VETERINARY TODAY

Popular Article
ISSN: 2583-8288

Role of the Fetal Pituitary-Adrenal Axis and Placenta in The Initiation of Parturition

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Introduction

The fetus should have a significant role in establishing the timing of parturition since it is imperative that it is born when it can survive in the extrauterine environment. However, there is just as much variability in the involvement of the fetus in the time of birth as there is in the species variations in hormonal profiles during pregnancy. The elimination of the progesterone barrier is the result of the pituitary-adrenal axis of the fetus becoming activated. Fetal cortisol levels dramatically increase in the final 20–25 days of pregnancy, peaking two–three days before delivery. The ability of fetal cortisol to bind to plasma protein increases in response to fetal stress or the production of specific other biochemicals. This lowers the level of free cortisol in the blood of the fetus. Because of this, the fetal hypothalamus is stimulated to release cortisol, which then acts on the fetal pituitary to produce ACTH. Cortisol is released into the fetal circulation by this ACTH's action on the fetal adrenal gland.

Role of fetal cortisol

- Action on fetus

Surfactant release helps the lung and lowers the surface tension of alveoli. Tri-iodothyronine or catecholamine production can be increased to raise BMR, which aids in controlling body temperature. To provide the calf energy up until nursing, it triggers the liver to metabolize glycogen.

- Action on placenta

The placenta's 17 alpha-hydroxylase enzyme is activated as a result, and this enzyme converts progesterone in the placenta into estrogen. As a result, the levels of progesterone gradually decline and the concentration of estrogen gradually rises.

High molecular weight versions of ACTH circulate in the fetus throughout the middle of pregnancy, acting—possibly—through type 1 ACTH receptors to deliver a basal stimulation to the fetal adrenal. The principal ACTH-secreting neurons in the pituitary transition from AVP-target cells to CRH-target cells in late pregnancy (about 125 days), which results in an increase in ACTH3 output. The type 11 adrenal receptors, which are currently uncontrolled, are the mechanism by which the ACTH stimulates a substantial rise in cortisol production. The adverse impacts of cortisol on CRH production are overridden by placental1 PGE, which acts at the level1 of the hypothalamus and adrenal, and cortisol production is increased. A higher ratio of maternal estrogen to progesterone results from the placenta's ability to convert progesterone into estrogen as a result of cortisol's action to stimulate placental 17, alpha-hydroxylase activity.

Stages of parturition:

- **Preparatory stage**

There are three major changes:

1) Dilatation of cervix-

Dilation begins at the outside surface and progresses within from there. The external cervical os first dilates widely and develops a palpable frill at the cranial end of the vagina. The internal os is the final portion to enlarge in the cone-shaped cervix that is subsequently created. The uterus and vagina create a continuous canal when the internal os is completely dilated, and the distended allantochorion engages this canal. The cervix of a pregnant female changes from its original solid firmness to one that is soft and flexible. The cervix is widened to the maximum extent possible by the conceptus's propulsion into it. The actions of numerous hormones, including as estrogens, adrenal corticoids, relaxin, and prostaglandins, are likely to be responsible for the alterations in the cervix.

Onset of myometrial contraction-

Both the circular and longitudinal uterine wall muscle fibers actively contract. Regular uterine contractions take place with breaks; they start off weakly but get stronger with time. Contraction begins at the uterine horn's apices and moves down the horn toward the cervix. The strain of the contractions of the muscles along the length of the uterus is able to progressively dilate the parturient's cervix thanks to this contractibility of the uterine musculature. Other changes are brought on by the uterus's contractions. The bonds between the placenta and endometrium weaken over time, and a deciduate placenta separates the edges with bleeding.

2) Fetal disposition for expulsion-

The fetus adopts a diving stance that makes navigating the birth canal simple. The first water bag's rupture marks the conclusion of the primary stage of parturition.

❖ **Birthing process**

The uterine contractions that precede bursts of abdominal contractions are what cause the fetus to first enter the birth canal (pelvic inlet). These bouts are made up of many abdominal contractions. Following episodes of straining are accompanied by uterine contractions that occur 4–8 times per minute in cows. The two are coordinated because the myometrial contractions push the fetus towards the pelvic inlet, activating the pelvic reflex and causing straining. By pressing the fetus on the cervix and anterior vagina, the straining triggers Ferguson's reflex, which releases oxytocin and pushes the myometrium to contract more. The chorioallantois membrane approaches the vulva as a consequence of these contractions, and in the course of the abdominal contractions, the chorioallantois ruptures. When the animal is standing, the allantois ruptures in the majority of instances. Others may rupture after the animal has fallen to the ground. It looks like a blue bag because of its extremely vascular structure. However, the amount of cotyledon separation will influence how far the chorioallantois extends from the vulvaAfter chorioallantois rupture, stomach pain may temporarily lessen or stop, but it will return when the amnion gets closer to the vulva. This membrane is a thin, mostly avascular, opaque, and white tissue. A fetal foot gradually pushes on the amnion, causing it to burst and let some of the lubricating amniotic fluid to escape. The fetal head then moves into the vulva, and at this point, the uterine and abdominal muscles contract at their hardest, just before the fetal head emerges. The mother may relax after giving birth to the head, but soon after, another round of straining allows the fetal thorax to make it through the vulva. Usually, the rear extremities may be evacuated simultaneously with the delivery of the hips. When straining begins, nearly all animals lie down. Sometimes a calf will be delivered with the dam still standing. The cow, bitch, and ewe are more prone to lie on their sternums than the mare and sow, who often rest in lateral recumbency. The umbilical cords of the of springs frequently remain intact after they are delivered, and minutes may pass before the mother or offspring moves and ruptures the chord. In order to avoid depriving the newborn of a significant amount of fluid that would typically be sent

to it from the placenta, it is crucial to let this happen naturally. Artificial or premature cord rupture can do this. The two umbilical arteries and urachus withdraw inward or into the belly when a rupture occurs, preventing bleeding. The fetus of the monotoccus species travels in an arching manner from the uterus to the outside. In addition to keeping the fetal pelvis high in the delivery canal, where the mother's bisiliac diameter is largest, this has the effect of reducing the fetal pelvis' dorsoventral width.

- **Placenta expulsion**

The cotyledons and caruncles rapidly and gradually separate at this stage, leading to the eventual expulsion of the complete fetal membranes from the uterus. The third stage of labor is virtually completely caused by the uterine musculature in action. Fetal membranes dehisce and are expelled during this time. Dehiscence in cows can occur in low quantities throughout the first and second stages as well as this stage. The chorioallantois and attached amnion parts are typically expelled in two stages, the first of which is the membranes from the non-gravid uterine horn, which appears right away after fetus delivery and hangs from the vulva, and the gravid horn portion of placenta, which is delivered later. The flow of blood to the uterus is reduced once the umbilical cord is severed. As a result of the villi getting smaller and the crypts getting bigger, the placentomes collapse and the cotyledons separate from the caruncles. The uterine contractions, which are accompanied by periods of abdominal straining, cause further separation. Finally, the membranes from the posterior genital canal are anticipated.