ISUOG Basic Training

Distinguishing Between Normal & Abnormal Appearances of the Skull & Brain

Learning objectives

At the end of the lecture you will be able to:

- Describe how to obtain the 3 planes required to assess, including measuring, the fetal head correctly
- Recognise the differences between the normal & most common abnormal ultrasound appearances of the 3 planes of the fetal brain

The 20 + 2 planes

Anatomical area	Plane	Description
Overview 1	Sweep 1	Longitudinal head & body for initial orientation
Spine	1 2 3	Sagittal complete spine with skin covering Coronal complete spine Coronal section of body
Head	4 5 6	Transventricular plane* Transthalamic plane* Transcerebellar plane*
Thorax	7 8 9 10	Lungs, 4 chamber view of heart Left ventricular outflow tract (LVOT) Right ventricular outflow tract (RVOT) & crossover of LVOT 3 vessel trachea (3VT) view of heart

* measurement required

Requirements from each plane

Plane	Description	Structures to be evaluated[2,3,4]	Measurement[1,2] & criteria for referral	Abnormalities that can be excluded from the normal appearances of the section
4	Transventricular plane	Skull shape, size, integrity & bone density Cavum septum pellucidi (CSP) Frontal/anterior horns of both lateral ventricles Posterior horn (PH) of lower lateral ventricle	PH, Refer if PH >10mm	Anencephaly Lemon shaped skull (open spina bifida) Ventriculomegaly Alobar holoprosencephaly
5	Transthalamic Plane	Frontal horns of both lateral ventricles CSP Thalami Hippocampal gyruses	BPD HC, refer if outside normal range of size chart	
6	Transcerebellar Plane	Frontal horns of both lateral ventricles CSP Thalami Cerebellum Cisterna magna (normal range 2.0 – 10.0mm)	TCD	Banana shaped/absent cerebellum (open spina bifida) Large cyst in posterior fossa Occipital encephalocoele Cystic hygroma Skin oedema

ISUOG Education Committee recommendations for basic training in obstetric & gynecological ultrasound, UOG, 2014, 43(1): 113-116
Practice guidelines for performance of the routine midtrimester scan, UOG, 2010, 13(1), 116-129.
Sonographic examination of the fetal central nervous system, UOG, 2007, 29(1): 109-116
ISUOG Practice Guideline (updated): sonographic screening examination of the fetal heart, UOG, 2013, 41 (1): 348-359.

Moving through the 20 planes

Plane	Description
1	Sagittal complete spine with skin covering
2	Coronal complete spine
3	Coronal section of body
4	Transventricular plane*
5	Transthalamic plane*
6	Transcerebellar plane*
7	Lungs, 4 chamber view of heart
8	Left ventricular outflow tract (LVOT)
9	Right ventricular outflow tract (RVOT) & crossover of LVOT
10	3 vessel trachea (3VT) view of heart

* measurement required

From plane 1 or 2 to 4 - rotate through 90^0
From plane 4 to 5 – (rotate &) slide minimally
From plane 4 to 6 - rotate

Imaging the head – the three planes - technique

1. Identify cervical spine & occipital junction in sag plane
2. Rotate probe 90^0 & identify the cranial vault
3. Gently angulate probe to identify plane 4 (transventricular) & plane 5 (transthalamic)
4. Gently rotate probe towards occiput for plane 6 (transcerebellar) – ensure CSP is also seen anteriorly

Planes 4, 5, & 6

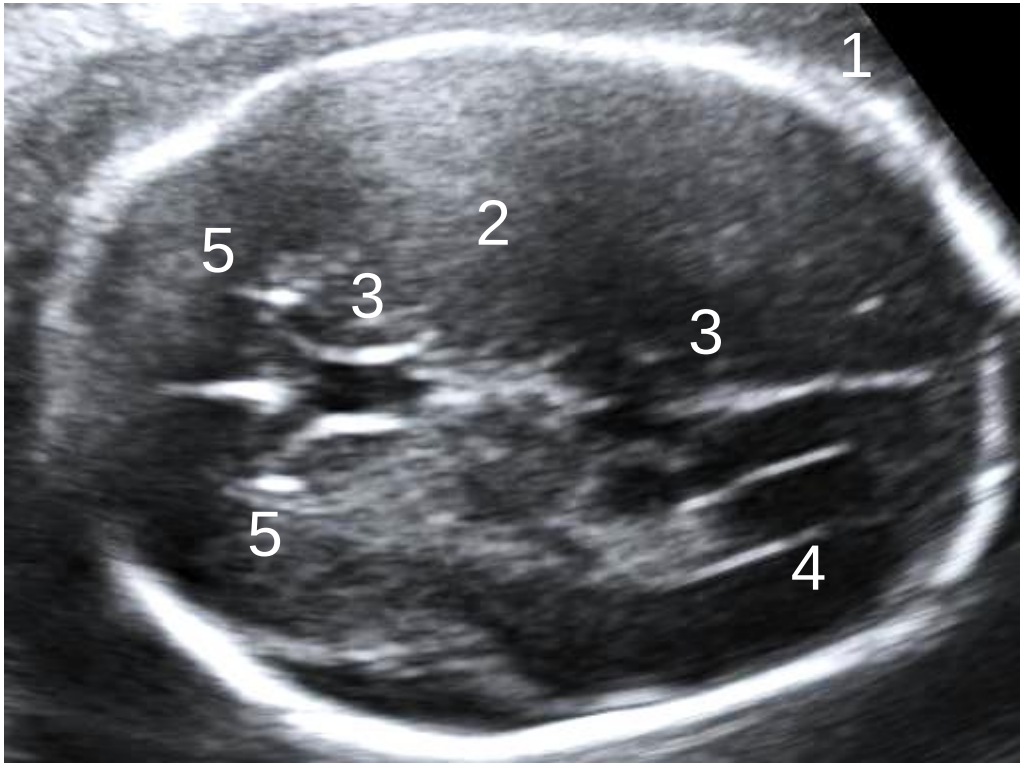
From plane 4 to 5 – (rotate &) slide minimally

From plane 4 to 6 - rotate

From plane 1 or 2 to 4 –
Identify junction of cervical spine & occiput
Rotate through 90^0

Plane 4 (transventricular)

The most cephalad of the three planes



1. **Integrity**: intactness of skull

2. **Bone density**: poor visualization of near field

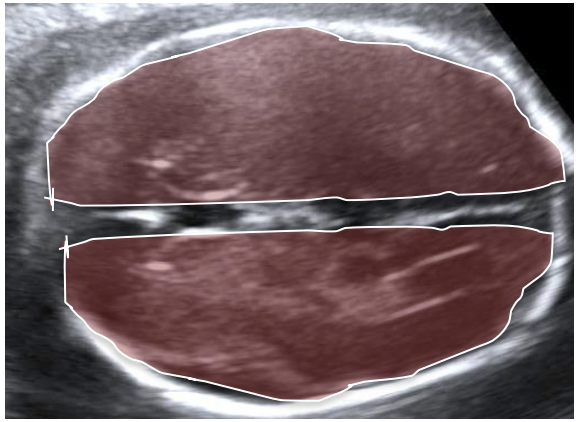
3. **Falx**: interrupted by CSP

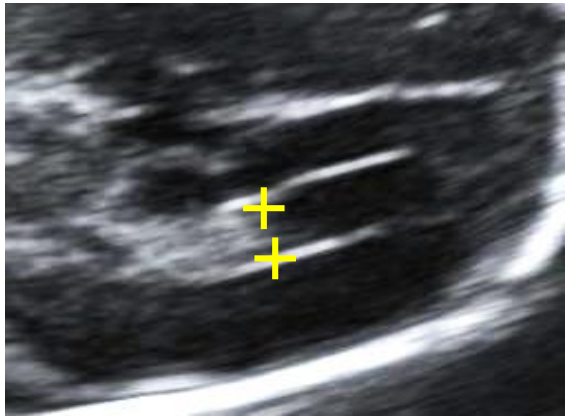
4. Occipital / posterior horn of lower lateral ventricle

5. Frontal horns of **both** lateral ventricles

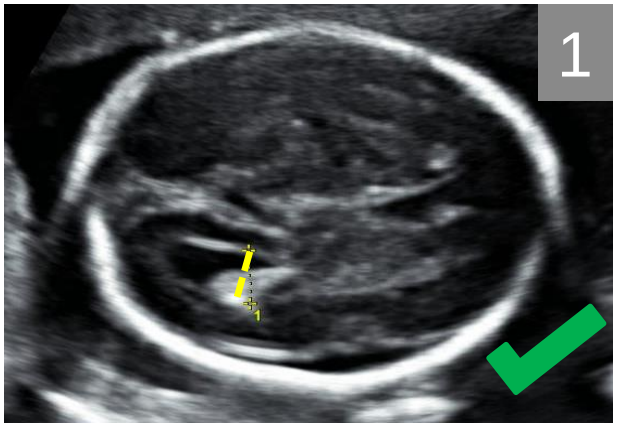
Atria of the lateral ventricles – measurement technique

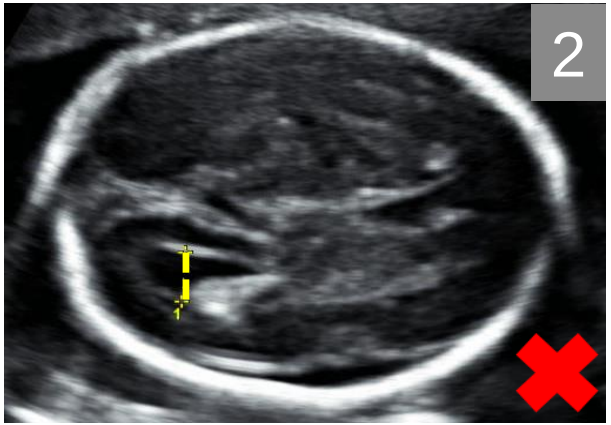
- Symmetrical axial view / optimal zoom
- Atrium measured at the level of the glomus of the choroid plexus, opposite the parieto-occipital sulcus
- Calipers placed touching the inner edges of the ventricle wall, at its widest part, aligned perpendicular to the long axis of the ventricle

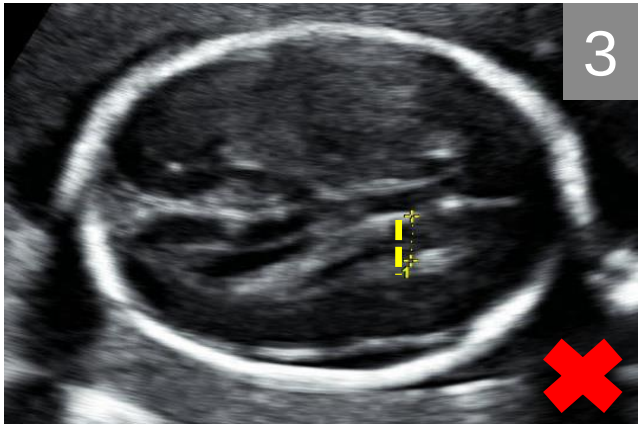




Measurement of the atria of the lateral ventricles

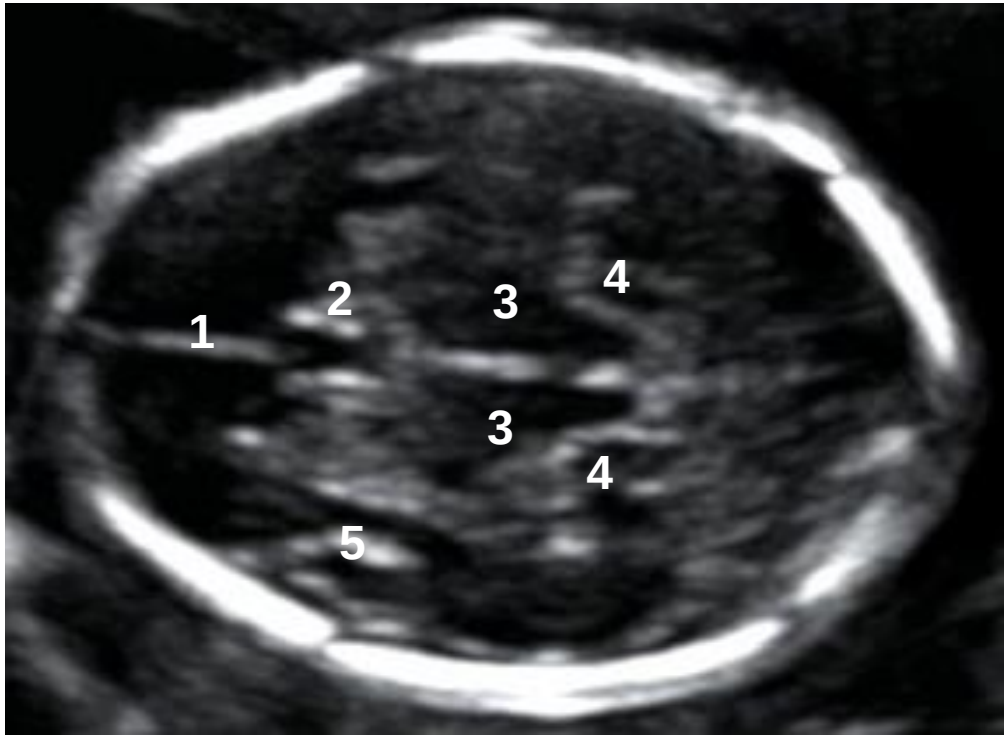






- Normal ventricle atrium (VA) < 10 mm
- Refer if VA measurement > 10 mm

Plane 5 (transthalamic) - anatomical landmarks



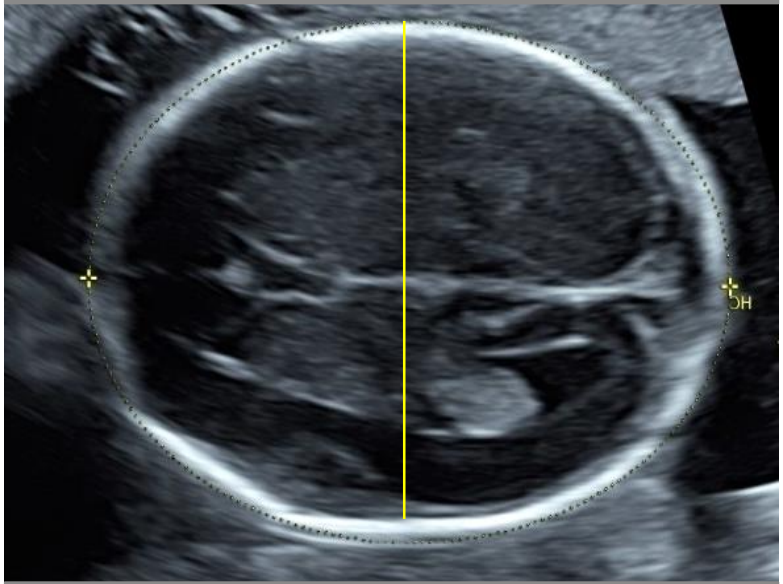
1. Midline falx
2. CSP
3. Both thalami in apposition & separated by falx
4. Hippocampal gyri
5. Lateral sulcus

Cranial biometry – BPD & HC

1. Transventricular plane
2. Angle of insonation 90^0 to midline echoes
3. Symmetric hemispheres
4. Falx with CSP & thalamus

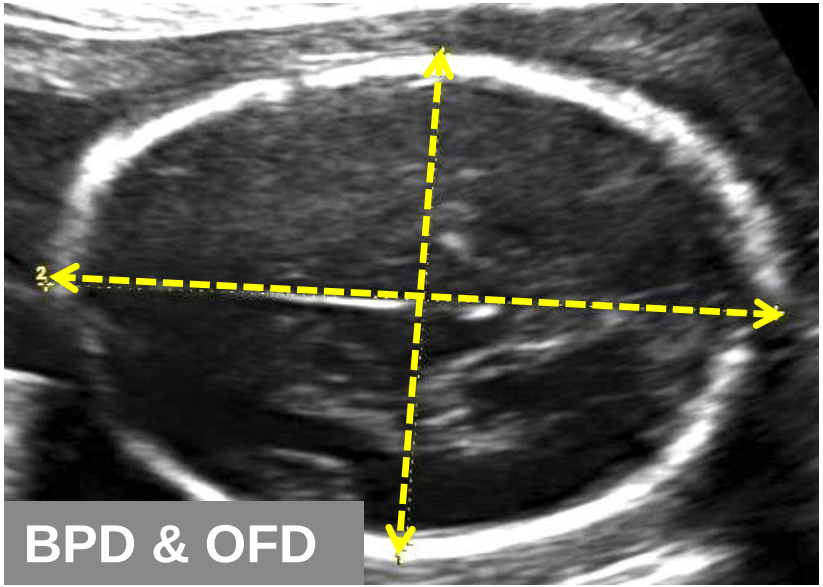
Cerebellum should **NOT be** visualised

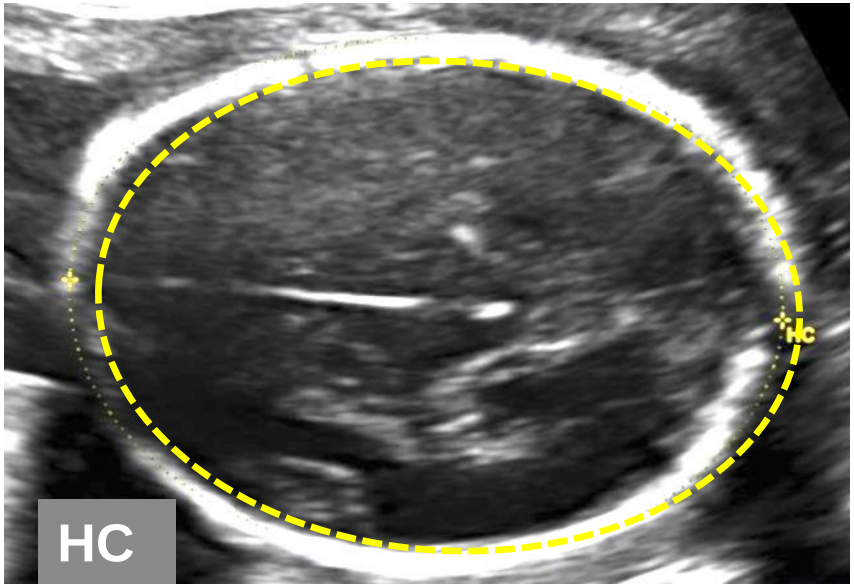
Calipers: outer to inner



Use appropriate charts

Cranial biometry – BPD & HC





- Cephalic index = BPD (outer to outer) /OFD X 100
- Normal = 75-85
- < 75 - dolichocephaly
- >85 - brachycephaly

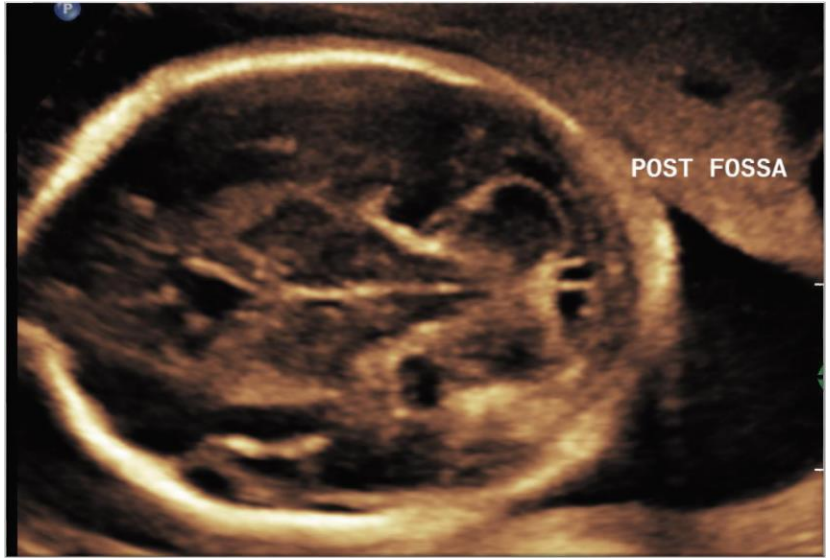
HC chart

Gestational Age (Weeks)	Head Circumference (mm) by Percentile								
	2.5	5	10	25	50	75	90	95	97.5
14	86	88	91	95	100	104	107	110	112
15	97	99	102	106	111	115	119	122	124
16	108	111	114	118	123	128	132	134	137
17	120	123	126	130	135	140	144	147	149
18	132	135	138	143	148	153	157	160	162
19	145	147	150	155	161	166	170	173	175
20	157	159	163	168	173	179	183	186	188
21	169	172	175	180	186	191	196	199	201
22	181	184	187	193	198	204	209	212	214
23	193	196	199	205	210	216	221	224	227
24	204	207	211	216	222	228	233	236	239
25	215	218	222	227	233	239	245	248	251
26	225	228	232	238	244	250	256	259	262
27	234	238	242	248	254	261	267	270	273
28	243	247	251	257	264	270	277	280	283
29	251	256	260	266	273	280	286	290	293
30	259	264	268	274	281	288	295	299	302
31	266	271	275	282	289	296	303	307	311
32	273	278	282	289	296	304	311	315	318
33	279	284	289	295	303	311	318	322	326
34	285	290	295	302	309	317	324	328	332
35	291	296	300	307	315	323	330	335	338
36	296	301	306	313	321	329	336	340	344
37	302	306	311	318	326	334	341	345	349
38	307	311	315	324	332	339	347	350	354
39	313	316	320	329	337	344	352	355	359
40	319	321	325	334	342	350	357	360	363

doi:10.1371/journal.pmed.1002220.t007

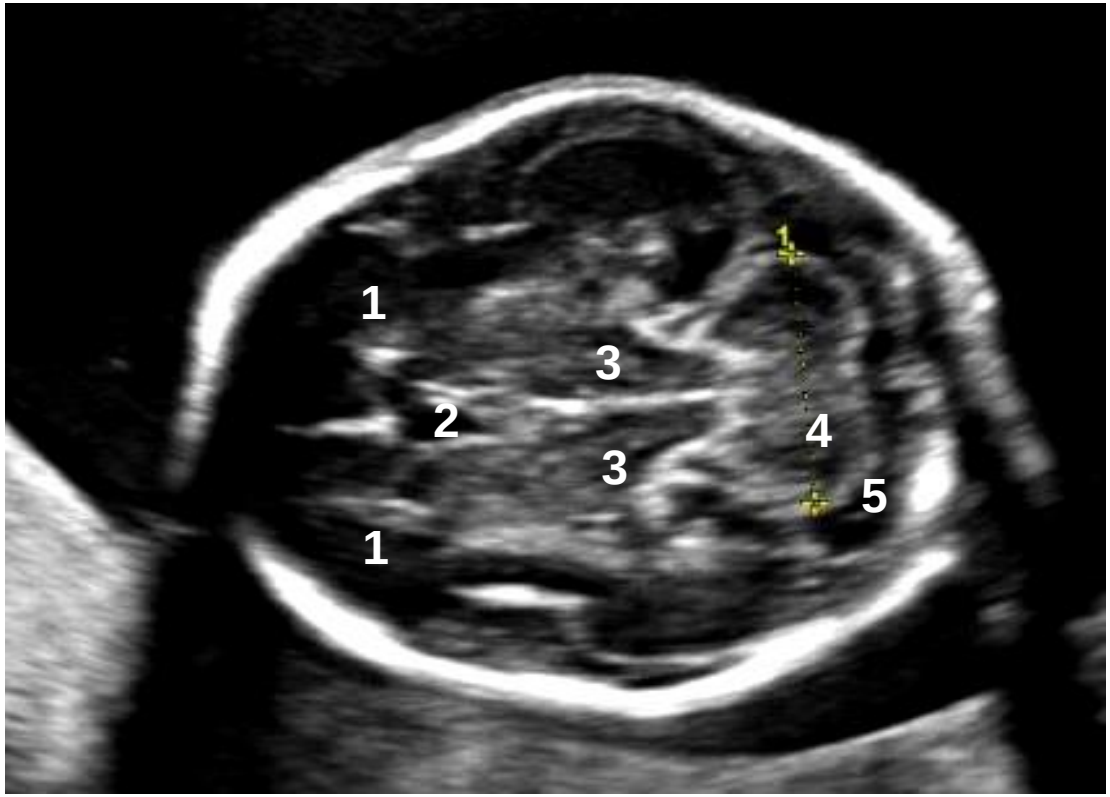
- Use standard reference charts
- Refer if HC outside normal range for period of gestation

Cranial biometry – cerebellar diameter
Key points



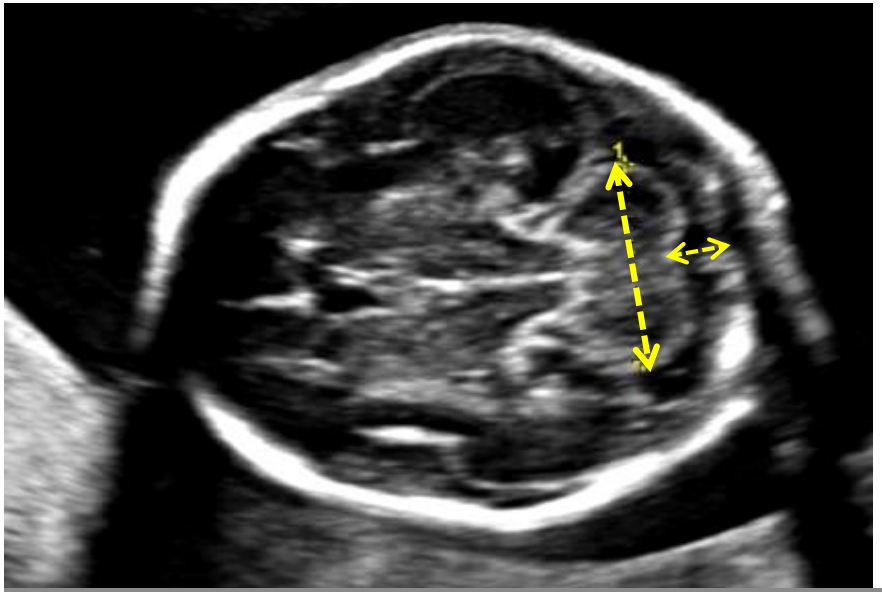
- Ensure complete visualisation of cerebellum
- Ensure anatomical landmarks – avoid steep angulation

Plane 6 (transcerebellar)



1. Frontal horns of both LV
2. CSP
3. Thalami
4. Cerebellum
5. Cisterna magna

Plane 6 (transcerebellar) biometry



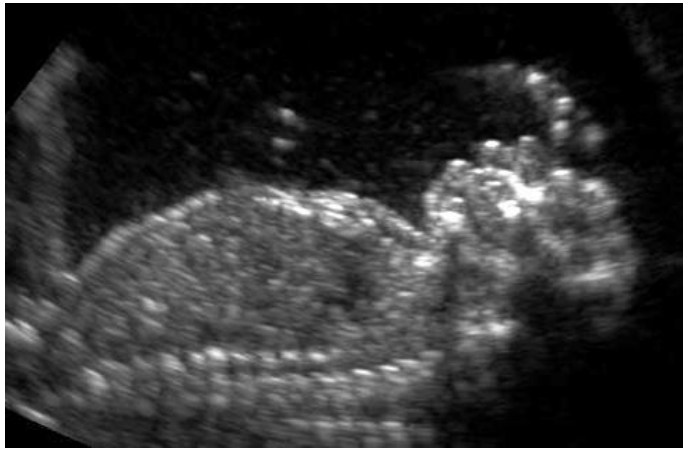
- TCD – maximum diameter in the correct plane
- Cisterna magna – outer edge of vermis to inner edge of occipital bone (normal range 2-10 mm)

Refer if:

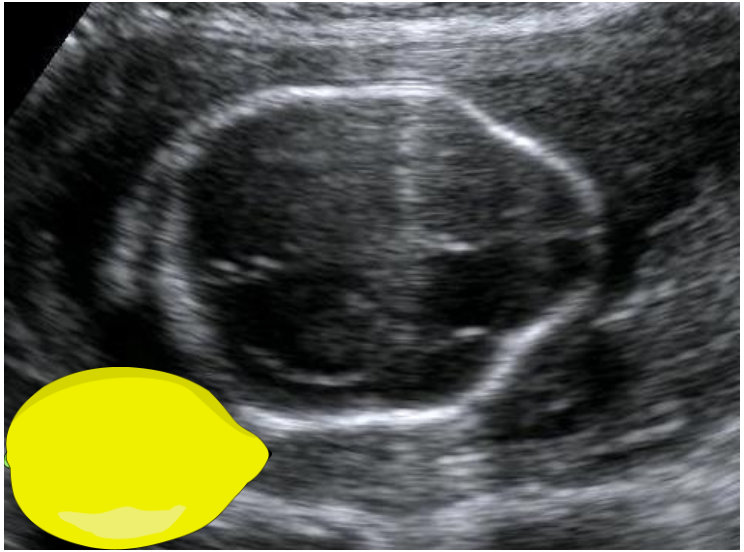
- TCD < 5th centile for period of gestation
- Cisterna magna > 10.0mm
- Cerebellar hemispheres appear separated

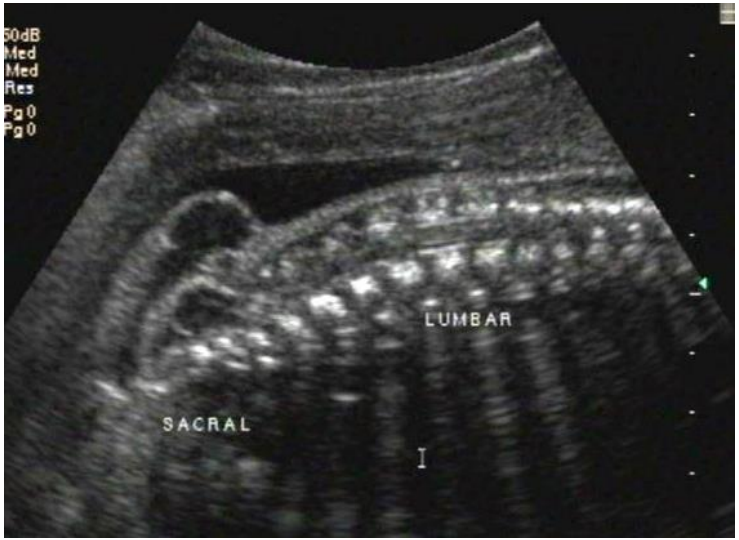
Common abnormalities that can be excluded from planes 4 (tranventricular), 5 (transthalamic), & 6 (transcerebellar)

The cranial vault - anencephaly

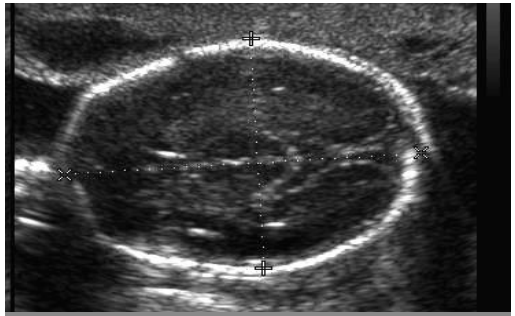


The cranial vault
‘lemon’ sign of open NTD





Other head shapes



Dolicocephaly

Brachycephaly

Strawberry

Clover leaf

Poor mineralisation of skull – reduced bone density
Osteogenesis imperfecta

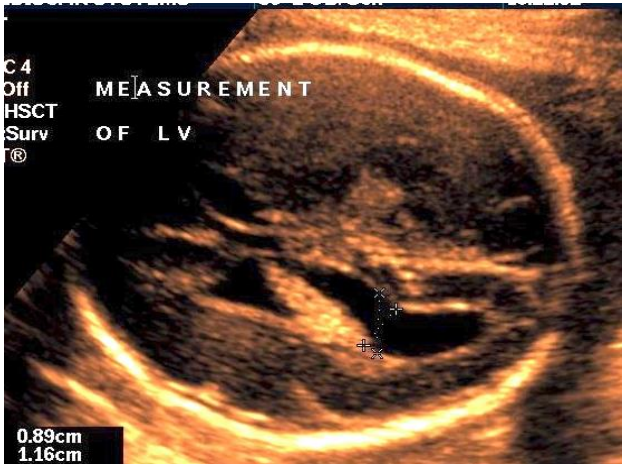
Normal skull

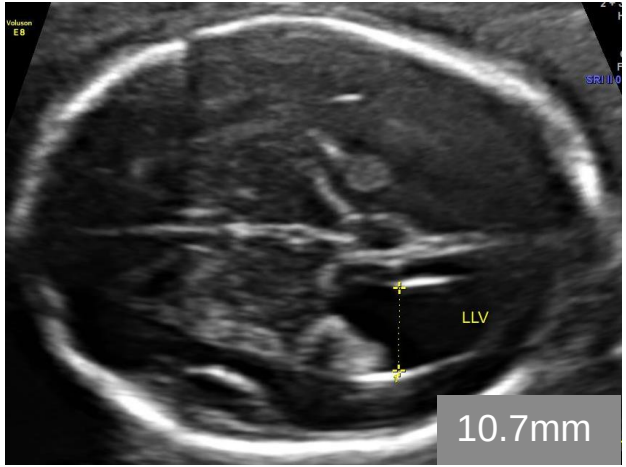
Poor near field visibility

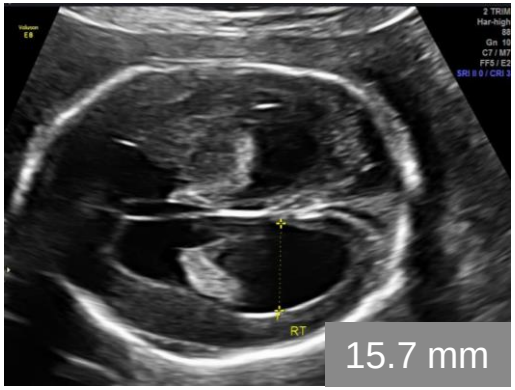
The cranial vault, skull integrity - encephalocoeles

- Can occur anywhere
- Most commonly occipital
- Meningocele / meningo-encephalocele
- Vary in size

Transthalamic & ventricular planes - ventriculomegaly



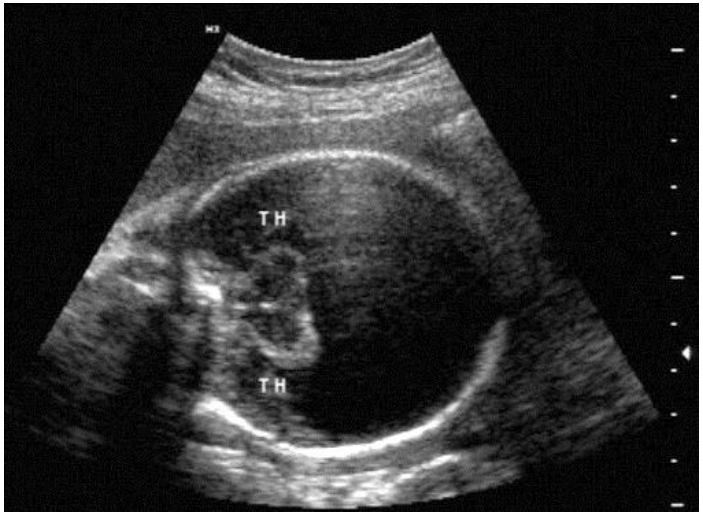


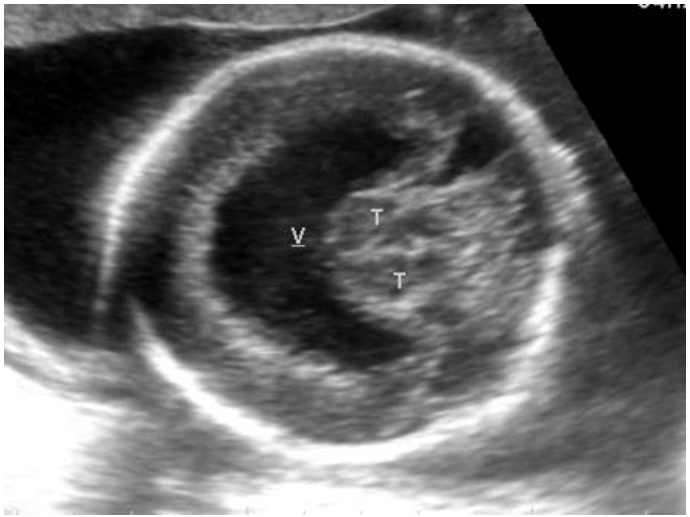


Refer if:

- Atrium of the lateral ventricle >10 mm
- Ventricular “tear drop” shape (colpocephaly) in agenesis of the corpus callosum (ACC)

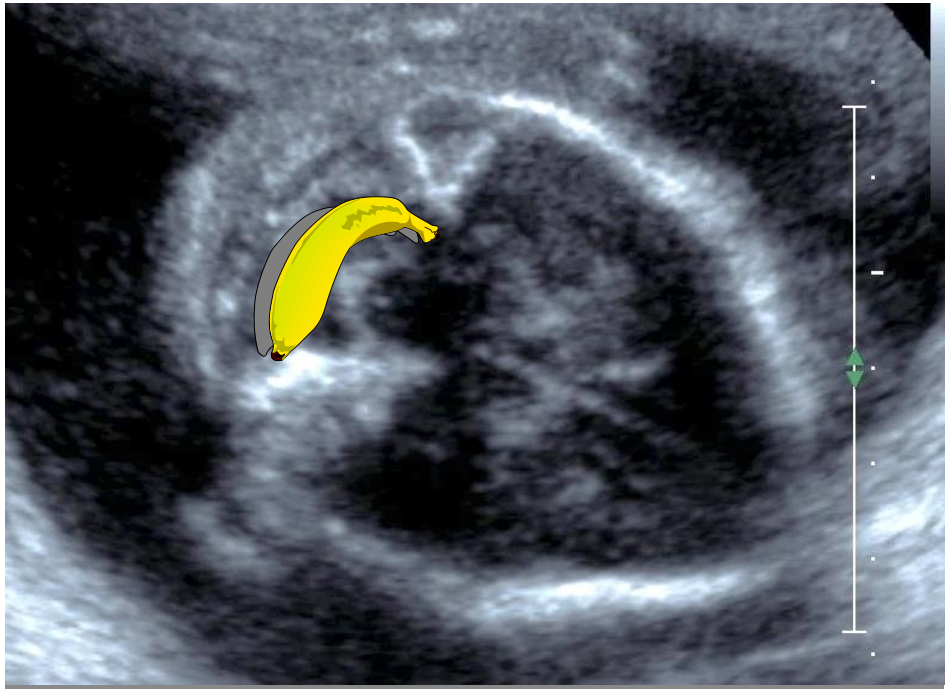
Holoprosencephaly





- Three types – alobar most severe
- Associated anomalies may be present
- Refer if midine falx not visualized & ventricles are fused

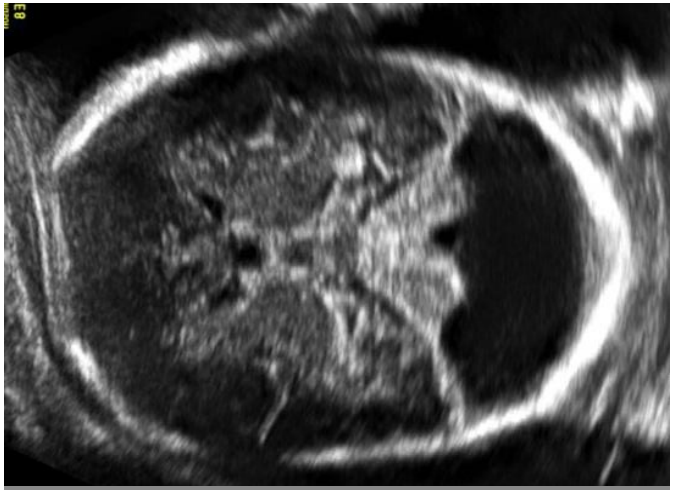
Trans cerebellar plane anomalies



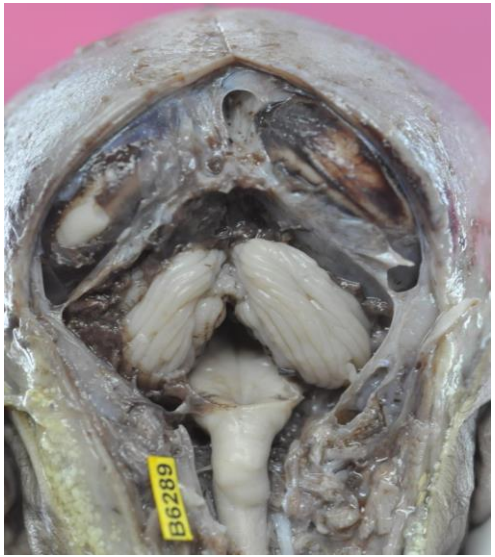
Banana shaped cerebellum in open spina bifida

Mega cisterna magna = cisterna magna > 10 mm

Trans cerebellar plane anomalies

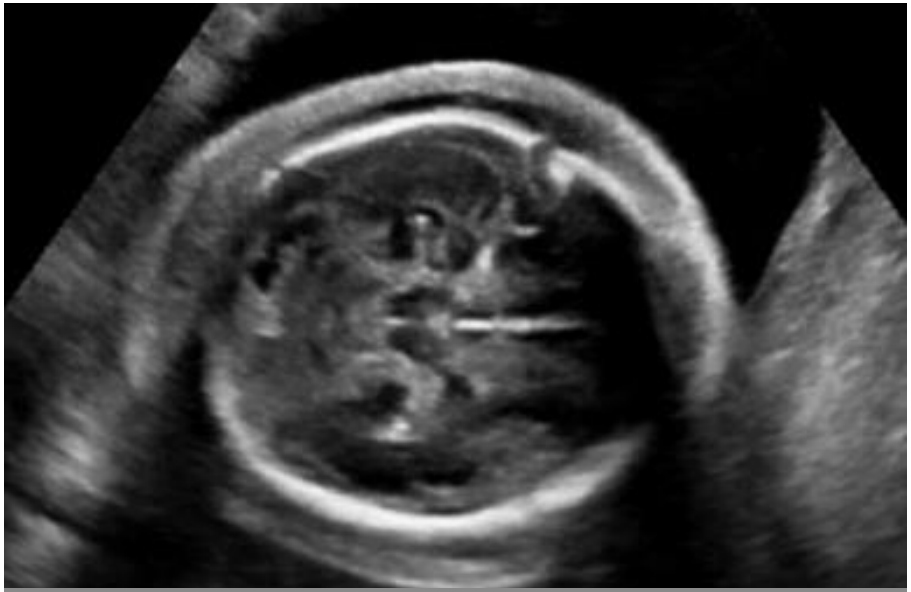


Dandy Walker malformation



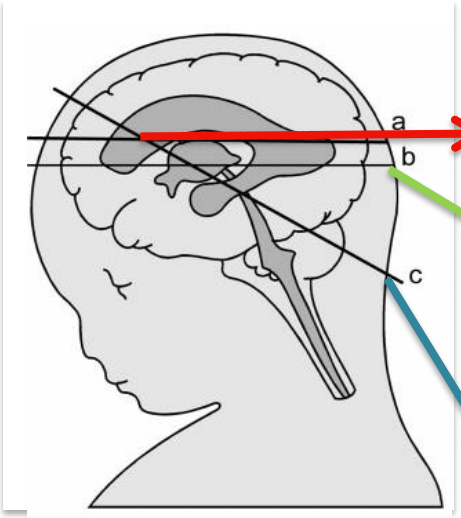
Trans cerebellar plane anomalies

Cystic hygroma



Oedema – hydrops

Key features of planes 4,5,6



Plane 4 Transventricular

Skull , Falx, CSP, LV

Anencephaly
Encephalocele
Alobar holoprosencephaly
Ventriculomegaly

Plane 5 Transthalamic

Biometry: BPD, OFD, HC

Plane 6 Transcerebellar

Biometry: TCD Cerebellum/ cerebellar vermis

Post fossa cyst
Mega cisterna magna
Cystic hygroma
Scalp oedema

Key points

1. The head is imaged in three planes – transventricular, transthalamic plane & transcerebellar planes
2. It is important to identify the specific landmarks
3. Any variation in the appearances should raise suspicion of an anomaly
4. Lateral ventricle > 10 mm, cisterna magna > 10 mm – refer
5. HC < 5th centile / > 95th centile – refer
6. TCD < 5th centile, or altered shape – refer