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

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Physiology of Labor

Hello students. Hope you are all doing good. I welcome you to today's 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 Multispeciality and Medical Research Center, IIT Kharagpur. Today, we are going to discuss regarding the physiology of labour.

So, in the last class, we did have a discussion regarding the stages of labour that is the first, second, third and fourth stage of labour which together comes under phase three of parturition, right. So, we have discussed the four phases of parturition, the stages of labour and the cause of onset of labour. Today's class is a bit theoretical and it gives us the concept or the theories that are prevalent or that are the causal factors for the onset of labour at the end of pregnancy. So, the concepts covered in today's class, the physiology of labour particularly the maternal changes occurring in the myometrium, decidua and the cervix as well as the fetal changes occurring in amnion and chorion and the key paracrine as well as endocrine factors that regulates the phases of parturition.

Key words for today's class are as follows, right. So, coming to the discussion proper regarding physiology of normal labour. So, here it is just of yesterday or the previous class which deals with the phases of parturition, right. So, phase one of parturition which involves your uterine quiescence and cervical softening and it starts right from conception. In some books it has been said that the uterine quiescence actually starts before conception, before implantation, immediately after the formation of zygote within the ampulla of the fallopian tube, the uterine muscles undergo or know they will have some chemical morphological changes which will lead to uterine quiescence thereby preventing or making it unresponsive to the various stimuli present inside or outside the uterus.

So, it starts right from conception up to the late pregnancy. This corresponds both uterine quiescence as well as cervical softening. What does the cervical softening means? There are some extracellular matrix changes within the cervix which causes change in the consistency of

the cervix from that of the tip of the nose as is present in non-pregnant state to the consistency of the lips of the mouth which is present during the period of pregnancy. And this can be elicited by the Hegar's sign from you know 4 to 6 weeks. We have discussed the signs of pregnancy where Hegar's sign was due to the softening of the cervix can be elicited from 4 to 6 weeks of pregnancy.

Next is phase 2. Phase 2 which corresponds to the last few weeks last few weeks of pregnancy that is 36, you know 37, 38, 39 weeks you know the last 4 weeks of pregnancy. And here what happens this is you know depicted by cervical ripening right. So, cervical ripening is actually the phase 2 component and here you have the formation of lower uterine segment. What is the lower uterine segment? This is formed from the isthmus and the cervix is gradually you know the isthmus which was 5 millimeter in the non-pregnant state now becomes 10 centimeter in labor right.

So, in this phase if you are considering the phase 2 actually in phase 2 the lower uterine segment will become 5 centimeter. So, from 5 millimeter it is becoming 5 centimeter and also the cervix is more edematous due to fluid accumulation and more distensible right. So, as well as as well as along with cervical changes there will be certain changes within the uterine musculature that is the uterine myometrium as well as the decidua which is called as uterine awakening. So, it is not associated with uterine contraction, but there are certain changes which will you know precede the uterine contraction and this is called as uterine awakening. And we have also given name to this phase 2 which is called as the preparedness for labor.

This was the prelude and this is the preparation for labor. Phase 3 is actually the process of labor. So, during this phase 3 is actually the process of labor where the 4 stages of labor comes into picture and it is composed of both uterine contraction. So, there is onset of uterine contraction as well as cervical dilatation plus effacement. So, these changes occur and this will lead to the onset of labor and the delivery of the fetus as well as the placenta.

And lastly is the phase 4 of parturition which is nothing but recovery and this extends from after delivery you can say more precisely 1 hour after delivery because this 1 hour is actually phase 4 of you know stage 4 of labor. So, after stage 4 starts the phase 4 of parturition which is 1 hour after delivery till 1 hour till fertility restoration which means till ovulation which is actually 4 to 6 weeks after delivery right. So, if the mother is breastfeeding then she will again ovulate or fertility is restored approximately 4 to 6 weeks after the delivery of the baby. So, these are the phases of parturition and now we will see the different you know changes that occur both in the maternal compartment as well as the fetal compartment. Coming to the maternal compartment we have to study the changes occurring in the uterus as well as the changes occurring in the cervix.

Now coming to the changes of the myometrium. Myometrial cells are typically have certain characteristics which help them to you know undergo the changes during pregnancy. They are not I mean terminally differentiated right. So, they can undergo certain changes under stimuli right. So, they will undergo certain changes undergo changes under various stimuli.

What are these stimuli? It can be stretch because the cells myometrial cells are getting stretched due to the you know over growing fetus. So, it may be due to stretch, due to infection or due to certain withdrawal of some hormones which was already present right. So, say progesterone, progesterone withdrawal or due to certain release of other hormones during the process of continuation of pregnancy like oxytocin release. So, all these stimuli will have effect on the myometrium. What will be the effects? There will be cellular growth or hyperplasia.

There will be hypertrophy of the myometrial cells, hypertrophy. It is also associated with secretion of certain substances which help in maintenance of pregnancy as well as it will have contraction right. And coming to this contraction part, this is the uterus and it has three layers of you know muscles. The outer is the longitudinal muscle layer. So, this is the longitudinal muscle layer which is surrounding the uterus like a dome.

This is the outer longitudinal layer. Next is the inner circular layer. These are the inner circular muscle layer right. So, they are actually covering the uterine cavity. So, this circular inside is the uterine cavity and around the uterine cavity are the circular muscle layer and in between, in between this inner circular and outer longitudinal here are I will use a different color.

So, here is the crisscross pattern of middle layer of uterine muscles and in between this crisscross muscle layer are the uterine branches of the uterine vessels. So, this is the middle criss cross layer and it is to be noted here that this crisscross layer is actually the living ligature of the you know of the uterus because when it contracts after delivery of the baby, it will obliterate the blood vessels passing in between this muscle layers and thereby you know it helps to control the bleeding, it helps to prevent your postpartum hemorrhage right. So, this is called as living ligature and it contracts like a figure of 8, figure of 8 contraction and when it contracts it will obliterate the blood supply to the uterus thereby decreasing the postpartum hemorrhage. So, this was regarding the orientation of uterine muscles. Coming to the contraction, yes the contraction wise it is it has more contractility than the skeletal muscles and also another point is your it has different directions.

So, outer longitudinal when it contracts it will decrease the height, inner circular when it contracts it will obliterate the uterine cavity. So, now this contraction will now there are different directions of uterine muscle contraction. So, overall the force of contraction is more right, force of contraction is more and they have a plexiform arrangement. These muscle fibers

have a plexiform arrangement which will augment their shortening as well as force of contraction production. So, all these characteristics of these myometrial cells help both in cellular hyperplasia and hypertrophy which is required during the continuation of pregnancy and it will secrete certain factors which will come we will discuss which helps in continuation of pregnancy and when these factors are withdrawn when they when they decrease in secretion and you know that will lead to the onset of labor and during this onset of labor or during the process of labor the uterine muscles contract that too in a very synchronized manner to help in fetal descent and delivery of the fetus following the delivery of the fetus it will again contract as a whole thereby decreasing the chances of postpartum hemorrhage.

So, that was regarding uterine myometrium. Now, coming to the uterine decidua which is nothing, but the endometrial lining during pregnancy which is called as decidua and this have some immunomodulatory functions right. So, what does that mean? Immunosuppression during the start of pregnancy. So, immunosuppression in the beginning in the start of pregnancy helps to prevent the fetus no implantation of the fetus. So, I mean this immunomodulation present within the decidua will help to accept the zygote right or the embryo to get implanted inside the decidua of the uterine cavity or else the zygote can get rejected and that will lead to implantation failure or early pregnancy loss.

So, this immunosuppression is very very important during the first half of pregnancy and this you know immunosuppression continues throughout the pregnancy, but at the end at the end just before the onset of labour there are release of pro inflammatory cytokines proinflammatory cytokines which help in the initiation of labour. So, that was the immunomodulatory function of decidua. Now, coming to the cervix, cervix also you know helps in continuation of pregnancy it you know maintains the cervical competence thereby helps to you know it helps to carry forward the growing fetus inside the uterine cavity and also acts as a protective epithelial barrier thereby prevent infection to ascend up inside the uterine cavity from the vagina thereby prevent chorionitis and other you know detrimental effect on the fetus. And number 3 are the extracellular matrix changes the ECM changes which causes greater tissue compliance right. So, that will help in cervical softening and that is required during the period of pregnancy right.

So, if you consider say this is the cervix, this is the internal os and this is the external os. So, during pregnancy what happens the extracellular matrix has both fibroblast and smooth muscle cells. In the internal layer they it consists approximately 50 percent the total stroma will consist of 50 percent of smooth muscles whereas, the external os contains only 10 percent of smooth muscle. And this you know balance between the smooth muscle and fibroblast helps to helps to maintain the cervical competency that will prevent you know miscarriage that will prevent second trimester pregnancy loss and ultimately help in continuation of pregnancy. So, this was regarding the cervical softening.

Now, coming to cervical ripening which occurs just before the onset of labor there are process of inflammation nitric oxide synthesis which will cause changes in the extracellular matrix right. So, what will it cause? It will cause degradation of the collagen fibers as well as cause fluid accumulation which will lead to edematous cervix right and this will ultimately cause cervical distensibility. Also the progesterone withdrawal which occurs in the phase 2 of a parturition. So, that will lead to nuclear factor kappa beta activation which will lead to different release of pro inflammatory mediators like interleukins, cox 2 and you know different inflammatory cytokines which will ultimately cause you know degradation of matrix metalloproteinase right. Hyaluronic acid increases increase in glycosaminoglycans these changes ultimately lead to cervical ripening ok.

So, this is the you know pictorial representation of the orientation of collagen fibers in the cervix now before cervical ripening the collagen fibers are more compactly arranged, but just you know the marking the onset of phase 2 that is during cervical ripening the collagen fibers are loosely arranged. Here you can see they have been loosely arranged loosely packed fibrils and also there is fluid accumulation which leads to cervical distensibility and cervical ripening. So, this is the changes which occur during the phase 2 of parturition. So, that was the maternal component now coming to the changes in the fetus, fetus you know town fetus will also have its effect in the onset of labor right. How? Fetus has 2 compartments the amnion and the chorion the amnion is actually a membrane which forms a protective covering around the fetus.

So, if you say this is the amnion and the fetus is inside the amniotic fluid the amniotic fluid will contain you know various exfoliated skin cells of the fetus the lanugo hair the exfoliated skin cells fetal skin cells right. Then it will have the vernix and you know that forms a cushion like effect around the fetus, but the amnion this membrane this membrane is having high tensile strength. So, it is stretchable right and this tensile strength of the amnion prevents its rupture and that will prevent preterm delivery. So, it will increase it will get stretched as the fetus go grows and this intactness of the membrane will prevent preterm labor also it is avascular. So, avascular so, this will give a protection right protective barrier protection against microorganism.

It will prevent entry of microorganism any lymphocyte or any neoplastic cells of the mother into the fetus of mother into fetus because it is avascular right. So, that was regarding amnion and coming to chorion chorion is actually the chorion is the fetal part of the placenta. So, what this chorion does? So, this is the amniotic epithelium the amniotic fluid fetus is inside the amniotic cavity and say this amnion will cause release of various prostaglandins like prostaglandin E 2 right, but what happens in the chorion? Chorion is actually formed by the trophoblastic the cytotrophoblastic cells right and this will release prostaglandin dehydrogenase right. So, prostaglandin dehydrogenase will be secreted by the chorion and that will degrade it will degrade the prostaglandin. It will degrade the prostaglandin E2 which was being formed from the amnion and thus prostaglandin will not reach the myometrium or the decidua of the

mother it will not reach.

So, this will maintain the uterine quiescence, but as pregnancy progresses right as pregnancy progresses say in the later stages of pregnancy you know phase 2 just before the onset of labor the prostaglandin dehydrogenase synthesis decreases in later stage of pregnancy right you know marking the onset of labor. So, what happens then? What happens then? There is no prostaglandin dehydrogenase in the circulation from the amnion. So, there will be prostaglandin synthesized by the amnion it will not be degraded and it will reach the uterine muscles and will lead to uterine contraction. So, that is also causing onset of labor. Now, coming to the sex steroid hormone sex steroid hormone actually progesterone.

Progesterone helps in maintenance of the pregnancy and progesterone by estrogen ratio is high during the period of pregnancy during pregnancy this ratio will decrease just you know before the onset of labor right. So, that will lead to uterine you know that will that will that will decrease the uterine unresponsiveness and will make the uterus or uterine myometrium responsive to various stimuli like oxytocin and prostaglandins leading to uterine contraction right. Now, coming to the prostaglandin role what is the role? Prostaglandin is actually synthesized from arachidonic acid which will cause the production of prostaglandin right prostaglandin H2 ok. So, this is by COX 1 and COX 2 enzyme and this prostaglandin H2 will ultimately form prostaglandin E2, prostaglandin F2 alpha and prostaglandin I2 that is prostacyclin right. So, these what happens this is changed by isomerase.

So, these prostaglandins will actually help in uterine contraction they will bring about uterine contraction and will lead to the expulsion of the fetus. So, during pregnancy what happens these prostaglandins are actually degraded right. So, these are inactivated by prostaglandin dehydrogenase. So, prostaglandin dehydrogenase which is secreted from Corion will will inactivate this prostaglandin and thus help to maintain the uterine quiescence.

Another thing is NSAIDs. NSAIDs will inhibit the COX 1 and COX 2 and thus it is used in preterm labor because there will be no production of prostaglandins no uterine contraction and thereby continuation of the pregnancy. So, NSAIDs are used in preterm labor, but what is the side effect it leads to premature closure of ductus arteriosus. So, it is not used in treatment of preterm labor previously it was used in the treatment of preterm labor ok. So, that was regarding the fetal and maternal component taking its role during the you know during the phase of parturition. Now, in a just in a nutshell you know phase 1, 2, 3 and 4 right.

So, this now it has changed it is phase 1, phase 2, phase 3 and phase 4 of parturition right. So, phase 1 is actually the prelude or uterine quiescence and cervical softening where you have the progesterone, the prostacyclin, the nitric acid right. Then other some other you can add here is your that we have already read prostaglandin dehydrogenase right. Then is your caspase right

caspase 3.So, these are helping in uterine quiescence. Coming to the phase 2 or the uterine activation or uterine awakening what happens number 1 is the uterine stretch receptors. So, more the uterine stretch receptors being activated it will lead to uterine activation. So, this graph is actually on the y axis is the uterine contraction it has been plotted. So, uterine contraction see in the uterine quiescence there is no uterine contraction. In the uterine activation stage slowly slowly uterine contraction is getting activated and during the process of labor this is the phase 3 or the process of labor when the uterine contraction is maximum and phase 4 is the recovery phase or the involution phase where gradually gradually the uterus reverts back to its pre-pregnancy period right.

So, that was regarding the phase 2. So, uterine stretch will lead to onset of the phase 2 of parturition that is known as mechanotransduction. More stretching will lead to uterine contraction activation right. Then progesterone withdrawal progesterone withdrawal then prostaglandin synthesis right. Then CRH corticotropin releasing hormone from the fetus which will lead to fetal cortisol. So, these are all the different parameters which help in activation of the uterine muscles for contraction. And phase 3 is actually the process of labor where we have the prostaglandins coming into play the oxytocin coming into play and in the phase of involution oxytocin mainly will act which will help in recovery of the total all the structures of the mother back to its pre-pregnancy state.

So, that was regarding the phases of parturition and the factors responsible. Coming to uterine contraction we know there are different you know modalities which lead to uterine contraction during labor. Number 1 is the actin myosin filament complex formation and we have already discussed that it is in a plexiform arrangement helping in more force of contraction as well as you know for the direction of contraction is also in different directions both longitudinal as well as inside due to the circular muscle arrangement. Then is the calcium calmodulin complex formation then your cyclic AMP cyclic AMP will decrease that will lead to trying contraction. So, during the period of pregnancy cyclic AMP levels are high right uterine gap junction uterine gap junction formation helps in transmission of signals thereby coordinated uterine contraction right.

Then others are your connexin 3 43 activation right contraction associated protein that will increase in its concentration all these will lead to uterine contraction and these uterine contraction in the first part of labor it will be there will be contraction and relaxation contraction and relaxation. But this relaxation during this relaxation the muscle fibers will not revert back to its original length, but it will be shortened permanently that is called as uterine retraction. So, the muscles are shortened permanently right. So, that is your uterine retraction and it will be synchronized so as to help in fetal descent right. Next is the pacemaker which is present in the tubal ostia the tubal ostia from here the signals start for uterine contraction and they will go downwards they will go downwards that will lead to the contraction of the fundus more strong.

So, these waves of contraction will be going downwards leading to more contraction more forceful contraction of the fundus compared to the lower segment lower segment will not contract that much that that means, it will help in the fetal descent and the lower segment will help to occupy the fetal presenting part during the process of labor. So, what are the patterns of uterine contraction I have discussed some will be downwards and some will be inwards right. But ultimately it will lead to contraction of the upper uterine segment and relaxation of the lower uterine segment. So, this is the upper uterine segment and the lower uterine segment will more or less be relaxed thereby leading to the physiological contraction ring. This is important because that this will help to physiological contraction ring this will help for the fetus to come down.

So, the fetus will be coming down. So, this is the fetus and the fetus from the upper uterine segment it will come down into the lower uterine segment and the lower uterine segment will help to accommodate the fetus thereby helping in fetal descent. So, that was regarding uterine contraction say here in the pre labor state there are different points of you know haphazard way there will be certain contractions these are called as Braxton Hicks contraction. But as the process of labor starts as the process of labor starts these will all be synchronized say all these uterine contraction impulses are synchronized and they work in the downward direction. Now, what is the contraction uterine contraction axis during contraction uterus becomes hard and somewhat is pushed anteriorly to make the long axis of the uterus parallel to the pelvic axis thereby helping in the fetal descent into the pelvis right.

So, that will help in the process of labor. Next is your retraction I have told that it is a phenomenon of the uterine muscles in labor in which the muscle fibers are permanently shortened. So, unlike other muscles of the body the uterine muscle have a property to become shortened once and for all right. So, these are permanently shortened and that will help to push the baby downwards. So, this is you know this is first in the relaxed state it was this length contracted the length decreases, but as the progressive retraction occurs the length of the muscle fibers are permanently shortened. What are the effects of retraction? It will help in the formation of the lower uterine segment that will help to accommodate the descending fetus it will maintain the descent of the presenting part it will favor the separation of placenta.

So, uterus getting shortened, but the placental surface area is not getting shortened. So, this difference in you know retraction and the surface area that will lead to separation of the placenta from the uterine wall and this retraction will also help in obliteration of the blood vessels thereby helping in effective homeostasis thus decreasing the hemorrhage following delivery. Now, coming to the pain that occurs during the process of labor why it occurs? Number one it may be due to hypoxia, it may be due to the stretching of the peritoneum on the fundus or due to the stretching of the cervix and the ligaments that will lead to pain and also the nerve ganglions

the sacral nerve ganglion the parasympathetic nerve ganglion which are present just you know outside the cervix. So, that will get compressed and will lead to pain. So, this pain is distributed between T10 to L1 right pain of cervical dilatation and stretching is referred back to the sacral plexus.

So, sometimes during the start of labor onset of labor the lower abdominal pain sometimes get radiated to the thighs. So, that was regarding pain coming to the tone of the uterine muscle tone increases as the labor progresses intrauterine pressure in between the contraction right. So, that is the uterine tone and it increases as labor progresses. Tone increases intensity of contraction also increases we will go through them. So, just note that the tone of the contraction increases the direction is downwards it is synchronized coming from the tubal ostia downwards to the lower uterine segment helping in descent of the fetus and as the labor progresses the intensity of contraction increases right 40 to 50 millimeter of hg becomes 100 to 120 millimeter of hg during the second stage of labor also the frequency and duration increases when the contractions just before the onset of labor it was coming at a interval of 15 minutes slowly slowly each contraction will come in every 1 to 2 minutes right.

So, duration decreases and frequency increases. So, all these occurs and that will lead to the process of labor which will you know help in the process of delivery. So, it is important to note that all the features of uterine contractions are mentioned above they are they they are effective only when they act in combination and in synchrony right their production right from the start of the impulse of contraction from the 2 tubal ostia the the direction of the flow of the impulse the uterine muscle contraction that you know the length or the direction of decrease of the length of the muscle fibers also the intensity the frequency the period of relaxation occurring between each contraction all these have to work in combination and in synchrony thereby helping you know effectively helping in fetal descent and in the process of labor. So, that was regarding the uterine contraction that was all regarding the physiology of labor references for today's class has been taken from 26th Williams obstetrics I will recommend to you all to go through this book because it has been written in a very lucid language also D.C.Dutta textbook of obstetrics and James book on high risk pregnancy have been discussed right. So, that was for today's class. Thank you and keep reading and keep clearing your doubts and hope to meet you all in our next class. Thank you.