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

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Physiological changes in pregnancy (Part 3)

Good morning students. Good morning students. Welcome 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 as assistant professor at B.C.Roy Medical College and Research Center, IIT Kharagpur. So today our discussion is the physiological changes occurring during pregnancy.

In the previous classes we have been dealing with the different changes occurring in the different systems inside the mother during the pregnancy. Today we will be dealing with the hepatic system changes that is the changes occurring in liver, gallbladder and very importantly the renal system changes during pregnancy right and also some little bit regarding the metabolic changes occurring during pregnancy. Coming to the hepatic changes in pregnancy. So this is the liver.

Liver what happens as a whole the size of the liver there is no change in the size of the liver but there is increase in liver metabolism, increase in production of proteins from the liver you know so the size remains same but the liver functioning will increase during pregnancy. Size remains unchanged, size will remain unchanged right, size remains unchanged but there is increase in the liver metabolism, increase in production of proteins and proteins like we have already done transferrin, ceruloplasmin, copper binding protein then albumin and globulin right albumin and globulin. Production of these proteins increase during pregnancy but no we have also discussed globulin meaning all types thyroid binding globulin, sex hormone binding globulin, corticotrophin binding globulin all increase during pregnancy but the increase in globulin you know will be higher compared to the increase in albumin. So the albumin globulin ratio which was normally in non-pregnant state 1.7 is to 1 it becomes 1 is to 1 during pregnancy right and there is also increase in both arterial and portal venous blood flow inside the liver.

Coming to liver function test, liver function test there is no change in bilirubin concentration during pregnancy right. The alkaline phosphatase this increases during pregnancy and this increase is mostly due to the production from the placenta right not from the liver but from the

placenta this alkaline phosphatase is being produced and thus it is increased in the maternal blood and may increase by 2 to 4 fold. If the value becomes more than 1000 then we need to think of some other cause of alkaline ALP, ALP production right some other cause meaning it may be you know from bone or from liver or from renal kidney. So we need to evaluate and reassure whether there is any pathological cause for this alkaline phosphatase rise right. Coming to SGOT and SGPT these decrease during pregnancy.

So the normal range which was you know normal during the pre-pregnant state during pregnancy the range decreases in the first and second trimester the normal is taken as 10 to 40 international units per ml and in the third trimester it further decreases and becomes in the range of 10 to 30 international units per ml right. So this is about liver function test in pregnancy. Coming to the gallbladder changes what happens to the gallbladder during pregnancy? We know that gallbladder you know it produces bile and bile has to be excreted from the gallbladder into the common bile duct but during pregnancy there is increase in estrogen and progesterone. Progesterone being a smooth muscle relaxant the contraction of the gallbladder will decrease so there will be bile stasis inside the gallbladder right which will you know make the female more prone to gallstone formation and also estrogen increases the cholesterol content in the bile. So ultimately the pregnant female is more prone to formation of cholesterol gallstones during pregnancy right.

So this is what I have already told progesterone decreasing the contractility of gallbladder and decreasing the emptying of the gallbladder so and also it impairs cholecystokinin all these leads to stasis of bile inside the gallbladder which is you know helpful for the formation of gallstones and estrogen will ultimately lead to cholesterol saturation in the bile leading to cholesterol gallstones right. Now coming to another important concept that is the intrahepatic cholestasis in pregnancy it is also called as icterus gravidarum or recurrent jaundice in pregnancy. There is a chance of 50% chance of recurrence in the subsequent pregnancy. So what happens during this the estrogen in pregnancy it you know it causes the bile acids causes stasis it prevents the transport of the bile acids through the canalicular system within the liver intrahepatic inside the liver the bile canaliculi the transport of bile acids is hampered due to the estrogen and there is stasis of bile acids in the bile canaliculi and ultimately it may so happen that the bile acids spill into the blood plasma and thus it may lead to pruritus. This is called as intrahepatic cholestasis in pregnancy and it is very notorious for recurrence if present in the present you know previous pregnancy there is a high chance of recurrence in the subsequent pregnancy right.

So what happens there is decrease in canalicular transport of bile acids due to estrogen and thus bile acids may spill into the plasma causing pruritus also it may be associated to with hyper bilirubinemia, but to note here that it never becomes more than 4 to 5 milligram per dl bilirubin will be never more than 4 to 5 milligrams per dl in case of intrahepatic cholestasis there is increase in bile acids increase in bile salts in intrahepatic cholestasis of pregnancy right. This is

a HP histopathological picture we take a cut section of the liver in case of intrahepatic cholestasis and we can see these are the biles these yellow yellow stained picture these are bile acids. So bile is inspissated inside the hepatic canaliculi and the cytoplasm, but to note that there is no necrosis no signs of necrosis, no signs of inflammation and these changes all disappear following the delivery of the fetus. After termination of pregnancy it will go away, but there is a chance of recurrence and in the subsequent pregnancy and also if the female takes estrogen containing contraceptives it may also recur right. So this is about the intrahepatic cholestasis in pregnancy.

Now coming to the renal changes. Renal changes what happens to the kidney? Kidney it increases liver we have talked about there is no increase in size of the liver, but the liver metabolism the production of proteins from the liver they will increase kidney yes the kidney size increases it increases in size and this size this increase in size in during pregnancy it will revert back to the pre-pregnant size by 12 weeks postpartum right. There is increased blood supply to the kidney and here a very important hormone that is the relaxin it increases renal blood supply mediated by nitric oxide that will increase the renal that will lead to renal vasodilatation and increase in blood supply to the kidneys right. So in this picture you can see we have told that the size of the kidney size increase by 1 centimeter there is increase in size increase in GFR why because increase in renal plasma blood flow there is increase by 16 weeks of gestation renal blood flow is approximately 400 ml per minute and it remains at this increased level throughout pregnancy. So increase in renal blood flow increase in GFR increase in urinary output and also due to progesterone what happens this is a smooth muscle relaxant so it will relax the muscles of the ureter and there will be stasis of urine.

The urine will get collected in the collecting system and it will lead to hydro ureter also you know dilatation of the renal pelvis renal calluses right. So there will be retention of urine in the collecting system of the kidneys right. So or in other words there is stasis of urine and this stasis of urine you know leads to more chance of urinary infections more chance of urinary infection and also there is increased frequency of urination right. Urinary frequency increases in pregnancy why because the gravid uterus the bladder is in front the uterus is just behind and as the uterus is growing the gravid uterus will fall on the bladder and it will compress the bladder. Just little amount of urine in the bladder will you know give a sense of micturition.

So there is increase in the frequency of urination in pregnancy right. Another thing to note here that GFR, glomerular filtration rate increases there is hyper filtration number 1 due to you know increased blood supply to the kidneys more blood through the glomerulus. So more filtration more filtrate is being formed in the gromelulars' right and number 2 is decreased tubular reabsorption tubular reabsorption is also decreased. So it will lead to increase in urinary output. So this ultimately you know leads to glycosuria proteinuria and amino aciduria all these are normal in pregnancy mind it these are all physiological these are not abnormal findings the urine

there may be glucose in the urine there may be some proteins present in the urine and amino acids present in the urine and these are all physiological due to increased in GFR right.

So what are the changes occurring: kidney size will increase by 1 centimeter where the right side kidney is preferentially increased a little bit more than the left side. There is increase in renal plasma flow as well as glomerular filtration rate by 50 percent and another point is hyper filtration why because increase you know this if this is the glomerulus. So these are the blood capillaries right. So there is increase in filtration number 1 increase in renal blood flow there is hemodilution and you know renal vasodilatation all these together will act and will increase in GFR. Renal vasodilatation I have already talked about is brought about by the relaxin hormone via the nitric oxide synthesis.

So number 1 is increase in GFR and number 2 is decrease in tubular reabsorption. These two together will lead to hyper filtration leading to glycosuria, proteinuria, amino aciduria in pregnancy right. I have talked yes there is dilatation of the ureters, dilatation of the collecting system of the kidneys that is the renal pelvis, the renal calluses and thereby leading to retention of urine. Retention of urine right in the tract itself leading to collection errors. What does this mean? Collection errors is that when we collect urine sample this urine sample is actually you know it was retained in the collecting ducts for a longer period there is stasis of urine inside the collecting system and so this urine which was produced much earlier it was there was stasis of urine and it was collected in the ureters for a longer time and then after a significant amount of time it is being voided right.

So the urine sample which we are collecting you know this gives a picture of the renal function not at that time, but you know it was sometime earlier. So this can lead to collection errors right and there is also a chance of increase in infection due to the urinary stasis and we thereby you know try to postpone elective pyelography if at all needed up to 12 weeks postpartum right. This is postpartum after the delivery of the baby up till 12 weeks after that we can go for pyelography. Okay now coming to serum creatinine this decreases in pregnancy right from 0.

7 to 0.5 milligram per day. So if the creatinine level in pregnancy if it is more than 0.9 then we call it as abnormal right. In normal people in non-pregnant state you know creatinine more than 1.1 is abnormal, but in pregnancy a creatinine of more than 0.

9 is taken to be abnormal. There is decrease in serum bicarbonate decrease in p a c o 2 right. P c o 2 if more than 40 millimeter of h g then it is also abnormal right. 50 millimeter of h g it is considered as abnormal. So these are you know the criteria or due to changes in the renal system there is changes in the blood parameters and thereby we keep changing the you know normal limits during pregnancy.

Okay now coming to proteinuria yes some amount of proteinuria is normal in pregnancy we have already discussed, but what is significant proteinuria? Normally protein up to 150 milligram can be excreted in a 24 hour urine sample this is normal, but if it increases and it becomes 300 milligram in 24 hour urine sample this is called as significant proteinuria. Why we are concerned? Because proteinuria you know associated with increase in blood pressure in pregnancy is a marker for preeclampsia. This is a very grave situation an obstetrical emergency and we need to you know manage the patient very promptly so that so as to save the life of the mother as well as the fetus. So how to diagnose preeclampsia when there is protein excretion is more than 300 milligram in 24 hours urine sample right. Now what are the methods of detection of proteinuria or significant proteinuria? Number one is dipstick test.

Dipstick test is nothing but a bedside test where we can see you know we put the urine collected urine from the patient into the dipstick and if it is more than 1 plus more than 1 plus then it is significant proteinuria. But you know there is due to dilution due to you know hemodilution there is dilution of also of the urine and this can lead to dilution errors sometimes you know 2 plus 3 plus cannot be detected so promptly. So, but it is you know just for you know gaining a idea at the bedside during the rounds in the wards we can use this test. Number two is quantitative 24 hour urine collection, but here also it can be associated with collection errors. I have already told you why these collection errors appear and we need to overcome this collection error right.

But the what is the criteria more than 300 milligram of protein excreted in 24 hours urine sample right then it is significant. And number three this is the most specific the albumin creatinine ratio these are all from spot urine. Spot urine just the patient urinates we collect the urine sample and we can go for albumin creatinine ratio or protein creatinine ratio. This is of more use because it is more available and you know in practical purpose we take it as less than 0.

3. Protein creatinine ratio less than 0.3 is normal right. So, I will write it has more than 0.3 more than 0.3 is you know towards preeclampsia right and albumin creatinine ratio more than 8 nanogram per millimole right.

These are indicators of pre-eclampsia more urine significant proteinuria right. So, this is about the methods of detection of significant proteinuria right. Now, a small discussion on the collection error how to avoid this collection error. So, we have already talked that the there is status of urine in the urinary collecting system. So, how to overcome we tell the patient that yes you go for left lateral position you rest in that phase and after some time when you feel like urinating you pass the urine right.

So, the collected urine which was present in the you know collecting duct in the renal pelvis

and the calluses it will be voided out and after the patient voids this urine of when being in the left lateral position for 50 10 to 15 minutes the patient voids the urine and from that time is the time for the 24 hours collection. Then we will discard the first voided urine and then we will know examine we will collect the urine after for the following 24 hours and at the end of the 24 hours the last urine sample which is collected is done in the same procedure we tell the patient to remain in the left lateral position and then after some time we collect the urine. This way the urine which was present previously which was there you know stagnant in the collecting system it is not taken into account. This collection error is actually due to the urinary stasis in the collecting duct right collecting duct in the renal pelvis in the ureters of the kidney. So, this has to be overcome and we overcome in this procedure right and then we measure the amount of protein that is secreted in 24 hours urine sample.

So, this is about proteinuria. Now, coming to another concept of hydro ureter. So, what happens this is the uterus with the baby. So, during pregnancy I have already discussed that the uterus moves towards the right side there is dextro rotation of the uterus and so, ureter right ureter is compressed by the dextro rotated uterus the gravid uterus will compress the right ureter. Another thing to note is here are the ovaries right. So, say here are the ovaries ovaries are in the pelvis they are present here and the ovarian vein the ovarian vein will also drain into these are back at the back of the uterus at the back of the uterus I draw with a dotted line this is the IVC IVC.

So, this ovarian vein will be draining into the IVC directly on the right side and thus it will cross the right ureter it will cross the right ureter and the right ovarian vein can also compress the right ureter while crossing it right. In the left side the left ovarian vein will drain into the renal vein right it will drain into the renal vein. So, on the left side the ovarian vein does not cross the left ureter. So, these two factors taken together right sided hydronephrosis or right sided hydro ureter is more common is more common than the left side in pregnancy right. So, right ureteral dilatation there occurs because of the dextrorotated gravid uterus the right ovarian vein drains directly into the IVC and during its draining it crosses the right ureter at the pelvic ureter junction and thus if these two taken together will compress or exert pressure on the right ureter leading to right sided hydronephrosis ok.

So, this was regarding the renal system. So, very important the renal system there is increase in renal size which will revert back to the pre pregnancy state by 12 weeks ok and also there is increase in renal blood flow by mediated mostly by relaxin hormone there is increase in GFR increase in urine production, increase in stasis of urine, increase in chance of hydronephrosis and hydro ureter mostly on the right side during pregnancy. To point out here that the left side in left side what is more common left sided thrombosis venous thrombosis on the left side is more common. We have talked about May Thurner syndrome where we have learned that left sided venous thrombosis is more common than the right side in pregnancy ok. So, next our topic is

endocrine system changes in pregnancy. So, these are the endocrine the pituitary starting with the pituitary.

What happens? Yes, there is enlargement of the pituitary gland by 135 percent. The increase in size and weight of the pituitary gland during pregnancy. Why? Because there is increase in the hyperplasia increase in lactotrophs in pregnancy we will come to them one by one ok. So, pituitary gland yes increase in size by 135 percent, gland size can increase up to 12 millimeter and it returns to normal pre-pregnant size by 6 months postpartum ok. There is increase in lactotrophs which is mainly due to increase in estrogen.

Growth hormone, growth hormone decrease. Why? Because growth hormone is being produced by the placenta, growth hormone production from placenta. The function is taken up by the placenta and growth hormone primarily is produced by placenta during pregnancy right. TSH, thyroid stimulating hormone there is no change ok. So, another thing to note here is thyroid binding globulin. These all increase in during pregnancy, increase synthesis from the liver.

Thyrotropin releasing hormone from the hypothalamus there is no change. TSH no change, but you know the normal values to be maintained is 2.5. TSH to be less than 2.5 in first trimester and less than 3 in second and third trimester right.

Another is T3, T4. T3, T4 they have you know increase total T3, T4 will increase, but free T3, T4 undergoes no change ok. So, next coming to ACTH, ACTH increases in pregnancy. FSH, LH decrease. Why? Because feedback inhibition by estrogen and progesterone ok. Next important very important hormone is the prolactin which increases during pregnancy.

So, if I draw a graph, prolactin increases throughout the pregnancy. Say this is the prolactin, this is the gestational age. Prolactin increases in pregnancy and say this is the termination of pregnancy or delivery of the fetus. So, after delivery the level of prolactin will somewhat decrease right. So, this level will decrease, but very important to note is though prolactin increases throughout the pregnancy, there is no lactation in the pregnant period.

Why? This is because of the inhibition effect of dopamine. Dopamine will inhibit the prolactin during pregnancy. This is the pregnant period, pregnancy, antenatal period. So, it will inhibit dopamine will inhibit the prolactin and so, there is no lactation during pregnancy and this is brought about by estrogen. Following delivery though the level of prolactin decreases, still there is lactation.

Why? Because dopamine here is not present, the inhibitory effect of dopamine is not present because there is no estrogen following delivery and even know a decreased level of prolactin

can maintain the lactation following delivery and help in breastfeeding. Coming to the adrenal gland, the adrenal gland there is increase in size as well as increase in hormone production. All types of cortisol increase in production during pregnancy. Para hormone hormone, it undergoes no change, calcitonin will increase right. So, these will help in maintaining the serum calcium level in the mother which will help in fetal supply of calcium which is required for fetal growth.

Posterior pituitary, oxytocin and vasopressin release from the posterior pituitary of which there is increase in oxytocin secretion and no change in vasopressin secretion ok. So, this was about the you know endocrine changes in pregnancy coming to the metabolic changes in pregnancy right. So, metabolic changes we will be discussing the BMR, the oxygen demand and the glucose metabolism which are most important during pregnancy. So, coming to one by one anabolic state pregnancy is a anabolic state and there is increase in BMR, basal metabolic rate is increased by 10 to 20 percent very important. That is why a pregnant female sometimes may feel you know more warm, she is feeling you know she is sweating right because of this increase in basal metabolic rate.

And oxygen consumption also increases by 20 percent in pregnancy and during labor it may further increase to 40 to 60 percent right. So, oxygen consumption also increases. Coming to serum calcium, total serum calcium can be you know said that it is a summation of ionized calcium and non-ionized calcium. Ionized calcium there is no change, but non-ionized calcium decrease in pregnancy right. The fetus is actually dependent, fetus is dependent on the mother for calcium, for vitamins, for glucose right.

So, there will be you know fetus is taking the calcium from the mother and leading to a decrease in non-ionized calcium to balance it in the mother. In mother what happens vitamin D increases, calcitonin increases, but para-thrombond there is no change ok. So, in pregnancy the requirement of these vitamin D calcium increase because there is more demand by the fetus. So, it you know it may increase as up to 10 microgram. Vitamin D requirement is 10 microgram or 400 international units per day and calcium requirement is 1200 milligram per day right.

Now, coming to carbohydrate metabolism, I have been talking right from the beginning that yes the fetus is dependent on the mother's glucose. For you know this mother's glucose should be at a high level. So, as this glucose can be transported through the placenta into the fetus. So, how to keep the glucose levels in the mother's blood high by insulin resistance. The insulin will prevent the glucose to gain entry into the maternal cells, it will be mostly in the circulation.

So, as pregnancy progresses due to mainly human placental lactogen which is secreted by the placenta right. This hormone will prevent or will lead to insulin resistance like state in the mother and thus will help to maintain a increased level of glucose right. So, insulin resistance mostly by human placental lactogen and it is somewhat also brought about by estrogen,

progesterone and cortisol. So, these will you know lead a diabetogenic state. Pregnancy is nothing, but a diabetogenic state and maximum resistance is between 24 to 28 weeks very important.

At 24 weeks we always always it is a routine to check the blood sugar levels in the mother because at this time there is maximum insulin resistance and more chance of gestational diabetes mellitus. So, we need to screen the mother by fasting blood glucose by 75 gram oral glucose tolerance test which you know help in screening for gestational diabetes mellitus right. Another is you know this transport from the mother to the fetus the transport of glucose occurs at the placental site via facilitated diffusion with the help of glute receptors mainly GLUT1 and GLUT3 okay. So, this is regarding the carbohydrate metabolism and we have you know learned you know there is insulin resistance which is brought about mostly by the human placental lactogen and it increases you know throughout pregnancy. As pregnancy increases the concentration of human placental lactogen also increases up till term okay and you know this will ultimately lead to hypoglycemia in fasting state fasting state there will be hypoglycemia in the mother and in postprandial state due to insulin resistance there will be hyperglycemia.

This hyperglycemia will help to transfer the glucose into the fetus, but hypoglycemia is not at all you know warranted is not at all acknowledged during the pregnancy period. So, we always you know refrain the pregnant female from fasting because if she goes for fasting there will be decrease in blood glucose level thereby decrease in transfer of glucose to the fetus and fetus if there is hypoglycemia there may be sometimes sudden fetal demise right. So, she should not go for fasting okay she will be taking intermittent meals at regular intervals okay. So, this is about the carbohydrate metabolism now in just about the different changes physiological changes occurring in the mother's body starting from the gastrointestinal tract I have told that progesterone is a smooth muscle relaxant and it will relax the muscles smooth muscles present all throughout the mother's body. The intestinal muscles will relax there will be decreased intestinal motility which you know leads to most common complaint of pregnant females which is constipation.

Sometimes the sphincteric action that is the gastroesophageal sphincter then the all these esophageal sphincter the gastric sphincter this sphincteric action will also you know decrease there is relaxation of muscles leading to acid reflux right. So, these are common in pregnancy. Number 2 in the cardiac what happens there is increase in cardiac output increase in heart rate increase in stroke volume decrease in peripheral resistance and this increase in cardiac output will be maximum at 32 weeks. So, a heart disease patient when becomes pregnant the maximum chance of heart failure in the antenatal period is around 32 weeks but we have also learned that during labor cardiac output increases much more and immediately after the delivery one hour after the delivery the cardiac output increases highest and the risk is highest during this one hour postpartum period. Coming to the pulmonary system there is increase in you know

ventilation all the inspiratory volumes will increase and the expiratory volumes will decrease due to elevation of the diaphragm right.

So, all pAo2 will increase and pACO2 the carbon dioxide partial pressure of the carbon dioxide will decrease right. Coming to the musculoskeletal system there is joint laxity and lumbar lordosis due to the gravid uterus. Hematological system yes we have read increase in RVC volume increase in leukocytes platelets no change as such, but there is also increase in blood plasma to a greater extent leading to physiological hemodilution and clotting factors in the circulation increase thereby leading to increased risk of thromboembolism. Next coming to the endocrine system in the endocrine system estrogen progesterone yes we know they are products of the placenta they increase during pregnancy.

Thyroid hormones there is no change as such TSH to be kept below 2.5 in first trimester second and third trimester TSH to be kept below 3. Prolactin hormone increases in pregnancy, but there is no lactation due to the inhibitory effect of dopamine which goes away following delivery resulting in breastfeeding. And cortisol all the adrenal gland hormone secretion also increase in pregnancy. Lastly coming to the kidneys there is increase in renal blood flow increase in glomerular filtration rate and increase in the you know size of the kidneys during pregnancy, but due to urinary stresses there is more chance of urinary tract infections right. And serum creatinine will somewhat decrease in pregnancy and urea nitrogen in blood will also decrease in pregnancy.

So, these are all regarding the different changes in the maternal physiology during pregnancy all are designed to you know help the fetus get the necessary nutrients from the mother helping in growth and development of the fetus and also you know safeguarding the mother during the process of pregnancy and also during the delivery which is associated with blood loss, associated with several stress these changes will are designed in such a way for both the well-being of the mother as well as the fetus right. So, this is all for today references taken out from D.C Dutta books of obstetrics, William's obstetrics and James's book on high risk pregnancy. So, keep studying take notes and meet you in the next class. Thank you.