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Parturition In Domestic Animals: A Review

Corresponding Author:
Mr. Govind Purohit,
Associate Professor, Vet Obst & Gynec, Raj University of Vet & Anim Sci Bikaner Rajasthan, Deptt of Vet Obst & Gynec Veterinary College Bikaner, 334001 - India

Submitting Author:
Mr. Govind N Purohit,
Associate Professor, Vet Obst & Gynec, Raj University of Vet & Anim Sci Bikaner Rajasthan, Deptt of Vet Obst & Gynec Veterinary College Bikaner, 334001 - India

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Author(s): Purohit G

Abstract

Parturition is the process of delivery of the fully grown fetus on the completion of the normal pregnancy period. Parturition is an interesting biological process in the sense that the uterus that was quiescent during the entire pregnancy starts contracting and the cervix that was tightly contracted relax sufficiently to allow the passage of the young one to the world outside the mothers womb, passing through the birth canal (which is formed by the uterus, cervix and vagina within the pelvic bones and their attachments).

Parturition is one of the most important events for the farmers as by this act of his animal he would derive gain in terms of milk or sale of animal and its progeny. Most domestic animals are prone to maximum injuries and infections, some of them endangering the life of the fetus and the dam immediately, and some of them affecting the future productive and reproductive life of the mother. Therefore, due care must be exercised in advance and sufficient vigilance must be kept during parturition to minimize parturient problems.

It is desirable and often safe to shift animals about to parturate to separate, quiet, clean area with sufficient protection from inclement weather. Cows, buffaloes and mares are often shifted to calving pens/foaling pens. Sheep and goat often parturate at pasture but at organized farms they may be shifted to kidding pens, separate from other animals that may disturb them. A close watch on the parturating animals is essential to provide assistance as early as possible when required. Mares can often inhibit or prolong parturition voluntarily in the presence of persons and daylight and they mostly foal during the night hours (Haluska and Wilkins, 1989, Purohit et al., 1999). Therefore, mares must be visualized from distance. Modern stud farms have closed circuit TV cameras fitted in the foaling boxes for this purpose.

Farrowing crates are highly desirable for sows with constant watch being kept on farrowing sows to prevent them from lying on newborn piglets. For bitches, whelping boxes of cardboard with newspapers are often good. The bitch should be familiar with this environment 15-20 days ahead of whelping. Queens often require a quiet environment and they thus seek solitude.

Introduction

Pre parturient Care of the mother

Throughout the gestation and especially during the last part, the nutrition of the pregnant animals is important. Feeding of animals should be oriented in such a way that the prepartum or parturient incidence of some of the commonly occurring metabolic disorders is minimized, a healthy viable progeny is produced and the milk production of the dairy type animals is optimum. It is beyond the scope of this book to discuss all of these strategies in detail. In dairy cattle, farmers often feed their pregnant cows with concentrates only during the last few days of pregnancy and often vegetable oil is added to the concentrates. Although growth of the fetus occurs maximally during the last part of gestation, however, the value of such oil feeding is not beyond doubt. Recent suggestions for feeding of pregnant dry cows include the feeding of high-fiber low-energy chopped straw (Roche, 2006; Wilde, 2006) and the feeding of anionic salts in combination with adequate calcium and magnesium (Beever, 2006) and restriction of rumen degradable protein (Taminga, 2006).

Extra energy feed is required for sheep and goats that have been diagnosed to be carrying twins. The feeding of the bitch should be aimed at increasing the energy intake during the last four weeks of pregnancy and 1.0 –1.8% calcium and 0.8-1.6% of phosphorous should be included in the diet of late pregnant bitches (Jackson, 2004).

Vaccination of pregnant animals for the prevention of some infectious diseases has been mentioned previously, however, these vaccinations depend on whether or not, the disease is prevalent and the species-specific requirement. Pregnant mares however, need to be essentially given tetanus antitoxin or tetanus toxoid during gestation and immediately after foaling.

Special attention need to be attached to the hygiene at the time of parturition and as such, animals must be shifted to hygienic parturition stalls and this would also prevent over crowding.

Signs of approaching parturition

Some externally visible changes do occur in animals when parturition is approaching. The most important external changes of approaching parturition are seen in the udder, vulva and pelvic ligaments and to some

extent in the behavior. The symptoms are inconsistent between individual animals, and between consecutive parturitions. The symptoms therefore, do not permit an accurate prediction as to the exact time of parturition in a certain animal but are only useful indications as to the approximate time parturition can be expected. Clinicians must therefore refrain from too positive statements concerning the exact time of parturition.

Animals like sow, dog and cat attempt to segregate themselves from the other animals to make a suitable nest or bed. Cats often hide in some isolated places when kept as a pet, and so do bitches attempt to hide. In the cow, buffalo, sheep and goat the pelvic ligaments, especially the sacro-sciatic ligaments become progressively relaxed as parturition approaches, causing a sinking of the croup ligaments and muscles and raising of the tail head . These changes occur because of the changing hormonal milieu including estrogen and relaxin. The changes are most marked in the cow and presence of very relaxed ligaments indicates that parturition will probably occur in 24-48 hours. The relaxation is less appreciable in the sow, bitch, cat and mare. In female camels the relaxation is visible some weeks before parturition. The vulva becomes progressively edematous, flaccid and enlarged (2 to 5 times normal size) as parturition approaches in most domestic animals.

The udder becomes enlarged and edematous. In heifers, udder enlargement may be initiated at 4 months of pregnancy but this may not be noticeable in pleuriparous cows 2 to 4 weeks before parturition. Edema in the udder may sometimes be extensive (towards abdominal floor even up to the xiphoid region) and may create difficulty in walking. Caudally this may extend up to the vulva.

Just prior to parturition the udder secretion changes from a honey like dry secretion to a yellow, turbid, opaque cellular secretion called colostrum which may sometimes dribble down.

In mares, the udder becomes distended with colostrums 2 days before foaling and oozing of colostrum from teats, called waxing is usually observed in most mares 6 to 48 hours before foaling (Renton, 1984).

The udder development is less marked in the ewe and doe. In bitches, cats and sows mammary enlargement may be evident a few days before, parturition and milk let down may occur in sows 24 hrs before farrowing.

Because of the liquefaction of the cervical seal in the cow tenacious vaginal mucus discharge may be seen. Similar discharges may be seen in the sheep, goat, buffalo, sow, female camel and bitch. Some vaginal discharge is seen in the cow from the seventh month of pregnancy but this is scanty, however near

parturition the discharge may be profuse (24 hours before calving).

In the cow a drop in body temperature may occur before parturition, but this is most marked in the bitch in which there is drop of 1°C body temperature 24 hours before whelping (Concannon et al., 1989).

As animals approach the first stage of labor the symptoms of restlessness, abdominal discomfort and anorexia become prominent and mares may roll down. Dogs may show little vomition.

Initiation of Parturition

The process of parturition is initiated because of many fetal, maternal and interrelated events some of which are yet poorly understood. In some species evidence shows that the fetus exerts an control over the length of gestation whereas, the mother can influence the time of birth within narrow limits (Noakes, 1999).

The primary precursor for initiation of parturition appears to be prostaglandin in the pig, fetal cortisol in sheep and interplay of prostaglandins and fetal cortisol in the cow (Jainudeen and Hafez, 2000). In the mare oxytocin appears to be the primary parturition stimulation molecule (Liggins and Thorburn, 1994). A complex mechanism is operative in the initiation of parturition in various species. Few of the factors responsible and the probable endocrine events are shown in Table 1 and figure

Fig 1 Possible endocrine changes that occur during the periparturient period in the sow, ewe, cow and their effects

The mechanism of parturition

Parturition involves a lot many changes in the maternal system and the fetus. Some of these changes are gradual occurring several days before completion of gestation while others occur more abruptly. The final growth of the fetus signals some molecules which alter the hormonal milieu of the mother and positive interactions between the mother fetus and the environment result in parturition. Successful parturition depends on two mechanical processes; the ability of the uterus to contract and the capacity of the cervix to dilate for an easy passage of the fetus.

Prepartum maturational events

Maternal changes

The essential prepartum events in the mother are those which ensure myometrial contractility, cervical dilation, lactogenesis and specific behavioral changes including nest making, the onset of protective aggressive behavior and after delivery, nursing and bonding with the neonate (Silver, 1990).

Myometrium: Throughout most of gestation in many species the myometrium is relatively quiescent and contains few gap junctions (Garfield, 1988). Slow

contractions (contractures) occur infrequently and generate little hydrostatic pressure but are detectable electromyographically (Hindson and Ward, 1973; Nathanielsz, 1985). The frequency and intensity of contractures rise towards term under the gradually increasing estrogen and decreasing progesterone. Estrogens generally favor the synthesis of contractile proteins in myometrial cells and enhance electrical coupling and the expression of oxytocin receptors leading to well propagated, coordinated contractions (Jenkin and Young, 2004). They also favor the release of prostaglandins. Prostaglandins also increase during labor in all species (Thorburn et al., 1977). The mechanism which initiates luteolysis in the sow is still unclear (Silver, 1990). The increasing PG also favors increased contractions. Relaxin, which is secreted from the corpus luteum in increasing amounts around the time of luteolysis, seems to be an important component in prepartum events in the sow (Sherwood, 1982) and presumably cow. It is inhibitory to uterine activity. Thus only when relaxin levels fall does uterine activity increase and PGF2 or its metabolites become detectable in uterine venous blood in the sow (Sherwood, 1982, Silver et al., 1979) although progesterone levels have fallen down. Relaxin is secreted by the placenta, in the mare and dog. In the cow relaxin probably causes relaxation of the pubic symphysis, sacro-sciatic ligaments and the cervix. Relaxin is usually seen in dogs, horses and pigs, whereas relaxin like molecules are also seen in ruminants. A ruminant like relaxin has been recently found in ovaries and utero placental units of female camel (Hombach-Klonisch et al., 2000).

In most domestic animals the uterus is thus transformed from a quiescent structure to an actively contracting organ near parturition due to changes in steroids and other molecules.

The prepartum steroid hormone changes in the mare are different from other domestic species. Circulating estrogens consist of the biologically inactive equilin and equilenin and total estrogen levels fall towards term (Pashen, 1984) whereas, although the circulating progesterone concentrations are low in late gestation, relatively high concentrations of 5a-reduced progesterone metabolites are observed near parturition (Holtan et al., 1975, 1991), suggesting that the estrogen/progesterone ratio is relatively unimportant in this species.

Oxytocin is the final hormone associated with parturition and in general is not secreted in significant amounts until the second stage of labor has began, since the primary stimulus to the posterior pituitary arises from distension of the cervix and vagina (Silver, 1990). Both changes in the estrogen; progesterone ratio and increases in PG production elicit oxytocin receptor formation (Soloff et al., 1985). The equine myometrium appears to be more active towards oxytocin in the last few weeks of gestation than most other species (Haluska et al., 1987) and oxytocin will readily provoke the onset of labor in the equine species (Pashen, 1980).

Cervix: While the smooth muscle component of the cervix reacts to changes in steroids in a manner similar to myometrium, the connective tissue matrix of collagen and glycoprotein is very different (Silver, 1990). The dilation of the cervix is known to be induced by maternal steroids and prostaglandins released locally (Silver, 1990) and proinflamatory cytokines (Van Engelen et al., 2009). The cervical softening (ripening) involves edema and softening because of enzymes. This occurs slowly as parturition approaches and rapidly with the onset of labor (Ourny et al., 1991). The increased hydration and release of enzymes during parturition loosens the collagen fibres that were tightly packed during gestation (Rajabi et al., 1991). The nature and extent of prepartum changes in the porcine and equine cervix are poorly described.

Mammary gland: The prepartum maturation of this organ includes a large rise in blood flow and changes in the overall volume and composition of secretion (Mellor, 1988). The increase in mammary blood flow is closely associated with a fall in progesterone and rise in estrogen (Burd et al., 1978) as are the changes in the volume and the nature of the milk. The changes in the electrolyte concentrations of the prepartum milk of the mare (high calcium and sodium near term) (Ousey et al., 1984a) have led to development of commercial kits (like Predict a Foal®) used to predict foaling in the mare. However the efficacy of such kits continues to be debatable. Similar studies in the ruminant species have been performed (Fleet et al., 1975) but their utility is negligible. Fetal changes before birth

The fetus which depended on the placenta for respiration, nutrition and excretion, makes a complex series of structural and physiologic adjustments before parturition for extra-uterine life. To meet the above challenges several fetal organs undergo maturational changes in late pregnancy that is largely regulated by the fetal cortisol (Liggins, 1994). The changes include:

1. Maturation of lungs to overcome the high surface tension with the first breath. Lung expansion is facilitated by secretion of surfactants which reduces the surface tension within the alveoli (Liggins and Kitterman, 1981; Possmayer, 1982; Silver, 1990).

2. Development of glycogen reserves in fetal liver and glucose production from these glycogen reserves to meet the energy supply of the neonate until suckling is started (Shelley, 1961).

3. Increased output of tri-iodothyronine and catecholamines to meet the sharp rise in metabolic rate and temperature regulation (Klein et al., 1978).

Closure of the ductus arteriosus.

Closure of the foramen ovale within a few hours of birth in foal.

Prepartum signals for parturition initiation

The initiation of parturition in most domestic animals continues to be only partially understood. It is fascinating that on completion of events necessary to render a young one capable of independent life outside the mother's uterus, closely coordinated changes occur in the fetus and mother resulting into delivery of the fetus by the act of parturition. Possibly the initial mechanism for the timing of birth is encoded in the fetal genome and is closely linked to, and activated when certain prerequisite developmental events have occurred in the fetus (Jenkin and Young, 2004). The possible factors that help in initiation and the act of parturition include physical, biochemical and neuro endocrine (Table 1) factors.

It is considered that in most species the fetus exerts a control over the length of gestation whereas, the mother can influence the time of birth within the narrow limits (Noakes, 1999). The fetal pituitary adrenal axis is known to initiate the prepartum events by which signals to the placenta trigger the maternal hormonal changes which allow normal labor to proceed at least in the ruminants and to some extent in the pig (Thorburn et al., 1977; Silver, 1990). The role of fetus and the nature of its signals to the mother for maternal changes are still unknown in the horse (Silver, 1990) and the dog (Taverne and van der Weijden, 2008).

The uterus remains quiescent during pregnancy in most domestic animals by a combined action of luteal and / or placental progesterone and molecules like relaxin, nitric oxide, prostacyclin and catecholamines (Lye, 1996). This is transformed into an oscillatory organ with cervical relaxation near parturition. Many biochemicals, hormonal and molecular changes precede parturition. The universality of the fetal glucocorticoid surge (sudden rise in levels) preceding normal labor at term suggests that it may represent a fundamental signal common to all species (Jenkin and Young, 2004).

Table –1: Possible factors responsible for initiation of parturition

	Probable factors	Effect
Physical factors	1. Increase in fetal size	Increase in uterine irritability
	2. Uterine distension	Reversal of progesterone block Reflex to reduce size by fetal expulsion
	3. Fatty degeneration of placenta & presence of infarcts	Leads to interference in fetal nutrition & separation process of fetus from uterus
Biochemical factors	1. Increase in CO_2 tension in maternal blood due to increased fetal activity	Increase uterine contractility
	2. Release of fetal antigens serotonin	Release of collagenase and stoppage of blood supply to cotyledons
Neuroendocrine factors	FETAL 1. Increase in cortisol in adrenals 2. Increase in ACTH by pituitary 3. Increase in corticotrophin releasing hormone (CRH) in hypothalamus 4. Increase in endogenous opiods MATERNAL 1. Reversal of progesterone block 2. Release of Relaxin 3. Placental estrogens rise 4. Proinflamatory cytokines 5. Release of PG 6. Release of oxytocin	Convert P_4 to E_2 & release of PG Stimulate cortisol release Stimulate ACTH Stimulate ACTH secretion Myometrial contractility Dilation of birth canal Release of PG In contractility Dilation of pubic symphysis and sacro-sciatic ligaments Softening of cervix, Stimulate smooth muscle contractility Myometrial contractions

The increase in uterine volume, fetal metabolism and fetal size might be some contributing factors. The high levels of cortisol in response to high fetal ACTH induces increased 17-a hydroxylase and C17, 20 lyase activity in the placenta which results in hydroxylation and aromatization of progesterone to estrogen (sheep, goat, pig, cow) (Anderson et al., 1975) or converts progesterone to inactive metabolites (rat) (Lye, 1996). The alteration in the steroid causes mobilization of two molecular/biochemical pathways (Lye, 1996) one leads to myometrial activation – increases in myometrial excitability, responsiveness to uterotonic stimulants and cell to cell coupling due to contraction associated proteins such as ion channels, agonist receptors and gap junctions. The other leads to increased production and release of uterotonic agonists (prostaglandins, oxytocin) to stimulate the activated myometrium. Estrogens increase PGs by changing the stability of lysosomal membrane in maternal placenta (Thorburn et al., 1977). Thus there is a reversal of progesterone block and prostaglandins not only initiate luteolysis but also result in formation of oxytocin receptors in the uterus and increased myometrial contractility.

Concomitant, to excitability of the uterus, the cervix must dilate and become soft and least in species like sheep, goat, cow and buffalo (which have a rigid cervix) and this softening involves an interplay of endocrine pathways and release of pro inflammatory cytokines (van Engelen et al., 2009). These changes might be initiated several days before parturition.

The altered maternal physiology especially the contracting uterus and a relaxed birth canal force the fetus to the exterior for its delivery. The vaginal distension and the tactile stimulation of the vaginal wall by fetal limbs evoke a cascade of oxytocin release (known as Ferguson's reflex) and potentiate the contractile forces.

Ruminants

The maximum number of studies on parturition processes has been conducted on sheep. Progesterone production in the pregnant sheep is derived from the corpus luteum during the first 50 days of pregnancy (Denamur and Martinet, 1955) but there is a gradual decline in ovarian progesterone secretion

thereafter (Edgar and Ronaldson, 1958). Thus ovariectomy after day 50 does not cause abortion because placental progesterone is adequate to maintain pregnancy (Linzell and Heap, 1968). However, in the goat and cow the corpus luteum is the major source of progesterone and its removal would initiate abortion throughout pregnancy at least in the goat although the placenta also produces some progesterone.

The initial stimulus for initiation of parturition in sheep was identified to be the fetal hypothalamo pituitary axis as birth did not occur in the sheep in the absence of fetal pituitary whether the latter was due to a genetic defect or surgical ablation (Liggins et al., 1973). The mechanism by which the fetal cortisol stimulates the hormonal cascade have been since then investigated in detail and it is increasingly acceptable that the fetus initiates the parturition in sheep (Silver, 1990; Lye, 1996; Jenkin and Young, 2004). It has been argued for quite some time that the initiation of parturition in the goat and cow depends on the lysis of the corpus luteum rather than the fetus.

However, it is increasingly clear that in ruminants (cow, sheep, goat), irrespective of whether the pregnancy is maintained by luteal or placental progesterone, the fetal pituitary-adrenal axis has the dominant role in initiating the prepartum hormonal changes in the mother (Thorburn et al., 1977; Silver, 1990; Lye, 1996; Liggins and Thorburn, 1994).

In the buffalo the plasma concentrations of estradiol 17-b start increasing 7 days before parturition to reach peak levels one day before parturition (Batra et al., 1982) and the progesterone decrease gradually over the last 7 days of gestation with an abrupt fall 1 – 2 days before parturition synchronous to peak PGF2a concentrations at the same time (Perera et al., 1981; Batra et al., 1982). The maternal plasma estradiol concentrations are higher before parturition in swamp buffaloes (Kamonpatana, 1984). It can therefore be believed that the mechanism of parturition initiation in this species is similar to that in cattle. Similar to buffaloes, the process of parturition has not been studied in detail in female camels (which also require the CL for the entire gestation) (Al-Eknah et al., 2001). Endocrinological studies however, depict that there is a prepartal (2-5 days before parturition) rise in circulating plasma estrogens and a concomitant rise in prostaglandin metabolites (El Belely, 1994; Skidmore et al., 1996). Both these hormones peak 2-5 hours before delivery (El Belely, 1994). Plasma progesterone concentrations decrease during the last month of pregnancy with a significant decrease 42-66 hours before delivery (El Belely, 1994; Skidmore et al., 1996; Zhao et al., 1998). The peaks of circulating maternal

corticosteroids are however, seen only 4 days prepartum with a sharp increase on the day of parturition (El Belely, 1994). Therefore, the stimulus for parturition initiation in camels is not clear.

Pig

In the pig the major site of progesterone production is the corpus luteum and ovariectomy at any stage results in abortion (Thorburn et al., 1977). However, the endocrine changes that are seen in both fetuses and sows in the prenatal period are similar to those in ruminants (Silver et al., 1979). Decapitation (Stryker and Djiuk, 1975) or hypophysectomy of the entire litter (Bosc et al., 1974) at an early stage of pregnancy results in prolongation of gestation and eventual death of fetuses in utero. If two or more fetuses remain intact delivery occurs at the normal time despite the presence of a majority without pituitary or active adrenal glands. It is therefore assumed that the fetal piglets initiate the maternal hormone sequence although with a mechanism that may not be directly through the pituitary adrenal axis (Silver, 1990). Alternatively it is possible that some different steroids or molecules of the fetus are operative.

Horse

The role of the fetus and the nature of its signals to the mare (if any) are still poorly known. The extremely low plasma concentrations of cortisol in the fetal foal until the end of gestation (Silver and Fowden, 1988), and a late growth of the adrenal gland (Comline and Silver, 1971) suggests that the pituitary adrenal maturation occurs much later in relation to the total gestation length (Silver, 1990). The fetal cortisol increases only in the last 48 hours before delivery and maternally administered glucocorticoid does not induce labor in the horse (Silver and Fowden, 1991). A very wide range over which normal term extends in the mare (320 – 360 days) and the comparative infrequency of premature delivery under natural conditions makes it virtually certain that some stimulus, whether endocrine or paracrine must pass from fetus to mother to indicate its readiness for birth (Rossdale and Silver, 1982). The link, most likely involves PGE2 which is secreted in increasing amounts by the placenta or fetal membranes in many species during late gestation (Jenkin and Young, 2004) and the prelude to labor (Fowden et al., 1994). It is also a potent activator of the fetal hypothalamo pituitary adrenal axis and glucocorticoid secretion (Louis et al., 1976).

Dog

Parturition in the dog and cat is preceded by a drop in plasma progesterone and rise in prostaglandin F metabolite levels (Concannon et al., 1989; Verhage et al., 1976; Baan et al., 2008) but it is not clear how these hormonal changes are triggered. Although the

fetal pups themselves are often said to initiate the whelping process, there are no indications in the literature that this is the case (Taverne and van der Weijden, 2008). A prepartum rise of cortisol has been detected in the peripheral circulation with peaks obtained 8-24 hours prepartum (Concannon et al., 1975). The plasma prolactin increases as progesterone decrease 1-2 days before whelping (Concannon et al., 1977). The mechanism of parturition continues to be poorly known in the dog and cat. The dog does not have a substantial increase in estrogen and it is possible that cortisol (if any) might act directly to stimulate prostaglandin release in the placenta or uterus in this species (Concannon, 2002).

Stages of parturition

Although events resulting into the delivery of fetus are a continuous process however, for the sake of understanding, the process of parturition has been divided into three stages referred as the stages of labor. The average time required for the three stages of labor for the various farm and companion animal species is mentioned in Table 2. The stages of labor defined previously are

1) The first stage of labor (Dilation of cervix)

2) The second stage of labor (Expulsion of fetus)

3) The third stage of labor (Expulsion of fetal membranes)

To describe the position of the fetus in the birth canal during its delivery some terms are used to understand its position. These are

Presentation

The relation of the spinal axis of the fetus to that of the dam is known of presentation. Thus, presentation of the fetus in the birth canal can be longitudinal, transverse or vertical. Longitudinal presentations are of two types: anterior longitudinal; when the fore limbs and head enter the birth canal first, and posterior longitudinal when the hind limbs and tail enter the birth canal first.

Transverse presentations are either dorsal or ventral, depending upon which portion of the fetus is towards the birth canal.

True Vertical presentations are not possible. A type of presentation which is considered partially vertical is the dog sitting posture.

Position

The relation of the dorsum of fetus in longitudinal presentation, or the head in transverse presentation, to the quadrants of the maternal pelvis is known as position. The quadrants are the sacrum, the right ilium, the left ilium, and the pubis. Thus positions can be dorso sacral, right or left dorso ilial, dorso pubic and right or left cephalo ilial.

Posture

The posture signifies the relation of the fetal extremities, or the head, neck and limbs to its own body. The extremities or head may be flexed or extended or retained on the left or right side, or above the fetus.

The normal birth presentation in uniparous animals is the anterior longitudinal presentation, dorso-sacral position with the head resting on the metacarpal bones and knees of the extended forelegs. Birth can occur without assistance if the fetus is in posterior longitudinal presentation dorso-sacral position and both hind limbs are extended. Unless, the fetus is small most other presentation, position and postures result in dystocia. The transverse presentation can occur in the mare, in which the fetus develops in both uterine horns, rather than in the body of uterus and one uterine horn. Transverse presentations are rare in ruminants, and the small animals.

In the multipara, posterior longitudinal presentations are considered normal and in fact around 40 percent of fetuses are delivered in the posterior presentations. Since the limbs of multiparous animals are small, short and flexible hence their posture is of little significance. Similarly, because of the short neck of swine fetuses the head and neck are seldom deviated.

First stage of parturition

The first stage of parturition comprises the initiation of contractions and the dilation of the cervix. The first stage of labor is presumed to have culminated with the delivery of the first water bag the allantois-chorion. This is usually grayish white in cattle (Fig __) and reddish (Fig __) in the mare.

The initial stages of the first stage of labor are characterized by active contractions that occur in both the longitudinal and circular muscles of the uterine wall, dilation of the cervix and assumption of the birth posture by the fetus. The dilation of the cervix takes place because of many complex events in cattle, and includes the remodeling of the cervical matrix with new collagen and proteoglycan synthesis (Challis and Lye, 1994). The dilation process also involves release of pro inflammatory cytokines (van Engelen et al., 2009). When both the os externus and os internus are fully dilated the cervix becomes continuous with the vagina and is palpable only as a small frill like structure.

Uterine muscle contractions are greatly increased the last 1 to 2 hours before birth basically because of the high levels of estrogens in some species. The oxytocin is seldom released from the maternal hyophysis before the second stage of labor in many species. In the cow the contractions occur about every 10 to 15 minutes and last 15 to 30 seconds. They progressively become intense, more frequent and of greater duration such that they occur about every 3 to 5 minutes in the

late stage of labor. (Roberts, 1985). In uniparous animals contractions start at the apex of the cornua while the caudal part does not contract but rather dilates from the pressure of the fetus and fluids forced caudally. During this stage in the mare and probably the bitch, the fetus is rotating from its "dorso-pubic" or "dorso lateral" position into the "dorso-sacral" position. In the bovine and ovine fetus no rotation is usually necessary as the fetus is already in a dorso-sacral position. By the end of first stage of labor the cervix is fully dilated and contractions occur rapidly. The allanto-chorion of the fetus enters the cervix and is ruptured here or when it protrudes out of the vulvar lips forcing the fluids of the allantois to be released.

In the multiparous animals, the contractions of uterus occur just cephalad to the most caudal fetus forcing it through the cervix into the birth canal, while the rest of the uterus remains quiescent. Then, the same process is repeated for the most caudad fetus in the other horn or the fetus immediately cranial to the one just expelled. The longitudinal fibers of the parts of the horn just emptied contract, but the circular fibers remain relaxed, so that the next fetus may pass through. This shortens the uterus as parturition progresses, so that each fetus in turn is brought back nearly to the cervix.

After the rupture of the first water bag the fetus wrapped in the amnion enters the birth canal and as the fetal legs enter the pelvis, there is reflex stimuli and release of high amounts of oxytocin from the pituitary. This is known as "Ferguson's reflex". There are increased uterine and abdominal contractions. The first stage of labor is considered to be over by the rupture of first water bag, and the entry of fetus wrapped in amnion in the vagina or outside the vulvar lips indicates the start of the second stage of labor.

The externally visible signs of the first stage of labor in the cow, buffalo, ewe and goat include symptoms of mild abdominal pain, frequent getting up and lying down which are marked in the primiparous animals. Animals evidence anorexia, stand with an arched back (Fig __) and raised tail, strain occasionally and ruminate irregularly. Buffaloes may evidence less intense signs compared to cows. In the mare, symptoms of restlessness, anorexia, colicky pains (Fig __), slight sweating behind the elbows and around the flanks, lying down and getting up are observed. The elevation of the tail, repeated stretching as if to urinate, frequent bowel evacuations, and looking at the flank are characteristic of abdominal discomfort in the mare. During the latter part of the first stage of labor the mare may roll back and forth (Fig __) in an attempt to rotate the fetus into a dorso-sacral position, or go down on her knees, rise again and be highly restless.

The body temperature may be slightly lower.

In the bitch, sow and cat nervousness, anorexia and an increase in pulse and respiratory rates usually occur. This may result in panting in bitches. Occasionally vomiting may occur in the bitch. There is usually a drop in body temperature (1 to 2°F) just before or during the first stage of labor in the bitch.

In the female camel there is increased restlessness and anxiety. The female seeks isolation. Animals may retain appetite until an hour before parturition. The animal shows signs of discomfort and frequently alternates between a standing and sitting position or walks in circles. The female may lie on one side from time to time. The first water bag may rupture within the birth canal in some females and hence does not appear out of the vulvar lips.

The second stage of labor

This stage of labor is characterized by the entrance of the fetus/fetuses into the dilated birth canal, rupture of the amnion, abdominal contractions and the expulsion of the fetus through the vulva.

In the cow, following the rupture of the allanto chorion the fetus wrapped in the amnion is pushed through the cervix and may appear at the vulva as a grayish blue translucent distended membrane. Intermittent straining occurs, and the amnion usually ruptures as the feet passes through (Fig __). In the mare, one leg of the fetus is ahead of the other by six inches as it passes through. Abdominal contractions are stimulated and they become intense as the head, shoulders or hips of the fetus pass through the pelvis. The head creates greatest difficulty in passing through in the uniparous animals. Often, after the fetal head passes the vulva, the dam will rest for a few minutes before straining again as the chest passes through the birth canal and vulva. The hips then follow. The fetus is delivered in an arc fashion.

Almost all animals lie down as soon as straining commences. Occasionally the foal or calf may be born with the dam standing. The mare and the sow usually lie out in lateral position with legs extended, whereas the cow, bitch and ewe are more likely to lie on their sternum.

Although foaling is very rapid in the mare however, it is accompanied by great expulsive efforts and the mare is usually exhausted and will lie down on her side for 15 to 30 minutes before rising. Since the umbilical cord in the mare is long it will remain attached to the fetus for an average 8 to 20 minutes until the mare or foal moves, when it breaks at a point 2 inches from the foals body. During the second stage of labor once the feet have appeared at vulva they should stay there and not appear and disappear with each abdominal contraction and so also the contractions should

gradually increase. If they rather decrease, assistance would be necessary in the delivery of the fetus.

In the bitch, the second stage of labor may be sometimes prolonged. After the delivery of first pup a bitch may deliver the second pup within 0.5-1 hour. Some bitches may not expel the second fetus for several hours after the first. Then, the next 2 or 3 may be expelled rapidly, followed by another delay. Pups may be delivered at irregular intervals. Rarely, they may be expelled in a short rapid time. The amnion of the fetus and the umbilicus of delivered fetus is usually broken by the bitch as she licks the vulva. After the birth of each pup the bitch rests, licks the pup and her vulva. The fetal membranes are expelled within 10 minutes after the birth of the pup and they are eaten by the bitch. Sometimes a bitch may eat even one or two puppies. Consumption of too many placentas by the bitch should be prevented as this may cause vomition and diarrhea. The greenish black fluid that is discharged following fetal delivery is normal and is due to breakdown of blood of zonary placenta resulting in the presence of bile like pigments, uteroverdin around the placental zone of attachment.

The sow and cat have a second stage of labor similar to that in the bitch. However, cats may evidence a cry during fetal delivery. The period of expulsion of pigs varies from 3 to 45 minutes or longer. The longest interval is observed between the first and second piglet and before the last piglet. After farrowing the sow urinates copiously.

In multipara the fetuses are expelled in an irregular manner from each horn. The presence of a dead fetus may delay the emptying of that horn. Occasionally in the mare, bitch and cat and only rarely in other domestic animals, the fetus may be born with the ammion or portion of it wrapped around its head. This may cause suffocation and therefore should be promptly removed. The intra abdominal pressure, caused by the contraction of the abdominal muscles and diaphragm and closure of the glottis is equal in all directions. The uterus is necessary to direct the fetus into the path of least resistance the pelvic canal. If a large hernia is present, abdominal contractions can force the uterus into the hernia. Sometimes, traumatic gastritis or displacement of abomasum can occur as sequel to parturition, due to the abdominal pressure.

When the umbilical cord ruptures on fetal delivery, the two umbilical arteries together with the urachus retract into the abdominal cavity of the fetus. The umbilical vein collapses, the blood drains from it and the fluids in the umbilical cord drain out, often aided by the licking of the cord by the dam.

The third stage of labor

The third stage of labor is characterized by the expulsion of placenta. After expulsion of the fetus the uterus continues to contract strongly for 48 hours and less vigorously, but more frequently there after. The changes necessary for the expulsion of the placenta in cow, ewe, goat and buffaloes start a few days before, parturition and are completed post partum. (Eiler, 1997). A weakening of the acellular layer of adhesive protein the so called "glue line" between the cotyledons and the caruncular epithelium need to be lysed or weakened for placental separation (Bjorkman and Sollen, 1960). The fetal villi shrink, owing mainly to the sudden loss of turgidity related to the loss of blood from the fetal side of the placenta when the umbilical cord ruptures. This is aided by the uterine contractions. The uterine contractions result in shrinkage of the fetal villi and dilation of the maternal caruncular crypts.

The fetal villi are drawn out of the crypts due to inversion of the allantochorionic sac. Cotyledon proteolysis and decreasing adhesiveness of the cotyledon-caruncle interface fluids seem to be the key issues for the release of placenta in the bovine species (Eiler, 1997). When a large portion of after birth becomes detached it forms a mass within the uterus which stimulates reflex contractions of the uterine and abdominal muscles and this straining completes the expulsion of the allanto-chorionic sac, which is seen to have its smooth, shining allantoic surface outermost (Noakes 1999).

In the mare, the resumption of substantial contractions of the uterine musculature in the third stage of labor causes abdominal pain, and it is quite common for expulsion of the membranes to be preceded by mild symptoms of colic. The placental separation however, is rapid in the mare compared to ruminants. With the exception of the mare domestic animals may sometimes eat their after birth.

In the dog and cats the fetal membranes are expelled irregularly between the fetuses; or one fetus may be expelled with its own placenta and that of a fetus expelled earlier. In rare instances expulsion of a few placentae may be delayed for 12 hours or more. In the sow, since a number of allanto chorions may be fused, the fetal membranes may thus be expelled at only 2 to 3 intervals during parturition. Most afterbirth is expelled within 4 hours after the birth of last piglet. The expulsion of last afterbirths thus stimulate the third stage of labor in the monotocous species with the exception of the sow, the females of other domestic species indulge in intensive licking of the newborn offspring. Within an hour of birth it is normal for the young of all species to start suckling milk. This suckling stimulus initiates the release of oxytocin which potentiates the myometrial contractions and

help in the expulsion of placenta.

Care of the post partum dam

Following parturition the dam should be allowed to lick and nurse her young one. Undue excitement should be avoided. Some animals have a strong maternal instinct and often object to shifting of their new born and this should therefore be done slowly. The roughage fed should be of good quality.

Table 2.   Duration of different stages of labor in domestic animals

Species	First Stage	Second Stage	Third Stage (Placental expulsion)	Reference
Cow	4-24 hours (Bluish vascular semitransparent chorio allantois appears & rupture)	0.5-3 hrs (Amnion appears with the fetus. Fetus is delivered)	12-16 hours (After birth is expelled)	Dufty, 1973 Norman and Youngquist, 2007
Buffalo	1-12 hours	45-90 min	7-12 hrs	Dobson and Kamonpatana, 1986; Jainudeen and Hafez, 2000
Mare	1-12 hours	30 min	Within 3 hours	Haluska and Wilkins, 1989; Das and Tomer, 1997; Jainudeen and Hafez, 2000; Threlfall, 2007
Ewe/Doe	6-12 hours	0.5-1 hours	Within 3-6 hours	Braun, 2007; Greyling and van Niekerk, 1991; Menzies, 2007
Sow	12-24 hours	0.5-4 hours	After 2-3 piglets or 4 hrs post farrowing	Bazer and First, 1983; Cowart, 2007
Bitch	4-24 hours	Ist puppy within 2 hours of 2nd stage of labor 5-60 min between puppies total time up to 24 hrs	After each puppy or within 2 hrs of last puppy	Long, 2006a; Jackson, 2004
Cat	2-12 hrs	Ist kitten within 5-60 min of labor subsequent kittens every 5-60 min.	Within 2 hrs of last kitten	Griffin, 2001; Long, 2006b
Dromedary Camel	3-48 hrs	5-80 min	Within 4 hrs	Elias and Cohen, 1986; Sharma, 1968; Musa, 1983

Mares must be given an injection of Tetanus toxoid or Tetanus antitoxin immediately after foaling.

The grain fed immediately post partum should be laxative, and easily digestible. Often dairy farmers feed some oil to parturient cows, however this often is questionable in ruminants but of value in mares. The diet of animals must be increased slowly, however, in dairy cows this has to be increased more rapidly. In the sow the grain feeding should be increased gradually after a week. In the mare a bran mesh is good. Excessive edema of the udder should be controlled by frequent milking and cold fomentations. Sometimes diuretics or corticosteroids may be required. However, complete milking in cows immediately after parturition and for 2-5 days should be avoided to prevent milk fever. Parturated animals especially mares should be put to light exercise. This improves their digestion and promotes involution.

Animals that have a placental retention beyond the specified time must be treated properly. The importance seems to be the post partum hygiene. The expelled placenta and time parturient discharges must be properly cleaned. Animals that develop post partum uterine infection mammary infections or metabolic diseases like ketosis or milk fever must be promptly referred to veterinarians.

Animals must be protected form inclement weather. The caslick sutures opened during foaling in mares must be resutured as soon as possible and if a mare has not been dewormed for the last 2 months it should be dewormed in a few days of foaling.

Owners of bitches with psudeopregnancy often request the cessation of milk from mammary gland. This can often be treated by injections of testosterone, estrogens or antiprolactins.

Buffaloes fed estrogenic feeds often show a drastic reduction in milk production. The feed should be changed and progesterone injections given.

Artificial Induction of Labor (Induced Parturition)

The induction of labor at or near term in domestic animals may be required for some physiologic and pathologic reasons. Planned deliveries allow closer attendance at parturition and reduce accidental deaths by dystocia and crushing by the mother (sow). Pathologic reasons for induced parturition include hydrops of fetal membranes, prepubic tendon rupture and maternal ill health. Any parturition induction regime must fulfill some prerequisites (i) The neonate must be viable and the dam must lactate normally (ii) the method must be reliable and delivery must be predictable and (iii) it must be safe with no adverse effects on either the dam or her young. Unfortunately, no single drug can achieve this entire criterion in all the domestic animals, therefore they are described separately.

Ruminants

Exogenous glucocorticoid administered to the mother can be used to induce parturition in the cow, sheep and goat (Thorburn et al., 1977). Likewise glucocorticoid can induce parturition in the buffalo (Phogat et al., 1994; Shukla et al., 2008) and camel. When administered about a week or less before term they are generally effective, although the timing of parturition is not very precise in sheep (Tempest and Minter, 1987). In the cow, sheep and goat parturition can be induced with exogenous estrogens (Silver, 1990). Similar to cows parturition can be induced in the buffalo with the use of exogenous estrogens. The induction is more precise when estrogens are given within the last four days of term. However, the use of either corticosteroids or estrogens alone result in some undesirable side effects like increased retained placenta, dystocia poor milk production and poor fetal survival. A combination of dexamethasone and estradiol has been suggested to minimize these side effects in cows (Garverick et al., 1974). By far the most satisfactory, reliable and predictable method for inducing parturition in the ewe is the administration of a 3b-hydroxysteroid dehydrogenase inhibitor (epostane) given IV, IM or orally to the ewe (Silver, 1988). The drug prevents the production of progesterone when given within 10 days of term.

When given parentrally (1.5 mg/kg in ethanol) it causes a rapid drop in progesterone within 15-30 min and a rise in PGFM and change in myometrial activity within 3-6 hr (Silver, 1990).

The administration of prostaglandins to ewes near term will not induce labor (Liggins, 1973) whereas it will induce labor in cows, buffaloes, goat and camel (Johnson and Jackson, 1982; Maule Walker, 1983; Vyas et al., 1999; Hassan et al., 2008). The induced labor may result into increased incidence of retained placenta and a poor viability of fetus (due to low surfactant production) when parturition is induced 10 – 14 days before term. This can be minimized by combining prostaglandins with relaxin (Musah et al., 1987) or corticosteroids (Jackson, 2004).

Little information is available on inducing parturition in the female camels. Since, the CL is required for entire gestation parturition can be induced by the use of prostaglandins in this pseudo ruminant species.

Pigs

The activeness of prostaglandin F analogues to induce labor in the sow has been investigated in some detail (First and Bose, 1979) and the method has gained widespread use in regulating delivery at term (Silver, 1990). Prostaglandin F2a analogue cloprostenol given IM up to 1 week preterm results in birth of viable piglets within 24 – 30 h of its administration (Silver et al., 1983).

Glucocorticoids are without effect in the sow and epostane is a less satisfactory agent in inducing parturition in the sow when given intravenously compared to cloprostenol (Silver, 1990). The farrowing induced by cloprostenol can be improved considerably when xylazine is given 20 h later of cloprostenol, with delivery within 1.5 ± 0.3 h later (Ko et al., 1989).

Horse

A prerequisite to inducing labor in a mare is determining whether the fetus is capable of surviving extra uterine life (Macpherson, 2005) because of a high variability in the length of gestation, and impact of season on gestation length (Hodge et al., 1982). Mares foaling during short days typically have a longer gestation, while mares foaling during long days have a shorter gestation. The equine fetus is at substantially greater risk of dysmaturity if delivered at an inappropriate time. The indicators that suggest fetal and maternal readiness for birth include adequate gestational length (at least 330 days, Purvis, 1977) mammary development (Ley et al., 1993; Rossdale et al., 1991) and cervical softening (Jeffcott and Rossdale, 1977; Le Blanc, 1988). Only after an assessment of mammary secretion electrolytes (evaluated on colostral fluid collected during evening or night hours) and cervical dilation should a foaling

induction program is initiated. Cervical dilation can be achieved by the use of prostaglandin E2 creams applied to the cervix locally (Rigby et al., 1998).

Oxytocin is generally considered the drug of choice for induction of parturition in the mare (Jeffcott and Rossdale, 1977; Bennett, 1988; Pashen, 1980; Pashen, 1984). In the last month or so of gestation the relatively high levels of circulating estrogen and low concentrations of progesterone together with high levels of progesterone metabolites (Pashen, 1984; Ousey et al., 1987) may well create a hormonal environment in which oxytocin receptors are present well before term and consequently endogenous myometrial activity is high (Haluska et al., 1987). Oxytocin has a rapid effect resulting in delivery within 15-90 min following administration (Jeffcott and Rossdale, 1977; Purvis, 1977; Pashen, 1980). Various methods and doses have been described including bolus injection of 20-120 units oxytocin, via intramuscular or intravenous injection; intramuscular or subcutaneous injection of 2.5 – 20 units oxytocin at 15 min intervals; and intravenous administration of 60-120 units oxytocin in 1 liter saline delivered at the rate of 1 unit/minute (Jeffcott and Rossdale, 1977; Purvis, 1977; Pashen, 1980). However low dose oxytocin is currently suggested (Mc Pherson, 2000) and higher doses considered unnecessary and inappropriate.

Most other methods of inducing labor in the mare have only a limited success. Glucocorticoids have limited efficacy for inducing parturition in the mare (Alm et al., 1975). High doses and prolonged treatments are required which may decrease PG production and can disrupt the normal endocrine pathways if given to mares close to term limiting their use as agents for inducing labor in mares. Prostaglandins and their analogues have been used in the mare for inducing labor (Rossdale et al., 1979) with limited success. These agents are ineffective in inducing labor except when the natural event was so close that any exogenous PGF merely accelerate it (Ousey et al., 1984). A more logical approach is the induction of labor in the mare using a combination of PGF2a plus low dose oxytocin (Pashen, 1980).

Dog and cat

The induction of parturition in these two species is a less opted method because often prompt surgical intervention is suggested if signs of fetal or maternal distress appear. Bitches or queens not showing signs of parturition beyond day 64 must be closely monitored. If the anterior vagina is relaxed and milk is present, an intramuscular injection of oxytocin (2-5 IU) may be given to induce birth (Jackson, 2004). If this fails an elective cesarean should be performed. The

induction of parturition in the bitch using glucocorticoids is of little value (Zone et al., 1995). Some studies have shown that parturition in the bitch can be initiated by blocking the activity of progesterone by using antigestagens like mifepristone or aglepristone (Concannon et al., 1990; Linde-Forsberg et al., 1992; Nohr et al., 1993). Parturition often follow within 30 – 46 h. Prostaglandins have also been suggested for inducing parturition in bitches (Meiera and Wright, 2000). Dosage rates of 1 µg/kg/24 h of S/C cloprostenol for 3-7 days were suggested as this dosage resulted in minimum side effects like polydypsia compared to a higher dose rate of 3 or 3 µg/kg/24 h (Meiera and Wright, 2000). Other doses suggested are 20 µg/kg 8-12 h for 72 h (Concannon and Hansel, 1977). A combination of prostaglandin and a antigestagen would be an ideal combination for inducing parturition in the dog. The dosage for mifepristone suggested is 2.5 mg/kg BID for 4-5 days (Concannon et al., 1990) whereas that of aglepristone is 10 mg/kg BID (Wanke, 2002; Fieni et al., 2001) repeated at 9 – 24 h interval (Baan et al., 2005; Baan et al., 2008).

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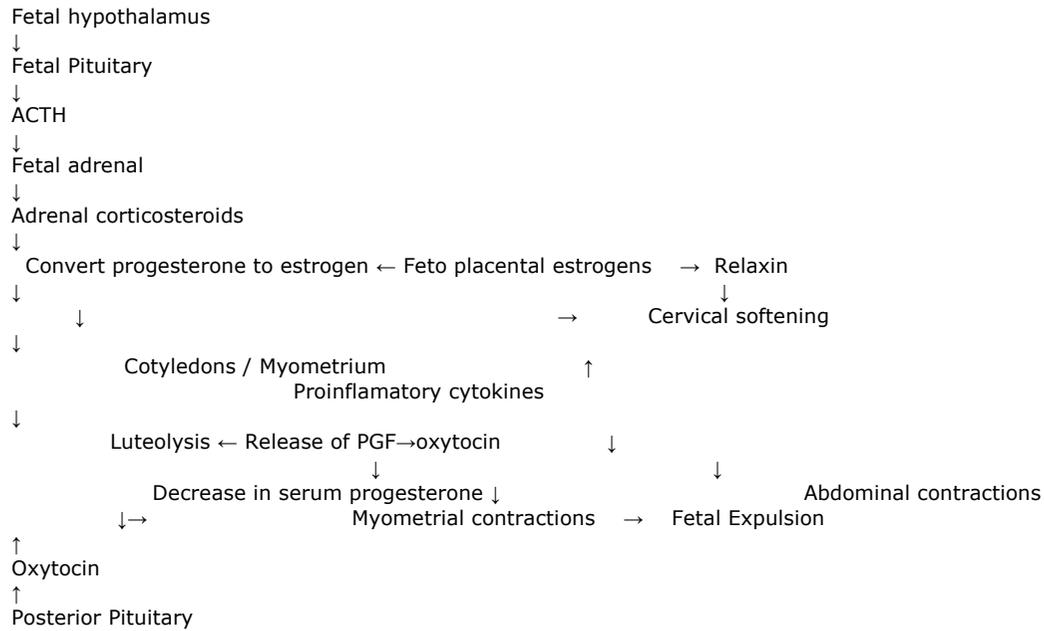
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Illustrations

Illustration 1

Figure 1
Possible mechanisms of parturition initiation

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Fetal hypothalamus
↓
Fetal Pituitary
↓
ACTH
↓
Fetal adrenal
↓
Adrenal corticosteroids
↓
  Convert progesterone to estrogen ← Feto placental estrogens    →  Relaxin
↓                                                                    ↓
     ↓                                              →           Cervical softening
↓
          Cotyledons / Myometrium                          ↑
                       Proinflamatory cytokines
↓
          Luteolysis ← Release of PGF→oxytocin              ↓
                                        ↓                          ↓
              Decrease in serum progesterone ↓                      Abdominal contractions
          ↓→                    Myometrial contractions   →   Fetal Expulsion
↑
Oxytocin
↑
Posterior Pituitary
```

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