

Course Name :An Overview on Maternal Health Antenatal, Intranatal and Postnatal Care

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Fetal Imaging and Amniotic Fluid Study

Hello students. I welcome you all to yet another session for the NPTEL online certified course on the topic and overview on maternal health, the antenatal, intranatal and postnatal care. I am Dr. Barnali Ghosh, an obstetrician and gynecologist working at B.C.Roy Medical College and Medical Research Center, IIT Kharagpur. Today we are going to discuss regarding fetal imaging right and amniotic fluid study. So, the concepts covered in today's class are fetal imaging, the sequential timing of the different pregnancy scans, the importance of the various USG parameters and in the end a short discussion regarding the amniotic fluid study and from the amniotic fluid study how to assess the fetal well being.

Keywords being fetal imaging, USG in obstetrics, amniotic fluid study, amniotic fluid index and fetal assessment by ultrasound. So, this is regarding the fetal ultrasound. This is the ultrasound picture of the fetus inside the uterus right. So, this is the bladder, if you want to note here this is the bladder, this is the fetus, this is the fetus right, this is the amniotic fluid right and we need here in this picture it is these are the limbs, these are the limbs.

In this picture the placenta is not seen, we need to know note also the position of the placenta. So, coming to this great man, he is the father of obstetric ultrasound, his name is Ian Donald. At present there is also a school in his name you know .

Ian Donald school of ultrasound and he was the first person to denote that how ultra you know sound waves right, how ultrasound waves can be used for assessment of the fetal well being and you know different fetal parameters can be calculated from the ultrasound. So, what are the basic property of ultrasound? The piezoelectric crystals these are present inside the probe of the ultrasound. So, this is the probe of the ultrasound and here there are the different piezoelectric crystals. And when electrical energy these are the electrical energy which are passing inside the probe, this is the USG probe and this piezoelectric crystals will convert the electrical energy into sound energy sorry not sound, but ultrasound that is frequency wise it is more than 20000 hertz right. And these ultrasound waves they will strike say this is the abdomen of the patient, this is the abdomen of the patient right.

And here these ultrasound will strike will strike will go inside and it will strike the different you know organs inside the abdomen. And depending upon the organ it is striking it will get reflected back right. So, this reflected ultrasound waves are then again captured and the attenuation of the reflected sound waves is different for the different tissues and this attenuation will help to form a picture. From these sound waves we get sometimes you know some of them are absorbed inside the tissue and some are reflected back. If all the waves are absorbed then that spot will turn out to be white right.

So, that spot that spot will be turning out to be white. So, that is called a hyperechoic lesion and if all the sound waves are you know reflected back it will be anechoic full black in color. So, that is regarding the ultrasound machine functioning and it helps to detect the different pathologies. So, our sound waves or ultrasound waves are safe in pregnancy yes they are safe in pregnancy, but it should be kept in mind that it should be done only when indicated right. Because in the you know it has some thermal effect and in the early stages in early you know stages of pregnancy in early pregnancy it can lead to vacuolation inside the cells inside the fetal cells right and sometimes prolonged exposure can cause cell death right.

So, this thermal effect is actually you know taken into account or it is utilized in case of ultrasound focused you know scan of fibroids. So, sometimes the thermal energy or magnetic resonance focused ultrasound right. So, that will cause intense heat and it will cause lysis of the fibroid right. So, that thermal effect has some detrimental effect no not detrimental, but it can lead to vacuolation and so, it should only be done when it is indicated in obstetric patient. Now coming to the different types of ultrasound probes it can be of two types that is the transabdominal probe and the transvaginal probe right.

So, what are the frequency of waves here it is 3 to 3.5 hertz right for transabdominal sorry for transabdominal it is 3 to 3.5 megahertz and for transvaginal it is 7 to 7.5 megahertz. So, transvaginal ultrasound are using more frequency of sound waves right.

So, next is your resolution. So, in case of transabdominal it is using less frequency less frequency we have just read 3 to 3.5 megahertz right. So, less frequency so, it is having less resolution, but penetration is more. In the case of transvaginal the frequency is more 7 to 7.

5 megahertz. So, the resolution is more, but penetration is less. So, this criteria is used for pelvic scan for different type of lower abdominal scan we will come to it. So, now coming to the USG of choice in case of early pregnancy, in case of ectopic pregnancy, in case of any pelvic organ pathology assessment what is the USG of choice. So, all these are within the pelvis, ectopic pregnancy be the pregnancy in the uterus not outside the uterus. So, it can be in the tubes, in the ovary right.

So, it is in the pelvis. Early pregnancies can also be within the uterus which is a pelvic organ or assessment of pelvic organs as a whole. So, actually we are talking about USG of pelvis. For this of choice is your TVS transvaginal sonography right. So, now coming to the transvaginal sonographic picture of the different you know appearance of the different pregnancy features in transvaginal scan right.

So, first will be the appearance of the gestational sac. So, this is the uterus and here you see a gestational sac which is also black in color right. So, this is the gestational sac and outside there will be a rim of hyperechoic nature. So, this is the hyperechoic rim right. So, this is a round hyperechoic structure and surrounded by hyperechoic rim.

It increases in size at the rate of 1 millimeter per day and it is eccentric in location. So, all these are criteria of the gestational sac right and first seen gestational sac first seen on TVS around 4 weeks 3 days to 4 weeks 5 days right. So, this is the time around 4 weeks 3 days of period of gestation to 4 weeks 5 days we first notice the gestational sac on an TVS. And just you know you have to note that in transabdominal scan you will notice the same feature after 1 week. So, in transabdominal you see the gestational sac after 1 week meaning that 5 weeks 3 days to 5 weeks 5 days right.

So, we will only study the TVS timing and you just have to add 1 week to them for the transabdominal scan. So, this was regarding the gestational sac right. Now coming to an important point is that is gestational sac and pseudo gestational sac. See here this is the we will use a different color. So, this is the decidua basalis, this is the decidua capsularis right and here this is the decidua parietalis right.

So, the gestational sac is eccentric in location, this is the uterine cavity you can see this is the uterine cavity which is still you know delineable and this is the uterine cavity and the gestational sac is eccentric in location whereas, it also increases in size at the rate of 1 millimeter per day and it is a round regular hypoechoic structure which is surrounded by a hyperechoic rim. But in case of pseudo gestational sac what happens in case of pseudo gestational sac say this is the uterus and you have a you know you will see a hypoechoic structure like this. So, this will be black in color. So, this hypoechoic structure which is not regular it is irregular in outline. So, hypoechoic structure which is irregular and it is central in location and does not increase in size, does not increase in size right and also it will not be associated with appearance of further yolk sac or embryo structure.

So, all these points towards pseudo gestational sac which is nothing, but due to fluid accumulation within the uterine cavity right within uterine cavity this is seen in case of ectopic pregnancy. So, pseudo gestational sac you need to be very cautious and if it is you know just

central in location it is not increasing in size and it is irregular without that you know hyperechoic rim around and also it does not have any other features like yolk sac or embryo developing inside that structure. So, it hints towards pseudo gestational sac which means that yes this is not the pregnancy sac this is not an intra uterine pregnancy this is an extra uterine pregnancy hinting towards ectopic pregnancy and this picture of pseudo gestational sac is due to fluid accumulation within the uterine cavity right. Another point in the early stages of pregnancy is the double decidual sac sign which we have already discussed yes this is the gestational sac and it is being implanted within the uterine endometrium called as interstitial implantation. And so, this sac will be you know have the decidua basalis on one side, the decidua capsular is on other side and the decidua parietal is on the other side.

So, these are the 3 rim these are the 3 hyperechoic rim which are seen in the USG scan and you see 2 sac 2 hyperechoic sac one of the gestational G sac and other of the uterine cavity. So, this is called as double decidua. So, double decidua here this one is another one decidua, this is one hyperechoic region, this is one hyperechoic region, this is another hyperechoic region right. So, double decidua sac sign DDSS double decidua sac sign it is a confirmatory of intra uterine pregnancy. Next, after the G sac will be the appearance of the yolk sac.

So, this is the G sac and inside the gestational sac is the appearance of the yolk sac and this occurs around 5 weeks in TVS. I have told that in TAS transabdominal scan just at plus 1 that is equal to 6 weeks of gestation. You see the yolk sac appearance of the yolk sac is confirmatory of a viable pregnancy ok. So, that was appearance of yolk sac. Next what will occur there will be appearance of the embryo.

So, that was the G sac, here was the yolk sac and say here we have the embryo. So, this is the embryo you are seeing. So, this is the embryo or the appearance of the embryo this occurs around 6 weeks in TVS right and the length of the embryo, length of the embryo that is from the crown to the rump leaving behind the appendages. This is the length of the embryo which is called as crown rump length or CRL. This is used for gestational age calculation which is done by the machine itself and it gives an accurate gestational age calculation you know just plus minus 3 days right.

So, that was regarding the embryo. Now the embryo has come now the cardiac activity will also appear. Cardiac activity appears around your 6 weeks right and to note is that if the CRL is more than 7 millimeter it says that more than 7 millimeter CRL if it is coming then cardiac activity must be present. If CRL is more than 7 centimeter and cardiac activity is absent that means, it is a case of missed abortion right. So, that means, that yes this fetus is abnormal this there it cannot be continued this pregnancy cannot be continued because the fetal cardiac activity has not come even when the CRL or the crown rump length is more than 7 millimeter.

Next coming you know step of appearance is the embryonic movements. So, this is the uterus and say this is the gestational sac, this is the yolk sac and here you have the embryo right. So, this is the embryo and you measure the fetal crown rump length which is you know more than a 7 millimeter say 9 millimeter. Now you will put the ultrasound probe around the heart here around the heart and you when you go for the pulse wave pulse wave switch on the ultrasound machine you can see the fetal heart rate tracing on the screen so that means, fetal cardiac activity has come right. Now, appearance of the embryonic movements movements of this embryo can be seen around 7 weeks of gestation these are all seen in TVS in TAS we add plus 1 week to this values right.

So, these are the eye you know the direct pictures from the USG scan machine here you see this is the uterus right. So, this is your endometrial cavity and here you see the gestational sac which is a regular and somewhat eccentric, but it does not still have the yolk sac here you can see the presence of yolk sac. So, this is around 4 weeks say 3 days to 4 weeks 5 days and this is around 5 weeks of gestation these are all TVS report right. So, this within the gestational within this gestational sac you see the yolk sac. Now just beside the yolk sac you can see the embryo right.

So, this is the appearance of the embryo and after a few weeks you can see the embryo to be growing and see these appendages should be excluded these appendages these are the appendages of the embryo these should be excluded and we take only the length from the crown to the rum. This is the crown rump length to be assessed to note the gestational age of the fetus and also to note the fetal cardiac activity. So, these are all the stepwise appearance of the pregnancy features in ultrasound in the early stages. Now coming to the serial wise USG scan. So, number 1 is first scan for the confirmation of intrauterine viable pregnancy to be made around 6 to 8 weeks of gestation.

Next will be the NT scan which we have read in detail in our prenatal diagnostic class which is to be done around 11 to 13 6 by 7 weeks right. Then is the third scan which is the target scan or also called as the targeted imaging for fetal anomalies it is also called as the congenital. Congenital anomaly scan which is done around 20 to 22 weeks we go get to know know the different anomalies present know depending on the heart the your diaphragmatic hernia any type of anomaly right. All the structures all the organs are you know are described in detail in the congenital anomaly scan right. And then next not done for all is the fetal eco fetal echocardiography which is done around 24 weeks 22 to 24 weeks right.

And then number 4 is the growth scan which we do in the third trimester around 30 to 34 weeks and the end is the term scan which is done around 36 to 37 weeks. Here to note another point is that growth scan in case of some high risk pregnancy say she is a case of uncontrolled PIH or preeclampsia or APLA syndrome or say SLE then in that case growth scan should start

from 28 weeks. So, these are the serial wise USG scan to be done in pregnancy. Now coming to one by one the first scan which was done around 6 to 8 weeks what is the significance it gives the information of the confirmation of intra-uterine of pregnancy right confirmation of a viable pregnancy. Number 2 is whether the what is the location whether it is intrauterine or extrauterine extrauterine meaning ectopic pregnancy where there will be a ring of fire appearance ring of fire appearance on the scan around the gestational sac which may be in the tubes right.

So, that is extrauterine. Then number 3 is gestational age calculation from the CRL and this is most accurate with a deviation of plus minus 3 days. Then the number of pregnancy whether single or multiple pregnancy. Number 5 is chorionicity if it is multiple then whether it is dichorionic or monochorionic and number 6 lastly is whether this pregnancy is normal whether this pregnancy is viable whether this pregnancy can be continued or it is a case of failed gestation or you know early pregnancy failure. So, all these are from the first scan done around 6 to 8 weeks. Now next scan is the NT scan which is done around 11 to 13 6 / 7 weeks and we have read that this is the NT where we you know calculate.

We calculate the I will not put a mark here, but just you look at the picture that we calculate the NT scan this is the NT scan. This is the nuchal translucency inner border to inner border in the widest plane and that should be less than 3 millimeter. We also note the nasal bone right the nasal bone, the tricuspid regurgitation, the ductus venosus blood flow pattern along with this right. So, that was regarding the NT scan it helps to screen the different aneuploidies the different you know chromosomal aberrations or anomalies and then you know that is a screening test it should be done for all pregnancy irrespective of the age of the mother.

So, this is normal NT scan this is normal right. So, this is normal, but here you see that this is increased right. So, this is increased NT scan right here this is increased this widest distance from the inner border to inner border is measured and it is increased and it is associated with different aneuploidies with different say cardiac defects of the fetus and we need to you know further investigate the pregnancy. Now the second trimester USG second trimester USG what are the parameters you look the biparietal diameter, the head circumference, femur length and abdominal circumference. Here just idea of the biparietal diameter how you measure you know you go to that section of the fetal skull where you see the falx cerebri, you see the you see the falx cerebri, you see the arrow like picture that is the thalamus and you see the cavum septum pellucidum right and then through the thalami you measure the you see this is the fetal skull. From outer table to inner table from outer this is the outer table from outer table to inner table you measure and this gives the biparietal diameter and this total will be the head circumference and from these two the gestational age will be calculated in the second trimester pregnancy scan.

Here two important scans are the congenital anomaly scan which rules out the different anomalies of the fetus as well as your eco fetal echo right. So, that was the second trimester

scan. Now the different you know anomalies which are abnormal USG findings which are found in the anomaly scan. Number one is a neural tube defect neural tube defect what is that? There is defect in the neural tube right. So, thus the CSF will leak out will leak out and it will pass now outside and that will cause pressure on the bones on the cerebellum right that is not we inside the neural tube the CSF is leaking out and due to this pressure the skull the skull will you know expand and it will become a Lemon shaped which is called as the Lemon sign.

Banana sign because within the brain matter there is more CSF and the cerebellum will be compressed right and that will become you know banana like. Dumbbell shaped normal cerebellum becoming banana like this is called as the banana sign. So, this here you can appreciate this is the cerebellum right. So, cerebellum is becoming banana like and here the skull this is the outline of the skull that is somewhat become like that of a Lemon. So, Lemon sign banana sign these all hint towards neural tube defect and here the most important marker is the maternal serum alpha-fetoprotein which is increased in open neural tube defects.

Now, coming to another anomaly that is the anencephaly which is due to folic acid or vitamin B9 deficiency where there is absence of the fetal skull absence of the fetal you know sorry fetal vault vault of the skull absence of the vault of fetal skull right. So, the vault is absent. So, only the face features are present the vault is absent and so, that is anomalous and it needs to be terminated it needs to be terminated and also it is there are several other markers of anencephaly. I will show you this is the picture of anencephaly baby. See this is the frog sign the face is looking like a frog.

So, this is the frog eye appearance also sometimes it is called as the Mickey Mouse sign. So, this is one this is one and this is one. So, this is the Mickey Mouse sign and as the vault is absent the vault is absent only the face is present the face is heavier now and that will lead to face presentation the heavier part goes down and it is you know anencephaly babies maximum time have face presentation right. Post term pregnancy they go for post term pregnancy why because there is no brain matter no posterior pituitary no anterior pituitary. So, no secretion of corticotrophin releasing hormone from the fetal pituitary.

So, adrenal glands of the fetus there will be hypoplastic. So, less secretion of fetal cortisol and thus no initiation of labor. So, it goes or tends to go for post term pregnancy, but nowadays it is not so common because we diagnose it you know in the second trimester by USG and immediately after diagnosis of anencephaly baby we will have to abort the pregnancy we will not continue the pregnancy because this is not compatible for life right. It is associated with polyhydramnios why because the fetus is urinating more because there is no ADH hormone secretion from the posterior pituitary and there will be more urine production leading to polyhydramnios and lastly it is associated with increased maternal serum alpha-fetoprotein. So, that was regarding the anomaly

now coming to the abdominal circumferences. So, we have discussed the biparietal diameter, the head circumference and next is the abdominal circumference.

This is the you know the section where you measure the abdominal circumference. Here this is the stomach bubble, this is the umbilical vein, hockey stick like umbilical vein and see this is the spine right. So, this is the spine. So, in this plane where it is not having the bladder, not having the heart only the stomach the umbilical vein and the fetal spine behind. So, this plane is you know this plane has to be brought in USG and then when we get this plane we will measure the abdominal circumference.

This dotted structure is the abdominal circumference it will be measured by the you know machine itself right. So, it is measured at the level of the fetal liver and what is the significance of abdominal circumference? It is a marker for fetal growth disorder. So, how much is the growth of the fetus depend you know in correspondence with the gestational age right. So, if the abdominal circumference is very high that means, you know the fetus you know there is more chance of fetal macrosomia. What is macrosomia? When the expected fetal weight is more than 90th percentile or more than 4 kg fetal weight it is called as macrosomia or if the abdominal circumference is very coming very less.

So, that means, towards intrauterine growth retardation or small for gestational age fetus. What is that when the expected fetal weight is less than 10th percentile then it is a small for gestational age fetus and if it is less than 3rd percentile for that gestational age it is a case of severe small for gestational age fetus or IUGR and in that case we have to start the growth scan right from 28 weeks right. So, that was the importance of abdominal circumference. Now one stomach bubble seen in the know that field of abdominal circumference is normal, but if stomach bubble is absent that hints towards esophageal atresia. Why there is no this why this stomach bubble is formed? Why this stomach bubble is formed? This is hypoechoic because the fetus has taken lot of fluids it is continuously swallowing the amniotic fluid.

So, the fetus due to has taken fluids it is present in the stomach and it is coming out as a hypoechoic round structure. So, if it is absent then it is case of esophageal atresia it cannot swallow the fluids. If there is double stomach bubble picture it hints towards duodenal atresia, triple stomach bubble it hints towards jejunal atresia. So, these are the different anomalies which can be seen in the USG. Now coming to the next part of the second trimester scan that is the fetal echocardiography where it when it should be done it should be done around 22 to 24 weeks and for whom not for all mostly for mothers with history of heart disease right and also for mothers who have history of heart disease in the offspring of previous pregnancy right and also in case mother has pre gestational diabetes mellitus uncontrolled.

So, in all these cases we will go for fetal echocardiography also SLE mothers there is chance of fetal heart defect in SLE mothers. So, they need to go for fetal echocardiography. So, second trimester scan completed. Now coming to the third trimester scan growth scan around 32 to 34 weeks. Here we measure the femur length for gestational age calculation number 1 and also for fetal you know weight calculation expected fetal weight.

See here is the femur length we focus the femur and we calculate the femur we will not associate or we will not measure the epiphysis of the femur right. So, just the 2 distal point they are measured and it gives the gestational age calculation of the third trimester. In third trimester we also measure the abdominal circumference to assess the fetal growth right. So, that was the growth scan. Now coming to the term scan which is done around 36 to 37 weeks why it is done to note the lie of the fetus to note the position of the fetus or the presenting part of the fetus right and also to note the liquor volume of the fetus right.

So, all these parameters are assessed in the term scan. So, that was regarding the USG of the fetus. Now coming to the amniotic fluid study with there are 2 concepts number 1 is the amniotic fluid index and number 2 is the single deepest vertical pocket assessment. So, what is amniotic fluid index or AFI? It is the sum total of 4 vertical cord free amniotic fluid cavities right. So, 4 vertical cord free amniotic fluid cavities are calculated in the 4 quadrants of the maternal abdomen and they are added and that will give the value of AFI right. So, this is the picture you can see say this is this 1 quadrant, 2 quadrant, 3rd and 4th quadrant and in each quadrant the cord free area that maximum distance that will be measured that has to be measured in all the 4 quadrants and adding these all 4 will give the amniotic fluid index and this is the single vertical or deepest pocket calculation right.

So, here just you know the single deepest pocket where which is also cord free that length is measured and that will give the single deepest pocket measurement. So, these 2 has its values. What are the normal volumes of AFI? Single is 10 to 15 less than 5 it is oligohydramnios. Oligohydramnios meaning that there is less liquor, polyhydramnios meaning there is more liquor in that case AFI will be more than 25.

So, normal range will be 5 to 25 right. So, that is AFI. Now single deepest vertical pocket assessment what is normal? Normal is 2 to 8. So, oligohydramnios oligohydramnios that will be when SDP is less than 2 centimeter, polyhydramnios will be when SDP will be more than 8 centimeters right. Now these are have some you know very important features this amniotic fluid study because oligohydramnios is associated with fetal hypoxia, it is associated with fetal IUGR, it is associated with certain placental abruption right all these can lead to decrease in amniotic fluid. So, when you see that the amniotic fluid assay is decreasing or it is you know depicting oligohydramnios in the third trimester scan, we need to investigate further for fetal antenatal fetal well being and if the fetus is in jeopardy if there is signs of fetal distress you need

to expedite the delivery right. And polyhydramnios you know sometimes are associated with anomalous fetus, anomalous fetus in the form of esophageal atresia right.

So, it cannot swallow cleft lip cleft palate it cannot swallow. So, there will be more liquor right. So, these you need to keep in mind and then you go for the amniotic fluid study in the third trimester. So, that was regarding the fetal imaging the stepwise pregnancy features coming in the USG scans and also the amniotic fluid study and you know it helping in assessment of the fetal status within the uterus. So, references taken out from D.C.Dutta book of obstetrics the Williams obstetrics and the James book on high risk pregnancy.

So, that was all for today's class. Thank you and I will you know look forward to meet you all again in our next video. Thank you.