

The maternofoetal anatomy and pathology biology essay

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The 11-14 week scan is performed mainly to determine foetal viability, detection of multiple pregnancies and the chorionicity, assess the gestational age, and nuchal translucency measurement (Borruto F. et al 2002, pg. 235).

The main features assessed during this scan are: Gestational sac –The gestational sac is usually located either in the mid or upper uterine cavity, where the embryo implants. The gestational sac is an anechoic structure of the extraembryonic coelom/chorionic cavity with an echogenic rim of the cytotrophoblasts, and assessment of its mean sac diameter is performed for evaluating early embryonic development and pregnancy outcome (Levine 2007, pg. 387). Irregular appearing gestational sac can indicate abnormalities of the uterine cavity such as fibroids, contractions, or blood collections (Graham III 2010, pg. 17). First trimester is considered the best time to diagnose twin pregnancies and assess the chorionicity and amnionicity by visualising the yolk sacs (Lee et al 2006, pg. 864).

Establishing zygosity of the twins is essential for tissue and organ transplantation (Moore and Persaud 2003, pg. 148). Ectopic pregnancies can be identified through position of gestational sac, and in such a case, tubal rupture and other maternal abdominal pathology should be assessed for (Nicolaidis K 2004, pg. 46). Crown Rump Length (CRL) –Crown rump length is the main and most reliable sonographic indicator of the gestational age. The estimation of CRL is essential for estimating sensitivity to teratogenic agents, clinical management and before performing invasive procedures such as chorionic villus sampling and amniocentesis (Moore & Persaud 2003, pp. 90-91). Assessment of intrauterine growth is also possible through the CRL and amnion measurements, since the foetus growth is most rapid

between weeks 9 to 12. Foetal heart rate (FHR) –FHR is indicative the foetal viability. Heart is functional from early week 6 and heart rate successively increases until week 11-14 and then ranges from 170 -150 bpm. Foetal tachycardia, bradycardia or tachyarrhythmia can thus be assessed. Nuchal translucency (NT) –NT visualises the subcutaneous collection of fluid behind the foetal neck, which is best performed at 11-14 weeks gestation (Brizol et al 2001, p. 653). Increased NT thickness may indicate foetal chromosomal abnormalities such as Trisomy 13, 18 or 21, structural abnormalities and genetic syndromes (Souka A et al 1998, pg. 392). Also, increased NT indicates increased risk of major congenital cardiovascular defects, along with assessment of the ductal flow with Doppler (Nicholais 2002, pg. 309). Increased risk of congenital diaphragmatic hernias and skeletal dysplasia is also identified (Guariglia, Rosati 2000, pg. 330). Accurate NT and CRL measurement are essential to proceed with further diagnostic examinations such as amniocentesis and even termination of pregnancy. Maternofetal anatomy and pathologyThe uterus and the adnexa also should be thoroughly examined and be systematically assessed for any fibroids or masses and gestational trophoblastic disease (Brown et al 2004, pg. 343). Implantation may cause bleeding anatomically or pathologically, and intrauterine blood collection should be assessed to differentiate between the two (Graham 2010, pg. 20). The placenta position may be reviewed for any placental abnormalities and to ensure that two umbilical arteries and one umbilical vein are present. The vascularity assessment is essential as it may indicate underlying pathologies, such as Single umbilical artery being associated with Trisomy 13 or 18 (Odibo et al 2011, pg. 231). The size of corpus luteum is

also assessed since its function is essential in preventing spontaneous pregnancy loss (Usadi et al 2008, pg. 4058). Other foetal features Since the ossification of the skull is complete by week 12, biparietal diameter, interhemispheric fissure and developed choroid plexus of fourth ventricle should be assessed for cranial development and pathologies such as anencephaly, acrania, encephalocele or any other neural tube defects (Imbruglia et al 2009, pg. 44) (Zhang et al 2013, pg. 3). The midgut herniation that occurs in week 6 is usually reduced by week 10 and should be fixated in the abdomen by the 11-14 week scan. Failure of midgut hernia reduction may result in congenital omphalocele or umbilical hernia (Moore & Persaud 2003, pg. 272). The metanephroi or the kidneys start functioning and contributing urine to the amniotic fluid by week 9. Oligohydramnios visualised on ultrasound may indicate renal agenesis, dysplasia, urinary tract obstruction and other renal pathologies (Nyeberg et al 2003, pg. 832). Polyhydramnios may indicate central nervous system anomalies or oesophageal atresia (Moore & Persaud 2003, pg. 139).

18-20 week Morphology scan

The morphology scan is ideal at 18-20 weeks due to favourable amount of amniotic fluid providing an ideal acoustic window for clear visualisation of functional anatomy and physiology of the foetus (Fuchs et al 2007, pg. 39). The following are the essential areas to be assessed, some of which are rechecking from the 11-14 week scan. 1. Fetal Number is generally and accurately assessed in 1st trimester scan. The leading twin must be identified in case of twin to twin transfusion syndrome. 2. Fetal Cardiac Activity is to determine foetal viability 3. Gestational Age is usually

determined from the 1st trimester scan⁴. Placenta Localisation: Placenta should be identified as either clear, low or covering. However, placental position may change and placental abnormalities such as placenta previa, accreta or percreta can not be accurately diagnosed until third trimester (Baughman et al 2008, pg. 1906). 5. Amniotic Fluid Volume: Oligohydramnios or polyhydramnios may indicate presence of pathologies as explained earlier. 6. Detection and evaluation of maternal pelvic masses⁷. Fetal anatomy including: a. Head i. Falx ii. Skull Bones iii. Ventricles iv. Choroid Plexus v. Cerebellum/Vermis The biparietal diameter of the head should be measured to assess adequate development of the cranial features and brain (Behrman R 2007, pg. 63). Any abnormalities may indicate cranial pathologies as mentioned earlier. b. Face i. Orbits - Essential in diagnosing pathologies such as anophthalmus, hypertelorism, etc. and may indicate underlying chromosomal abnormalities (Goldstein et al 2005, pg. 1230). ii. Nose - Indicative of Trisomy 21 iii. Jaw iv. Lips - Failure of the cleft palate bone and tissues to fuse causes a cleft lip at week 14-16 and is clearly visualised at 18-20 week scan (Johnson et al 2000, pg. 237). c. Diaphragm Diaphragm should be fully developed, the pleuroperitoneal canals closed, the pleuroperitoneal membranes fused with the diaphragmatic components and should have undergone positional changes by week 12. Assessment of the crus of the diaphragm and the position aids in diagnosing pathologies such as the posterolateral defect of the diaphragm, congenital diaphragmatic hernia, lung hypoplasia, polyhydramnios (Moore & Persaud 2003, pg. 196). d. Cardiac i. Foetal Heart Monitor Doppler ii. 4 Chambers iii. Great Vessels Cardiac ultrasonography provides information about the function and

structure of the developed heart from week 17. Diagnosis of cardiac abnormalities such as ventricular septal defect, transposition of great arteries, tetralogy of fallot, pulmonary stenosis or atresia is essential in the viability of the foetus after birth. Doppler aids in assessment of cardiac dysrhythmias, suspected ventricular dysfunction, and abnormal wall thickness (Vettraino et al 2005, pg. 566).

e. Abdomeni.

Stomach

ii. Bladder

iii. Kidneys

iv. Abdominal Wall

The abdominal circumference is measured to estimate the embryonic growth. The development and rotation of the stomach and duodenum is complete by week 7 and failure in the same, causes pathologies such as pyloric stenosis or duodenal stenosis and atresia. The positional change of the kidneys occurs at by week 9 and failure to do so results in ectopic, malrotated, horseshoe or pelvic kidneys (Moore & Persaud 2003, pg. 296). All these pathologies may present along with polyhydramnios.

f. Spinei.

Ossification Centres

ii. Skin Line

The position of spinal cord in relation to the vertebral column varies throughout the pregnancy and thereafter. However, in cases of defects in the vertebral arches, the spinal cord or the meninges protrude out and pathologies such as spina bifida, meningocele are caused and associated meroanencephaly or anencephaly may be present. Assessment of neural tube defects is essential in assessing foetal mortality rate (Ghi et al 2006, pg. 901).

g. Extremities.

Upper Limb Including Humerus, forearm, hands and fingers, 5th finger middle phalanx.

ii. Lower limb including femur, lower leg, feet and toes. The foot length correlates well with the CRL and is an important indicator of embryonic growth (Moore and Persaud 2003, pg. 104). Thorough assessment is required to assess for amelia, meromelia, syndactyly and pathologies such

as talipes equinovarus. Oligohydramnios may be associated and could be the cause for vascular disruption and ischaemia causing some of the skeletal pathologies.

h. Umbilical Cord. Insertion- both foetal and placental

ii. 3 Vessels

iii. Amniotic Volume

The foetal insertion of the umbilical cord is usually the centre of the placenta (Rocha et al 2012, pg. 2). However, in velamentous cord insertion, the umbilical vessels diverge before reaching the placenta, increasing the foetal mortality rate. The assessment of foetal and placental insertion points of the umbilical cord aids in the decision of caesarean vs. natural birth and in assessing the risk factors involved (Hasegawa et al 2009, pg. 24). An overview of the embryological developments that occur prior to 11-14 weeks scan are listed as follows:

Gestational age

Embryological and foetal developments

Week 1 Superficial implantation of blastocyst into the endometrium completed

Week 2 Completion of blastocyst implantation and formation of bilaminar embryonic disc
Formation of chorionic cavity, yolk sac
Decidual reaction in the endometrium occurs

Week 3 Formation of trilaminar embryonic disc during gastrulation
Formation of primitive streak, notochord, neural tube, neural crest, somites, intraembryonic coelom, and chorionic villi
Formation of primordial cardiovascular system

Week 4 Folding of the embryo begins
Functioning of the primordial heart is initiated
Caudal neuropore is closed (Failure in the same causes neural tube defects)
Formation of complex vascular network between mother and the embryo
Formation of Septum Transversum - incomplete partitioning of pericardial and abdominal

cavities
Formation of primordial gut
Week 5
Rapid growth of brain
Formation of mesonephric kidneys
Week 6
Formation of skeletal system and lymphatic system initiated
Week 7
Herniation of intestines into the proximal part of the umbilical cord through extraembryonic coelom
Ossification of bones and upper limbs is initiated
Primordial mediastinum that extends from sternum to vertebral column is formed
Final relative length of oesophagus reached
Week 8
Ossification of lower limbs is initiated
External appearance of the embryo resembles human
Compression of the decidua capsularis and formation of smooth chorion occurs
Positional change of diaphragm
Week 9 -10
Head constitutes half the CRL
Liver performs erythropoiesis
Metanephri assume adult position and start functioning
Reduction of physiological midgut hernia
Week 11
Week 12
Spleen starts to perform erythropoiesis
Urinary system is formed and urine contributes to increase in amniotic fluid
Primary ossification centres appear in skeleton
Final relative lengths of upper limbs are reached
External genitalia of the foetus formed and visible on ultrasound
Chorionic villus sampling may be performed to detect chromosomal abnormalities
Between the two scan time points, the following significant developments may occur, besides the ones mentioned earlier:
The contribution of urine into the amniotic cavity makes week 14 to 18 the ideal period for amniocentesis (Moore and Persaud 2003, pg. 113). The growth and thickness of the placenta continues rapidly until 20 weeks of gestation
The overall growth and development of the structures of the foetus occurs and the functionality of the organs is able to be tested by the morphology scan time point.