





# Reciprocal Tension Membranes





# Plagiocephaly

The term plagiocephaly is derived from the Greek words meaning 'oblique head'

Glat classified it into 3 main types

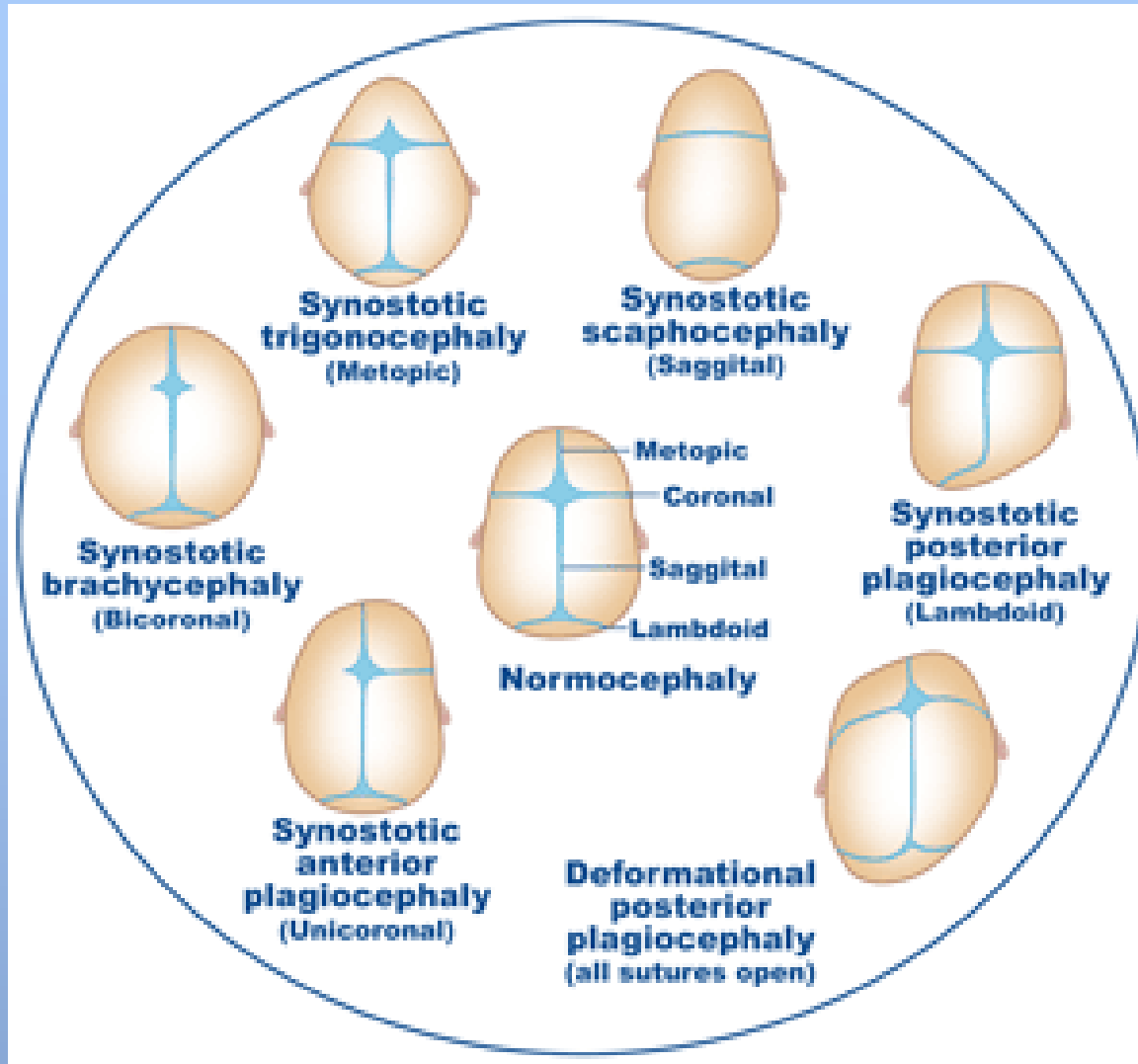
Type 1 From cranial suture synostosis

Type 2 From non-synostotic causes -  
deformational

Type 3 From cranio-facial microsmia

Glat et al Ann Plast Surg 1996 May;97(5):496-74

# Plagiocephaly (Oblique Head)



# Craniosynostosis

- Synostosis entails either-
  - 1- *Fusion of a suture that is not meant to fuse*
  - 2- *Premature fusion of sutures which do fuse*
- Abnormal skull shape results from the growing brain compressing the skull which cannot expand normally
- Skull shape will depend on where the fusion occurs

# Craniosynostosis

- Aetiology is unknown - but it has been linked to intra-uterine constraint Graham et al Pediatrics 1980;65(5):995-9 Higginbottom et al Neurosurgery 1980;6(1):39-44
- Kirschner demonstrated in studies using mice that artificially induced constraint produced sutural fusion Kirsher et al Plast Reconstr Surg 2002 Jun;109(7):2338-4613:
- Constraint caused premature fusion of the SBS in murine experiments Smartt et al [Plast Reconstr Surg.](#) 2005 Oct;116(5):1363-9

# Deformational Plagiocephaly

- Clarren used the term positional plagiocephaly, referring to the supposed cause: a uniform sleeping position Clarren SK J Pediatrics 1981; 98:92-95
- Researchers found positional preference in 8.2% of infants probably from a KISS syndrome Boere-Boonekamp, van der Linden-Kuiper . Pediatrics 2001 Feb:107(2):339-43 Biedermann H Manual Therapy in Children 2004 Churchill Livingstone
- 65% showed skull asymmetry

# Deformational Plagiocephaly

- Losse et al (2005) looking at non-synostotic occipital plagiocephaly found on CT:-
  - Focal fusion present in 25%
  - Endocranial (inwards) ridging - 78%
  - Narrowing - 59%
  - Sclerosis - 19%
  - Overlapping/end to end orientation - 100%

Lossee JE et al Plast Reconstr Surg 2005 Dec;116(7):1860-9



# Plagiocephaly

- Peitsch found the prevalence of anomalous head shapes to be 24% in single babies and 56% in twins
- Risk factors include:-
  - Operative delivery
  - Prolonged labour
  - Primiparity
  - Male gender Peitsch WK et al Pediatrics 2002;110(6)
- A more recent study of 8-12 week old infants (n283) found DPP in 38% Ballardini et al Eur j Pediatr 2018 Jul  
20

# Plagiocephaly

- The use of forceps and suction have been implicated in plagiocephaly Sergueef N et al Compliment Ther Clin Pract 2006 May;12(2)101-10
- Supine sleeping is changing the head shape of infants in the USA from dolchicephalic (elongated) to brachycephalic (shorter and broader). Premature infants are particularly susceptible Hummel P, Fortado D Adv Neonatal Care 2005 Dec;5(6):329-40

# Plagiocephaly and Development

- An early study in 2000 concluded that-  
*“Infants with deformational plagiocephaly comprise a high risk group for developmental difficulties...”* Miller and Clarren Pediatrics. 2000 Feb;105(2):E26
- DPP infants have decreased language acquisition at 3  
Korpilahti et al Childs Nerv Syst 2012 Mar;28(3):419
- Infants with DPP show marked gross motor delays in  
infancy and as toddlers Hutchinson et al J Paediatr Child Health 2012  
Mar;48(3);274-8, Collett et al Arch Pediatr Adolesc Med 2011 Jul;165(7):653-8

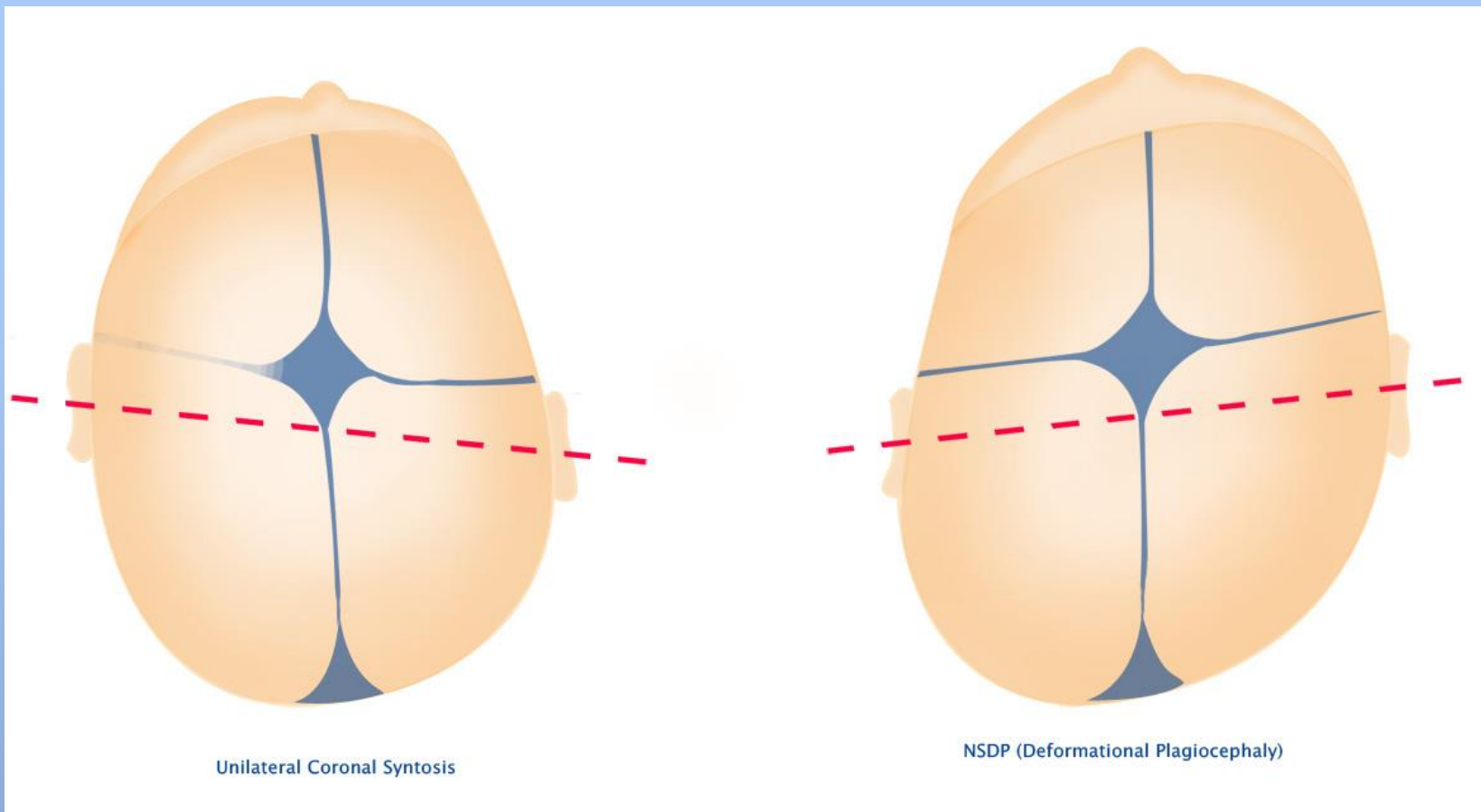
# Plagiocephaly and Development

- Children with previous history of DP present changes in head position, muscle shortening and a poor balance when compared to control at 3-5 yrs Carbrera-Martos et al J Paediatr Child Health. 2016 May;52(5):541-6
- The health care system is being inundated with DP Martiniuk et al Child Care Health Dev. 2016 Nov;42(6):941-950
- Manual therapy (cranial mobilisation) is superior to just repositioning in its RX Carbrera-Martos et al Childs Nerv Syst. 2016 Jul 27
- It may also benefit motor function Cabrera-Martos et al Childs Nerv Syst. 2018 Jul 19
- For PP, manual therapy was found to be more effective than repositioning including tummy time Ellwood et al. Chiropractic & Manual Therapies 2020 28:31

# Plagiocephaly - DDX

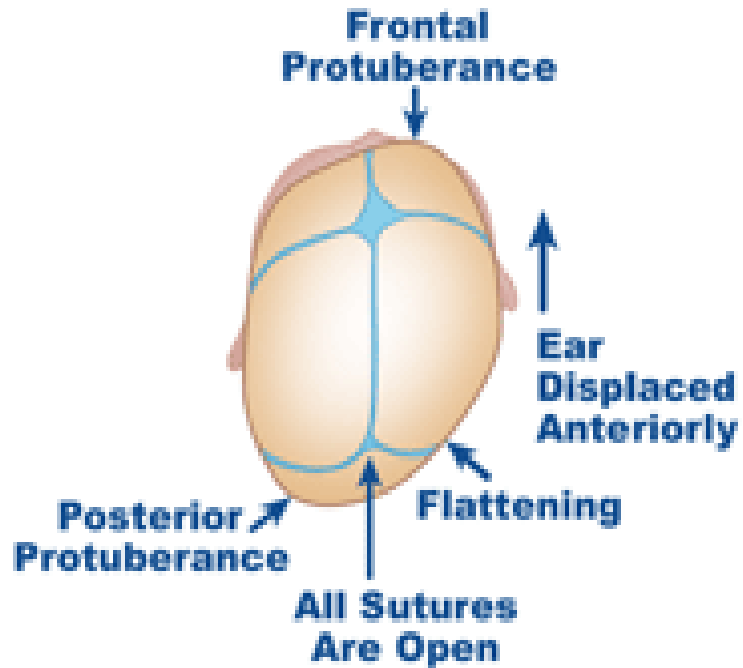
- Palpate the SCMs for fibrosis or tumour
- Bony ridging (ectocranial) is common in sagittal and metopic synostosis but not in coronal or lambdoidal Bruneteau RJ, Mulliken JB *Plast Reconstr Surg* 1992 Jan;89(1);21-31; discussion 32-3
- Was the skull symmetrical at birth or already deformed?
- CT can be useful

# Unilateral Coronal Synostosis vs. Deformational Plagiocephaly

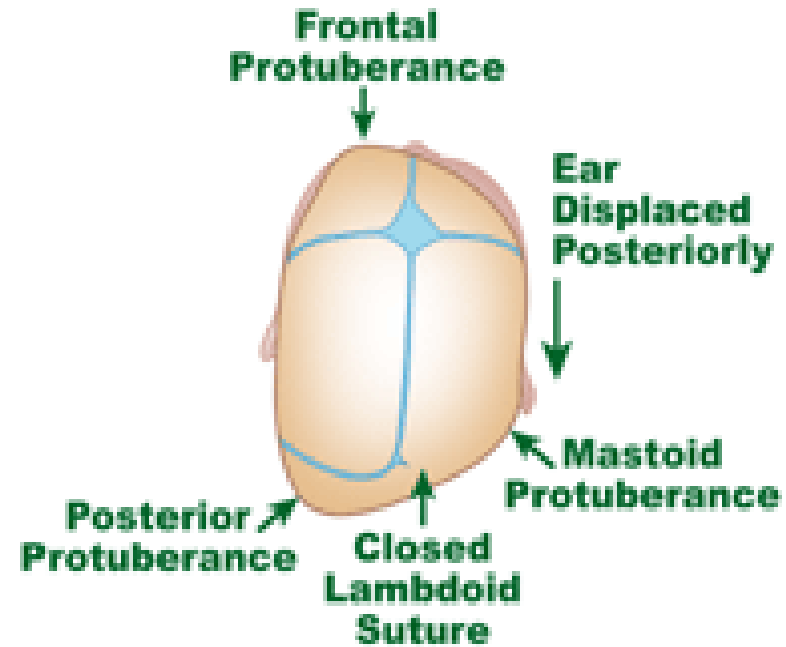


# Plagiocephaly Differential Diagnosis: Posterior Cranium

Deformational Plagiocephaly



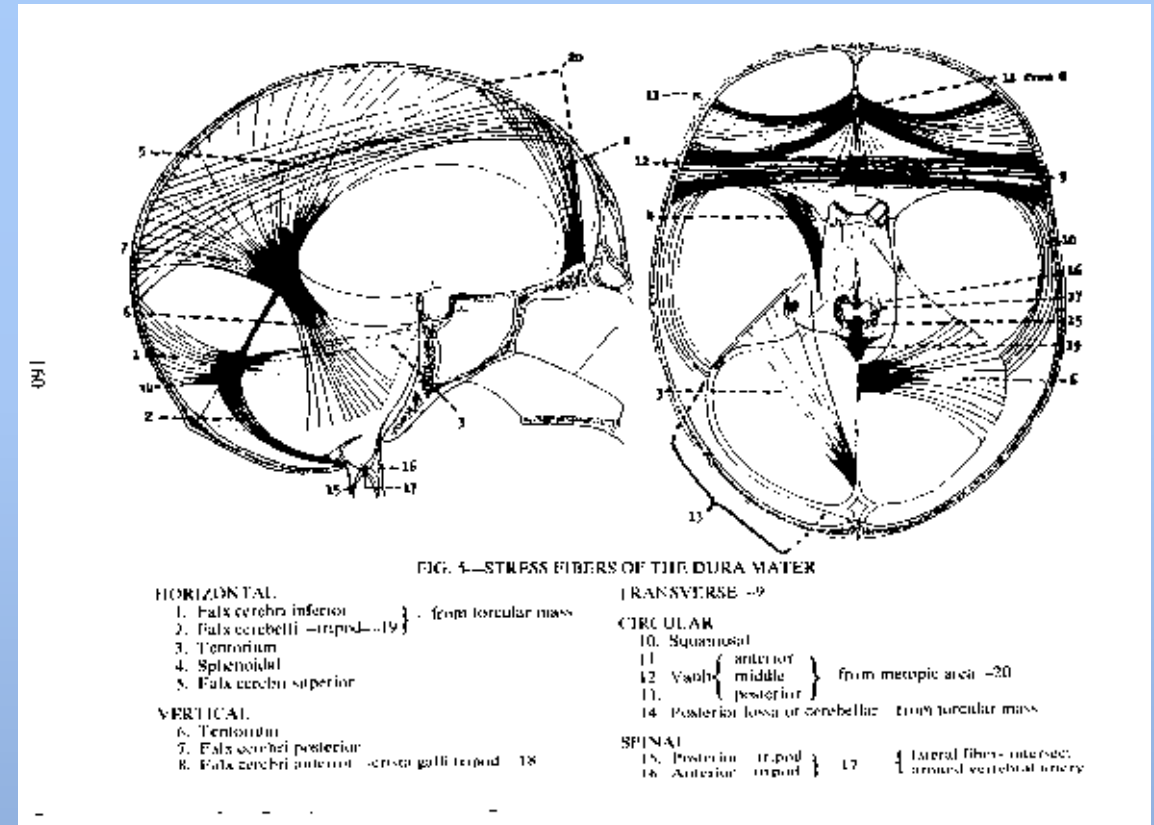
Synostotic Plagiocephaly





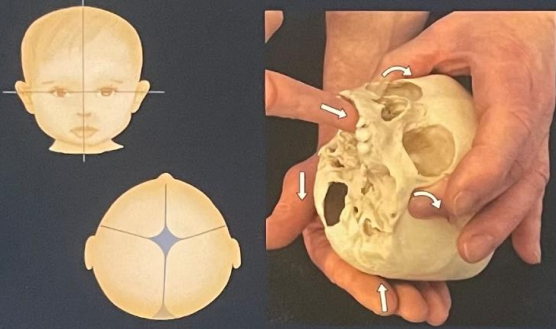
# Foetal Skull Base

- Arbuckle in the 1940s theorised that distortions of the component parts of the skull base not evident at birth were the main cause of distortions in the skull vault, via the action of the dural membrane system Arbuckle BE. The Selected Writings of Beryl E Arbuckle 1994 (Repub) The American Academy of Osteopathy

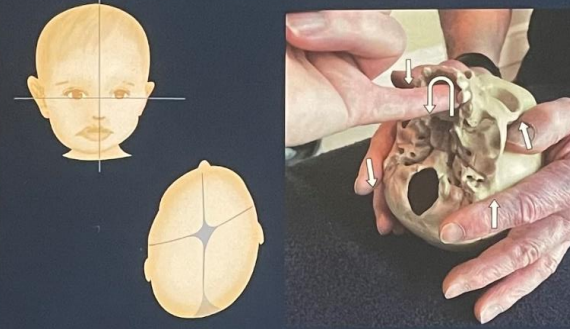


# Chiropractic Cranial Corrections

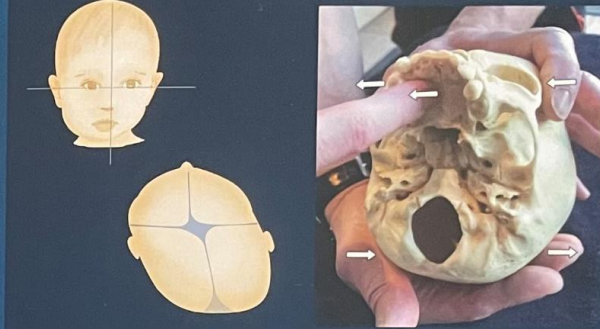
**Flexion Strain Correction**



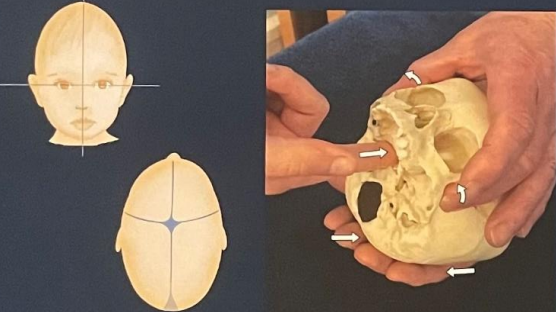
**Anterior Posterior Strain Correction**



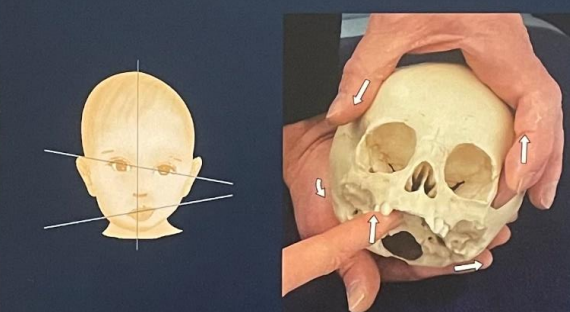
**Lateral Strain Correction**



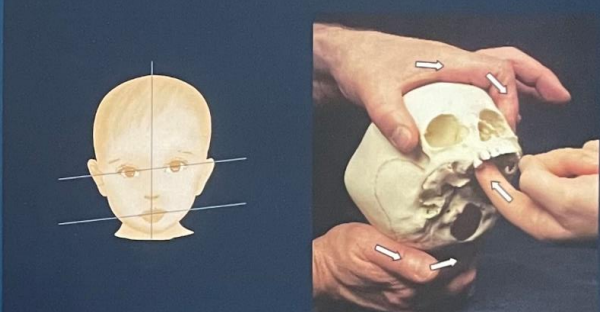
**Extension Strain Correction**



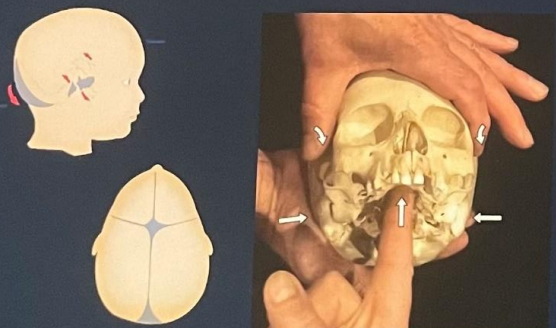
**Sidebend Correction**



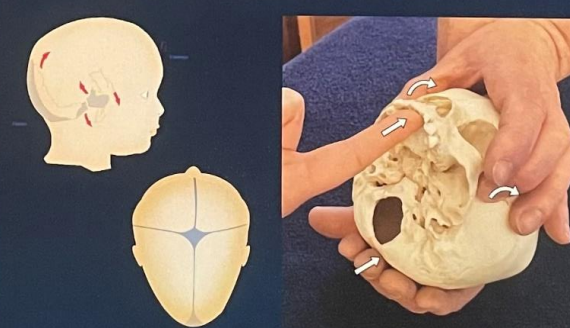
**Torsion Correction**



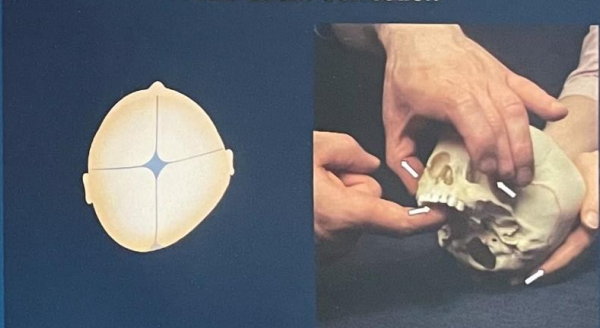
**Inferior Vertical Strain Correction**



**Superior Vertical Strain Correction**



**Plate Strain Correction**

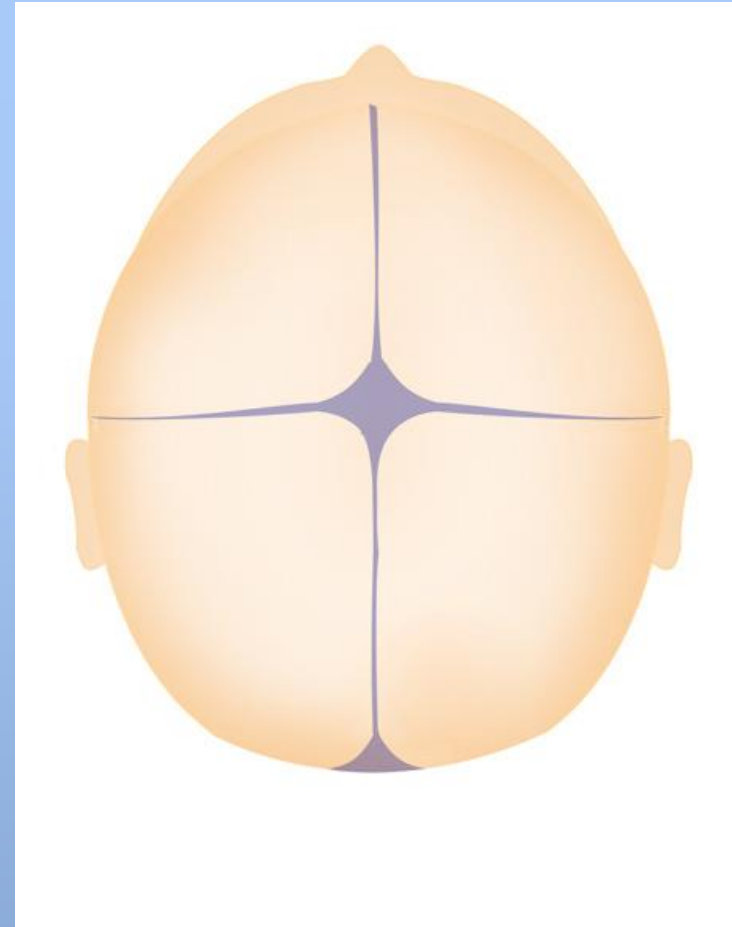
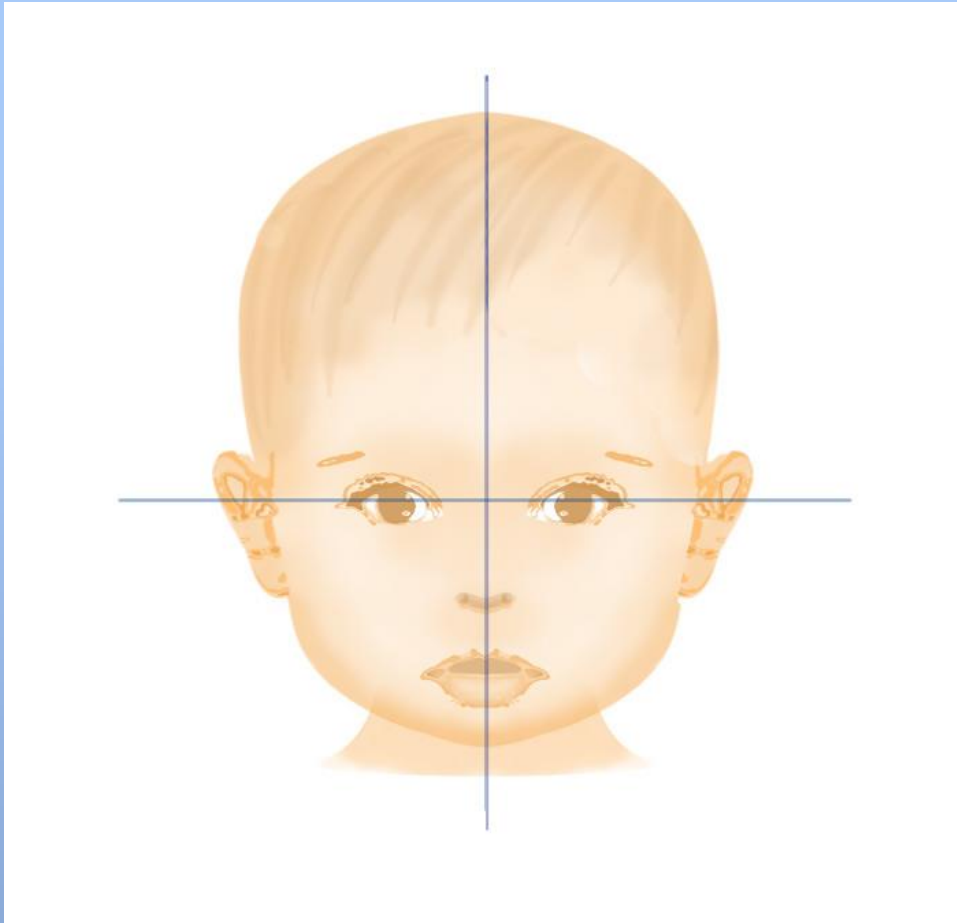


# Cranial Corrections

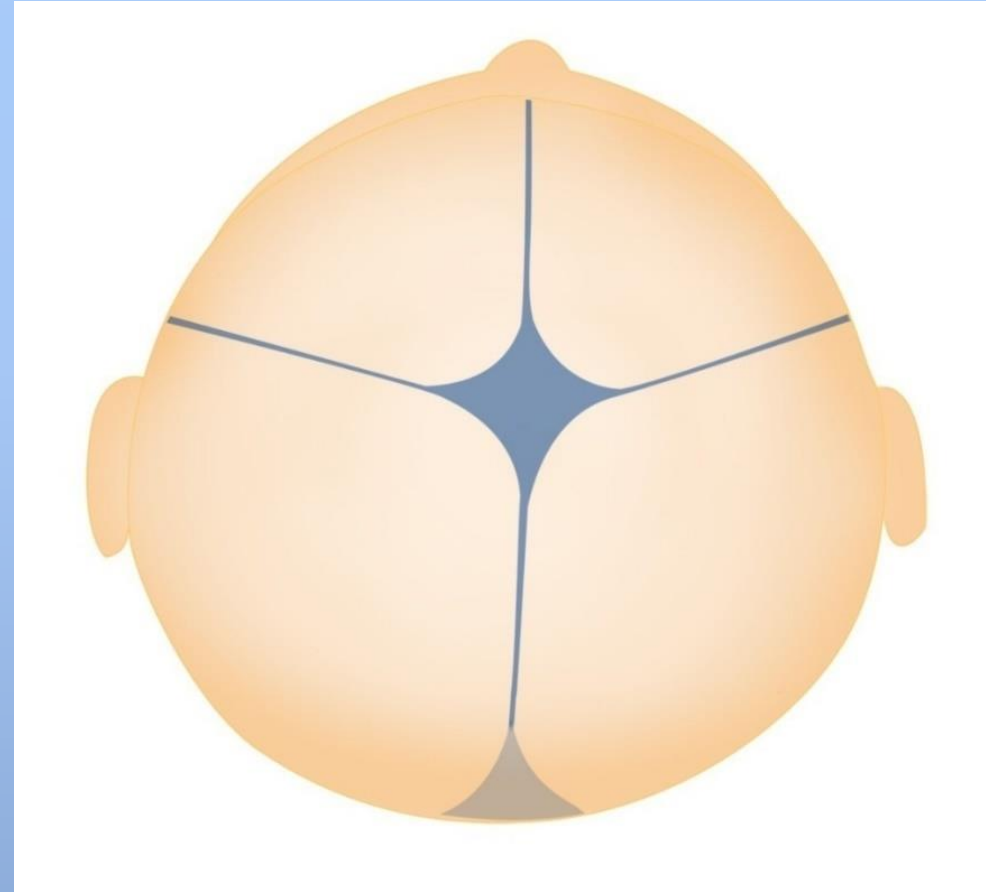
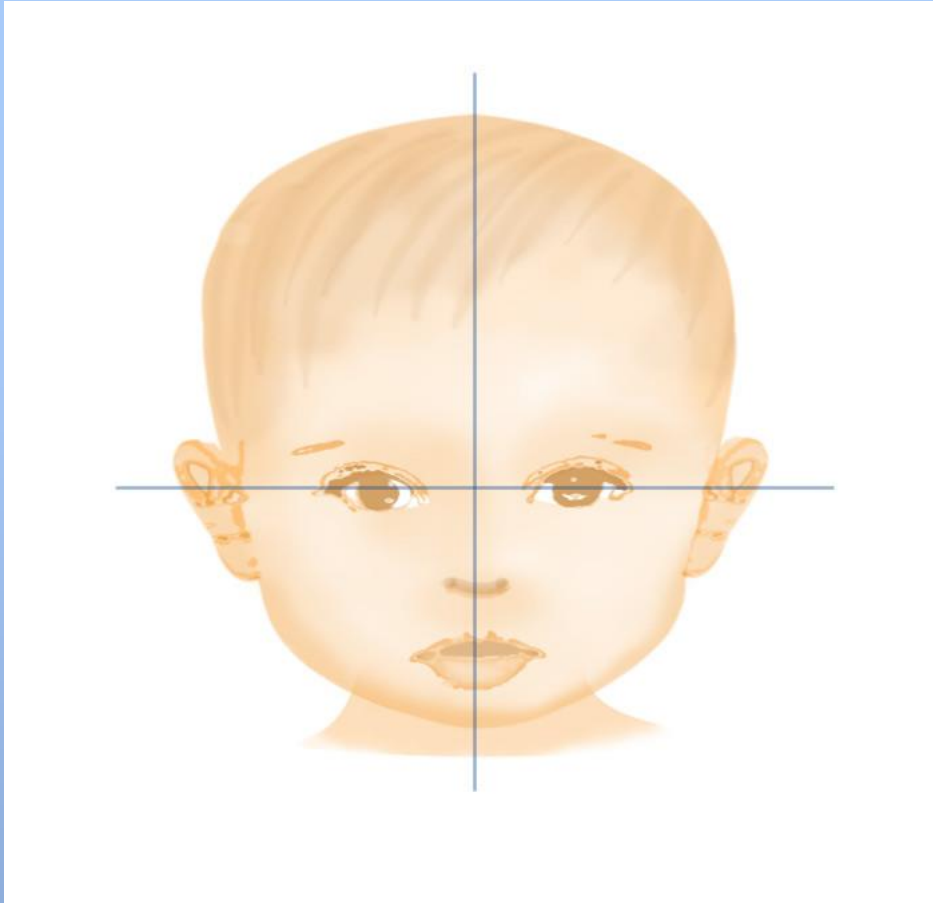
- Must be performed with the utmost gentleness - **NEVER USE FORCE**
- Always first normalise sacral and occipital function as much as possible
- If there is no 'give' felt when performing the correction reevaluate your visual indicators
- Take pre and post photographs to document any change



# Normal Skull A-P and Vertex



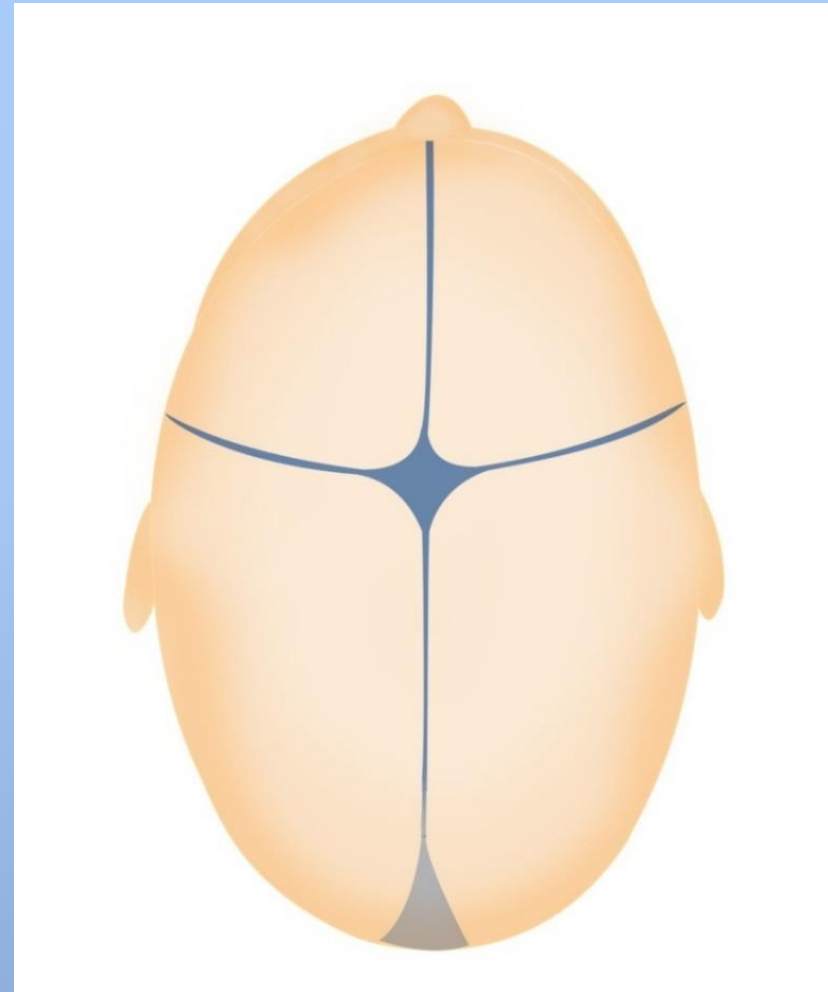
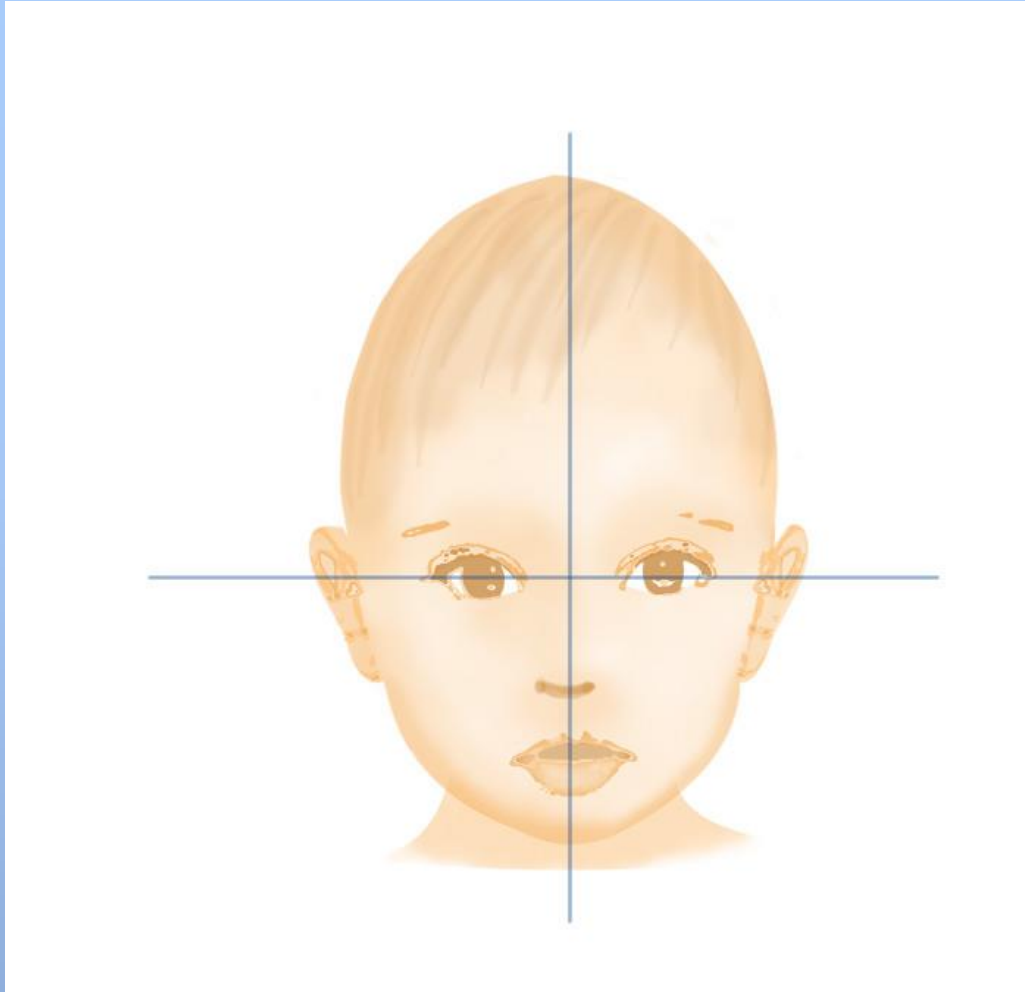
# Flexion Strain



# Flexion Strain Correction

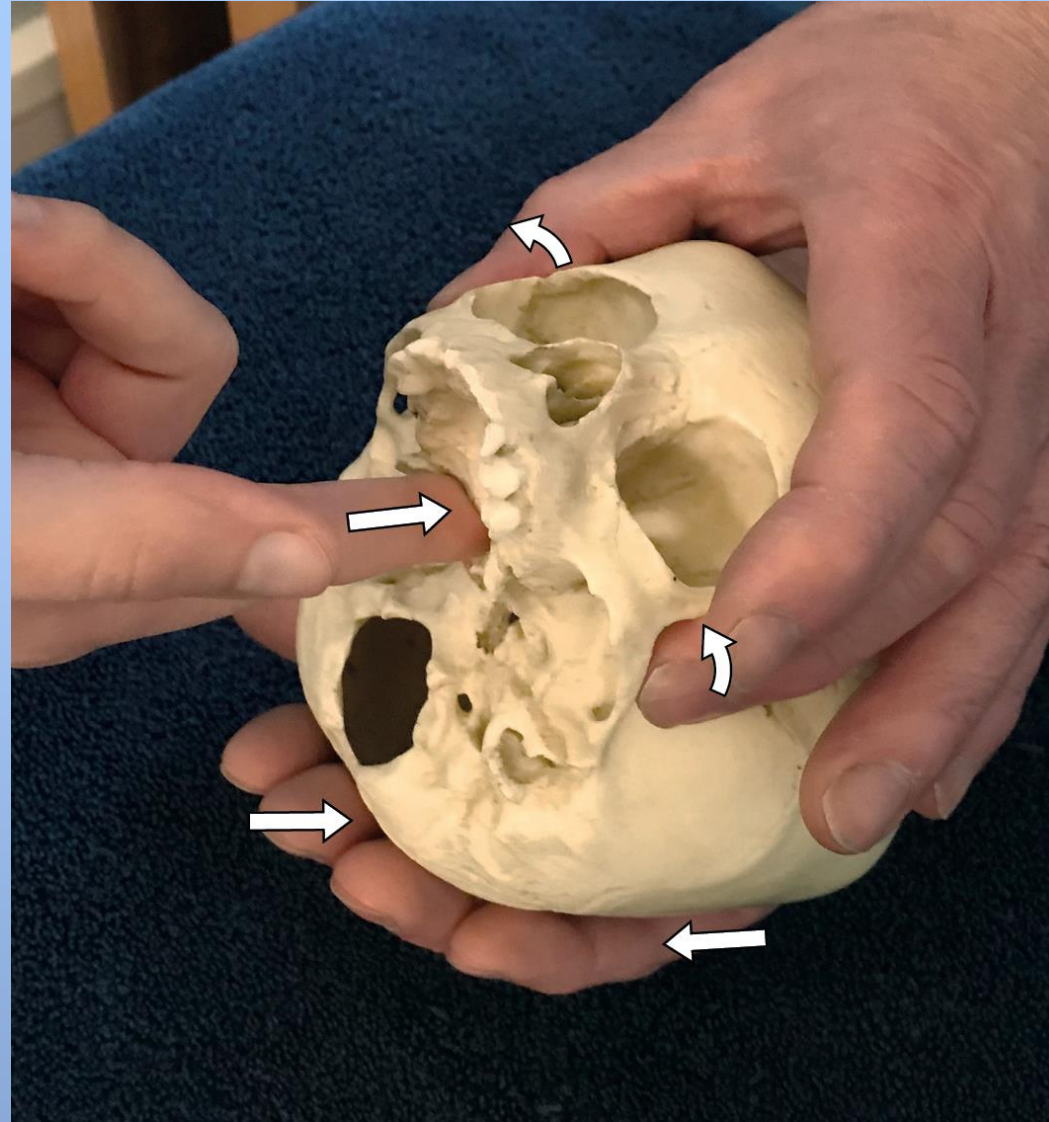


# Extension Strain

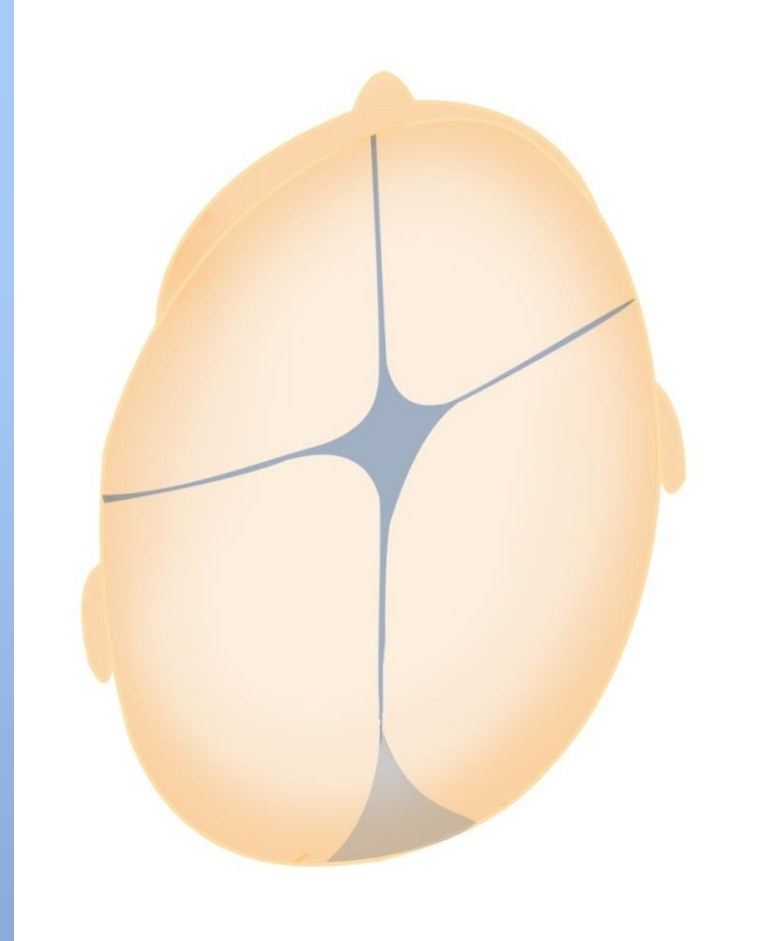
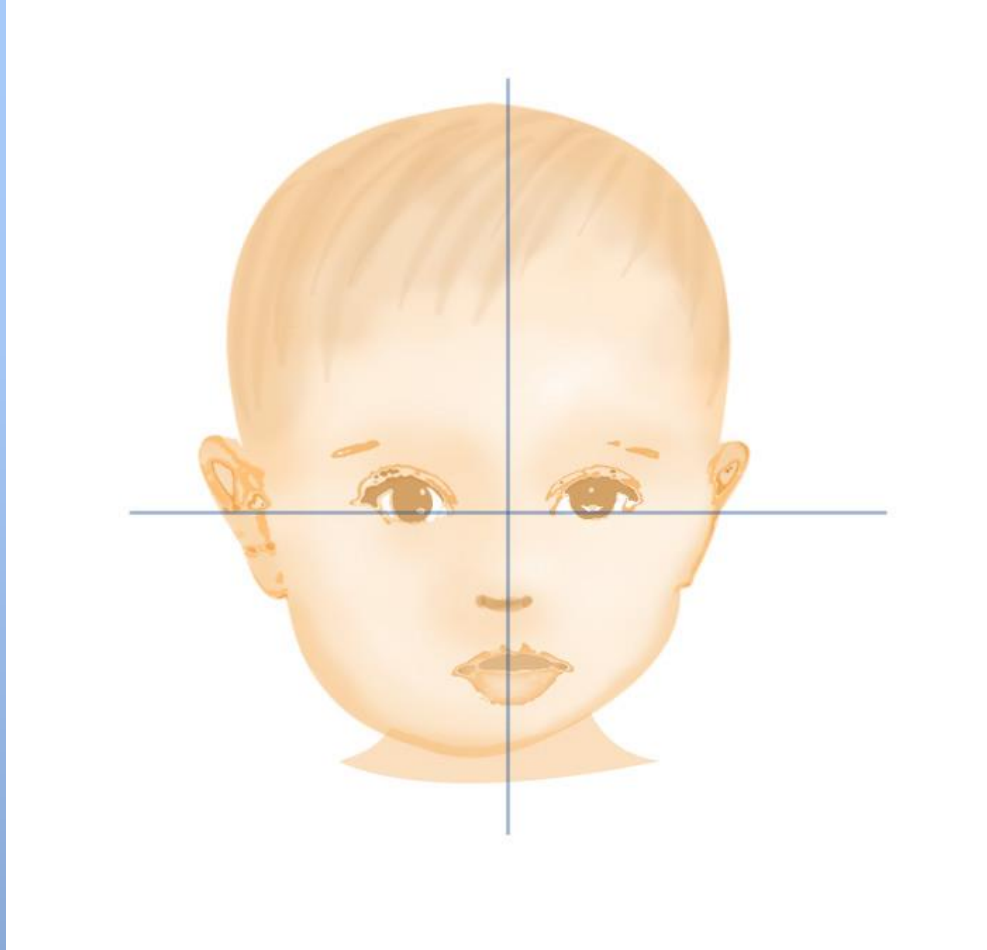




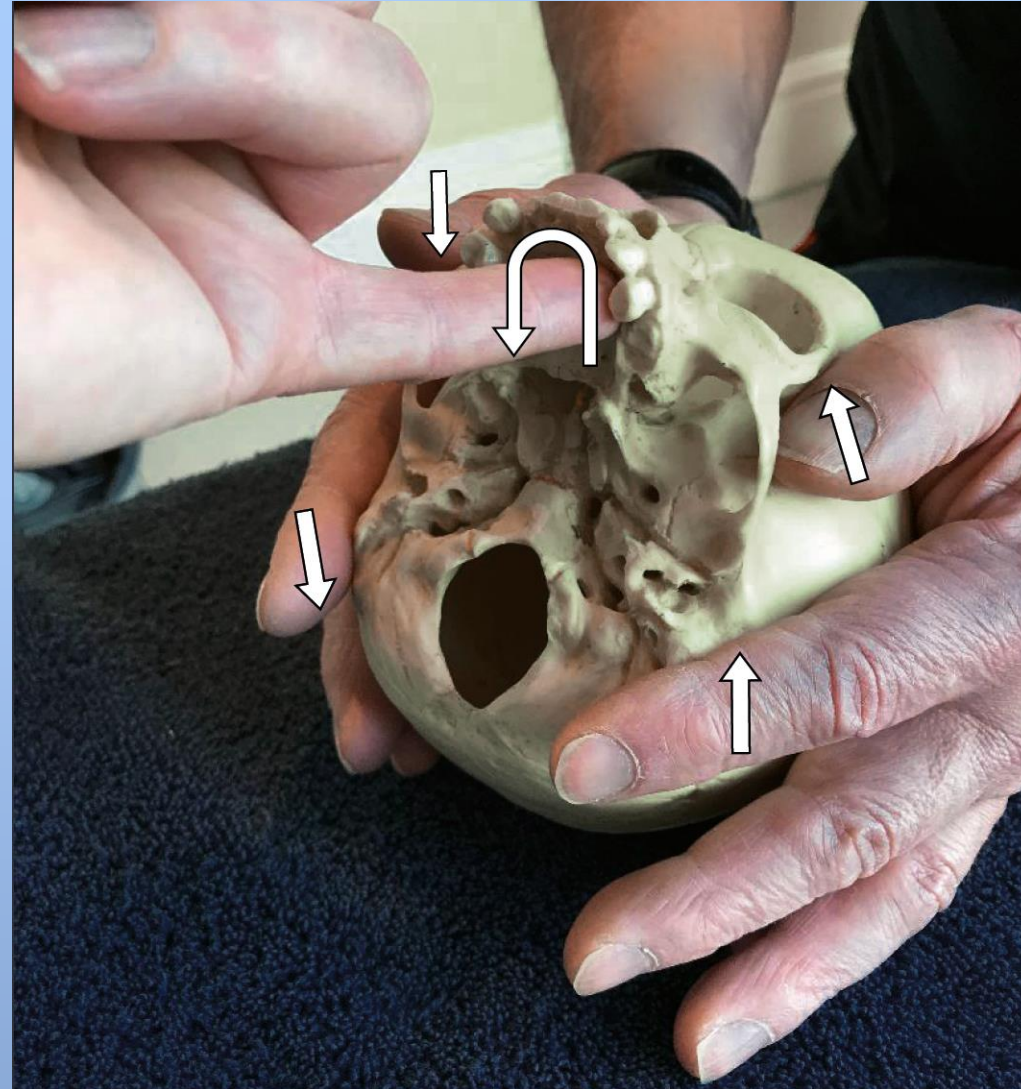
# Extension Strain Correction



# A-P Strain



# Right A-P Strain Correction

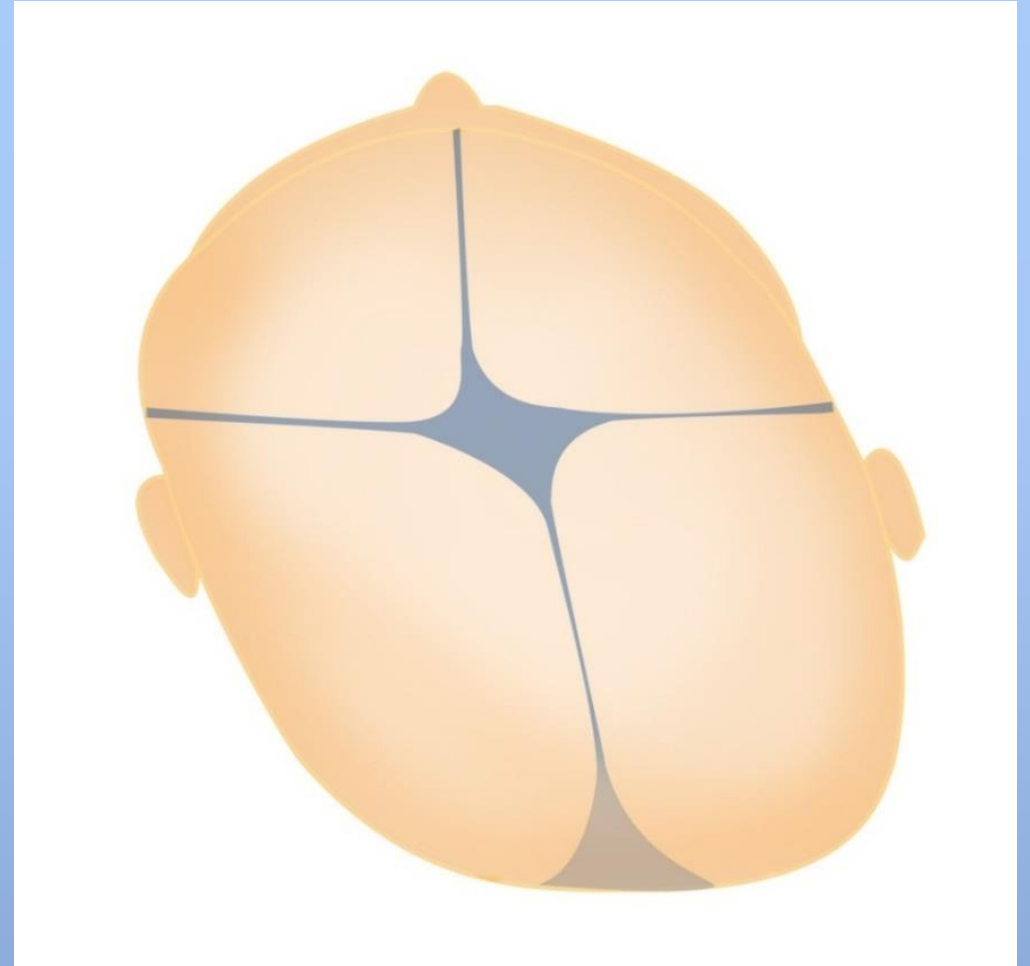
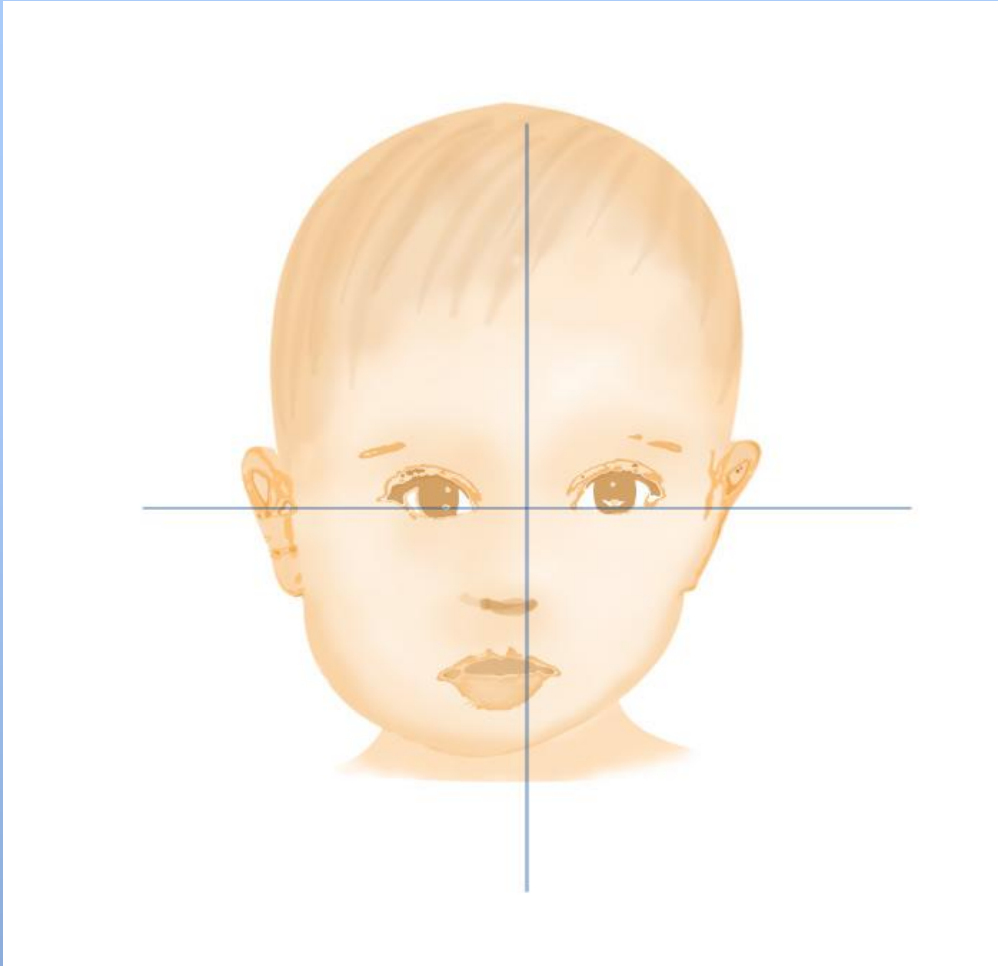




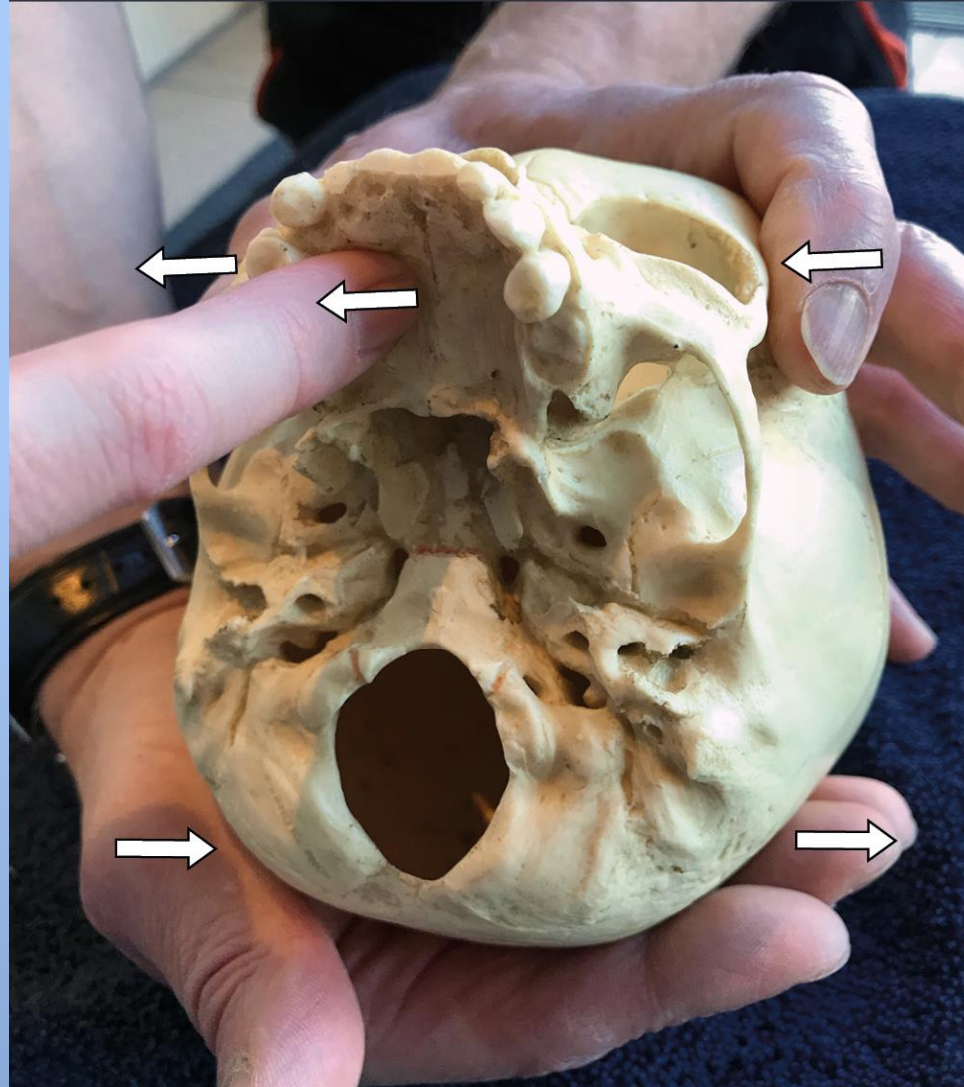
# A-P Strain Pre & Post Rx



# Lateral Strain



# Lateral Strain Correction



# Lateral/AP Strain Pre/Post Rx

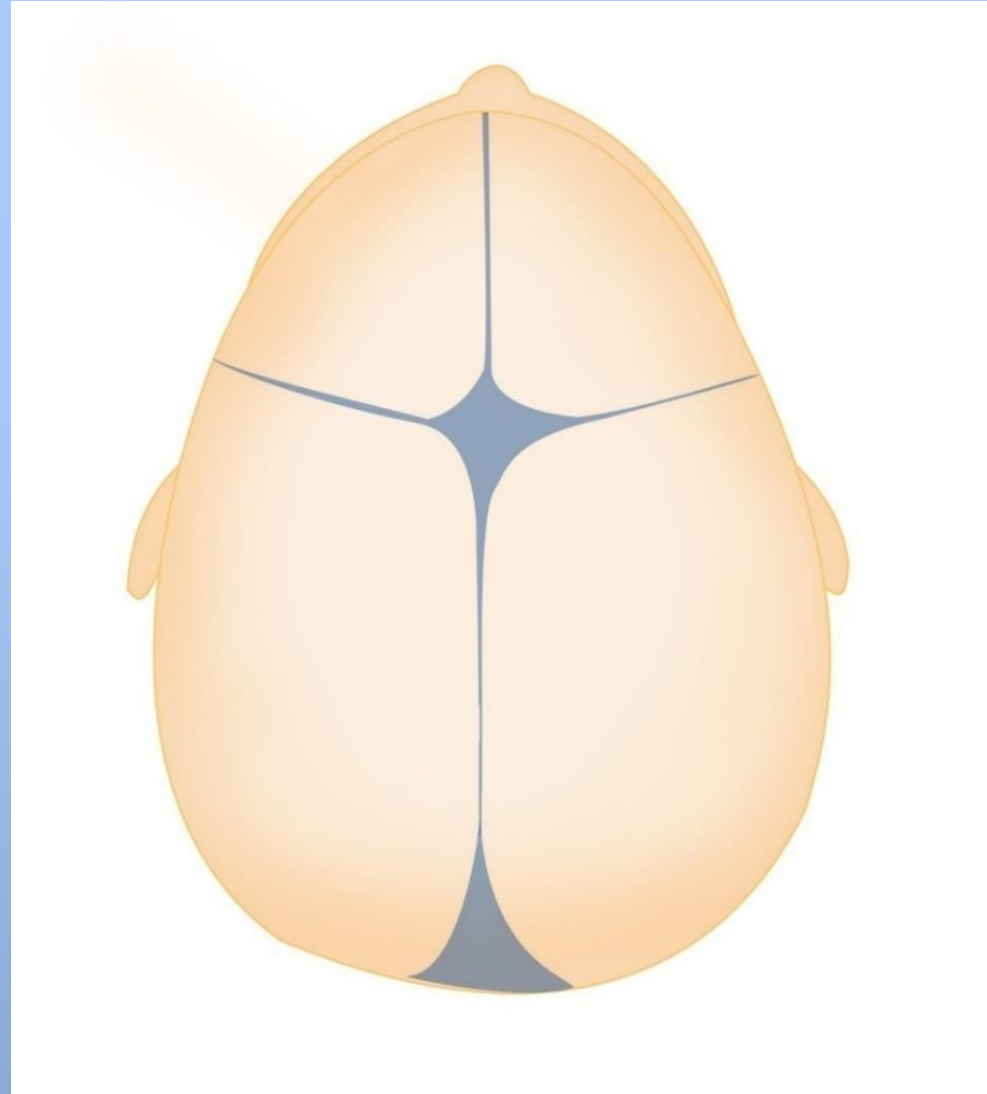




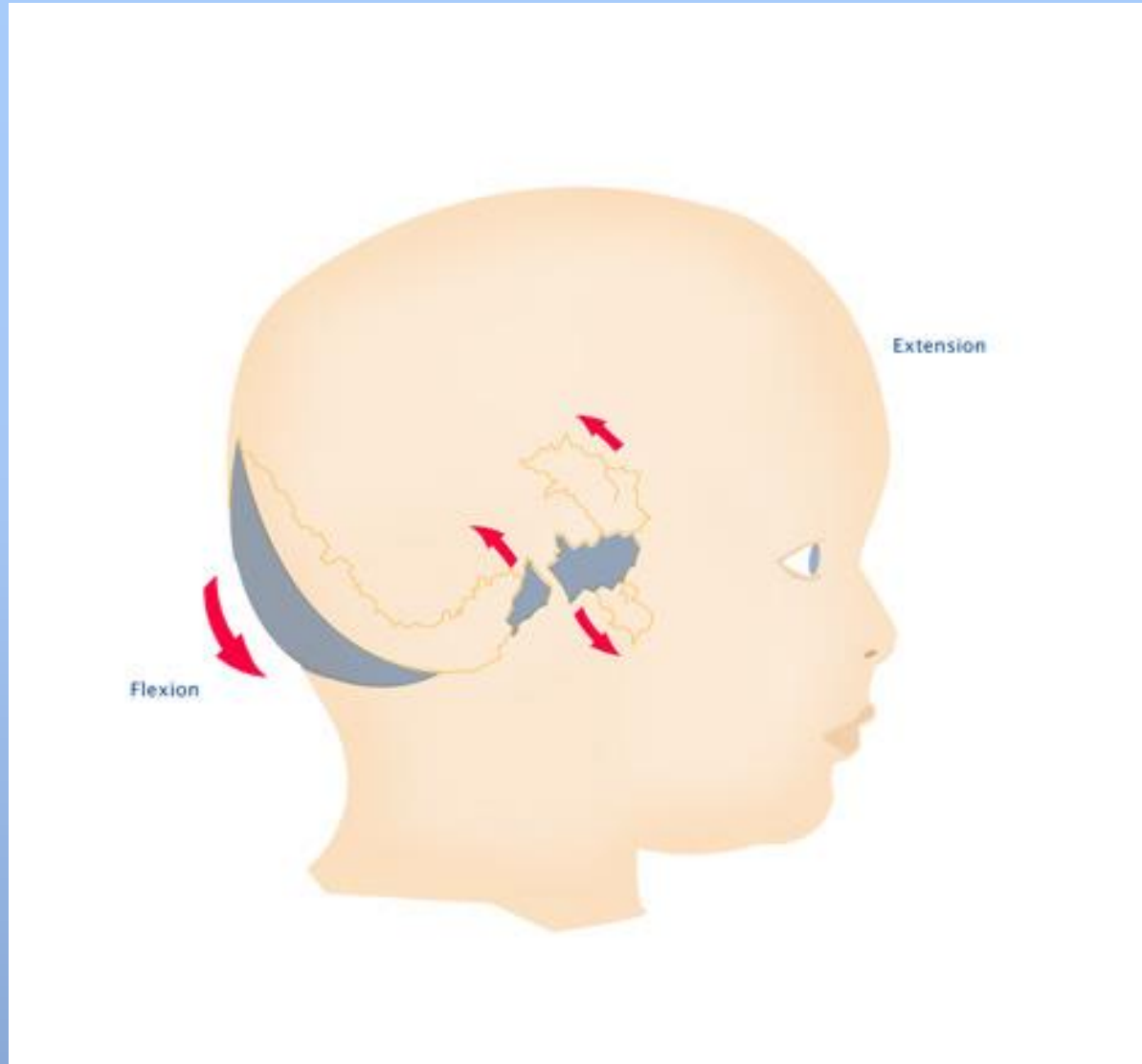
# A-P/Lat Under Care



# Inferior Vertical Strain



# Inferior Vertical Strain

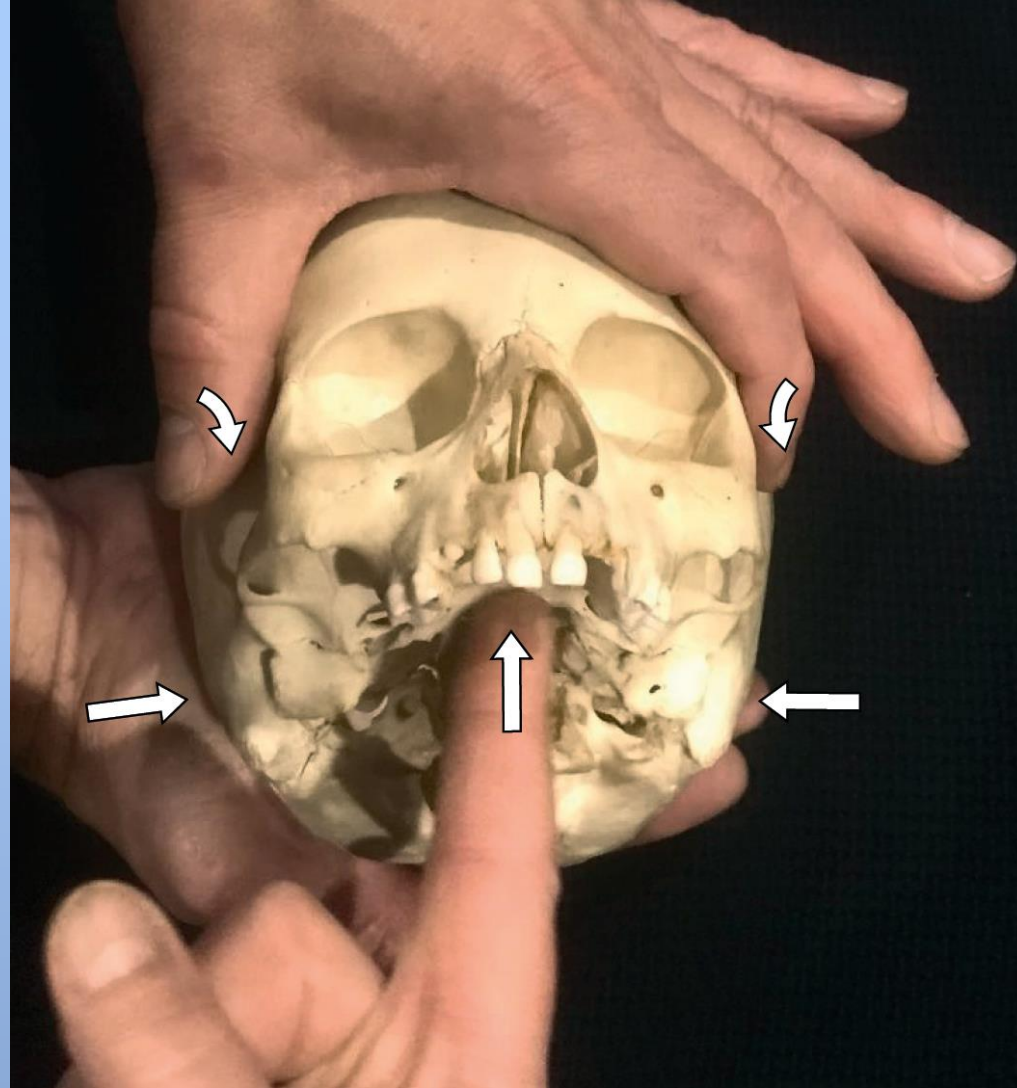


# IVS





# Inferior Vertical Strain Correction



# TMJ and Posture

- D'Attilio demonstrated that children with Class 2 bites showed a decreased cervical curve and an extended head position D'Attilio et al Cranio J Craniomand Pract Jul 2005;23(3):219-28
- Augustine et al 2008 (ii) and Olomos et al 2005 (iii) showed the effectiveness of correcting Class 2 malocclusions regarding head posture Augustine et al Cranio J Craniomand Pract Apl 2008;26(2):136-43 Olomos et al Cranio J Craniomand Pract Jan 2005;23(1):48-52

# TMJ and Posture

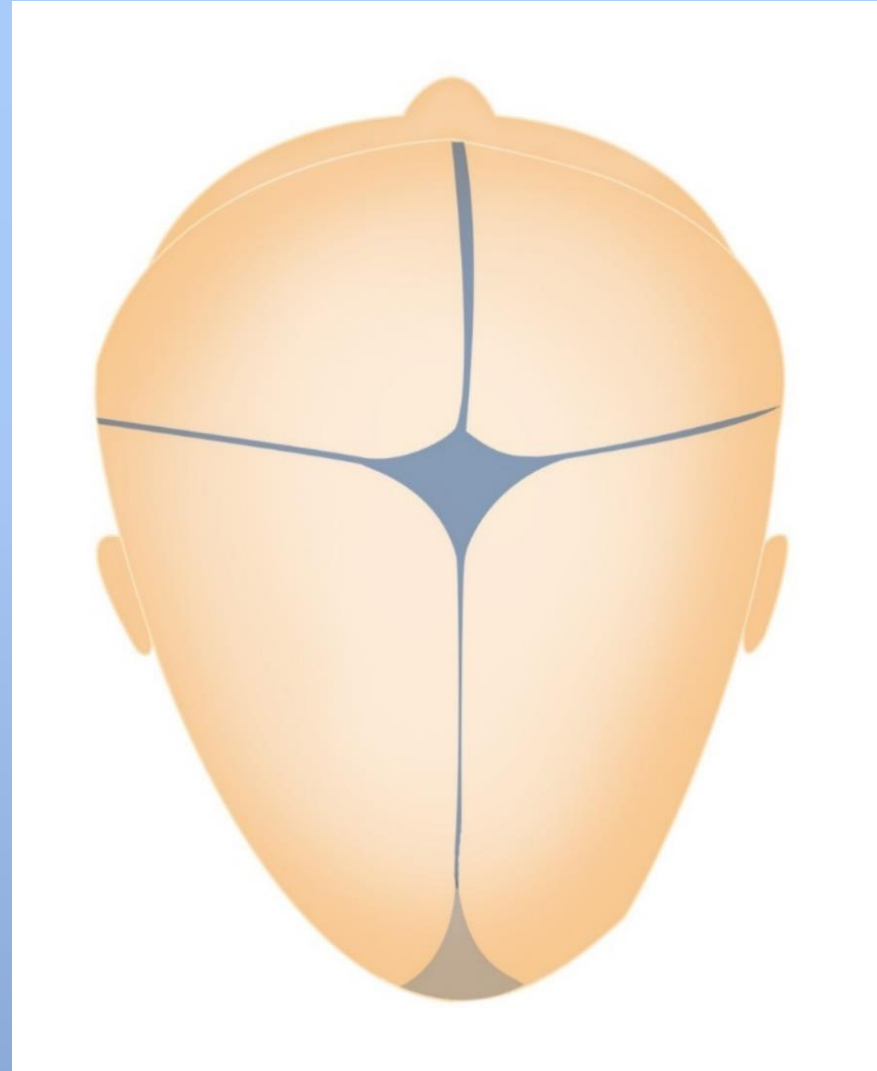
- Sakaguchi demonstrated that not only did mandibular position change body posture, but that body posture changed mandibular position Sakaguchi K et al Cranio J Craniomand Pract Oct 2007;25(4):495
- D'Attilio et al 2005 (ii) using x-ray studies in rats showed the development of a scoliosis apex at T1 after creating bite asymmetry D'Attilio M et al Cranio J Craniomand Pract Apr 2005;23(2):384



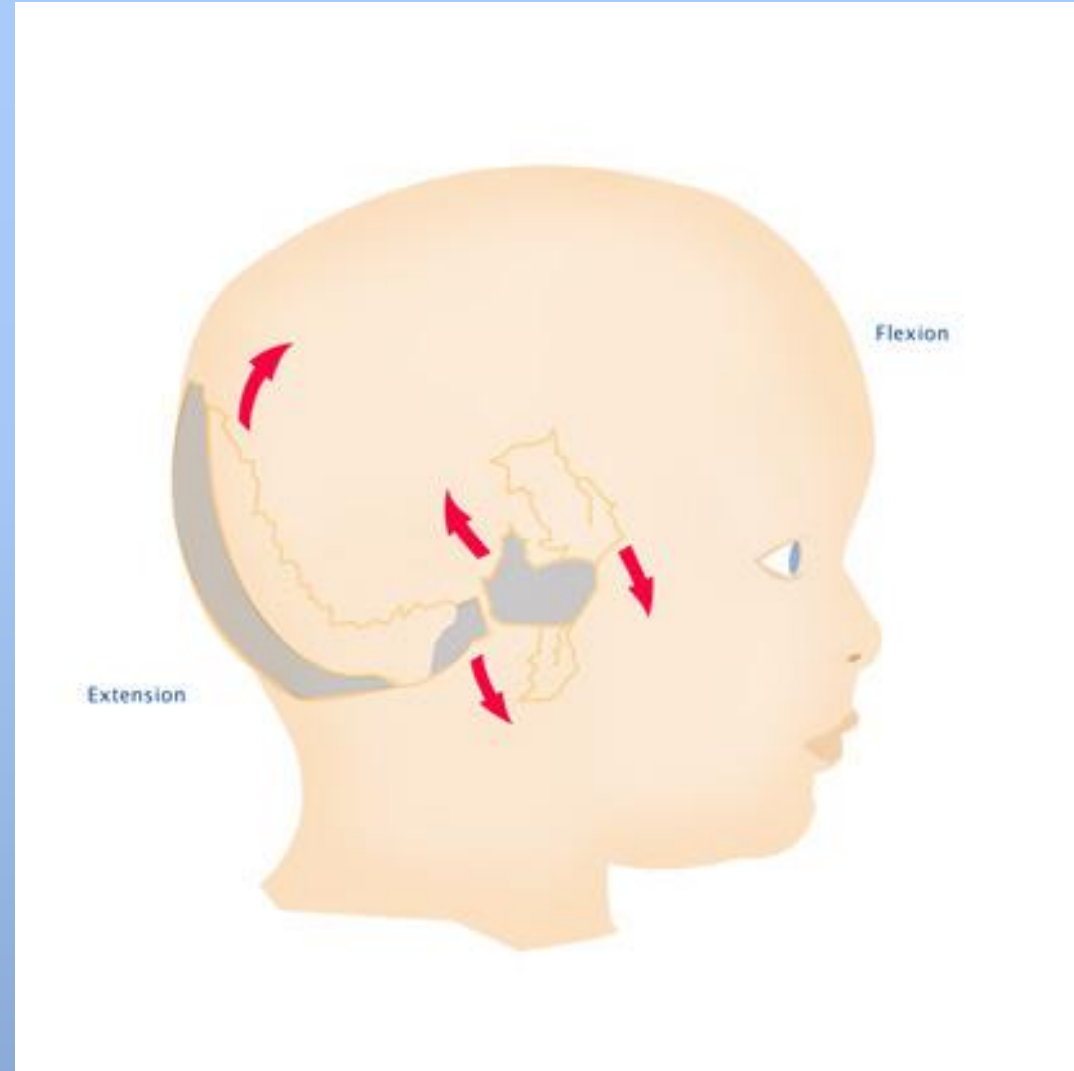
# TMJ and Back Pain

- There appears to be a dose response type relationship between TMD and spinal pain Wiesinger et al BMC Musculoskelet Disord. 2009 Mar 2;10:28
- Temporomandibular disorders (TMD), headaches, and spinal pain show co-morbidity and may therefore influence each other Marklund et al European Journal of Pain 14:2010;366–371
- 55% of patients with TMJ dysfunction had at least two other sites of body pain compared to 38% of controls (n295) vivaldi et al Headache 2018 Sep 4

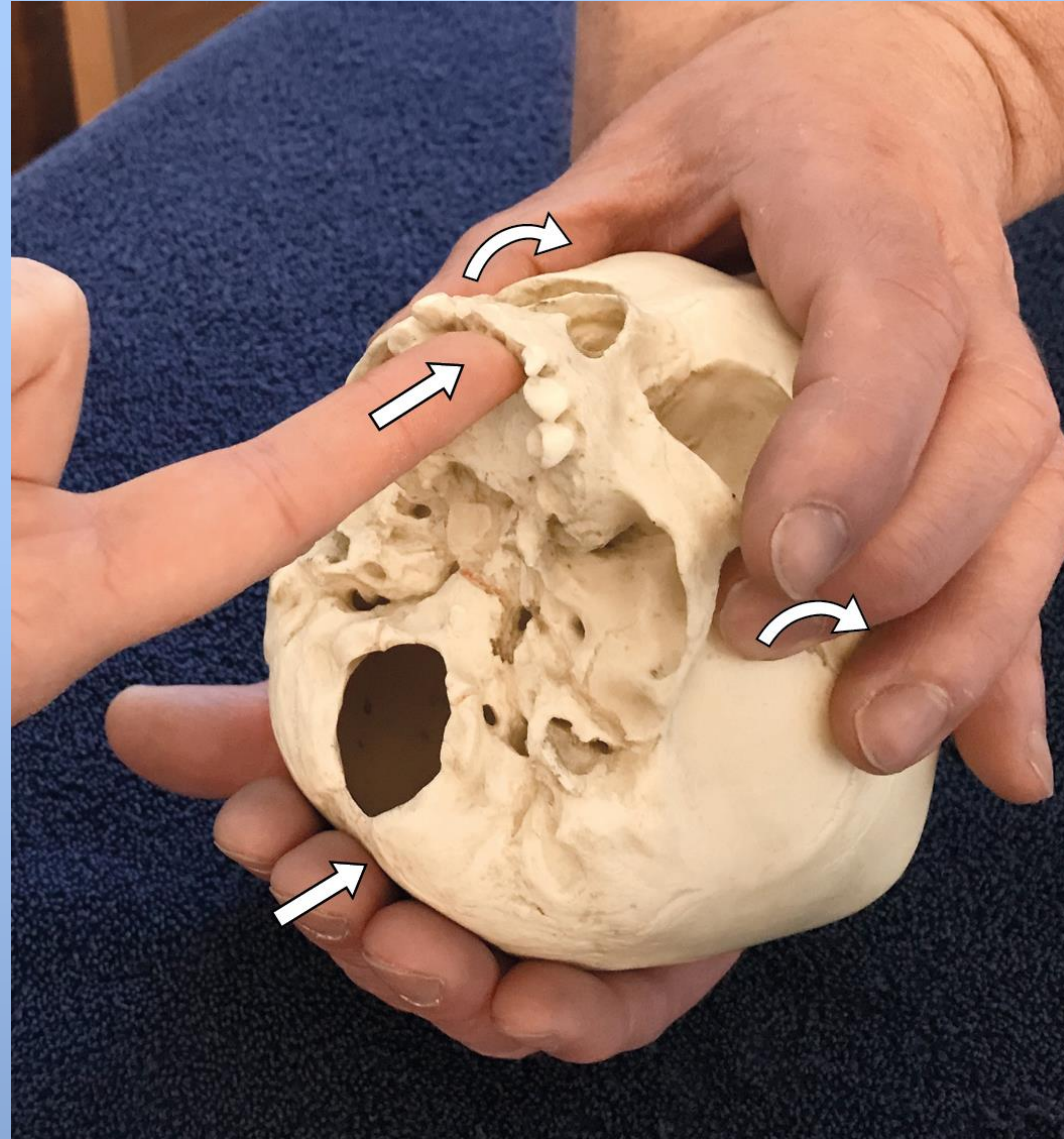
# Superior Vertical Strain



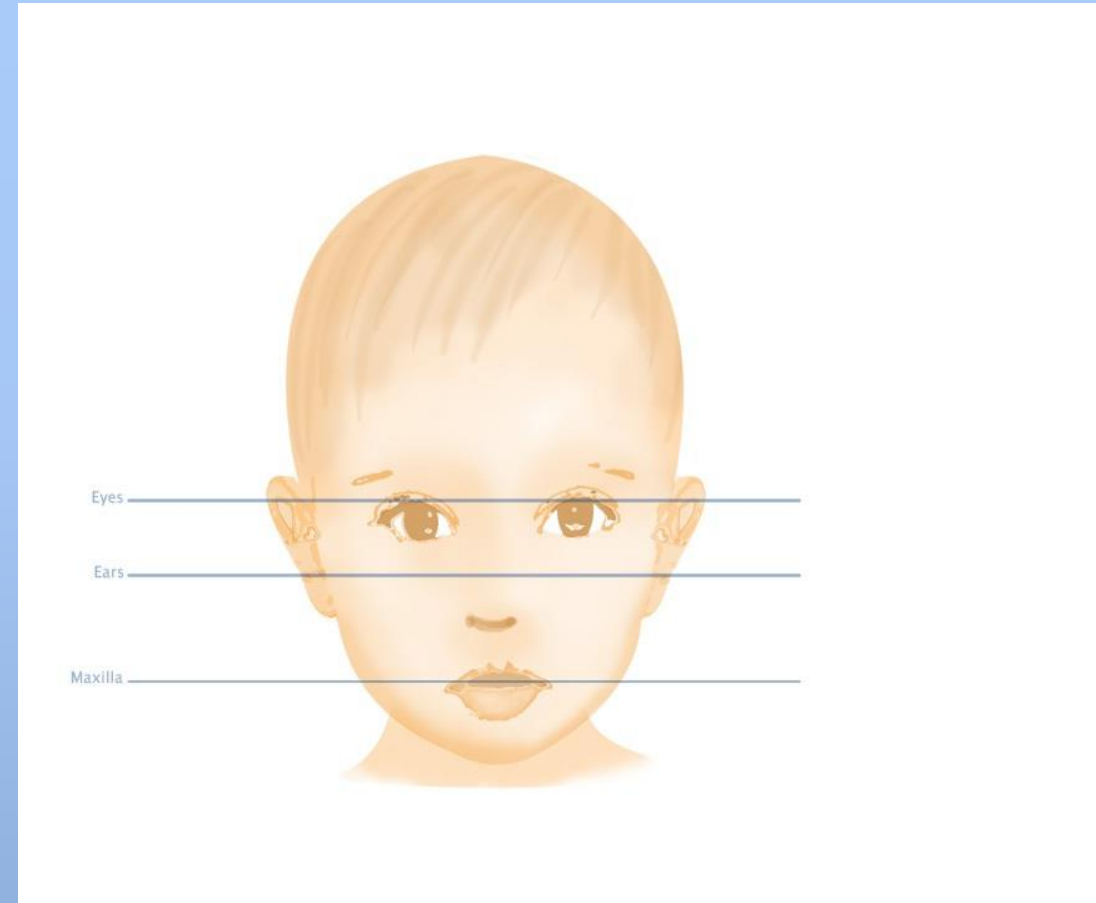
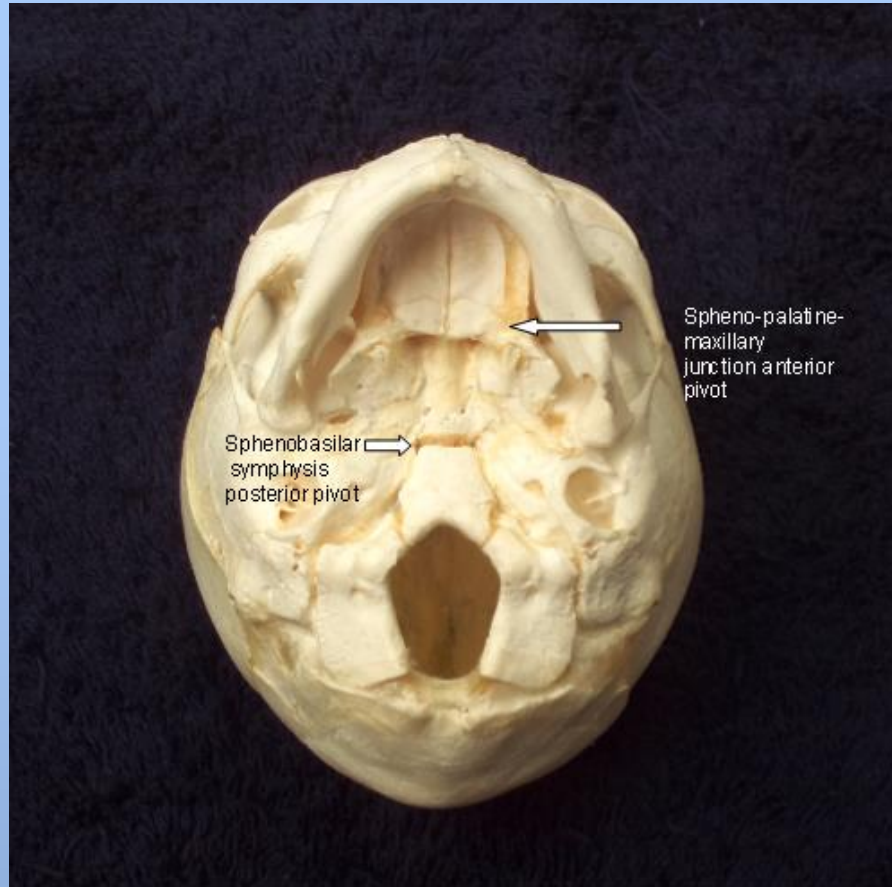
# Superior Vertical Strain



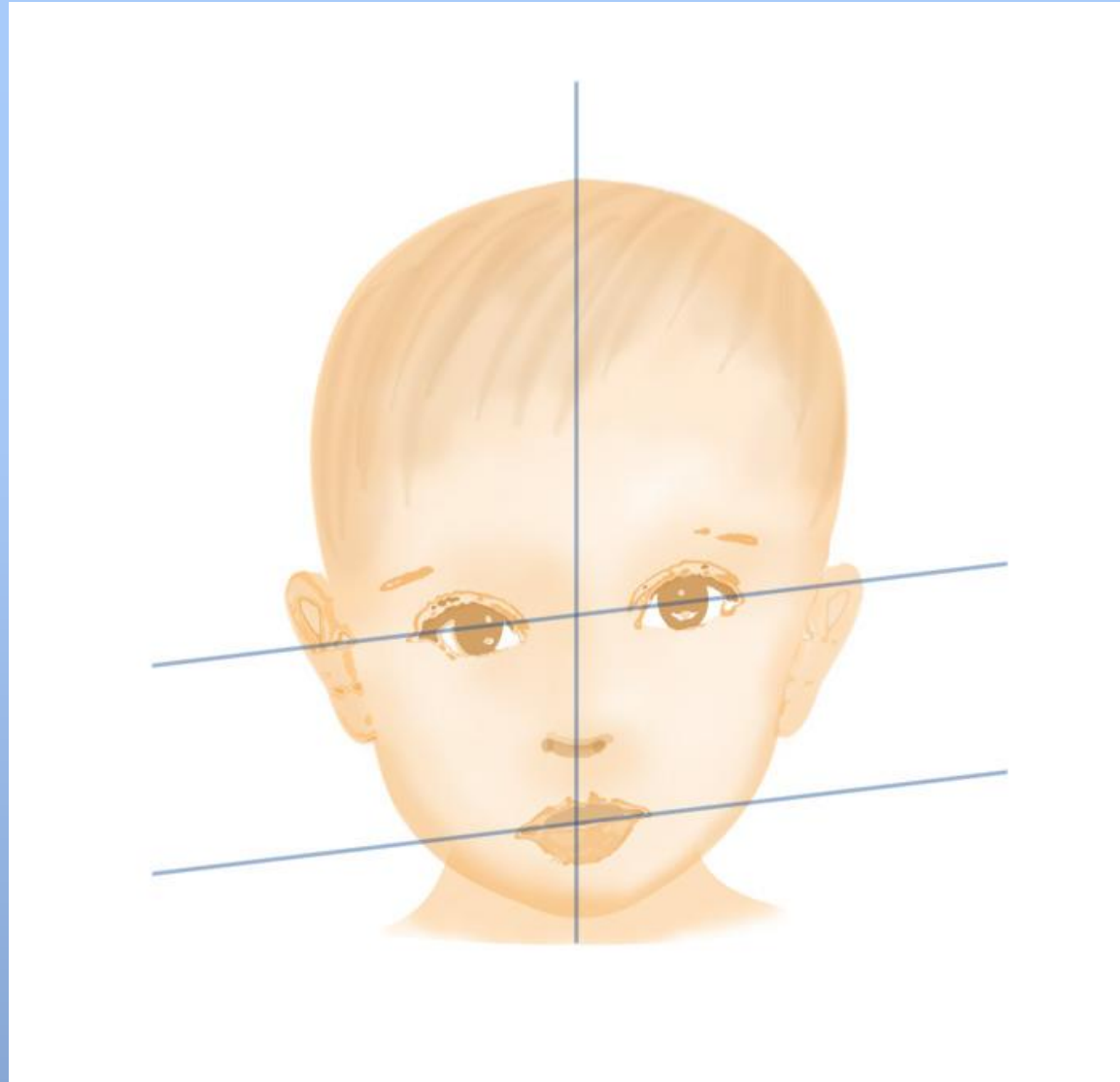
# Superior Vertical Strain Correction



# Skull Pivots

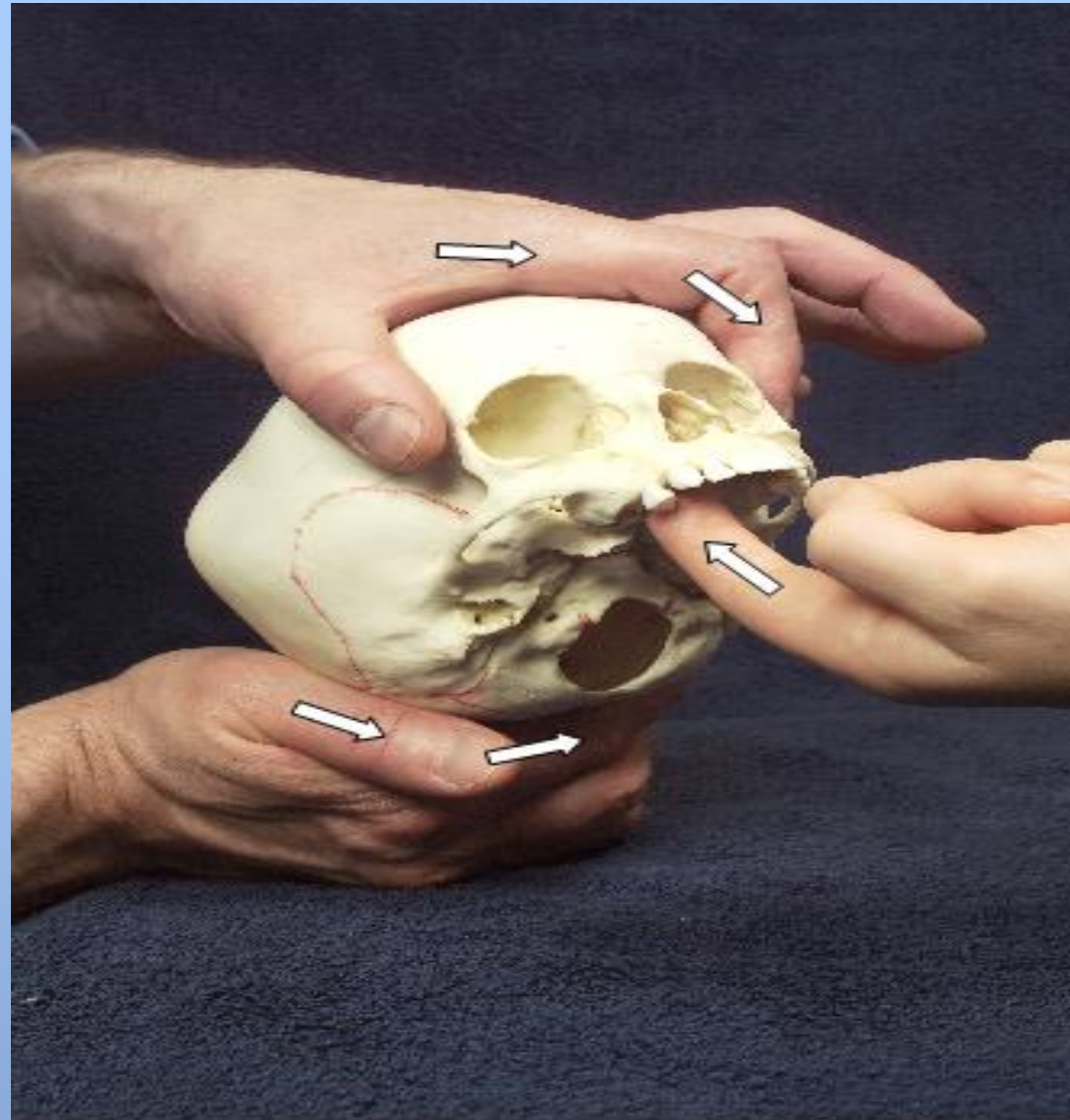


# Right Torsion



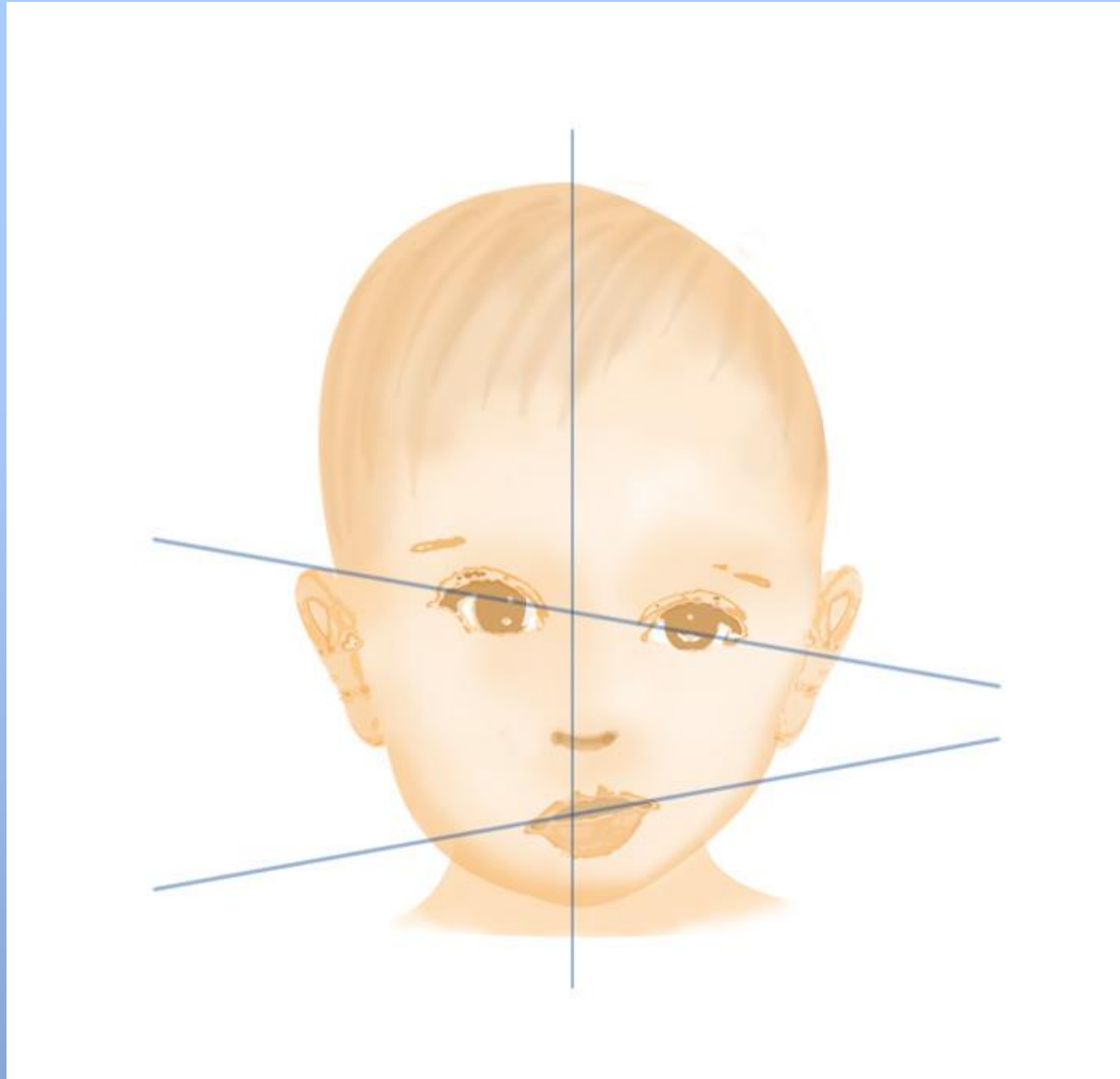


# Right Torsion Correction

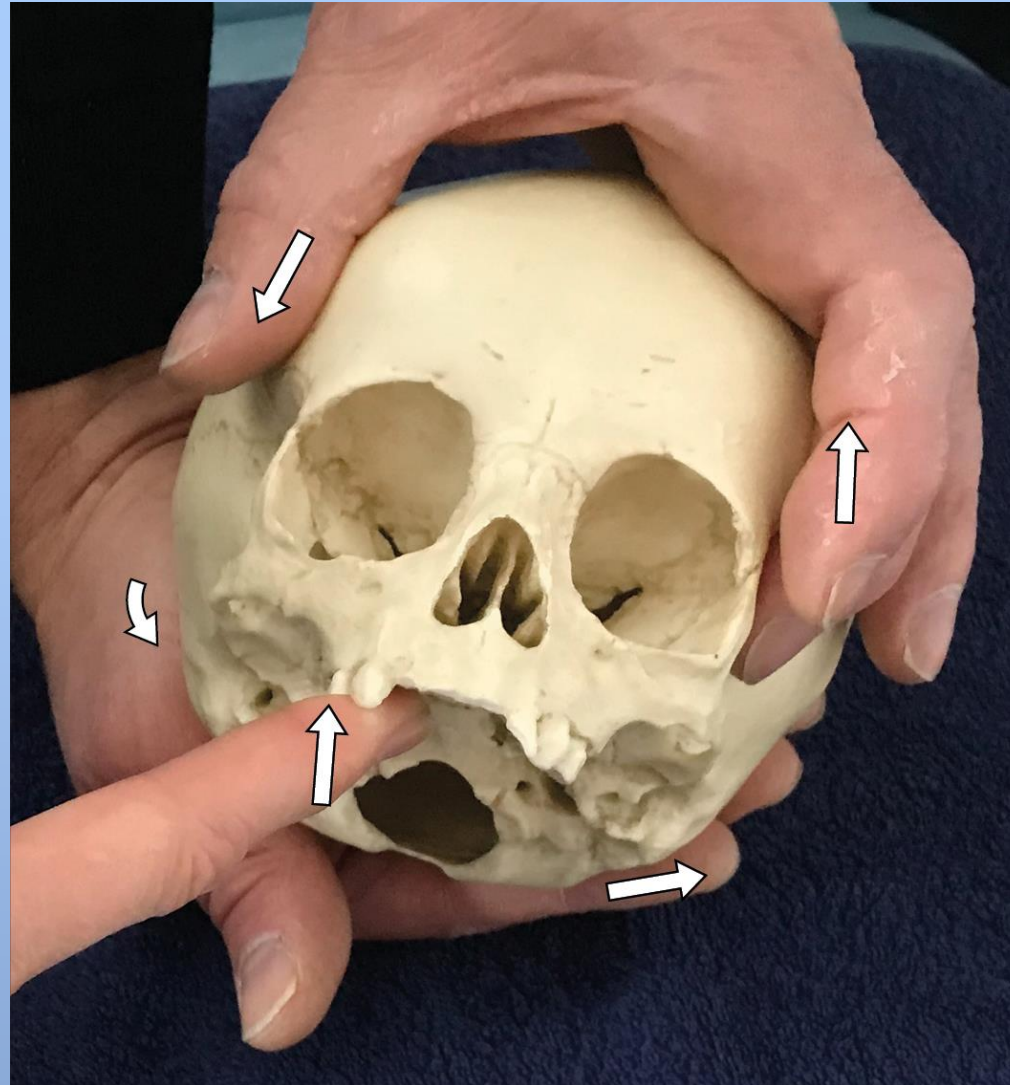




# Left Side Bend (Fan)



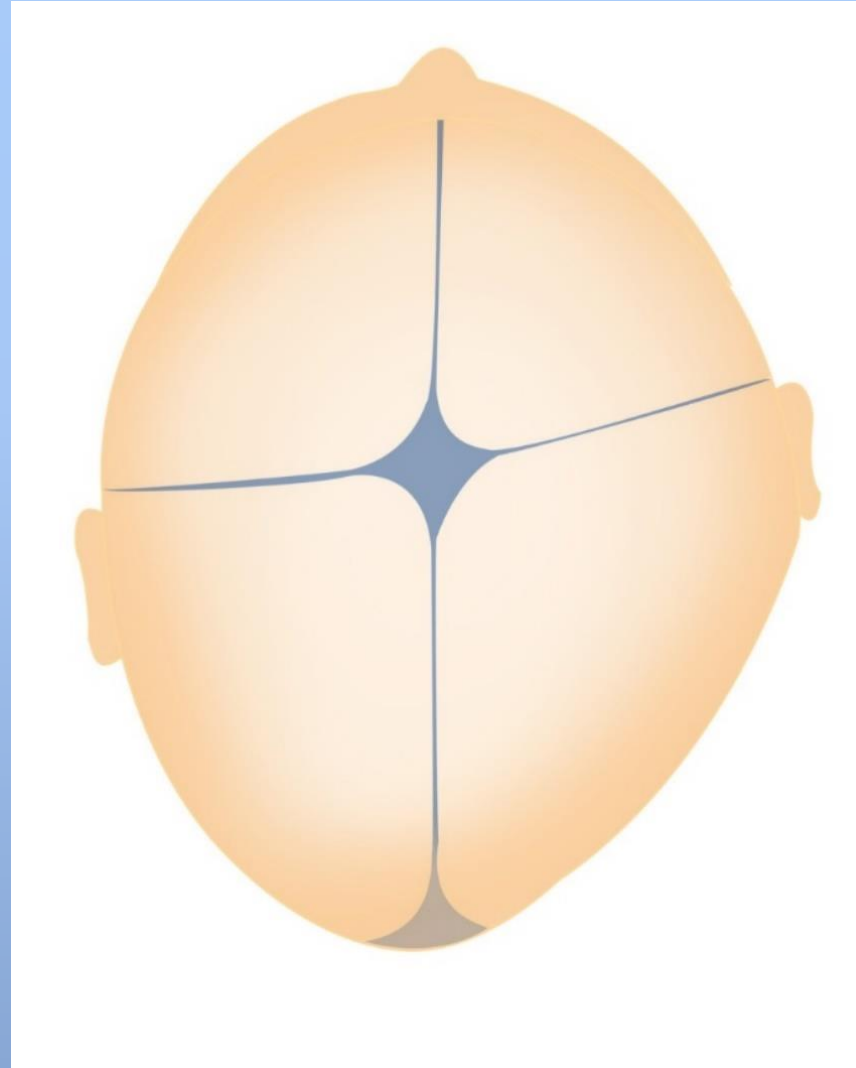
# Left Side Bend Correction



# Fan Pre/Post Correction



# Plate Strain - Posterior Deformational Plagiocephaly





# Plate Strain Correction







# Home Rx

- Mums to keep infants on them for much of the day for the 1<sup>st</sup> 6 months
- Sleep repositioning
- Tummy time
- Approach the baby from the opposite side to the flattening
- Prone infant on fit ball, roll head towards the ground and the infants head should extend.....start with a minute or two and increase...tummy time on steroids!!!

# Home Rx Co-Sleeping

- Infants who co-sleep (breastsleep) spend more than 50% of their time side sleeping McKenna et al Pediatrics 1997 Aug;100(2):214-9
- Babies who co-sleep have higher active sleep-higher muscle tone and more arousals
- Mothers reposition the infant even in their sleep
- Much less time is spent supine Renz- Polster and de Bock [Evol Med Public Health](#). 2018; 2018(1): 180–185.

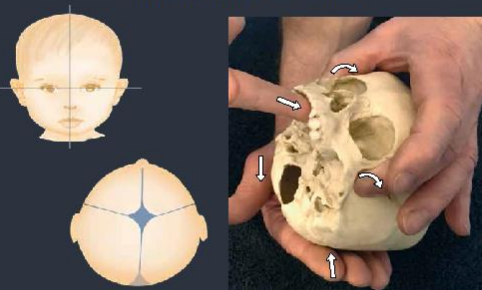
<https://www.nhs.uk/conditions/baby/caring-for-a-newborn/reduce-the-risk-of-sudden-infant-death-syndrome>

- If you share a bed with your baby (co-sleeping), you should:
- make sure they sleep on a firm, flat mattress lying on their back
- not have any pillows or duvets near them
- not have other children or pets in the bed at the same time
- It's important not to share a bed with your baby if they had a low birthweight (less than 2.5kg or 5.5lb) or if you or your partner:
- smoke (no matter where or when you smoke and even if you never smoke in bed)
- have had 2 or more units of alcohol
- have taken recreational drugs
- have taken medicine that causes drowsiness

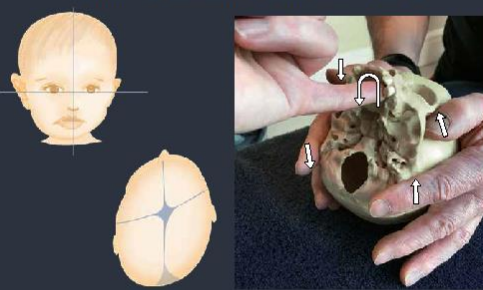
# Cranial Strain Corrections

## Chiropractic Cranial Corrections

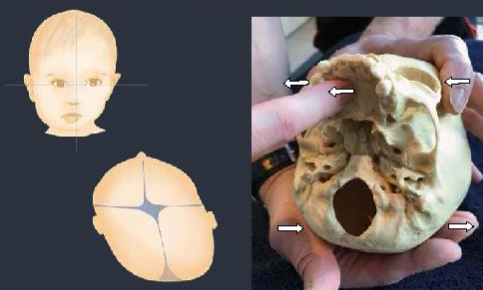
Flexion Strain Correction



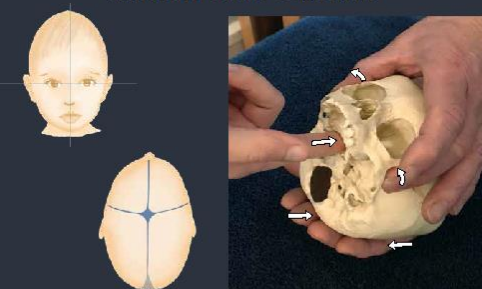
Anterior Posterior Strain Correction



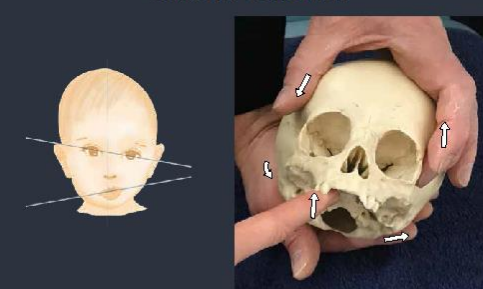
Lateral Strain Correction



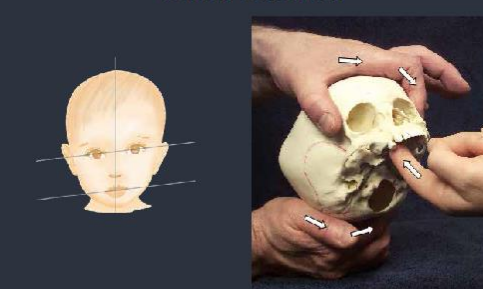
Extension Strain Correction



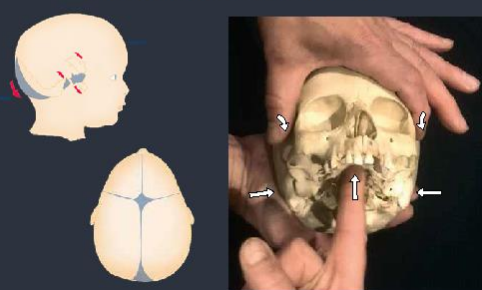
Sidebend Correction



Torsion Correction



Inferior Vertical Strain Correction



Superior Vertical Strain Correction

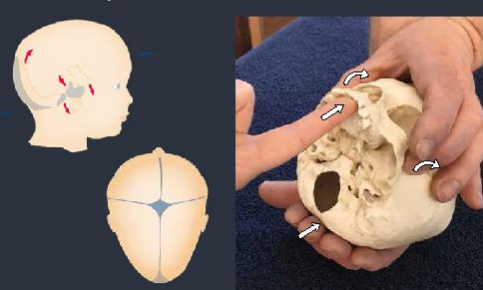


Plate Strain Correction

