Physiology of pregnancy

Pregnancy is the condition of female in which unborn fetus are contained within the body.

Pregnancy begins with fertilization, end with parturition and includes implantation and placentation .

There are many events precede the pregnancy which includes:

- Ovulation,
- Ovum transport to the fertilization site,
- Sperm deposition and sperm transport.
- Sperm capacitation
- Fertilization

❖ **Ovulation**:

The ovulation occurs under the influence of LH released from the pituitary gland and this ovulation occurs in different time according to species as following :

in cow ovulation occurs 12 hr after ending of estrus ,in mare before 48 hr from ending of estrus ,in ewe occurs after 24-36 hr after starting estrus and some animals the ovulation occurs after mating (indused ovulation) like rabbit ,cat and camel.

❖ **Ovum transport**:

At ovulation the ovum or egg is collected by the fundibular end of the oviduct or fallopian tube .

It is transported down the oviduct towards the uterus possibly by a combination of cilial (hair-like) action and muscular contractions.

Transport through the oviduct appears to be under the control of ovarian steroid hormones since estrogens reduce and progesterone increases the speed of passage of ova through the oviducts. Fertilization normally occurs in the ampulla section of the oviduct close to the junction with the isthmus.

In the cow, the ovum enters the uterus 4–5 days after ovulation in morula stage.

❖ **Spermatozoa transport** :

In the case of natural service, semen is deposited in the anterior vagina whereas with artificial insemination it is usual to place it just inside the uterus or in the anterior cervix.

Spermatozoa ascend the female tract by both active and passive processes. Active transport involves activity of the sperm tail or flagella, but clearly its interaction with epithelial surface secretions and cilia is also important. Propulsion of spermatozoa through the uterus appears to be quite rapid and the isthmus of the oviduct acts as a spermatozoa reservoir in many species.

❖ **Capacitation**:

Before spermatozoa are able to fertilize the ovum, they have to undergo a further series of maturational changes in the female tract. These processes are known as **capacitation** and the **acrosome reaction** and are thought to require about six hours in the cow.

This requirement for maturational changes is the main reason why it is preferable to inseminate cows several hours before ovulation .

The process of capacitation is stimulated when sperm enter the female reproductive tract.

The acrosome reaction follows capacitation and involves the fusion of the sperm cell membrane and the acrosome and the formation of gaps through which the acrosome contents can diffuse. The acrosome reaction is necessary to allow penetration of the oocyte by the sperm.

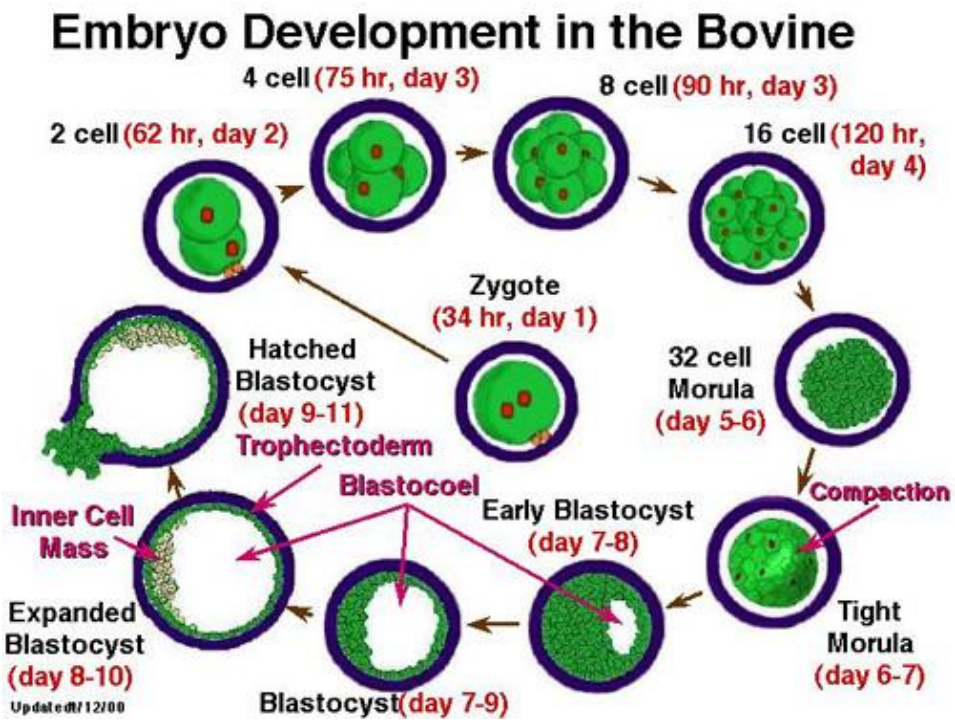
❖ **Fertilization**:

When the sperm reaching the ovum, the sperm penetrates any remaining cumulus oophorus by the action of the enzyme hyaluronidase from the acrosome and comes into contact with the zona-pellucida.

Mobility of the spermatozoa is also important in the process of sperm penetration.

The fusion of the sperm and ovum cell membranes begins at the middle of the sperm head region. The sperm head becomes engulfed by the ova with the loss of the tall.

Fertilization is completed with the fusion of the haploid male and female pronuclei , a process known as syngamy.



Early development of the embryo

Gestation is often divided into three stages:

(1) the ovum from 0–13 days,

(2) the embryo from 14 days, when germ layers begin to form until 45 days, and

(3) the fetus from 46 days until parturition.

After fertilization, the zygote divides many times without significant growth (**cleavage**).The first cleavage produces a 2-cell embryo, followed by 4-cell, 8-cell, 16-cell embryos and so forth.

During the cleavage process, the embryo enters the uterus as a 16- 32cell embryo (**morulla**) in 3-4 days.

Peristaltic contractions transport the embryo to the uterus. These contractions appear to be controlled by a balance of estrogen and progesterone.

- During the next several days, fluid collects inside the embryo, forming a cavity surrounded by single spherical layer of cells, (the trophoblast) with a group of cells, (the inner cell mass) at one edge to form **blastocyst**.
- A mass of cells, destined to become the fetus.
- The embryo or blastocyst, as it is called at this point, begins to elongate ending the period of cleavage.
- The nutritive requirement of the developing blastocyst are satisfied by diffusion from yolk in the oocyte and by secretion of the oviduct and uterus (uterine milk) until it become fixed in position in the uterus.

At about day 8 the zonapellucida begins to fragment and the blastocyst 'hatches'. This is then followed by a period of blastocyst elongation. Development of the so-called germ layers begins from about the fourteenth day and characterizes the beginning of the embryo phase.

Inner cell mass of embryo is developing to fetus. Through formation of the 3 germ layers (**Ectoderm, Mesoderm and Endoderm).**

1. **Ectoderm**

In general forms The ectoderm gives rise to the external structures such as skin, hair, hooves and mammary glands and also the nervous system.

2. **Mesoderm**

In general forms structural tissue including: Muscle, Circulatory system, and reproductive system heart, muscles and bones

3. **Endoderm**

In general forms internal organs including:Digestive system, liver, and endocrine glands

After differentiation, fetus has all the necessary parts & mostly have an increase in size.

Calf fetal size at various stages of pregnancy in relation to the size of some commonly known adult animals.

Stage of pregnancy	Calf fetal size
2 months	Mouse
3 months	Rat
4 months	small cat
5 months	large cat
6 months	Dog

How can you determine the age of fetus ?

In cow : fetus age (days) =2.5 (Y + 21)

In sheep : fetus age (days) =2.1 (Y + 17)

Y : it mean the distance between the crown to the anus (cm).

The changes in position of uterus during the gestation period:

30 days:

- One uterine horn slightly enlarged and thin.
- embryonic vesicle size of large marble.
- The uterus, in much the same location as a nonpregnant uterus.
- Fetal membranes may be slipped between fingers.

45 days:

- Uterus still on pelvic floor.
- Uterine horn somewhat enlarged, thinner walled.
- Slip membranes.
- Embryonic vesicle size like size of egg.
- The caruncles on the uterus join the cotyledons on the fetal membranes for nutrient exchange. (Attachment of the membranes to the uterus has just taken place at approximately 38 to 40 days, therefore, avoid moving the fetus about in the uterus).

60 days:

- Pregnant horn is dropping over brim of pelvis.
- Slip membranes in both horns.
- Uterus feels like a balloon filled with water.
- Fetus size of mouse.

90 days:

- Both uterine horns swollen
- The cervix pulled to the pelvic brim so that the cervix, body and horns of the uterus are in the abdominal cavity.
- Fetus is size of rat.
- Another indication of pregnancy is enlargement of the uterine artery with its characteristic pulsation “thrilling'.

120 days

- Similar to 90-day but fetus more easily palpated.
- Fetus is size of small cat with head the size of a lemon.
- Presence of the cotyledons is more noticeable.
- The pulsating uterine artery may be palpated.

150 days

- Uterine horns are deep in body cavity.
- fetus size of large cat, but difficult to palpate fetus.
- Good pulse of pregnancy, artery is 1/4 to l/2 inches in diameter.
- Cotyledons can be palpate.

180 days:

- Horns with fetus still out of reach.
- Fetus size of small dog.
- Uterine artery is l/2 inch in diameter.
- Cotyledons more enlarged.
- From sixth month until calving a movement of fetus may be elicited by grasping the feet, legs or nose.

210-270 days:

- From 7 months until parturition fetus may be felt.
- increase in fetal size.
- The uterine artery continues to increase in size.

Placenta

- The placenta is the fusion of the fetal membranes with the maternal endometrium and this process called placentation .
- The growing embryo get its nutrition from the mother through the placenta via the umbilical cord (umbilical cord consist from two vein one artery and urechus ,the urechus transport the urine from the kidney to the allantois cavity and the artery carried the nonoxygenate blood from the fetus to mother while the vein carried the oxygenate one)
- Although the placenta serves as an interface for fetal and maternal blood and the exchange of nutrients, gasses and water.
- the blood of the fetus and mother never mix.
- the placenta act as a fetal digestive tract, lungs, kidneys and liver.
- Placenta act as endocrine organ by produced many hormone like progesterone , estrogen, eCG and relaxin etc.

Fetal membranes and fetal fluid

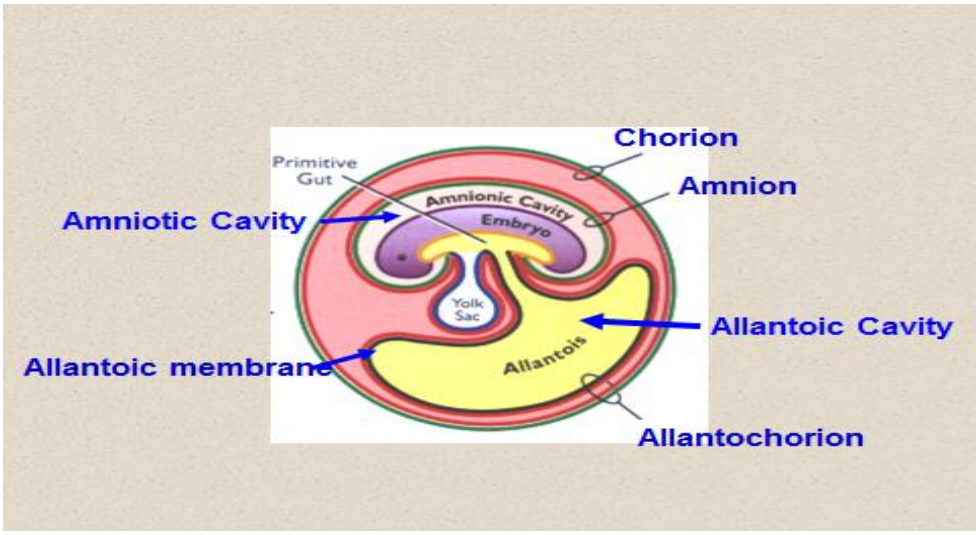
1- Yolk sac :- its primitive structure developing early in the embryonic period from the endoderm and disappearing after ashort period of time in ruminants and swine but persisting for 4-6 weeks in mare before becoming a remnant in the F.M. .

Prior to formation of amnion ,the yolk sac perform limited placental function of providing nutrients and care of wastes for early embryo.

2- Amnion :- its formed about 13-16 days after conception in the mare ,sheep and cow from the ectoderm as a double walled sac that completely surrounds the fetus except at the umbilical ring .

Then inner layer of this double walled sac is the **true amnion** and the outer layer is the **false amnion**.

Until allantois is formed the outer layer of amnion fuse with the chorion to form amnionicchorion which acts for very short period as did the yolk sac ,in providing for the transfer of nutrients and for care of waste for the embryo.



When amniotic sac is completed its filled with fluid called amniotic fluid and this fluid are clear, colorless and mucoid in nature .

Am.f. is present toward the end of gestation in amount of 2-8 litters in cattle.

Am.f. contains protein, fat ,fructose and salt.

The source of am.f. in early to midgestation is probably from amniotic epithelium and fetal urine as the fluid is quite watery.as gestation advanced the fluid become viscid and glairy because the bladder sphincter prevent the further release of urine into the amniotic cavity ,the probably source of mucoid amniotic fluid is then the saliva and secretion of the nasopharynx of the fetus .

The volume of fluid are probably regulate d by the swallowing by the fetus.

Function of am.f. :

a- Suspend the embryo and thus is a mechanical protection to the fetus.
b- Prevent adhesion between the soft developed tissue of the embryo and surround membrane.
c- Its considers bactericidal .

d- Assist in parturition because its slippery .mucoid consistency lubricates the fetus and birth canal.

Amniotic plaques :- are small irregular shaped ,flat ,white ,elevated epithelial thickening s present in the inner surface of the bovine amnion.

They are most noticeable of these structure is not known.

3- Allntois:- its double sac arises the second and third week of gestation in bovine from the endoderm. The inner layer fuses with the amnion to give rise to the allantoamnion . the outer layer fuses with the chorion to form the vascular allantochorion which eventually surrounds the allantoamnion is separated from it by the allantoic fluid.

Allantoic fluid : its formed from the waste product of the kidney which pass to it from the bladder through the umbilical cord by means of the urechus.

This fluid is clear ,watery and amber in color and contain albumin, fructose and urea.

The volume of it toward the end of gestation varies from 4-15 l. in cow and 8-18 L in mare .

Hippomanes :- Amorphous ,semisolid ,amber –colored, soft pliable, rubber –like, irregular shaped masses or bodies 0.3-3.8 cm in diameter, found in the allantoic cavity, floating in the allantoic fluid of cow, mare and ewe.

This structure consist from cell debris, protein .mineral mainly calciumand phosphate.

4- Chorion :- it's the outer part of fetal membrane which is fused with outer layer of the allantois to form the chorioallantois.

This structure are richly supplied with blood vessels communicating with fetus and intimate contact with the endometrial.

Its designed to carry on the metabolic interchanges of gases, nutrients and wastes between the fetal and maternal circulates.

In cow pig and sheep the chorioallantois is attached to the amnion at various point ,this divided the allantoic cavity into a number of compartments.

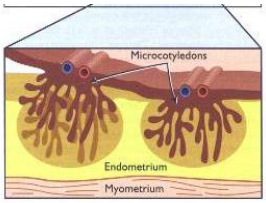
In dog cat and mare there is no attached between them and the amnion containing the fetus floats free in the allantoic cavity attached only by the umbilical stalk .

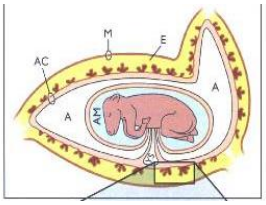
In this later animals the young are more apt to be born covered by the amnion or portion of it , unless it is promptly removed, they will smother if it lies over the nostrils and mouth . this rarely happens in the cow ,sheep and pig.

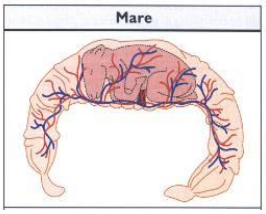
TYPES OF PLACENTA

A- Placentae may be classified according to the way the villi are distributed on the fetal chorion. Thus,

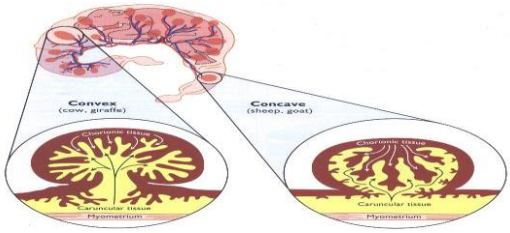
1- where they are uniformly dispersed, as in the mare and sow, the placenta is said to be *diffuse*.



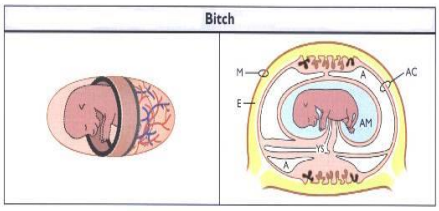




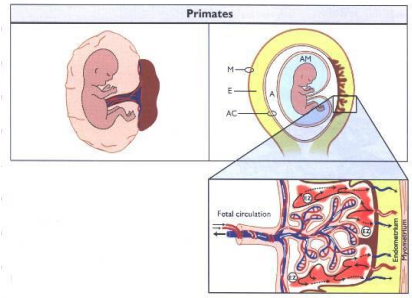
2- Where they are grouped into multiple circumscribed areas, as in the ruminant, the placental arrangement is called *cotyledonary*,



3- while in the bitch and cat the villi are disposed in the form of a broad encircling belt forming a *zonary* placenta.



4- In human called discoid placenta



B- Formerly, the placentae were differentiated according to whether or not maternal tissue separated off with the fetal tissue at birth. Thus, of the domestic mammals, the placentae of the bitch and cat were said to be deciduate and those of the remainder non-deciduate.

C- Histological : more recently, division of placental types in which the degree of proximity of the maternal and fetal blood circulations is the criterion of classification. Such a concept recognizes the phagocytic property of the trophoblast , or chorionic epithelium, that may be exerted on tissues with which it comes in contact.

1- In the simplest, or *epitheliochorial* type of placenta, seen in the horse and pig, the chorion is everywhere in contact with the endometrium, and there is no loss of maternal tissue.

2- In the cow, the placenta is described as being *synepithelialchorial*.
Soon after embryonic attachment a syncytium is formed on the maternal side of the placentome by the fusion of binucleate cells derived from the trophectoderm and the endometrium.

3- In the third, *endotheliochorial* type, there is further invasion of the endometrium by the trophoblast, which is now apposed to the maternal capillaries. Such a type is typical of the carnivore .

4- In the *haemochorial* placenta of primates only the tissues of the chorionic villi separate the fetal and maternal blood.
The placenta of the dog and cat is partly haemochorial in that the main zonary placenta of endotheliochorial type is flanked by marginal haematomata – 'the green border' in the dog and 'brown border' in the cat – in which an accumulation of maternal blood between the uterine epithelium and the chorion directly bathes the chorionic villi that project into it.

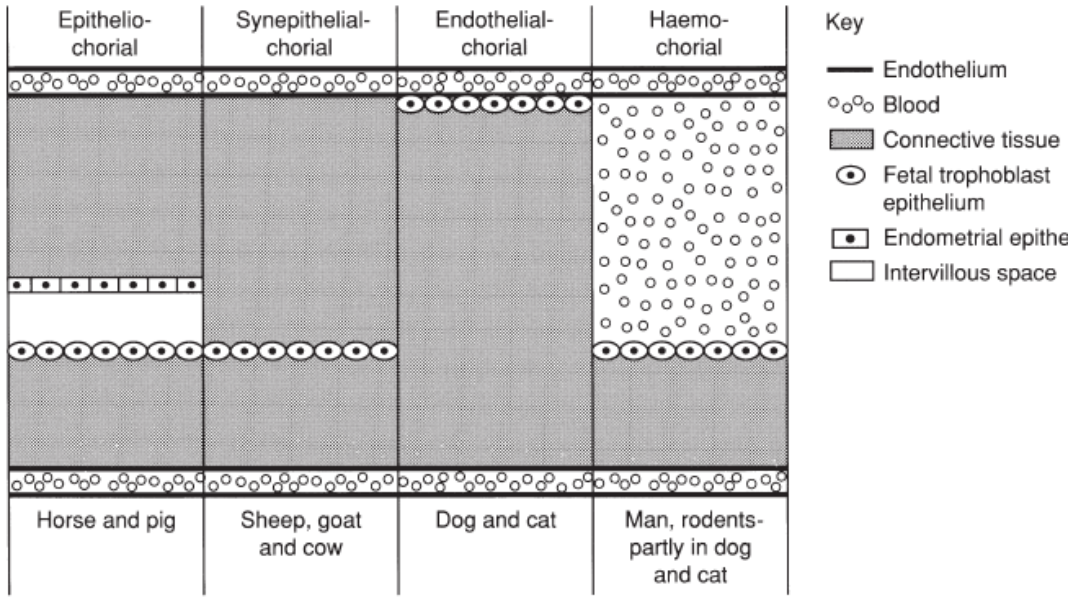


Fig. 2.10 Diagrammatic representation of types of placenta found in domestic species based on Grosser's origina classification.

Implantation

- Implantation of embryo occurs when it becomes fixed in position and form a physical and functional contact with the uterus, it occur 2-5 weeks after fertilization.
- During this period, the uterus is primarily under the control of progesterone. Progesterone decreases the muscle tone of the uterus and increases the secretory capacity of the inner lining of the uterus (endometrium).
- The presence of the embryo in the uterus must be recognized by the cow to prevent the regression of the corpus Iuteum.
- The embryo produces a substance which prevents release of the Iuteolytic factor (prostaglandin F2 a).This process called:

(Maternal Recognition of Pregnancy)

In most domestic species, the establishment and maintenance of pregnancy require that the luteal phase of the oestrous cycle is prolonged by the persistence of a single corpus luteum (CL) or a number of corpora lutea (CLs). As a result of the persistence of the luteal tissue, progesterone concentrations remain elevated. This results in a negative feedback on the hypothalamus and anterior pituitary with a resultant inhibition of follicular development and ovulation and, in polyoestrous species, a prevention of return to oestrus . In many species, the placenta subsequently replaces or supplements the luteal source of progesterone.

The presence of a viable, developing embryo(s), however, prevents the CL from regressing and thus, in polyoestrous species, inhibits the return to oestrus.

The sheep

In sheep , the conceptus produces a protein. It was named ovine trophoblast protein or oTP-1.This substance has been shown to be a type 1interferon, which together with the same substance produced by the bovine conceptus, is classified as a tau

interferon (IFN-τ). It is produced by the trophectoderm from about day 10, when the blastocyst starts to elongate.

The effect of IFN-τ in the maternal recognition of pregnancy is to alter the dynamics of PGF2α secretion at this early stage of pregnancy, compared with the same stage of the oestrous cycle.

IFN-τ prevents the rise in endometrial oestrogen receptors which precedes the rise in endometrial oxytocin receptors ,which is necessary for the secretion of PGF2α.The consequence of this is that there is a reduction in the synthesis of PGF2α from arachidonic acid.

The cow

In the cow, the importance of the blastocyst in prolonging the life span of the CL if the blastocyst was removed at day 17 or day19, the inter oestrus intervals were extended to 25and 26 days, respectively, compared with those in which the embryo was removed at day 13, or which were not mated; in the latter cases the intervals were 20–21 days.

The anti luteolytic signal produced by the bovine conceptus is called bovine trophoblast protein (bTP-1) As in sheep, it is now classified as tau interferon (bIFN-τ), with maximum secretion occurring between days 16and 19 of gestation; it is first secreted at the time of elongation of the blastocyst and, unlike oIFN-τ, continues to be secreted until day 38 of gestation

As in the ewe, It is likely that bIFN-τ exerts its anti luteolytic effect by modifying oxytocin receptors, there by inhibiting the synthesis from arachidonic acid and subsequent release of PGF2α.

The goat

In the goat, the removal of conceptuses from the uterine lumen between days 13 and 15 does not prolong the life span of the CL, but removal on day 17 increases the inter oestrus interval by 7–10days.

The caprine conceptus secretes a protein, originally designated cTP-1, which as in other ruminants is cIFN-τ .

The mare

In the mare, the mechanisms responsible for the recognition of pregnancy are less well understood. However, evidence of the importance of the developing conceptus has been shown by its removal at varying stages of gestation; if it was removed at 10,15 and 20 days, then the return to oestrus was22.3, 38.0 and 47 days respectively .

The importance of the migration of the conceptus within the uterine lumen until it becomes 'fixed' at 16–18days of gestation at the base of the uterine horn has been demonstrated in some elegant experiments. By restricting the mobility of the conceptus using ligatures at various parts of the uterus, the maternal recognition was compromised so that the CL regressed spontaneously. It is likely that the stimulus elicited by the migratory conceptus in its contact with the endometrium is comparable with the stimulus associated with the rapid elongation of the blastocyst in ruminants and the pig.

Maintenance of Gestation

The maintenance of pregnancy in mammals is dependent on prevention of uterine contraction.

A. Species with Progesterone from the CL:

Cattle:

- One blastocyst is usually sufficient to signal maintenance of pregnancy.
- The CL and ovarian progesterone are essential for pregnancy maintenance through 215 days of the 280 day bovine gestation.
- After day 150 the placenta compare to produce progesterone to maintain pregnancy.
- Maintenance of the CL is likely dependent on pituitary LH.

Horses:

- The original corpus luteum is maintained through day 140.
- About day 35, cells of fetal trophoblast stimulate the endometrial cups of the uterus and by day 40 produce equine chorionic gonadotropin (eCG).
- The gonadotropic hormone stimulates follicular growth on the ovaries, occasional ovulation and considerable luteinization occurs by day 50 to form numerous accessory corpora lutea.
- The eCG levels remain high and accessory corpora lutea greatly elevate plasma progesterone through day 140.
- The accessory and original CL regress and pregnancy is maintained by low levels of progestin or some as yet unexplained mechanism.

B. Species with Pregnancy Maintained by the Placenta

Sheep:

- The CL and anterior pituitary LH needed to cause CL secretion of progesterone are essential for the first 55 days of ovine pregnancy.
- Thereafter the placenta produces sufficient progesterone for maintenance of pregnancy until the end of the 146 day gestation.

Length of Gestation

Length of gestation is calculated as the interval from the last fertile mating to parturition and its may be called gestation period .

The gestation length are varying between the species ,the following is the gestation period in some animals :

Cattle **280 ± 5 days**

sheep **148 ± 5 days**

horses **338 ± 15 days**

dog **60 ± 5 days**

The length of gestation is influenced by:

1. Genetic factors: the small variation in pregnancy duration among breeds within species may be due to genetic factors.
2. Fetal factors :

   Fetal sex: Male calves and foals are carried 1 to 2 days longer than female.

   Twinning: Twin calves are carried 3 to 6 days less than singles.

   Life of the fetus: late fetal death or abnormalities of the pituitary or adrenal glands will extend gestation in cattle, sheep and swine.
3. Maternal factors:

   The age of dam influence the duration of pregnancy with in species ex. Young heifers carry their calves for a slightly shorter period than older.
4. Environmental factors:

   Season ; in seasonal animals like horse the foals conceived in summer have significantly shorter gestation period than those conceived at start of breeding season in early spring.

   Nutrition :Well-fed mare have gestation period length about 4 days shorter than those on maintenance ration.

METHODS OF PREGNANCY DETECTION

A variety of methods can be used to detect pregnancy; many are common to all species whereas others are species-specific.

There are four broad categories which are:

1- management.

2- clinical.

3- ultrasonographiy.

4- laboratory-based.

PREGNANCY DETECTION IN THE MARE

1- Management methods:

Failure to return to oestrus is a good sign that a mare is pregnant. The demonstration of the signs of oestrus usually requires the presence of a teaser stallion.

False positives will occur:

- if the mare has a silent heat.
- if the mare becomes anoestrous as a result of lactation or environmental factors
- if the mare has a prolonged dioestrus yet has not conceived.
- if the mare has a prolonged luteal phase associated with embryonic death; this is referred to as 'pseudopregnancy'.

False negatives will occur in a few mares which will show oestrus at this time although they are pregnant.

2- Clinical methods:

-Vaginal examination.

Vaginal speculum examination is performed 18 to 21 days after ovulation, usually in conjunction with examination of the reproductive tract per rectum. Speculum examination is not indicated unless per rectum examination is equivocal. The presence of a dry, pale, tightly closed cervix with the external os protruding into the center of the cranial vagina is suggestive of pregnancy.

-Rectal palpation.

- Palpation of the conceptus is first possible at 17–21 days, when it is a small soft swelling of 2.4–2.8 cm in diameter or is an apparent 'gap' in the otherwise tonic horn. It is more easily felt between 21 and 30 days, but still only the cranio ventral portion of the distension can be appreciated.

-At 35 days, it is 4.5–6 cm and at 40 days 6–7 cm in diameter – about the size of a tennis ball. Thereafter, it is not possible for the conceptual swelling to be com- pletely cupped within the palm of the hand.

- By 60 days, it is becoming oval in shape and measures approximately 13 × 9 cm,

- whilst by 90 days it has increased to approximately 23 × 14 cm. There is a natural variation in the size of the conceptual swelling in mares of similar size and ovulation dates owing to the variation in the volumes of fetal fluids present.

- At about 100 days, it is often possible to ballotte the fetus as it floats in the fetal fluid of the uterine body. Growth of the fetus and reduction in tension of the fetal sacs enable the examiner to palpate parts of the fetus in the uterine body from the end of the fourth month onwards.

3- Ultrasonographic methods:

Major advantages of transrectal ultrasound for pregnancy detection in the mare are:

- Earliest positive detection of pregnancy, with the embryonic vesicle visible as early as day 9 or10 of gestation. The accuracy of vesicle detection approaches 99% by 15 days of gestation.
- Permits fetal sexing at approximately days 60 to70 of gestation.

4- Laboratory methods:

Milk or blood progesterone.

Plasma progesterone concentrations remain elevated just before, or during, the time when the mare would have returned to oestrus.

Blood or milk samples collected 16–22 days after service should have elevated progestogen concentrations in pregnant mares, whilst in non-pregnant mares the levels would be low and typical of those obtained at oestrus. 100% accuracy in diagnosing pregnancy using this method.

False positive results occur with a prolonged luteal phase, and, in general, the method is not very reliable.

Identification of eCG. :

Recall that eCG is produced by endometrial cups in the pregnant mare uterus beginning on days 36 to 40 of gestation. The period of detection of eCG in mare serum is limited to days 40 to 120 of gestation.

To test for presence of eCG, serum either can be submitted to a reference laboratory for testing or can be analyzed with a commercially available "mareside" kit. However, false-positive reactions are possible.

If a pregnancy is lost after days 36 to 40 of gestation, when endometrial cups are already functional, a false-positive result occurs (i.e., eCG is present in spite of pregnancy loss).

False-negative reactions occur if serum is evaluated before days 36 to 40 of gestation, when concentrations of eCG in the mare's serum may be too low to detect, or after day 120 of gestation, when concentrations have declined after endometrial cup regression. In addition, false-negative results are common (81%) in mares carrying mule fetuses.

-Blood oestrogens.

A method of detecting pregnancy by determining the concentration of total oestrogens in the peripheral blood By 85 days of gestation the concentration should exceed the maximum values obtained in non-pregnant mares.

-Urinary oestrogens. Oestrogens (oestrone and oestradiol-17 β) are present in the urine of pregnant mares in sufficient amounts for accurate detection by a chemical method. between 150 and 300 days of gestation. Very little equipment is required and the results are easy to interpret. It is nearly 100% accurate between 150 and 300 days.

- Serum Early pregnancy factor (EPF) is an immune-supressive glycoprotein associated with early pregnancy, first identified in the mouse (Morton et al., 1974) and subsequently identified in a number of domestic species, including the horse. Using the **rosette inhibition test** it has been possible to detect the presence of EPF in the serum from peripheral blood from as early as 7–10 days after ovulation .

Methods of pregnancy diagnosis in cattle

1- Management methods

Failure to return to oestrus and persistence of the corpus luteum.

Failure of regression of the CL at about 21 days, as determined by transrectal palpation, provides a method of anticipating that the cow is probably pregnant. Rectal examination at about this time in an individual which was close to, or at, oestrus would demonstrate the presence of a turgid, coiled uterus and a mucoid vaginal discharge.

How reliable is failure to return to oestrus as a method of diagnosing pregnancy? This will be dependent on the efficiency and accuracy of oestrus detection.

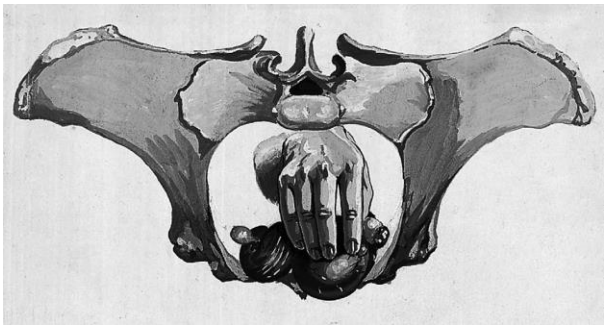


Fig. 3.12 Detection of pregnancy in the cow by rectal examination. Uterus gravid 70 days.

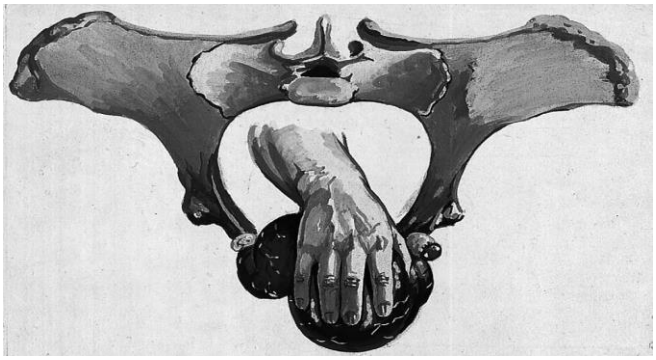


Fig. 3.13 Detection of pregnancy in the cow by rectal examination. Uterus gravid 90 days.

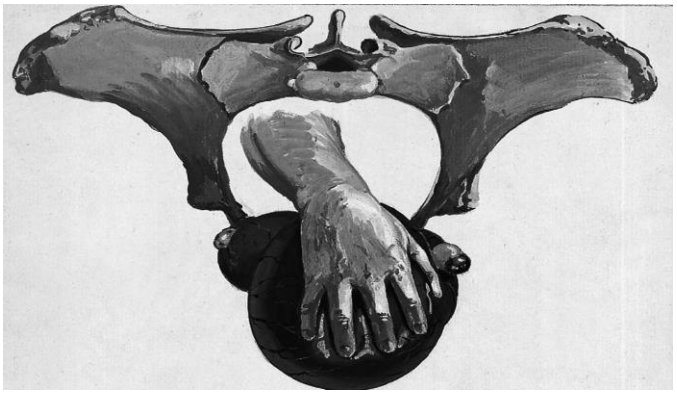


Fig. 3.14 Detection of pregnancy in the cow by rectal examination. Uterus gravid 110 days.

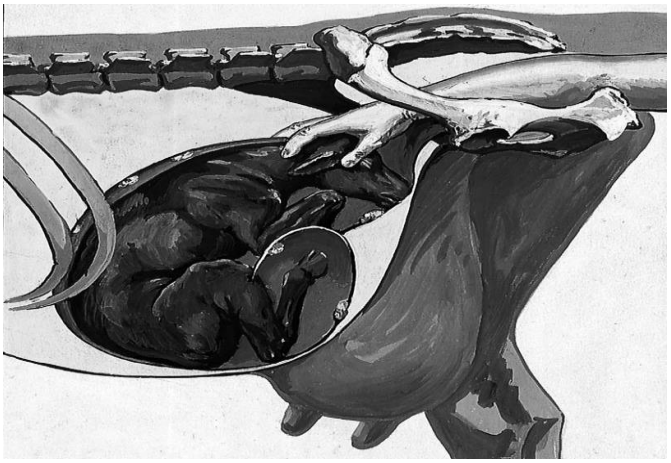


Fig. 3.15 Detection of pregnancy in the cow by rectal examination. Pregnancy approaching term.

Laboratory methods

-Identification of early pregnancy factor/ early conception factor.

Early pregnancy factor (EPF) is an immunosuppressive glycoprotein associated with pregnancy.

Commercially available test kits are available which use the 'dip-stick' principle and can detect early conception factor (ECF) in serum and milk from as early as 3 days after artificial insemination, although more accurate results are obtained if samples are taken later at 7 to 8 days .

-Assay of pregnancy-specific protein B.

This protein has been identified in the maternal serum of cows from 24 days of gestation; the concentration is measured by radio-immunoassay .

It is secreted by the Binucleate cells of the trophoblastic ectoderm, and thus its presence can be used to confirm pregnancy.

However, since it has a long biological half-life it can also be identified in serum for many weeks postpartum; for the same reason, false positives can occur after embryonic or fetal death.

At present, it can only be measured by radioimmunoassay (RIA) but, with the development of suitable enzyme-linked immune-sorbent assay (ELISA) methods, it could well become an 'on farm' diagnostic test .

Using RIA to detect the protein, a 90% accuracy at 30 days of gestation. It has been shown that there is a good correlation between pregnancy-specific protein B (PSPB) in peripheral plasma concentrations and fetal numbers, and thus the method can be used to identify twins .

-Progesterone concentration in plasma and milk.

Since the CL persists as a result of the pregnancy, if a blood sample is taken at about 21 days after the previous oestrus, progesterone levels remain elevated.

If the cow is not pregnant and is close to or at oestrus then the progesterone levels will be low. Although this is a perfectly valid and reliable laboratory method,

-Oestronesulphate in milk.

Oestronesulphate is quantitatively one of the major oestrogens in the milk of pregnant, lactating cows. During gestation the concentration increases gradually so that after day 105 it is present in the milk of all pregnant animals, whereas in non-pregnant individuals it is low or undetectable; the source of the hormone is the fetoplacental unit. The identification of oestronesulphate in the milk of a cow at 105 days of gestation, or later, is a very reliable method of pregnancy diagnosis .

3-Clinical methods

Transrectal palpation

Palpation of the amniotic vesicle. This method involves the palpation of the amnion towards the end of the first month of pregnancy.

Palpation of the allantochorion (membrane slip).

This method is dependent upon the facts that in the cow, attachment of the allantochorion to the endometrium occurs only between the cotyledons and the caruncles, and that the intercotyledonary part of the fetal membrane is free.

The method was first described by Abelein (1928) (see Cowie, 1948), who reported that it could be used from the fifth week of gestation.

Unilateral cornual enlargement. Unless there are twin conceptuses, one in each horn, it is possible to detect a difference in the size of the two horns.

Palpation of the early fetus .At about 45–50 days of gestation the amniotic sac becomes less turgid, and it is sometimes possible to palpate directly the small developing fetus. This should be done with care.

Palpation of caruncles /cotyledons. Caruncles / cotyledons first become recognisable by rectal palpation at 10–11 weeks as roughened elevations

Palpation of the cervix. Evidence of pregnancy can be assumed when there is tension on the cervix. In the non-pregnant or early pregnant cow or heifer the cervix is freely movable from side to side. However, as pregnancy advances the cervix becomes less mobile and it is pulled forwards and downwards over the pelvic brim.

Hypertrophy of the middle uterine artery and development of fremitus .

In a non-gravid or early pregnant cow, identification of the middle uterine artery by palpation is usually not possible transrectally.

At some stage during pregnancy it will cease to have the usual pulse, and instead it will becomes a 'thrill' or tremor, which is called fremitus.

There is considerable variation in the time at which the change can first be felt and also when it becomes continuous. The earliest the author has been able to detect it is at 86 days.

Palpation of the late fetus.

Palpation of the fetus, either per rectum or by abdominal ballottement, is diagnostic of pregnancy. The ease of palpation depends upon the size of the cow, the degree of stretching of the suspension of the uterus, and the degree of relaxation of the rectum and uterine wall.

Accuracy of pregnancy diagnosis by rectal palpation.

The most likely reason for making a false positive diagnosis is subsequent embryonic or fetal death, which is impossible to exclude. Other reasons for false positives are incomplete uterine involution, pyometra, mucometra and hydrometra, and failure to retract the uterus.

The inexperienced person may well make a diagnosis of pregnancy because the uterus is out of reach and cannot be palpated. It is important that the diagnosis should be made on the identification of positive signs. It is perfectly permissible to admit uncertainty, to note in writing the changes that can be identified, and to re-examine the animal in 2 or 3 weeks' time.

-Vaginal examination.

Examination may be manual or visual. In the latter case, an illuminated speculum is used. The condition of the vaginal mucous membrane does not afford definite clinical evidence of pregnancy, for the degree of 'dryness' and blanching which occur during the diestrous period are very similar to those of pregnancy. It is to the external os of the cervix that attention is directed.

During pregnancy the secretion of the cervical glands becomes gelatinous and tough, forming a plug for sealing the canal. In many cases the seal covers or protrudes from the external os. It has developed by day 60.

4-Ultrasonographic methods

Using the ultrasonic fetal pulse detector, which employs the Doppler principle, it is possible to identify the fetal heart from 6–7 weeks using a rectal probe.

Realtime B-mode grey-scale ultrasound scanning is the method of choice for the early diagnosis of pregnancy in the cow.

5- Other methods

-Mammary glands.

Mammary changes during pregnancy are best observed in primigravida.

The teats of the pregnant heifer begin to enlarge about the fourth month, and with a little experience it is an easy matter to distinguish them from those of the non-pregnant or early pregnant animal.

From the sixth month the mammary glands become more firm to the touch and their enlargement can be seen. Hypertrophy is progressive and is particularly marked during the terminal month.

The abdominal wall, particularly in the region of the umbilicus, may also become swollen by oedema.

-Abdominal ballottement. This is often possible as early as 7 months of gestation in some small breeds such as the Jersey. However, in some fat cows of large breeds it is sometimes impossible even at term. The method involves fairly vigorous pummeling of the ventral abdomen and flank with clenched fists. The object is to push the fetus, which is floating in the fetal fluids, away from the body wall and then identify it as it swings back against the fist which is kept pressed against the abdominal wall.

Table 3.4 Methods of pregnancy diagnosis in the cow

Method	***Earliest time***
-Early pregnancy factor (EPF)/early conception factor (ECF)	**3 days**
-Realtime ultrasound (direct imaging)	**13 days**

-Failure to return to oestrus and persistence of corpus luteum	21 days
-Progesterone concentration in plasma and milk	21–24 days
-Assay of pregnancy-specific protein B (PSPB)	24 days
-Palpation of the allantochorion (membrane slip)	33 days
-Unilateral cornual enlargement and disparity in size, thinning of the uterine wall, fluid-filled fluctuation of enlarged horns	35 days
-Palpation of the early fetus when the amnion loses its turgidity	45–60 days
Palpation of the carnucles/cotyledons	80 days
Hypertrophy of the middle uterine artery until presence of fremitus	85 days
Oestronesulphate in blood or milk	105 days
Palpation of the fetus	120 days

Methods of pregnancy diagnosis in the ewe

There are a large number of published methods of diagnosing pregnancy in the ewe, many of which are historical, and these have been reviewed in detail.

Management methods

Traditionally the method used by shepherds is the observation that ewes, which have been marked by a 'keeled' or 'raddled' ram, fail to be marked again within 16–19 days. This is a sufficiently reliable sign of pregnancy for most purposes, but subsequent embryonic death will reduce its accuracy, and 20–30% of pregnant ewes will show oestrus during early pregnancy. Beyond 100 days of gestation the fetus may be palpated through the abdominal wall, and development of the udder is then obvious in primipara. The best way to ballotte the

fetus is to have the ewe standing normally and to lift the abdomen repeatedly immediately in front of the udder; the fetus can be felt to drop on to the palpating hand.

Ultrasonographic methods

The fetal pulse detector (Doppler) has been used to diagnose pregnancy in ewes, and two types of probe are available. The external probe is applied to the skin surface of the abdomen just cranial to the udder. The fleece in this region is sparse and with transmission gel applied to the end of the probe it is slowly moved over the surface.

The ewe can be restrained either standing or sitting on her haunches. Characteristic sounds indicate the presence of the fetal heart ('tack, tack, tack') or vessels ('swish, swish, swish'); the frequency greatly exceeds that of the mother's heart rate, except in late gestation when the fetal heart rate is reduced.

More recently the use of the linear-array real-time ultrasonography for the diagnosis of pregnancy in sheep .

The use of transabdominal ultrasonography for pregnancy diagnosis is often preferred in sheep in the field. The pregnancy can be determined by transabdominal ultrasonography 30 days after breeding. Its application is recommended between day 40 and 80 after breeding because of its high accuracy rate.

Moreover pregnancy can be determined transrectally by means of ultrasonography. The authors showed the successful pregnancy diagnosis using 5 MHz transducer after day 25 of gestation. The earliest indication of pregnancy, based on scanning extraembryonic fluid and membranes, has been observed on day 15 after breeding .

Laboratory methods

Vaginal biopsy.

The method is similar to that reported for the sow where the stratified squamous epithelium of the vaginal mucosa is sensitive to the hormonal changes that occur during the oestrous cycle and pregnancy (Richardson, 1972).

Milk and plasma progesterone.

Pregnancy can be diagnosed on the fact that in the pregnant ewe the CLs persist and hence peripheral progesterone concentrations will remain elevated at 15–18 days after mating. In lactating ewes it is also possible to determine the progesterone levels in milk. Plasma and milk progesterone values in pregnant sheep 18–22 days after mating were similar (3.7 ng/ml), whereas in non-pregnant ewes they were 1 ng/ml.

Rosette inhibition titre (RIT) test.

This is an established test for determining the immunosuppressive potential of anti lymphocyte serum which has been applied to determining the presence of an 'early pregnancy factor' (EPF) in ewes. In ewes which were subsequently found to be pregnant, the factor could be demonstrated as early as 24 hours after mating .

The RIT test is time-consuming and difficult to maintain, the development of a radio-immunoassay or ELISA for EPF should provide a more reliable method.

Clinical methods

Radiography. Both dorsoventral and lateral radiographs can be taken. Using an exposure time of 0.3–0.5 seconds and depending on the dorsoventral dimension of the ewe, fetuses weredetectable from 70 days of gestation.

The overall accuracy of the method in detecting pregnancy increases with advancing gestation: 52% between 66 and 95 days to 100% after 96 days.

Palpation of caudal uterine artery.

Identification of enlargement of the caudal uterine artery has been reported as a fairly reliable method of diagnosing pregnancy; the technique requires patience and skill. The arteries can be palpated per vaginam as they run outside the arterior vaginal wall at the 10 o'clock and 2 o'clock positions (Richardson, 1972).

Peritoneoscopy.

91% accuracy of pregnancy detection between 17 and 28 days by means of direct inspection of the uterus and ovaries with a laparoscope, using general anaesthesia.

pregnancy Problems

1- Hydropsy fetal membrane

Both the amniotic and allantoic sacs can contain excessive quantities of fetal fluid ; when this occurs it is referred to as hydramnios or hydrallantois, depending on which sac is involved. Hydrallantois is much more common than hydramnios, although the latter is always seen in association with specific fetal abnormalities such as the 'bulldog' calf in the Dexter.

Hydroallantois: or hydrops of the allantois, is due to a defective placenta (the chorio-allantois).

- The fetus is normal.
- The condition is characterized by a rapid accumulation of watery, clear fluid, usually in the last trimester.

Clinical signs :

The cow is rounded in the caudal view, and you normally can't palpate the fetus or placentomes.

Usually the condition results in a sick cow with anorexia, decreased rumen motility, dehydration and weakness. The cow may be down. The placenta is thick. If the cow survives, postpartum metritis is common. The condition usually ends in death or intervention.

- The prognosis is guarded to poor for life and fertility.
- Treatment: consists of Caesarian section. Dexamethasone can be used if the cow is not down.

Hydramnios: or hydrops amnios, is due to a defective calf, usually attributed at least partly to a defect in swallowing. The placenta is normal.

The condition is characterized by a gradual accumulation of thick fluid during the last half of gestation.

- Clinical signs :Usually you can palpate the fetus and placentomes. The cow is clinically otherwise unaffected. The pregnancy usually goes to term, and frequently a small, deformed fetus is delivered. Postpartum metritis is uncommon.
- The prognosis is good for life and fertility.
- No treatment is required.

2- Superfecundation:

Its occur without causing problem when offspring from more than one sire are conceived at the same estrus period. Its occur in dog and cat but may be occur also in cow. In sow the condition occur routinely.

3- Superfetation:

Its occur when an animal that is already pregnant and come to estrus, is served, and conceives a second litter. This occur in wild species such as the kangaroo and sow

4- Ectopic Pregnancy:

The condition of fetal development outside the uterus. Its common in human. In this condition urgent surgery is necessary to terminate the problem.

There are two type of ectopic pregnancy which are :

1- **True ectopic pregnancy** :it occur when the embryo attach in the other uterine tissue (like omintum or oviduct etc.) and continuous in the development .this condition are more common in human when the embryo development in the oviduct ,and it will led to tearing of the oviduct and cause severe bleeding ,it also may occur in the animals.

2- **Secondary ectopic pregnancy** :this case occur when the embryo are normally developed in the uterus and then escape outside of uterus like in peritoneal cavity or vagina with many reason like uterine torsion or uterine rupture .

5- Twin:

the animals are divided into monotocous (that animals which often bearing one fetus in each pregnancy like mare and cow) and polytocous (that animals which bearing more than one fetus in each pregnancy like goat ,pig ,cat and bitch).

In the monotocous animals the twin may combined with many complication such as abortion , premature birth and dystocia ,therefore the twin consider a problem in this animals (specially in mare).

6- Embryonic death:

Termination of pregnancy may occur at varies stage :

1- Before maternal recognition of pregnancy (before 14 days of gestation in cow), in which case the length of cycle is not affected (early embryonic death).

   The early embryonic death consider the main causes of repeat breeder in cattle

2- After maternal recognition of pregnancy and is associated with a delay in the length of the cycle (late embryonic death).(this time between 14 days of gestation to 45days)

3- During the fetal stage (after 45days of gestation) is called fetal death.

Causes :

1- Genetics factors
2- Infection
3- Immunological
4- Environmental
5- Chromosomal aberration
6- Nutrition
7- Endocrine imbalance

7- Abortion

Abortion: expulsion of dead conceptus or a living one incapable of life.

Premature delivery: preterm birth of immature viable fetus.

Stillbirth: dead fetus expelled at term.

Abortion in dairy cattle is commonly defined as a loss of the fetus between the age of 45 days and approximately 260 days.

Abortion is usually caused by agents affecting the fetus, fetal membrane or endometerium.

Common Causes of Abortion

1- Infectious causes which includes :

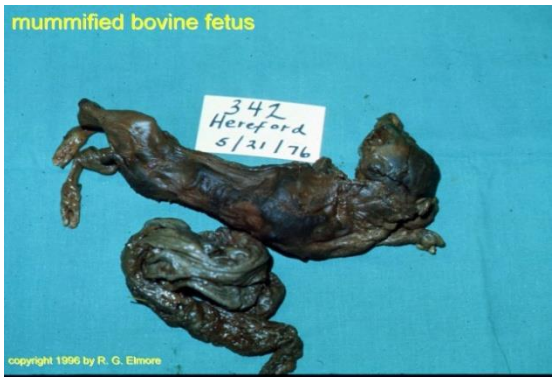
   1- Bacterial infection such as brucella, compylobacter(vibriosis),leptospirosis,listeriosis
   2- Protozoal (trichomoniasis)
   3- Viruses(infectious bovine rhinotracheitisIBR,epizootic viral abortion EVA
   4- Mycoplasma
   5- Fungal :mycoses(aspergillus)

2- Non-infectious causes

1. Chromosomal abnormalities
2. Nutritional: Toxic plants, Nitrate poisoning, Phyto-oestrogens, Iodine deficiency, Vit. A deficiency .Selenium deficiency, Lead and Cadmium poisoning
3. Stress: Handling, High body temperature, Trauma, Surgery, Vaccinations
4. Miscellaneous: Multiple pregnancy (twinning), Insemination during pregnancy, Corticosteroid therapy, Prostaglandin therapy, Allergy, Dehydration

SEQUELAE TO EMBRYONIC OR FETAL DEATH

Fetal mummification



This occurs in cases of fetal death without involution of the corpus luteum and fetal expulsion, followed by autolytic changes, absorption of the fetal fluids and involution of the placenta.

In cows the maternal caruncle involutes and hemorrhage occurs between the placenta and the endometrium, leaving a reddish-brown, gummy mass that imparts a reddish brown color to the mummified fetus.

Causes :

The etiology is varied and ranges from infectious causes such as BVD, leptospirosis, etc. to non-infectious causes such as genetic, compressed umbilical cord, etc.

Diagnosis :

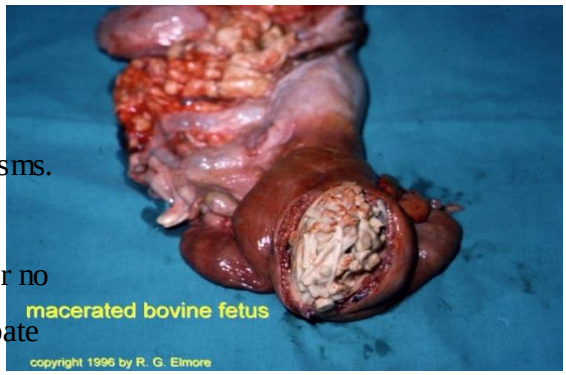
Diagnosis is based on the presence of a CL, the lack of fremitus in the uterine artery and lack of fetal fluid in the uterus. The fetus feels dry and mummy-like on palpation. Oftentimes the head, ribs, etc. can be felt.

Prognosis : is good **if** the fetus is removed. After the fetus is removed, conception usually occurs 1-3 mo. later.

Treatment : is accomplished by administering PGF2a (with or without estrogen) to lyse the CL. Steroids are ineffective with dead fetus and non-functioning placenta. After treatment, check the vagina because sometimes the mummy may be lodged in the vagina when expelled.

Fetal Maceration

Fetal maceration results from death of the fetus followed by dilation of the cervix and incomplete abortion or dystocia, usually during the last half of gestation. This condition can be due to a variety of miscellaneous organisms.



Diagnosis

On palpation per rectum, the uterine wall is thick, little or no fluid is present in the uterus and you may be able to palpate fetal bones and pus, or bones crepitating against each other in the uterus.

Prognosis

The prognosis is poor for cows with this condition. This is not a "retained CL" problem so lysis of the Cl is not helpful. Endometrial damage is present even if all fetal parts are removed.

Treatment

Treatment is very difficult. The cervix cannot usually be dilated sufficiently to remove all the fetal parts and any remaining fetal parts act as an IUD. Surgery has been performed in valuable individuals but is very difficult.

Uterine torsion

Uterine torsion usually occurs near term and is usually found at parturition because of the subsequent dystocia.

Herniation of the pregnant uterus:

Inguinal hernia:

This hernia is seen in bitch, the original hernia may be acquired or congenital.

Diaphragmatic hernia:

This rarely contain pregnant uterus.

Ventral hernia:

This occur in large animal but it seen also in cat, dog, sheep and goat with weak abdominal muscle.

Perineal hernia:

This can be seen in sheep

Rupture of the prepubic tendon:

This occur in heavy horse but may be occur in other farm species. This condition accompaind by edema just anterior to the udder. The edema is characheristically painful.

PROLAPSE OF THE VAGINA DURING PREGNANCY

Prolapse of the vagina is an important and common condition requiring careful management. It is seen chiefly in cow, ewe, and sow; less commonly in mare, doe, bitch, and queen.

Etiology Excess antepartum relaxation of pelvic tissues and increased intra-abdominal pressure.

Predisposing factors These include: breed in cattle (there is a high incidence in Hereford cows); high levels of estrogen in the diet (for example in some clovers); possible high endogenous production of estrogen; sloping environment; rumenal tympany; overfeeding with bulky food. Other factors include aging – the pelvic muscles and ligaments become less elastic with

2 Considerations Severity of prolapse, species involved, proximity of parturition, extent of damage sustained.

3 Methods

- *Conservative*: if the prolapse is intermittent or slight the obstetrician or attendant may simply clean, lubricate, and replace the prolapse periodically while awaiting birth. Parturition is then carefully supervised to avoid further damage to the prolapsed organ. In the cat and dog it may help to put a protective collar round the patient's neck to prevent licking. A cow may be placed in a stall with an elevated rear end so that her hindquarters are higher than her head. The forces of gravity may assist in keeping a small prolapse in place. In other cases repeated injections of epidural anesthetic combined with xylazine have been used to prevent straining, with varying degrees of success.
- *Suturing methods/trusses*: numerous suture patterns are available including a simple mattress suture and

to lamb without removal of the replacer. Lambing can be delayed or the vagina severely lacerated if sutures are in place and the ewe is unsupervised. At one time heavy metal trusses and clamps were used to hold the vagina closed often with poor results. With any suture pattern the obstetrician must ensure that the patient is able to pass urine. This can be achieved by suturing only the dorsal two-thirds of the vaginal lips.

Induction of Parturition

Induction of Parturition in Cows

Indications

1. To prevent dystocias due to feto-pelvic disproportion.
2. When programming calving and pasture availability.
3. In the management of medical problems, such as hydrops allantois.
4. Abortion of small heifers.

Side effects

The most common problem associated with the induction of parturition in cows is retention of the fetal membranes.

Procedures:

1. Short-acting Corticosteroids

- Dexamethasone **(20mg)** as a single intramuscular injection.
- 80% - 90% effective when administered to cows within 2 weeks of full term.

- The interval from injection to parturition is about 48 hours.
- The incidence of retention of the fetal membranes is estimated to be about 75%.

2. Long-acting Corticosteroids

- Dexamethasone trimethylacetate or Betamethasone suspension **(20 mg)** as a single I.M. dose about 30 days before term.
- Parturition occurs about 15±8 days after injection.
- This method associated with a lower incidence **(9 to 22%)** of retained placenta.
- There is a high incidence of calf mortality **(17 to 45%)** that is thought to be associated with premature placental separation and/or uterine inertia, and the colostrum immunoglobulin concentration is reduced.

3. Prostaglandins

- PGF2 alpha (**Lutalyse) (25 mg)** used as a single I.M. injection.
- Calving occurs 24 to 72 hours later in 90-100% of cows treated.
- Calf viability is good if given less than 2 weeks prior to term.
- The incidence of retained fetal membrane is similar to the short acting corticosteroids.
- Some studies have shown a higher incidence of dystocias with prostaglandin than with the corticosteroids.

4. Cortiscosteroid-Prostaglandin Combination

- Calving occurs sooner than for either drug alone **(34.6+ 1.4 hours).**
- The incidence of retained fetal membranes is equally as high as when each drug is used alone.
- 25 mg **PGF2** alpha I.M. and 25 mg. dexamethasone I.M.

5. Short-acting Corticosteroids and Estrogens Combinations.

- 20-25 mg estradiol I.M. and 25 mg dexamethasone I.M. tends to shorten the average interval to calving.
- This procedure decreased the incidence of retained fetal membranes.
- Estrogens produces residues in milk which limits the use of this method in dairy cattle.

Induction of Parturition in the Mare

Indications

- 1. Mares with a history of premature placental separation.
- 2. Delayed parturition due to uterine atony.
- 3. Prevention of injury to the mare at foaling.
- 4. Possibility rupture of the prepubic tendon.
- 5. Possibility death of the mare.
- 6. Prolonged gestation

Methods

- Both oxytocin and prostaglandins have been used to induce parturition in mares. Oxytocin is however the drug of choice.
- Oxytocin at a low (**20 IU**) dose given I.V. is preferred over high (**40 to 120IU)** doses given I.M.
- Lower doses **(<20IU)** of oxytocin are associated with a lesser degree of discomfort in the mare and shorter delivery times than higher **(>40 IU)** doses.
- After I.V. administration of oxytocin, foaling ordinarily begins in 15 to 30 minutes
- Mares may be induced with prostaglandins (**250 µg im.)**

Complications:

- 1. Delivery of premature foals
- 2. Decreased passive transfer of immunoglobulins
- 3. Myometrial spasm
- 4. Premature placental separation
- 5. Dystocias
- 6. Retention of the fetal membranes

Induction of Parturition in the Ewe

- Management of ewes with pregnancy toxemia.
- Injection of 16 mg dexamethasone as a single I.M. injection within 5 days of term. result in normal parturition in 2 to 3 days.
- Two I.M. injections of 1-2 mg of estradiol benzoate 5 to 6 days before term or with a single injection of 15 mg estradiol benzoate 5 days before term.

Induction of Parturition in Goats

- Prostaglandin **(250 µg im of luteolase**) at 144 days of gestation results in delivery between 27-35 hours after injection.
- 20 mg dexamethasone produces delivery in 1-2 days.

Parturition

It is essential for the veterinarian to be perfectly familiar with the normal course of parturition in domestic species in order to be able to differentiate between physiological and pathological birth.

Parturition is the process of delivery of the fully grown fetus on the completion of the normal pregnancy period.

Initiation of parturition

Parturition is one of the most fascinating of biological Processes .The uterine musculature is the key component of labour , and the **essential physiological change between gestation and birth is a liberation of the contractile potential of the myometrium;** the factors involved in this transformation are neural, humoral and mechanical.

The humoral factors are most important is the reversal of those mechanisms which are necessary for the maintenance of pregnancy, in particular the removal of the progesterone block, which ensures that, during this phase of the animal's reproductive life, the myometrium is largely quiescent.

Parturition occurs as result of activation of the fetal hypothalamus–pituitary–adrenal (HPA)axis.

There is still uncertainty about the mechanisms responsible for the activation of the fetal hypothalamus.

A number of theories have been proposed. These are:

- maturation of the fetal hypothalamus which might result in the development of critical synapses in the para ventricular nucleus, allowing an increase in fetal neuroendocrine function.
- ability of the hypothalamus to respond to the effects of placental hormones
- fetal stressors such as hypoxia, hyper-capnia, changes in blood pressure and blood glucose

During the last 20–25days of gestation, there is a dramatic rise in fetal cortisol concentrations, which reach a peak 2–3days before birth, thereafter declining 7–10 days postpartum. The source of the increase in fetal cortisol is the fetal adrenal, which is due to both an increase in the size of the organ in relation to total body weight, and an increase in its sensitivity to adrenocorticotrophic hormone (ACTH) ,maternal cortisol concentrations only rise around the time of parturition.

The reis an increase in corticotrophin-releasing hormone (CRH) in the fetal hypothalamus during the last10 days of gestation.

The rise in fetal cortisol stimulates the conversion of placental-derived progesterone to oestrogen by activating the placental enzyme 17α hydroxylase; this hydroxylates progesterone via androstenedione to oestrogen .

The consequences of the rise in oestrogens in the peripheral circulation are three fold :

Firstly: oestrogens have a direct effect upon the myometrium, increasing its responsiveness to oxytocin.

Secondly: they produce softening of the cervix by altering the structure of collagen fibers.

Thirdly : they act upon the cotyledon–caruncle complex to stimulate the production and release of prostaglandin F2α(PGF2α). The latter change is induced by the activation of the enzyme phospholipaseA2 stimulated by the decline in progesterone and rise in

oestrogen. This enzyme stimulates the release of arachidonic acid from phospholipids, so that under the influence of the enzyme prostaglandin synthetase, PGF2α is formed.

Prostaglandins play a key role in initiating parturition; because of their molecular structure they are soluble in fat and water so that they readily pass from cell to cell via cell membranes or between cells in the extracellular fluid.

Prostaglandins have a wide range of actions which are :

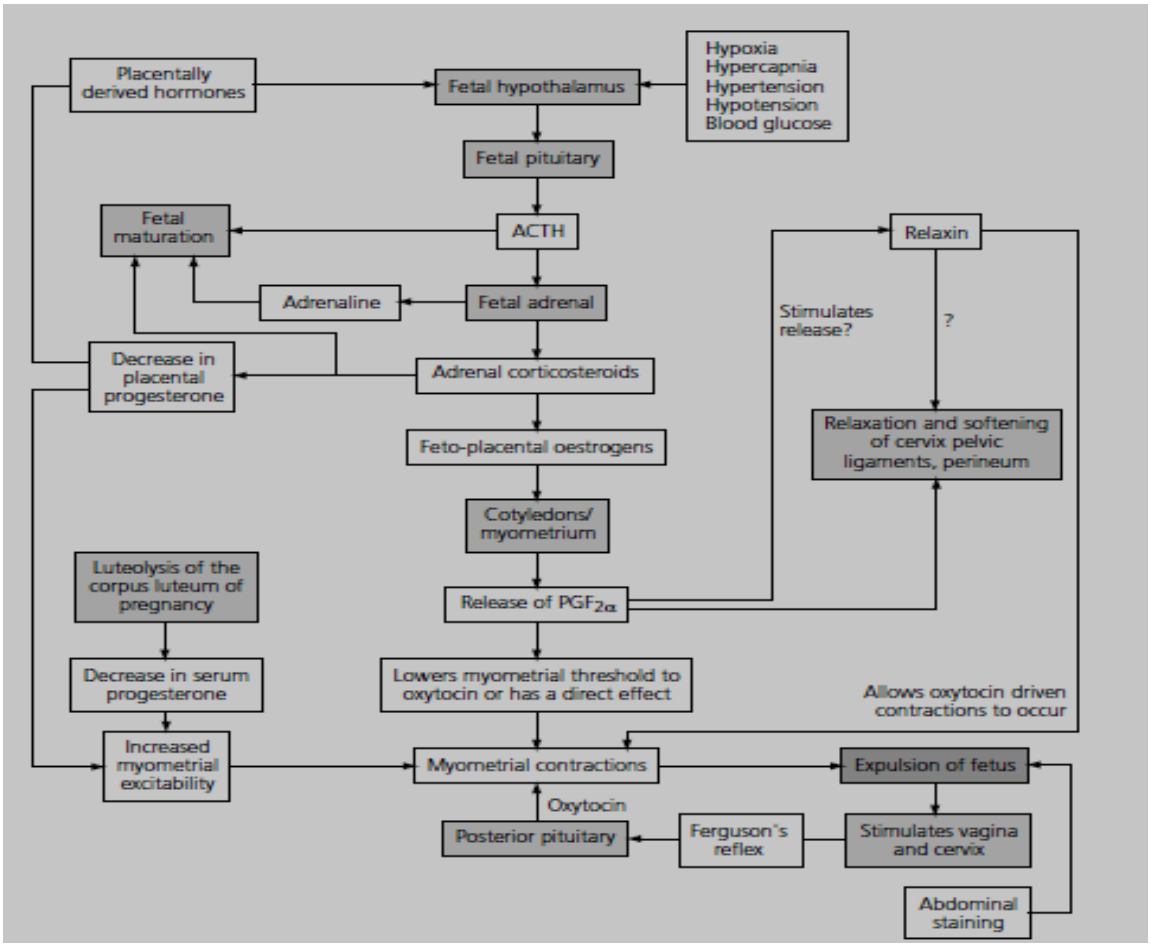
1- they cause smooth muscle contraction.
2- Luteolysis (regression of CL in ovary).
3- softening of cervical collagen .
4- Stimulating smooth muscle cells to develop special areas of contact called gap junctions, thereby allowing the passage of electrical pulses and ensuring coordinated contractions.

PGF2is considered to be the intrinsic stimulating factor of smooth muscle cells, and thus its release is important in initiating myometrial contractions.

The effect of these contractions is to force the fetal lamb towards the cervix and vagina where it will stimulate sensory receptors and initiate Ferguson's reflex, with the release of large amounts of oxytocin from the posterior pituitary.

Oxytocin will stimulate further myometrial contractions and the release of PGF2 from the myometrium. Hence both these hormones, together with uterine contraction, seem to work as a positive feedback system of increasing magnitude, thus stimulating further uterine contractions and consequent expulsion of the fetus.

Other important changes which are brought about by the endocrine events of parturition have been observed. For instance, maturation of the fetal lamb's lungs, especially the production of alveolar surfactant, is stimulated by cortisol, as are many other changes in fetal function and structure that enable the lamb to survive after birth.



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 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 4months 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 .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 bitchin which there is drop of 1°C body temperature 24hours before whelping.
- 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 vomiting.

Stages of parturition

Although, the events resulting into the delivery of fetus are a continuous process, however, for the sake of understanding the process of parturition, it has been divided into three stages referred as the stages of labor.

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 which 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 0extremities, 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 and reddish 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.

When both the oss externus and oss 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 hypophysis before the second stage of labor in many species. In the cow the contractions occur about every 10 to 15minutes 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.

By the end of first stage of labor the cervix is fully dilated and contractions occur rapidly. The allantochorion 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.

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 and raised tail, strain occasionally and ruminate irregularly. In the mare, symptoms of restlessness, anorexia, colicky pains, 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.

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 allantochorion 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.

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. 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 for15 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.

Occasionally in the mare, bitch and cat and only rarely in other domestic animals, the fetus may be born with the amnion 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 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 thereafter.

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. A weakening of the a cellular 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 .

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.

When a large portion of afterbirth 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 .

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 polytocous animals(bitch ,cat and pig) there are no third stage because the fetal membrane are expelled readily with each fetus .

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.

Dystocia

Dystocia means difficult birth; the corresponding Greek word for normal birth is eutocia. The diagnosis of dystocia is frequently based on a high degree of subjectivity, since there are situations that one person will consider to be normal, but another will consider difficult. For this reason, some of the data on the incidence, causes or efficacy of treatment of dystocia are not very reliable, although there are many circumstances when distinguishing between the two will present no difficulty. The diagnosis and treatment of dystocia constitute a large and important part of the science of obstetrics, and require a good understanding of normal parturition, sensitivity to the welfare of both dam and offspring, and good and sensitive practical competences. In addition, veterinarians must always try to prevent dystocia where possible, by the application of sensible sire and dam selection, and good husbandry and health care.

CAUSES OF DYSTOCIA

Obstetricians have usually regarded dystocia as being either maternal or fetal in origin.

Each case of dystocia is a clinical problem that may be solved if a correct procedure is followed. A correct diagnosis is the basis of sound obstetric practice.

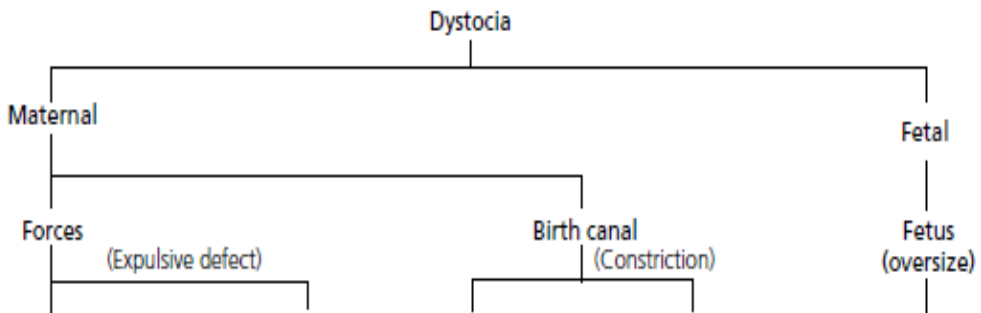
HISTORY OF THE CASE :

Therefore, before proceeding to examine the animal, a brief history of the case should, whenever possible, be obtained. Much of it will be the outcome of questioning the owner or attendant, but many points will also be elicited from personal observation of the animal.

- Has full term arrived or is delivery premature?
- Is the animal a primigravida or multigravida?
- What is her previous breeding history?
- What has been the general management during pregnancy?
- When did straining begin? What was its nature – slight and intermittent or frequent and forceful?
- Has straining ceased?

- Has a water-bag appeared and, if so, when was it first seen?
- Has there been any escape of fluid?
- Have any parts of the fetus appeared at the vulva?
- Has an examination been made and has assistance been attempted? If so, what was its nature?
- In the case of the multiparous species, have any young been born, naturally or otherwise, and if so, when? Were they alive at birth?
- Is the animal still taking food?
- In the case of the bitch and cat, has there been vomiting?

By a consideration of the answers to these and similar questions, it is possible to form a fairly accurate idea of the case to be dealt with.



FAILURE OF THE EXPULSIVE FORCES

Uterine inertia

Primary uterine inertia

Etiology The most common cause is hypocalcemia.

often still intact. In cases of hypocalcemia the patient will be dull, reluctant or unable to rise, and have a low temperature, dilated pupils, and reduced rumenal activity. The head is turned back to the flank and, if untreated, the cow may become comatose with death ensuing. In cases of hydrops uteri there will probably have been a history during pregnancy of increasing abdominal size and debility. If accessible the uterine wall is found to lack muscle tone when palpated.

Treatment If hypocalcemia is suspected, intravenous treatment with 400 mL of either 20% or 40% calcium borogluconate solution should be given. A further 400 mL of the drug is given by subcutaneous injection. If the farm has a history of coincidental magnesium deficiency, an injection of 400 mL calcium:magnesium:phosphorus:dextrose solution should be given intravenously. In many cases, parturition will resume but

should be in cases of uterine inertia resulting from other causes. Failure to deliver the calf promptly may result in its death if placental separation occurs. Following removal of the fetus, an injection of 20 IU oxytocin should be given by intramuscular injection to encourage uterine involution and placental expulsion.

Failure of abdominal expulsive forces

Etiology The abdominal musculature – so important during the second stage of labor – is either incapable of contracting or it is too painful for the animal to strain. In very old cows, or those suffering from hydrops, the abdominal muscles may have been stretched beyond the capacity of their natural elasticity. Tears in the

Clinical signs There may be an unexpected vaginal discharge during pregnancy. An abnormal and sometimes foul-smelling placenta may be visible or is passed by the patient. The fetus, often small and hairless, is palpable in the anterior vagina or uterus. If the fetus has been delivered and not observed, only placental remnants may be left in utero.

Treatment The fetus and birth canal may both be very dry. The fetus is delivered by gentle traction applied by hand to its head and limbs after thoroughly lubricating all the structures involved.

All cases of premature birth in cattle (a pregnancy of less than 271 days of gestation) must be notified in the UK to the local Divisional Veterinary Manager (DVM) of the Department for Environment, Food and Rural Affairs (DEFRA). The DVM may require the fetus or its stomach contents, a vaginal swab, maternal milk and blood samples to be submitted to the Veterinary Laboratories Agency (VLA) and examined for evidence of brucellosis. Other infectious causes should also be investigated and for this a piece of placenta, including a cotyledon, may be of additional diagnostic value.

its circulation is compromised, fetal death can occur. Sterile peritonitis may result in the fetus becoming adherent to the mesentery or other abdominal organs. Signs of pregnancy fail to develop and the intra-abdominal abnormalities may be detected by investigative clinical examination and possibly by exploratory laparotomy. If the placenta is unaffected by uterine

fetus is delivered manually. If beyond reach it may be raised by assistants lifting the abdominal floor externally and is also aided by the patient lying down. In cases of diagnosed traumatic reticulitis or pericarditis where maternal health is deteriorating, or in cases of laryngeal or diaphragmatic disease, an elective cesarean should be considered.

Uterine rupture

Etiology Tearing of the uterus may occur as a result of traumatic injury to the cow, for example following collision with a vehicle. It may also occasionally occur spontaneously through an unsuspected weak point in the uterine wall. The fate of the fetus in such cases depends on whether it passes into the peritoneal cavity and the degree of compromise sustained by the fetal membranes. Small tears may be symptomless and the fetus remains in the uterus, where it develops normally and is born without difficulty. Larger tears may allow passage of the fetus into the peritoneal cavity. Maternal death may follow rupture with severe uterine hemorrhage. In cases where the placenta is compressed and

OBSTRUCTION OF THE BIRTH CANAL

The bony pelvis

The dimensions of the bony pelvis are too small to allow passage of the fetus.

Etiology *Maternal immaturity* is the most common

nal small intestine may be palpable. These must not be confused with the exposed intestinal loops often palpable with a schistosomus reflexus fetus (see p. 48). The uterus feels smaller than normal on rectal examination and occasionally the intraperitoneal fetus may be palpable. It may be possible to locate the fetus in an abnormal position – such as underneath the rumen – by external ballottement or a transabdominal ultrasonographic scan.

Treatment The fetus should be delivered from the peritoneal cavity by laparotomy. If the presence of a uterine rupture is anticipated an elective laparotomy/cesarean section just prior to the end of gestation will increase the chance of delivering a living fetus. The extent of any peritonitis should be noted. If this is severe, or if it involves the ovaries or oviducts, future breeding may have a poor prognosis and the cow should be salvaged at an appropriate time.

Uterine torsion

This is discussed in the section on obstruction of the birth canal (see p. 43).

symphysiotomy', in which the unfused pubic symphysis of heifers is prized open with an obstetric chisel, has no place in modern bovine obstetrics.

Prevention Prompt removal of the bull from the breeding herd should avoid exposure of heifer calves to service. Suspected or confirmed pregnancy in calves served by mistake should be terminated as soon as

heifer being mounted by a very heavy bull. The downward displacement of the vertebral column that results at the lumbosacral junction may also reduce the size of the pelvic inlet.

Clinical signs There is lack of progress in the second stage of labor. If the fetus is able to partially enter the pelvis, severe unproductive straining may occur. A single large fetal foot may be seen at the vulva. If the fetus is too large to enter the pelvis, no progress is made after the completion of first-stage labor and the heifer looks uncomfortable, strains occasionally, and may stand with her back arched and tail raised. Vaginal examination reveals the presence of a small bony pelvis of insufficient size for the fetus to pass through.

Treatment The obstetrician must decide – by comparing fetal and pelvic dimensions – if the fetus is likely to be able to pass through the maternal pelvis. In many cases of misalliance involving young heifers vaginal examination reveals that the calf will clearly *not* pass through the pelvis. In cases of doubt, moderate traction may be applied but if this is unsuccessful cesarean section is indicated (for further discussion on decision-making in such cases see the section on Fetopelvic disproportion, p. 46). The technique of 'pubic

controlled fashion during the passage of the fetus. The episiotomy wound should be repaired by suturing the skin and mucosa immediately after delivery to re-establish the normal morphology of the vulval lips.

The vagina

Etiology The vagina also relaxes in preparation for

mal preparations for birth but occasionally – especially in heifers – full relaxation of this part of the birth canal does not occur. In older animals damage sustained at an earlier calving or a horning injury with the formation of scar tissue and fibrosis may occur preventing normal relaxation.

Clinical signs Although relaxation of the pelvic ligaments has occurred, the vulva may not appear to be relaxed or there may be evidence on close examination of an earlier injury. Some difficulty may be experienced in inserting the lubricated hand, and the lips of the vulva may have a hard and fibrous consistency. Beyond the confines of the vulva, vaginal dimensions are normal.

Treatment In poorly relaxed heifers, gentle manipulation and stretching of the vulva with a clean lubricated hand may cause the vulva to relax sufficiently to allow calving without damage being sustained. If relaxation does not occur within a few minutes, or if scar tissue is present, there is a risk that the dorsal commissure of the vulva will tear upwards into the rectum. This must be prevented by performing an *episiotomy*. An incision is made about one-third down the lateral wall of the vulva through the skin mucosal junction (Fig. 4.1) to allow the vulva to stretch in a

Hymenal remnants are unusual in cattle but if present are located immediately anterior to the external urethral orifice. Usually thin and easily broken down, they extend laterally from the vaginal walls to occlude part or almost all of the lumen. Perivaginal abscesses or hematomas may press on the vaginal walls, through which they may be felt as smooth fluctuating or firm masses. The contents of masses in the vaginal wall can be investigated by needle aspiration or a direct ultrasonographic scan. Vaginal tumors are uncommon in cattle but occasionally one or more leiomyomas may be palpable attached to the vaginal wall and, more seriously, a large invasive squamous cell carcinoma may obstruct the caudal vagina.

Treatment The extent and consistency of the obstruction is palpated and if possible the fetus is guided past it assisted by gentle stretching of surrounding tissues. This may be done with one hand initially. Further dilation may be achieved by inserting both hands with the fingers intertwined into the vagina and gradually separating the arms as they are advanced in an anterior direction. It may also be possible to guide the fetus past one side of a vertical pillar in the vagina, but if this is not possible the structure can be removed with scissors after clamping both extremities with artery forceps to control hemorrhage. Hymenal remnants can usually be broken down by the obstetrician's fingers. It is unwise to attempt to drain perivaginal abscesses or deal with hematomas immediately before fetal deliv-

Cervical obstruction can also result from the presence of scar tissue arising from previous injury, possibly at an earlier calving.

Clinical signs Signs of first-stage labor are prolonged and do not proceed to the second stage. Cervical obstruction is detected on vaginal examination when the case is investigated. When fully dilated the cervix is flattened into the vaginal wall and is not palpable. When fully closed, the obstetrician's finger may be inserted into but not passed through the external os. During pregnancy the os is sealed with a thick mucous plug, which is passed out through the vagina a few hours before fetal delivery. The partially dilated cervix is palpable as a circular rim extending into the lumen of the vagina at the junction of the vaginal and uterine walls. Partial dilation may allow passage of parts of the fetus such as a foot or the nose but not wider parts such as the thorax, to which the edges of the cervical rim are tightly applied. If only slightly dilated the obstetrician

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Treatment The pa
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is made to dilate the cervix manually by inserting one or two fingers (or the hand with the fingers pointed in a conical shape) into the external os. Expansion of the fingers may be accompanied by dilation of the cervix, which can be felt to give way laterally under gentle digital or manual pressure. The hand is then inserted

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Clinical signs The condition has been reported in animals from mid-pregnancy onwards. Affected animals may show signs of discomfort, some straining, and the tail head may be raised. Death may occur in

spasmolytic drugs effective in producing cervical relaxation. Vetrabutine hydrochloride (Monzaldon; Boehringer Ingelheim) given by intramuscular injection at a dose of 2.5 mg/kg may help in some cases. Cesarean section should follow if no progress has been made after 30 minutes. Surgical delivery is also indicated if there is evidence that scar tissue is obstructing the cervix or that fetal life is at risk.

The technique of cervical section or vaginal hysterotomy has been described for treatment of non-dilation of the cervix. In this technique the rim of the cervix is incised in one or more places to allow dilation of the birth canal at that point. There is a considerable risk, especially in the ventral quadrant, of severe hemorrhage, and uncontrolled tearing may also occur as the fetus passes through. The technique has no place in modern bovine obstetrics; cesarean section is a much safer procedure.

Torsion of the uterus

Uterine torsion has been found to be the cause of up to 7% of all bovine dystocia cases in some surveys. The pregnant uterus rotates about its long axis with the point of torsion being the anterior vagina just caudal to the cervix. The uterus (which may have some vascular compromise and is fragile) is carefully untwisted. Antibiotic and non-steroidal anti-inflammatory therapy is provided. The fetus and placenta can be monitored after treatment by ultrasonographic scan. Separation of the placenta from the endometrium and abortion may be complications.

Torsion of the uterus as a cause of dystocia at term

Etiology The bovine uterus has been said to be basically unstable for a number of reasons. These include: (1) the caudal parts of the uterus are attached to the lateral walls of the pelvis by the broad ligaments; (2) as pregnancy advances the cranial parts of the uterine horns lie on the abdominal floor with no stabilizing ligamentous attachment; (3) a single-calf pregnancy chiefly occupies one horn of the uterus, making the organ heavier and more bulky on one side than the other; (4) the instability may be increased by the cow lowering her front end first when lying down. Torsion occurs when the cow – or the fetus – makes a sudden movement causing the unstable uterus to rotate about its long axis. The bovine amnion is fused in places to the surrounding allantois, which is attached through the chorion to the uterine wall. If the fetus rotates

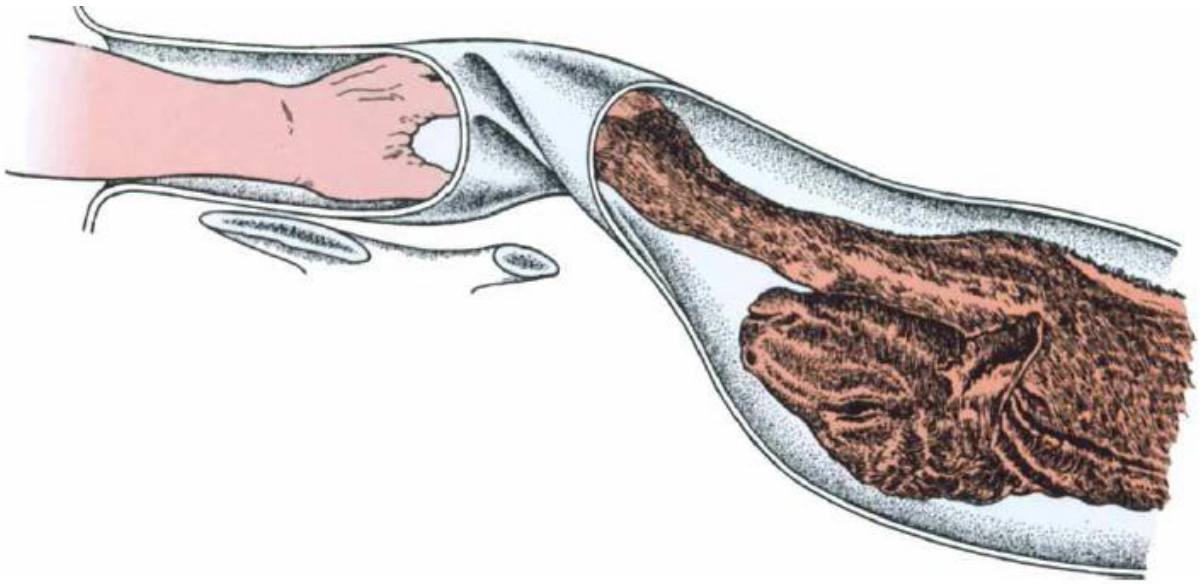


Figure 4.2 Torsion of the uterus – vaginal examination.

wards than normal. Torsion of the birth canal may cause one or both lips of the vulva to be pulled in. Vaginal examination reveals an abnormal disposition of the birth canal (Fig. 4.2). The hand cannot immediately be passed anteriorly towards the cervix. The vagina narrows conically and folds of vaginal mucosa may be felt going into an oblique spiral. The direction of the vaginal folds may indicate the direction of the torsion – either clockwise or anticlockwise.

If the torsion is less than 180° the obstetrician's hand may be passed through the constriction to palpate the fetus. In such cases care must be taken to avoid mistakenly thinking a dead fetus is alive. When palpated through the twisted anterior vagina the fetus may appear to float away from the obstetrician's hand and then spontaneously return as if alive. The cervix is normally dilated.

If the torsion is greater than 180° the birth canal may be totally occluded, with the vagina coming to a wall may become necrotic and friable. Uterine rupture may occur spontaneously or at attempted treatment by rolling, and peritonitis, toxemia, and death may occur. The possibility of unseen uterine damage should always be remembered in cases in which treatment has been delayed or which do not do well after treatment.

Treatment A number of methods are available:

Rotation of the fetus and uterus per vaginam back into their correct position This is possible if the obstetrician's hand can pass into the uterus and touch the fetus and if fetal fluids remain within the uterus. The fetus is grasped by a convenient prominence such as the elbow, sternum, or thigh and is rocked from side to side before being pushed right over in the opposite direction to the torsion (Fig. 4.3). If the maneuver has been successful the torsion will have disappeared and the vagina regains its normal morphology.

Rolling the cow The principle of this method is to roll the cow around its uterus while that organ remains

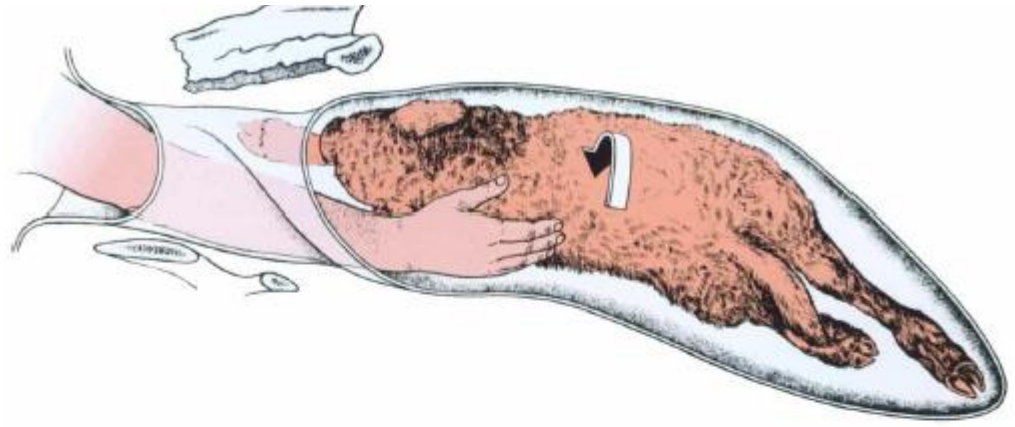


Figure 4.3 Torsion of the uterus – rotation of the fetus and uterus per vaginam.

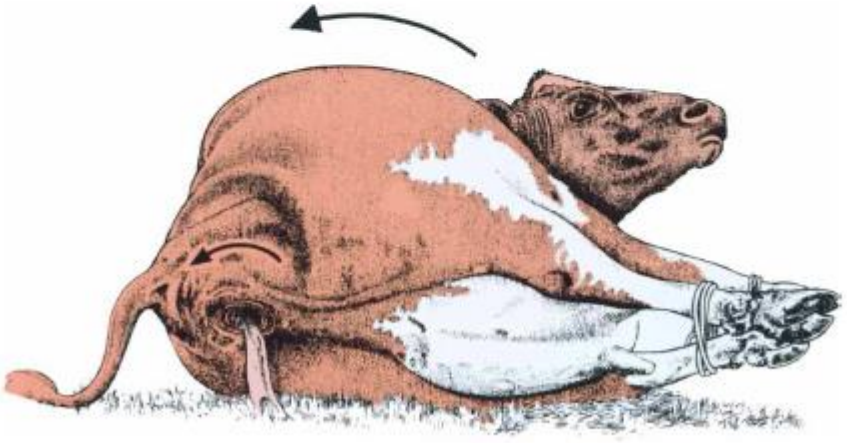


Figure 4.4 Torsion of the uterus – rolling the cow.

still. Three assistants are required. The cow is cast on the side to which the torsion is directed (Fig. 4.4). Thus in an anticlockwise torsion she is cast on her left side. The two forelegs and the two hindlegs are tied together and the head is restrained with a halter or head collar. The cow is rolled sharply over onto her other (right) side. The patency of the vagina is checked and if the torsion persists the cow is gently rolled back onto her other (left) side and the process is repeated. The cow may have to be rolled two or three times before the torsion is corrected.

The efficiency of rolling can be improved by putting external pressure on the cow's abdomen in an attempt to 'hold the uterus still' while the cow's body is rolled. Manual pressure over the uterus can be used or a board rested against the caudal abdomen and downward pressure exerted by a person standing on it.

The calf should always be delivered by the obstetrician as soon as the torsion has been corrected. The cervix may close within 30 minutes of resolution of the torsion preventing fetal delivery by the vaginal route and necessitating cesarean section.

Surgical correction This may be necessary if fetal rotation is impossible and rolling the cow is unsuccessful. A left flank laparotomy is performed on the standing cow under local anesthetic (see also Chapter 11). The uterus is located and the direction of the torsion confirmed by palpating and examining the cervical region. The uterine wall or a fetal limb within the uterus is grasped firmly and an attempt made to rotate the uterus back into its correct position.

Once the uterus is correctly in place the calf may be delivered per vaginam or by cesarean section. If the uterus cannot be rotated cesarean section must be performed with the uterus in its abnormal position. Once the fetus has been delivered the uterus can normally be readily rotated into its correct position after repair of the uterine wall. The condition of the uterine wall should be carefully checked before abdominal closure. If the uterus is discolored, its blood supply may have been compromised. If normal color is not restored after correction of the torsion the prospects for survival are not good. Antibiotic cover and the administration of a non-steroidal anti-inflammatory drug such as flunixin may aid recovery and provide analgesia.

Downward deviation of the uterus

Etiology This uncommon cause of dystocia may occur in animals suffering from a ventral hernia or rupture of the prepubic tendon. In such cases the pregnant uterus is unsupported and passes partially into the hernia. The caudal uterus and cervix are under tension and deviate sharply downwards just in front of the pelvic brim.

Clinical signs The condition should be anticipated in cases of ventral hernia or prepubic tendon rupture when spontaneous delivery is unlikely to occur. First-stage labor is not followed by fetal delivery and vaginal examination is performed. The birth canal may be partially or completely occluded but the oblique vaginal wall folds found in cases of uterine torsion are absent.

Treatment The obstetrician's hand can usually be passed through the constriction of the birth canal by application of gentle pressure. The fetus may be beyond reach in the standing animal and casting the cow may assist the obstetrician to locate the fetus and deliver it by traction. Alternatively, the abdominal floor can be raised by using a sack under the abdomen held and lifted by two assistants. Cesarean section is performed if vaginal delivery is impossible. Postparturient repair of the ventral hernia or prepubic tendon are not normally practical. The udder may hang close to the ground increasing the risk that it might be damaged and making access for the calf difficult.

FETOPELVIC DISPROPORTION

Etiology This important cause of dystocia occurs when the fetus is larger than normal, the pelvis is smaller than normal, or there is a disproportion between them. Factors affecting pelvic and fetal size are discussed above (see p. 40). In summary, pelvic size is influenced by the age, breed, weight, and pelvic dimensions of the dam. Fetal size is influenced by many factors including breed, parental and grandparental factors, gestation length, sex of the calf, litter size, parity of the dam, double-muscling of the fetus, and the nutritional state of the dam.

Clinical signs The cow is unable to complete, or has great difficulty in completing, the second stage of labor. Straining of varying intensity is seen and the fetal feet and possibly the nose (in cases of anterior presentation) may be visible at the vulva. In a normal birth the calf is usually delivered within 2 hours of the fetal nose being seen at the vulva – in cases of fetopelvic disproportion this does not occur. If the case is untreated the calf will die, with serious consequences for the cow.

Treatment Vaginal examination is often difficult as the disproportion between calf and pelvis may leave little room for the obstetrician's hands. In some cases a severe degree of disproportion may be immediately obvious and it is clear that successful vaginal delivery is highly unlikely. In such cases, if the calf is alive immediate cesarean section should be carried out. If the calf is dead and access to it within the uterus is possible, delivery after fetotomy may be considered. If access per vaginam is likely to be difficult, cesarean section is advisable. In other cases where vaginal delivery is considered possible an attempt to deliver the calf by trial traction should be made.

The important decision-making process of deciding whether a fetus is likely to pass through the birth canal is discussed in the section Manipulative delivery (p. 64).

DYSTOCIA CAUSED BY FETAL MONSTERS

Etiology Fetal monsters arise from adverse factors affecting the fetus in the early stages of its development. The adverse factors are mostly of genetic origin but

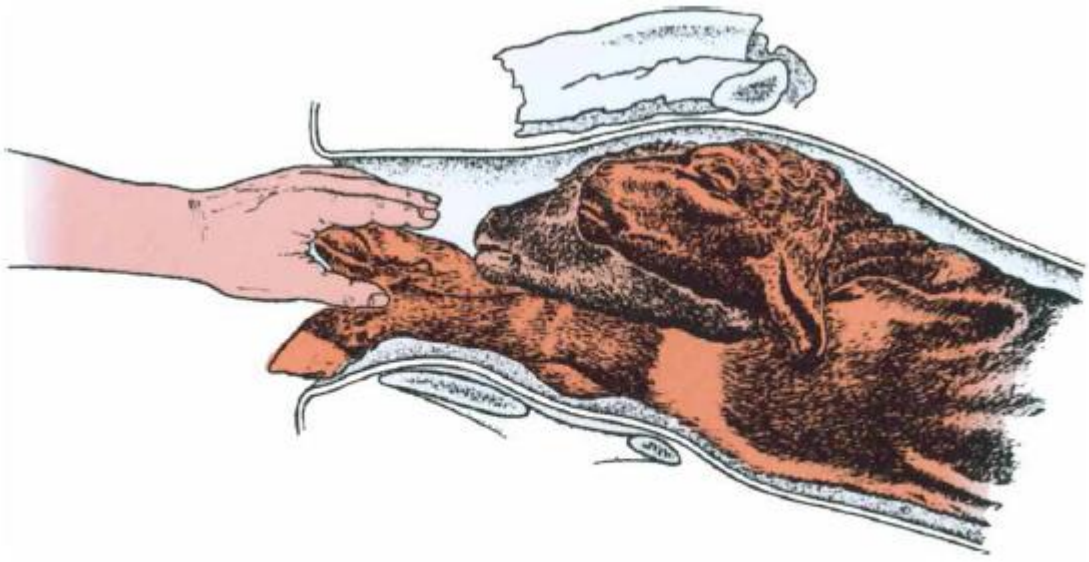
may also include physical, chemical, and viral factors. These adverse factors are particularly likely to affect the fetus before day 42, when organogenesis is complete in cattle. Fetal monsters are relatively uncommon and mostly occur sporadically but the incidence in cattle is higher than in other species. Occasionally a series of monsters may be encountered on one farm or a series of farms, which may have been sired by one bull. A large number of monsters have been recorded and only the more common ones are described here. A review of the literature suggests that 33.2% of bovine fetal monsters are conjoined twins, 31.8% are schistosomes, and 8.4% bulldog calves. Other monsters account for 26.6% of cases with none exceeding 8% of the total. Fetal monsters pose problems for the obstetrician as it is often impossible to palpate the whole structure per vaginam. The monetary value of a monster calf is clearly low and where vaginal delivery seems likely to be complicated it is often better to proceed immediately to cesarean section if the fetus is alive or fetotomy if the fetus is dead. When cesarean section is employed problems may be experienced in removing the abnormal fetus from the uterus and, before this can be done, some fetotomy may be necessary.

Conjoined twins

Sometimes known as 'double monsters', these are the most common group of monsters and arise from incomplete division of a fertilized ovum and show great variation from partial duplication to almost complete separation of the two individuals. Their presence, although rare, should always be suspected when an apparently normal birth cannot be delivered as anticipated.

Great variation on the degree of separation is seen but the following are amongst the most common conjoined twins:

- *Diprosopus*: the monster has two faces, including mouths with cleft palates, but not two complete heads. The wide double face will normally prevent the fetus from entering the maternal pelvis and cesarean section or fetotomy is required to permit delivery.
- *Dicephalus*: two heads and necks that join at the shoulder (Fig. 4.5). The divergence of the necks again prevents normal entry into the pelvis. Treatment is by removal of one head by fetotomy followed by vaginal delivery of the rest of the fetus or by cesarean section.
- *Dipygus*: duplication of the trunk and some of the limbs. Delivery is normally by cesarean section.
- *'Siamese twins'* (the somatodidymi): separation of the twins is almost complete with points of attachment being along the sternum or elsewhere. One of the more common of these rare monsters is *pygodidymus*, in which the two calves are joined at the rump and are facing in opposite directions. It is seldom possible to detect the point of attachment on vaginal examination. The first calf is often in normal presentation, seems quite small, but cannot be moved by traction. Delivery is by cesarean section



Fetal monster – dicephalus.

with fetotomy required in most cases to permit removal from the uterus.

The *fetal mole* or acardiac monster *amorphus globosus* is occasionally seen as co-twin to a normal calf. It consists of a collection of mixed fetal tissues, is mostly quite small, and is not normally associated with dystocia.

Schistosomus reflexus

The monster most frequently described in the literature, this is also known as a 'celosomian monster' or 'moon calf'. In this monster the spinal column has undergone dorsiflexion and the head and tail approximate. The limbs are ankylosed and deformed (Fig. 4.6). The vertebrae and ribs form a discoid plate of bony tissue. The grossly abnormal shape makes unaided passage through the birth canal unlikely. The deformed calf may be a singleton fetus or co-twin to a normal calf.

The calf may be presented with either its head and extremities or its exposed viscera towards the pelvis. When the head and extremities are presented they may be mistaken for twin calves presenting simultaneously but careful examination should reveal that they all belong to the same abnormal fetus. When the viscera are presented they may be covered by a thin membrane or be fully exposed to direct touch. The intestines, heart (beating if alive), and the liver may all be palpated. The size of the small intestine should indicate that it is of fetal rather than maternal origin. (Maternal small intestine may appear at the vulva in cows with uterine rupture.) The fetal intestines could, however, have arisen from a calf with a simple umbilical defect and not from a schistosome. Occasionally an additional fetal abnormality may be present. Cases have been recorded in which the monster also had hydrocephalus (see below) and the cow was suffering from hydrops amnion.

Treatment It is occasionally possible to carefully deliver a small schistosome monster by traction following generous lubrication but in most cases this is not possible. In head and extremities presentations, cesarean section, with fetotomy at surgery, is mostly necessary. If the fetus is alive it must be euthanized before fetotomy with an intracardiac injection of pentobarbitone sodium. When the viscera are presented they may be removed from the dead or euthanized fetus manually followed by fetotomy if it is possible to pass the wire around the monster. In other cases cesarean section is required.

Bulldog calf

This monster is seen chiefly in Dexter and Kerry cattle (and occasionally in Holstein–Friesians and other breeds). The abnormality is a very severe form of achondroplasia, possibly associated with a single autosomal gene, and in purebred Dexters approximately one in five calves may be affected. The abnormal fetus has

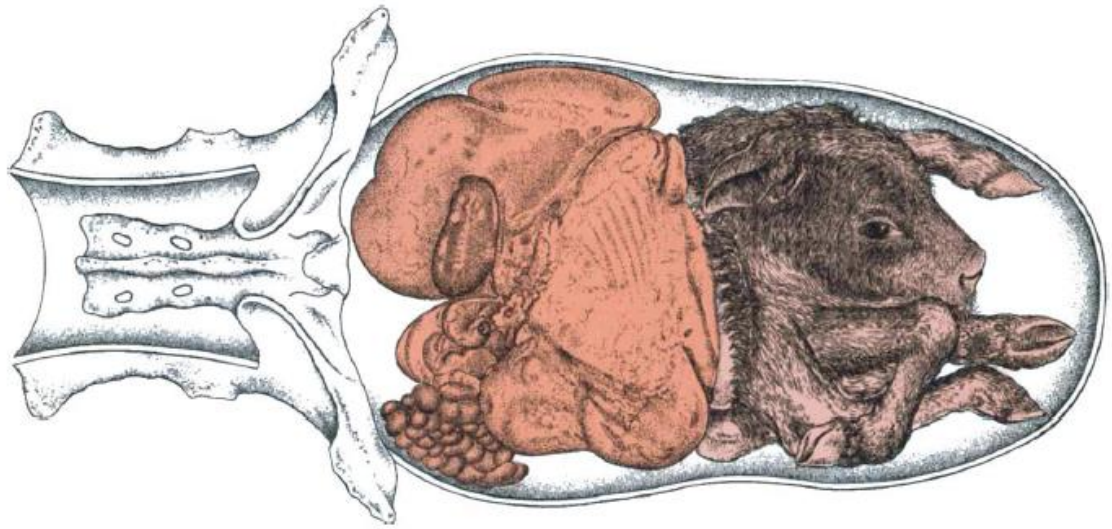


Figure 4.6 Fetal monster – schistosomus reflexus.

a very large bulldog-like head with very short legs. There may be an additional complication of either fetal ascites or, less commonly, anasarca. Affected fetuses are occasionally expelled without assistance but dystocia may arise if the head is unable to enter or pass through the birth canal. Manual delivery by the obstetrician is usually possible aided by generous lubrication.

Perosomus elumbis

This monster has a deceptively normal anterior end but rudimentary lumbar vertebrae and spinal cord, and hindlimbs that are contorted and ankylosed, possibly as a result of lack of movement by the developing fetus. In anterior presentation the monster may initially be mistaken for a normal calf but attempts at assisted delivery are resisted by the rigid hind parts, which may not permit passage through the pelvis. In posterior presentation the abnormal fetus can be more readily recognized. Delivery is by fetotomy or cesarean section possibly accompanied by fetotomy.

Hydrocephalus

Affected animals have a gross enlargement of the cranium that can prevent the fetus from entering and passing through the maternal pelvis. In some cases when the calf is dead it may be possible to break down the cranial swelling manually or to separate it from the cranium using the embryotome. In other cases cesarean section may be required. Cranial enlargement is also occasionally seen in calves with pituitary hypoplasia in which prolonged gestation has occurred.

Fetal anasarca

Generalized subcutaneous edema is present in this abnormality. Affected calves often have no hair and uterine fluids appear to be deficient leaving little natural lubrication. Generous application of obstetrical lubricant and instillation of fluids into the uterus will normally allow delivery of the fetus by traction. Some reduction in body size may be achieved in the dead calf by making numerous incisions into the skin, which allow some release of subcutaneous fluid with resultant reduction of body dimension.

Fetal ascites

This may be seen in calves at term or in cases of premature fetal death. The head, neck, and thorax of the calf will readily enter and pass through the maternal pelvis but the distended abdomen will not. If there is mild disproportion the calf may be delivered by traction after generous use of lubricant. If access to the fetal abdomen is possible through the cow's vagina it may be drained using a scalpel blade or catheter to release the abnormal fluid, with resultant reduction of fetal abdominal bulk. In the occasional case cesarean section may be required.

FETAL MALDISPOSITION

The term 'maldisposition' includes abnormalities of presentation, position, and posture that render it difficult or impossible for the fetus to enter or pass through the birth canal.

Etiology It is not clear why the fetus adopts its normal birth posture but it has been suggested that the mammalian fetus may 'practice' assuming this posture during the later stages of pregnancy. Mild or severe fetal ill health and fetal death may predispose to fetal maldisposition, as may maternal ill health or abnormal hormone levels. A mild fetal maldisposition may be made worse as it fails to engage correctly at the pelvic inlet and expulsive forces compound the difficulty. Self-correction of a maldisposition is extremely unlikely.

Clinical signs A delay in fetal delivery with unproductive straining may be seen if part of the fetus has entered the maternal pelvis. In normal birth the fetal forelimbs and nose are seen at the vulva. In some maldisposition cases these normal findings are absent. In cases of lateral deviation of the head the fetal forelimbs alone may be seen at the vulva whereas in bilateral shoulder flexion the fetal head may protrude from the vulva. In breech presentation (bilateral hip flexion) only the fetal tail may be seen. The abnormality is confirmed by careful vaginal examination.

Treatment In many cases uterine and abdominal contraction will force the abnormally disposed fetus tightly into or against the pelvic inlet, making it difficult for the obstetrician to diagnose the abnormality or take corrective action. To provide more space the fetus must be repelled (i.e. pushed back) from the pelvic inlet. The hand is placed against a solid fetal part such as the head, brisket, or (in posterior presentation) the hindquarters. The fetus is repelled from the pelvic inlet by gentle but firm pressure exerted by the obstetrician. The maneuver is aided by generous lubrication and also, if necessary in cases where little uterine fluid remains, by instilling

some warm water into the uterus. In cases where the maldisposition has been present for some time, repulsion and manipulation of the fetus is restricted by loss of fetal fluids and by the uterine walls contracting tightly around the fetus. Maternal straining is often increased by attempts at fetal repulsion and in some cases an epidural anesthetic is required. An injection of 300 μg clenbuterol can be given to reduce the tone of the myometrium. Although facilitating fetal repulsion, the epidural anesthetic will also result in reduced maternal straining assistance during the subsequent delivery.

Once the nature of the maldisposition is clearly identified the obstetrician should attempt to replace any abnormality into its correct position. Although it is occasionally possible to deliver a very small fetus in an uncorrected maldisposition, such delivery should not normally be attempted in cattle. There is a considerable risk that damage to the soft tissues of the birth canal will occur, unless great care is exercised, as the fetus is replaced in its correct disposition.

Sharp, pointed, or hard extremities of the fetus, such as the hooves, teeth, or poll of the head, should be covered by the obstetrician's hand to avoid damage to or penetration of the uterine wall. Once the fetus has been returned to its normal birth posture it should be delivered by traction in the normal way. If the maldisposition cannot be corrected or if, after correction, a degree of fetopelvic disproportion is discovered the fetus must be delivered by cesarean section or by fetotomy.

The common maldispositions seen in cattle are discussed in greater detail below.

Malpresentation

Posterior presentation

Although calves 'coming backwards' may be delivered spontaneously, posterior presentation is not normal in cattle. Assistance during delivery may be required, especially when fetopelvic disproportion is also present. Despite anecdotal accounts by farmers it is not normally possible to convert a posterior presentation into an anterior one. In an uncomplicated posterior presentation the fetal hindlimbs may be seen at the vulva with the soles of the hooves showing dorsally. This orientation of the hooves can also occur in very rare cases with the fetus in anterior presentation, ventral position, and with a deviation of the head, and care must be taken to ensure that the exact nature of the maldisposition is known.

Vaginal examination will permit the limbs to be followed up towards the hocks, hips, and tail. The relative sizes of the fetal hindquarters and the maternal pelvis need to be compared and a decision taken as to whether traction is likely to be successful.

Whenever delivery of the fetus by traction in posterior presentation is planned, the obstetrician must ensure that sufficient help is available *before* delivery is attempted.

The umbilical cord may break or become compromised at an early stage during the delivery of a fetus in posterior presentation. When this occurs the fetus may attempt to breathe while its head is immersed in amniotic fluid and death by drowning can occur if there is even the slightest delay during delivery.

Transverse presentation

This may be dorsotransverse, ventrotransverse, or laterotransverse, depending on whether the dorsal, ventral, or lateral surface of the fetal body is facing the pelvic inlet. In some cases the fetus may lie obliquely across the pelvic inlet. Careful palpation per vaginam will confirm the orientation of the fetus. An attempt is made to place the fetus in a longitudinal presentation by obstetrical version – repelling one end of the body and applying gentle traction to the other. Ideally the caudal end of the body is brought towards the pelvic inlet because the two hindlimbs may be more easily manipulated into the pelvis than the forelimbs and head. Once in a longitudinal presentation the fetus must be rotated from its lateral position into a dorsal position. Delivery by traction follows correction of the malpresentation. If the malpresentation cannot be corrected the fetus must be delivered by cesarean section or fetotomy.

Vertical presentation

An extremely unusual malpresentation in which the fetal body is found lying vertically across the pelvic inlet. The fetus may be in dorsovertical, ventrovertical, or laterovertical presentation, depending on which body surface is facing the pelvic inlet. An attempt is made to place the fetus in a longitudinal presentation by repelling one end of the fetus and applying gentle traction to the other. If manipulative delivery is impossible the fetus must be delivered by cesarean section or fetotomy.

The 'dog sitting position' form of vertical presentation, which has been described in the mare, is rarely encountered in cattle. However, this abnormality should be suspected if the head and shoulders of the

calf have been delivered but no further progress is possible, even when modest traction is applied to the fetus.

The situation is somewhat similar to the problem of stifle lock (see the section Manipulative delivery, p. 69). In the dog sitting position only the head and shoulders pass through the vulva; in stifle lock the head, shoulders, and thorax pass through the vulva.

Careful examination may reveal that the fetal hindfeet are resting on the pelvic floor, thus preventing caudal extension of the hindlimbs to allow fetal delivery. If the presence of a dog sitting position is confirmed, an attempt should initially be made to repel the fetal hindlimbs from the pelvic brim back into the uterus. If this can be accomplished, the fetus can be delivered by traction. Repulsion of the whole calf is seldom possible. In cases where this cannot be achieved, euthanasia of the calf and fetotomy may be necessary. Removal of the head and thorax of the calf will allow repulsion of the caudal parts of the calf and after locating the hind limbs, delivery in posterior presentation.

Malposition

In normal delivery the calf is in dorsal position with its spinal column beneath that of the dam. Abnormalities of position include *ventral position*, in which the calf is 'upside down', or *lateral position*, when the calf is 'lying on its side'. These abnormalities of position may also be seen when the fetus is in posterior presentation. Although very small calves can occasionally be delivered in an abnormal position it is unwise to attempt to do so and the fetus should be manipulated into a dorered in an abnormal position it is unwise to attempt to do so and the fetus should be manipulated into a dorsal position by the technique of obstetric rotation. An attempt is made to rotate the calf around its long axis by applying lateral pressure to the shoulders (or the hindquarters in a posterior presentation). This may be done by direct pressure or by rocking the calf from side to side around its long axis before pushing it firmly back into dorsal position.

In cases where little fetal fluid remains or the uterus has contracted tightly down onto the fetus, rotation prior to delivery may be difficult or impossible. In such cases, after generous application of obstetric lubrication, rotation may be attempted as traction is applied. Downward pressure is exerted on one extended limb and upward pressure on the other as traction is applied. If no progress is made, delivery by cesarean section may be necessary. If there is good access to the uterus and the calf is dead, delivery by fetotomy may be attempted.

It should be remembered that in some cases of apparent malposition the cause of the problem may be torsion of the uterus, in which case a degree of vaginal narrowing may be detected. For details of diagnosis and treatment of uterine torsion, see the section Obstruction of the birth canal (p. 43).

Malposture

Abnormality of posture may involve the head, forelimbs, hindlimbs, or a combination of these. In some surveys lateral deviation of the head and carpal flexion have been recorded as the most common malpostures in cattle.

Lateral deviation of the head

Clinical signs The fetal forelegs are normally found within the vagina and the feet may protrude through the vulva. The head may not be immediately palpable but as the forelegs are traced upwards the base of the neck is palpable and further examination will indicate the position of the head. Occasionally the fetal neck is rotated axially and the fetal mandibles are uppermost. The head is usually found lying against the rib cage and in more extreme cases – especially when fetal size is small – may be almost beyond reach near the fetal rump.

Treatment The fetus is repelled, the muzzle is located and covered by the obstetrician's hand before being guided round in the arc of a circle and up into the pelvis (Fig. 4.7). If the muzzle is just beyond reach the fetal head can be safely grasped using the eye sockets. A calving rope may be looped around the lower jaw, tightfetal head can be safely grasped using the eye sockets. A calving rope may be looped around the lower jaw, tightened, and used to pull the head round with one hand while the obstetrician's other hand protects the uterus from damage by the calf's muzzle and teeth. The rope should not be used thus attached to apply traction to the calf. If the head is even further forward traction may be applied to the bend in the neck in an attempt to bring the head within reach. If it is impossible to correct the malpresentation it may be necessary to perform cesarean section or fetotomy.

Downward deviation of the head

Clinical signs Varying degrees of this condition are seen. In mild cases the fetal nose rests on the pelvic brim in the *vertex posture* (Fig. 5.5). In more severely abnormal cases the head may be deviated downwards between the forelimbs and adjacent to the sternum in the *breast–head posture*.

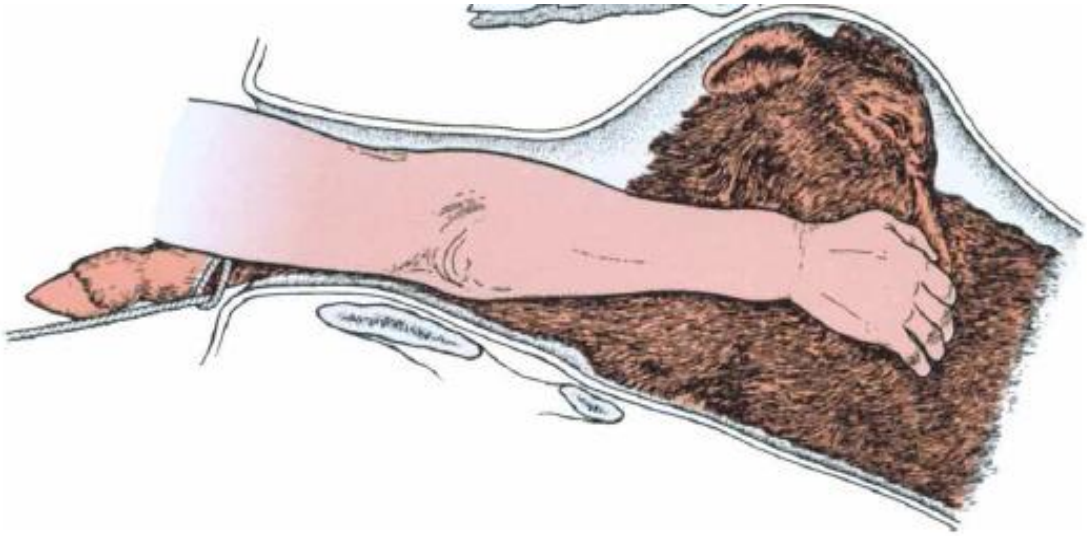


Figure 4.7 Correction of fetal malposture – lateral deviation of the head.

Treatment Having located the forelimbs in the vagina, a search for the head is made. The vertex posture is corrected by repelling the fetus and lifting the muzzle up into the pelvis. If the head is displaced below the forelimbs there may be insufficient room to bring it up into the pelvis unless one of the forelimbs is flexed and pushed back into the uterus. Once the head has been retrieved, the forelimb is relocated and the calf delivered by traction. In cases where great difficulty is encountered in attempting to bring the head up the cow may be cast, rolled on her back, and her legs secured. Gravitational forces may then assist in bringing the fetal head down into the pelvis. If manipulative delivery proves impossible, delivery must be performed by cesarean section or fetotomy.

Retention of a forelimb

This may involve carpal flexion or shoulder flexion affecting one or both forelimbs. Incomplete extension of the elbow, which causes dystocia in mares, is seldom encountered in the cow.

1. Carpal flexion

Clinical signs If only one leg is involved, the normal leg and the head are found within or protruding from the vagina. The flexed carpus of the other foreleg is found at the pelvic inlet or impacted in the vagina.

Treatment The fetus is repelled and the flexed carpus pushed upwards and forwards from the obstetrician so that the missing foot can be found more readily. The foot is cupped in the hand and brought carefully up into the pelvis (Figs 4.8 and 4.9). Occasionally, maternal straining or lack of space can make this maneuver difficult because the obstetrician is trying to raise the carpus and retrieve the fetal foot at the same time. In this case a calving rope can be placed around the fetlock and is used to bring the foot within reach while the obstetrician repels the carpus. Once the foot is within reach it must be cupped in the hand and brought into the pelvis as before. In rare cases where manipulation is impossible and the calf is dead fetotomy may be required.

2. Shoulder flexion

Clinical signs If both legs are involved the fetal head alone may be found in the vagina or protrude from the vulva, where it may become swollen and edematous. If only one limb is affected the other limb often protrudes from the vulva with the head.

Treatment The fetus is repelled to allow the retained limb to be found and manipulated into its correct position (Fig. 4.10). If the head is grossly swollen, generous lubrication and firm pressure are needed to push it back into the vulva and towards the uterus. If the calf is dead and repulsion difficult, the head may be amputated using a scalpel or the embryotome. Once the calf has been repelled the missing limb or limbs are located by searching the uterus methodically. The calf's neck is followed down to the shoulder.

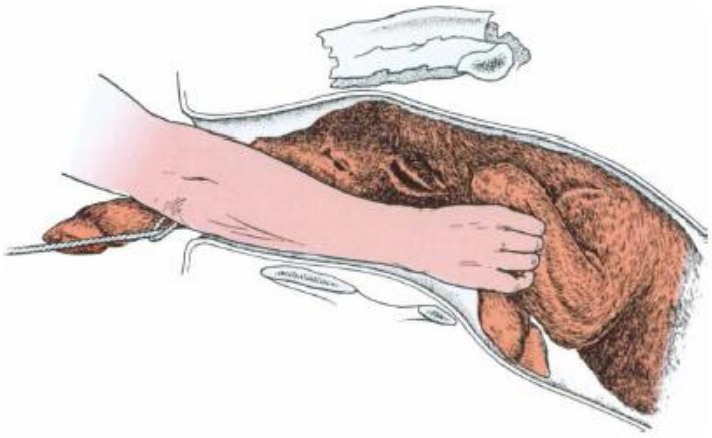


Figure 4.8 Correction of fetal malposture – carpal flexion (stage 1); see the text.

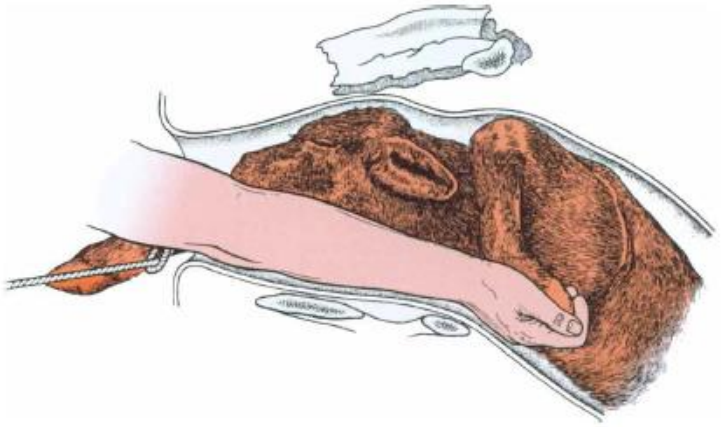


Figure 4.9 Correction of fetal malposture – carpal flexion (stage 2).

The obstetrician's hand is advanced down the limb towards the carpal joint. The limb is grasped and brought up into the carpal flexion position, and then the foot is brought into the pelvis as described above. In some cases it may help to loop a calving rope around the retained limb and slip it down towards the carpus. Gentle traction on the rope will bring the carpal joint within reach of the fingers. If correction of the malpresentation is impossible delivery is by cesarean section or fetotomy.

Retention of a hindlimb

This occurs in some cases of posterior presentation and may involve hock flexion or hip flexion of one or both hind limbs.

1. Hock flexion

Clinical signs The tip of the fetal tail may protrude from the vulva and the flexed hocks are palpable either at the pelvic inlet or impacted within the pelvis. If only

one limb is flexed at the hock the other may extend through the vulva.

Treatment This is aimed at extending the flexed limb and bringing the foot up into the pelvis. Great care must be taken to ensure that the uterus is not damaged in this manipulation. Plenty of lubrication is essential and the fetus is carefully repelled by pressure on its perineal region. One of the fetal hindfeet is located and cupped in the obstetrician's hand. The foot is drawn backwards and upwards in the arc of a circle into the pelvis (Fig. 4.11). Upward pressure is exerted on the hock. In some cases both movements (raising the foot and exerting pressure on the hock) can be accomplished with one hand. If this is impossible the

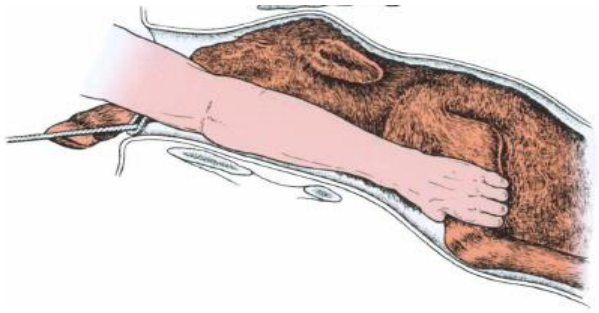


Figure 4.10 Correction of fetal malposture – shoulder flexion.

Figure 4.11 Correction of fetal malposture – hock flexion.

obstetrician may have to transfer from one position to the other. Alternatively, an assistant can be asked to push the hock upwards while the obstetrician deals with the foot. (A small obstetrician may be able to insert both hands into the uterus and carry out both procedures at once.) A calving rope can be looped round the pastern joint and then taken between the hooves and used to gently lift the foot backwards and upwards while the obstetrician pushes up on the hock joint. Care must still be taken to protect the uterus from damage by the fetal hoof. The second leg is dealt with in a similar fashion. Lack of space may make the manipulation more difficult with the second limb and further repulsion may be required to provide room in which to extend this limb.

If the hock joint is ankylosed and the fetus is dead the lower limb is sawn through just below the hock with the embryotome.

2. Hip flexion (breech presentation)

Clinical signs The tail may protrude from the vulva or be held against the fetal flank. The fetal hindquarters are palpable on vaginal examination (see Fig. 12.8). The hindquarters may be level with the pelvic inlet or lying in front of and below the level of the pelvic floor. Occasionally, only one limb is retained and the other is in the normal extended position.

Treatment The aim of treatment is to convert the hip flexion into hock flexion and then extend the limb(s) into an uncomplicated posterior presentation. The fetus is repelled by exerting pressure on the rump and the obstetrician reaches down one of the limbs to locate the hock joint, which is pulled backwards and upwards into the flexed position. It may help to pass a calving rope round the limb and slide it down to the hock. Gentle traction on the rope may help bring the hock joint within reach. With the hoof cupped in the hand, the flexed hock is extended into the pelvis (as described above in the section Hock flexion). The second limb is dealt with in a similar manner. These manipulations may be aided by the administration of epidural anesthesia and clenbuterol. It is not possible to deliver a calf in an uncorrected hip flexion malposture. This should not be attempted in cattle as severe damage may be sustained by the birth canal.

If manual correction of the malposture is impossible the limbs may be removed by fetotomy (see Fig 12.8) in the dead fetus while in the living calf cesarean section may be required.

Simultaneous presentation

Twinning and multiple birth

Twinning occurs in about 3% of all calvings. Triplets are much less common and higher numbers of calves, up to 11, have been recorded on rare occasions in the literature. Whenever a calf has been delivered the obstetrician should always search the uterus to ensure that no further fetus remains.

The cow is not well equipped to deal with multiple birth and a number of problems may occur during pregnancy and at parturition. Attempts to induce twin pregnancy either by superovulation or by implantation of twin embryos have not always met with good results. The incidence of both uterine inertia and of retention of the fetal membranes is higher than with a normal singleton birth.

Dystocia in twinning and multiple birth can arise in a number of ways:

- Uterine inertia: caused especially by overstretching of the myometrium.
- Simultaneous presentation of two or more fetuses: the fetuses may be in the same presentation (usually anterior or posterior) or one may be in anterior and the other in posterior presentation.
- Maldisposition of the first, the second, or subsequent fetuses.

Clinical signs Twins may be suspected or anticipated as a result of a larger than normal abdominal size during pregnancy, by recognition of twins on ultrasonographic pregnancy diagnosis, or following implantation of twin embryos. Signs of dystocia vary with the exact nature of the problem. Careful vaginal examination will indicate the presence of more than one calf. Great care should always be taken in any delivery to determine if the fetal parts presented belong to one or more than one fetus. This is achieved by methodically following all the palpable extremities back to the body to ascertain their origin. If two heads or two sets of forelegs are palpable they probably belong to two calves but the remote possibility of a double-headed monster or an additional pair of limbs should be borne in mind. The obstetrician should try to build up a mental picture of the position of the extremities and their origin (Fig. 4.12). Gentle repulsion of one calf may help identify which limbs belong to that calf, as they will go back into the uterus with the repelled body.

Treatment After carefully sorting out the disposition of the fetuses an attempt should be made to deliver

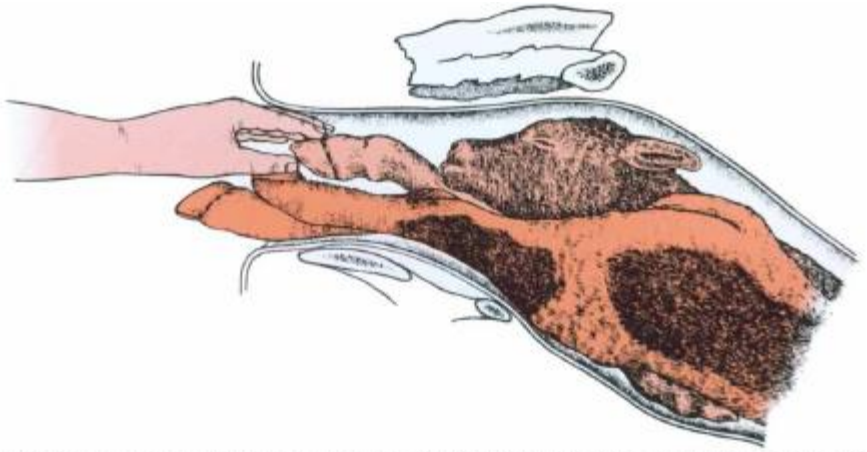


Figure 4.12 Dystocia caused by simultaneous presentation of twins. The twin in anterior presentation has a flexed left shoulder.

one after it has been placed, if necessary, into the correct presentation. If one calf is closer to the pelvic inlet or birth canal than the other this calf should be delivered first, followed by the second. If one calf is in posterior presentation this should be delivered first because only two extremities – the hindlimbs – have to be manipulated into the pelvis. After delivery of the second calf the uterus must be carefully checked to ensure that another calf is not present. Following the delivery of multiple calves uterine involution and placental passage may be encouraged by administration of 20 IU oxytocin by intramuscular injection.

DYSTOCIA CAUSED BY FETAL DEATH

Death of the fetus in late pregnancy or in the early stages of parturition may result in dystocia, which may arise in a number of ways:

- The fetus may have suffered from chronic hypoxia during pregnancy, possibly as a result of an ineffective placenta. This situation may arise especially in first-calf heifers, which show little preparation for calving and in which the fetus is found to be dead when signs of impending delivery eventually occur.
- The fetus may fail to release sufficient quantities of those hormones, including ACTH and cortisol, that initiate parturition.
- The fetus is unable to adopt the normal birth posture and thus maldisposition may occur, preventing birth.
- The cervix may fail to dilate fully – thus not allowing the fetus to pass.
- Uterine fluids may be lost and fetal delivery may be impeded by absence of natural lubrication.

When numbers of cases of stillbirth and dystocia caused by fetal death are encountered in a herd, further investigations are advisable. The management of the cattle during late pregnancy and at calving should be reviewed. Could the farm staff be missing early signs of dystocia and not seeking help until too late? The role of iodine deficiency in the etiology of fetal death in late pregnancy is unclear but there is some evidence that *Leptospira hardjo* or *Neospora caninum* may be involved in some cases. Low-grade pregnancy toxemia may reduce the responses of the maternal body to the initiation of parturition by the fetus.

Clinical signs The first sign of fetal death may be a foul-smelling vaginal discharge at the time that birth is anticipated. Investigation will reveal a partially or fully dilated cervix through which may protrude necrotic fetal membranes and parts of the fetus. If infection has gained access to the fetus through the cervix the fetus may be bloated and emphysematous. Pockets of gas are palpable beneath the fetal skin and the hair is readily pulled out. The loss of fetal fluids makes it difficult for the obstetrician's hand to move around in the uterus, the walls of which are tightly applied to the dead fetus. There is no sign of fetal life. If the fetus has been ill before death it may have developed fetal ascites with gross abdominal enlargement. In the early stages the

cow may be quite unaffected but in a proportion of cases severe life-threatening metritis with toxemia ensues. Fetal death earlier in pregnancy may result in abortion, fetal mummification, or fetal maceration (described in Chapter 2).

Treatment If the cervix is dilated an attempt is made to deliver the fetus by traction per vaginam. The obstetrician's hands and arms should be protected in such cases by arm-length plastic gloves. Obstetric lubricant is introduced by hand into the uterus and applied to the presenting parts of the fetus. If conditions in the uterus are very dry, warm water may be carefully introduced into the uterus using a stomach pump and tube. Traction is applied to the fetus either directly by hand or through calving ropes attached in the normal way. If the fetus is decayed traction may result in one or more of the extremities being pulled off. In such cases the remainder of the fetus is delivered manually, aided if necessary by fetotomy.

The emphysematous fetus may seem much too large to pass through even a fully dilated cervix. With ample, frequently applied lubrication resistance can usually be overcome without the cow sustaining damage. In some cases fetal volume may be reduced by incising into some emphysematous parts of the skin to release the gas. The abdominal size of the ascitic calf can be reduced by draining the fetal abdomen if access can be gained.

If manual delivery of the dead fetus is not possible it may be delivered by fetotomy or cesarean section. Both procedures in these circumstances carry a severe risk to maternal health but may be the only course available.

Evidence of fetal life

- Positive response to pedal withdrawal and palpebral reflexes.
- Response to pressure on the eyeball or pinching the nose or ear.
- Sucking reflex if fingers are placed in the calf's mouth.
- Contraction of the anal sphincter when a finger is inserted.
- Spontaneous movement of the fetus, but excessive movements of the extremities or the tongue may indicate a developing hypoxia. Discoloration of the amniotic fluid with green meconium is a further sign of fetal compromise. Fetal breathing or bellowing

within the uterus may indicate impending placental collapse and imminent fetal death. Delivery in such cases should be immediate but passage through the birth canal without the support of placental circulation is a life-threatening experience for such fetuses and there may be insufficient time for a cesarean section. Apparent spontaneous but not genuine fetal movement can be caused by straining activity in the cow.

Note: a negative response to appraisal of reflexes does not necessarily confirm fetal death, especially in cases where the fetus is so tightly impacted in the birth canal that it is unable to move in response to stimuli. Less commonly, a non-responsive fetus may simply be in a somnolent phase.

- If the fetal head is protruding from the vulva the ocular mucous membranes may be inspected. They should be pink in a healthy, well-oxygenated calf. Cyanosis indicates at least a degree of hypoxia. Extreme pallor of the membranes may suggest that the fetus is severely anoxic.
- Detection of fetal pulse in the metacarpus or metatarsus is occasionally possible but is also made difficult by maternal straining.

If sophisticated equipment is available the following may be tried but straining movements of the cow make recording difficult:

- Detection of heart beat by Doppler or B-mode ultrasonography or by detection of the fetal electrocardiograph. A long Doppler rectal probe can be inserted alongside a small fetus to rest against the chest wall giving clear signal of the heart rate.
- Po_2 and Pco_2 in the fetal blood can be measured if a blood-gas machine is available. A blood sample is taken from the metacarpal or metatarsal vein of the calf if the vessels are accessible. An immediate estimation of Po_2 and the fetal pulse rate can be obtained by means of pulse oximetry techniques. The attachment of a pulse oximeter to the ear or tongue of the calf during delivery is not always easy.

Evidence of fetal death

- Absence of positive signs of life (subject to the caveat concerning impacted fetuses).
- Blood staining of the amniotic fluid occurs 12 hours after fetal death and the development of corneal opacity commences; 72 hours after death collapse of the eyeball may begin – a useful observation if the fetal head is visible or palpable.
- Sterile autolysis of the fetus commences immediately after fetal death and if infection gains access via the cervix, putrefactive decay occurs with fetal emphysema and possibly the complication of septicemia and toxemia in the cow.
- Degeneration and separation of the placenta with loss of fetal fluids.

Care of new born:

OBJECTIVE: To reduce the calf mortality at the time of birth.

During intrauterine life, the foetus is nursed entirely by the dam. At birth, the maternal connections are severed due to rupture of umbilical cord resulting in cessation of nutrient and oxygen supply to foetus. Various measures can be taken to reduce new-born mortality.

1. To initiate respiration:

• Remove mucus from the nostril and mouth with the help of fingers.

• Draw out the tongue to and fro.

• Blow air into the nostrils.

• Vigorously rub the chest with a gunny bag or towel. This tactile stimulus may stimulate respiration.

• Hold the hind legs of newborn and swing backward and forward resulting in discharge of copious quantity of fluid or mucus from the larger bronchii, throat and nose.

• Pinch the fetal nose.

• Tickling the nasal mucosa with straw.

• If respiration is not started but cardiac function is present, then artificial respiration should be attempted.

Once spontaneous breathing is established, the calf may be given further care. Severe dyspnoea may occur in immature calves and these animals should be given an intravenous injection of 2-4 mg. of dexamethasone which encourages surfactant production.

2. Prevention of umbilical infection :

• lf the umbilical cord is not ruptured, it should be ligated at about 2 inches from the umbilicus and severed with scissors, and the stump should be cleaned with antiseptic. The navel cord should not be tied but allowed to drain if bleeding is not so profused.

• To this stump, tincture iodine should be applied. The ligation should be removed within 12 - 24 hours.

3. Thermo-regulation:

Thermo-regulation in the newborn can be improved in a number of ways.

• Ensure that there is adequate milk intake.

• Arrange the birth to occur in a thermally neutral environment as far as possible.

• New born puppy should be placed in an environmental temperature of 30-330C for the first 24 hours, which can be reduced to 26-30oC by 3 days.

• The new born's coat should be adequately and quickly dried.

• Suitable jacket should be provided in winter.

Note: The new born has little subcutaneous fat and hence insulation is poor.

4. Management of acidosis :

• The foetus at the time of a normal birth will usually have a mild metabolic and respiratory acidosis.

• Dystocia is likely to cause a severe respiratory and metabolic acidosis.

• Severe acidosis has an adverse effect on both respiratory and cardiac function.

• Signs of acidosis

• Abdominal breathing.

• Low heart rate.

• Prolonged jugular filling time.

• Poor body muscle tone.

• Absence of a pedal reflex.

• Time to attain sternal recumbency (T-SR) is greater than 15 minutes.

Note: *A T-SR of*> 15 *minutes is an ominous sign of severe acidosis.*

1." "y

• If there is no sign of spontaneous improvement, give 250-500 ml. of 4.2% sodium bicarbonate by slow intravenous injection

5. Colostrum feeding :

• The young one should get first colostrum within first two hours after birth.

• In case colostrum is not available, 200-500 ml. of dam's blood or serum should be injected subcutaneously to young one of large animal and in smaller animals, 20-100 ml. to their young one (s) animal.

PUERPERIUM

puerperium is that period after the completion of parturition, including the third stage of labour, when the genital system is returning to its normal non-pregnant state. In the polyoestrous species (the cow, mare and sow) it is important that there should be a normal puerperium since it is the practice under most systems of husbandry to breed from individuals of these species fairly soon after they have given birth. Thus any extension of the puerperium may have a detrimental effect on the reproductive performance of the individual animal concerned.

There are four main areas of activity in this period:

1- The tubular genital tract, especially the uterus, is shrinking and atrophying due to tissue loss, thus reversing the hypertrophy that occurs in response to the stimulus of pregnancy. Myometrial contractions, which continue for several days after parturition, aid this process and help in the voiding of fluids and tissue debris; this is normally referred to as **involution**.
2- The endometrium and deeper layers of the uterine wall is restored.
3- There is a resumption of ovarian function in polyestrous species and a return to cyclical activity.
4- Bacterial contamination of the uterine lumen is eliminated.

Involution

The reduction in the size of the genital tract is called involution; it occurs in a decreasing logarithmic scale, the greatest change occurring during the first few days after calving. Uterine contractions continue for several days, although decreasing in regularity, frequency, amplitude and duration. The atrophy of the myofibrils is shown by their reduction in size from 750 to 400 μm on the first day to less than 200 μm over the next few days. The diameter of the previously gravid horn was halved by 5 days and its length halved by 15 days.

There is some dispute about when uterine involution is complete; the differences are probably only subjective. In six studies reported in dairy cattle the time taken for complete involution ranged from 26.0 to 52.0 days, whilst in three studies in beef cattle it was 37.7–56.0 days. The changes after 20–25 days are generally almost imperceptible.

The cervix constricts rapidly postpartum; within 10–12 hours of a normal calving it becomes impossible to insert a hand through it into the uterus, and by 96 hours it will admit just two fingers. The cervix also undergoes atrophy and shrinkage due to the elimination of fluid and the reduction in collagen and smooth muscle.

Factors influence the uterine involution.

Many of the methods used to measure the rate of involution have been largely subjective and thus inaccurate; however, with the advent of transrectal ultrasound imaging, accurate measurements of uterine and cervical dimensions are now possible and there are some factors which influencing the Uterine involution:

1. *Age*. Most observers have found that involution is more rapid in primipara than pluripara.
2. *Season of year*. If there is any influence, involution is probably most rapid in spring and summer.
3. *Suckling vs. milking*; it may be a breed influence on the effect of time to return of cyclical ovarian activity.
4. *Climate*. There is evidence that heat stress can accelerate and inhibit the speed of involution.
5. *Periparturient abnormalities*. Dystocia, retained placenta, hypocalcaemia, ketosis, twin calves and metritis delay involution. Periparturient problems cause an overall delay in the completion of this process of 5–8 days.
6. *Delayed return to cyclical ovarian activity*. This inhibits involution.

Restoration of the endometrium: :

Although placentation in the cow is considered to be of a non-deciduous type it is well recognized that during the first 7–10 days after calving there is usually a

noticeable loss of fluid and tissue debris (**lochia)** which is usually yellowish brown or reddish brown; the volume voided varies greatly from individual to individual. Pluripara can void up to a total of 2000 ml.

- The greatest flow of **lochia** occurs during the first 2–3 days; by 8 days it is reduced, and by 14–18 days postpartum it has virtually disappeared.
- Normal **lochial discharge** does not have an unpleasant odour.
- The **lochia** are derived from the remains of fetal fluids, blood from the ruptured umbilical vessels and shreds of fetal membranes, but mainly from the sloughed surfaces of the uterine caruncles.
- Regeneration of the epithelium of the endometrium occurs immediately after parturition in those areas which were not seriously damaged and is complete in the intercaruncular areas by 8 days.
- Complete re-epithelialisation of the caruncle, which is largely derived from centripetal growth of cells from the surrounding uterine glands, is complete from 25 days onwards, although the stage at which complete healing occurs is variable.

Return of cyclical activity (ovarian rebound)

- An ovulatory follicular wave occurs periodically during pregnancy, with the emergence of follicles of up to a maximum of 6 mm in diameter. However, because of the prolonged period of inhibition during pregnancy, due to the continuous negative feedback effect of progesterone secreted by the corpus luteum and placenta, the pituitary is refractory postpartum, as demonstrated by a lack of response to the administration of gonadotrophin releasing hormone (GnRH) .This eventually recovers with time.
- As a result of the absence or low output of gonadotrophins the ovary is relatively quiescent and the cow is in the anoestrous phase, which may be prolonged in suckler and high-yielding cows.

- In the immediate postpartum period both oestradiol and progesterone are low. The anterior pituitary is capable of releasing FSH during the first few days postpartum, so that with the sporadic release of endogenous GnRH there is a gradual and sustained rise in plasma FSH. After about 7–10 days, this is sufficient to result in the emergence of the first follicular wave; this occurs at about 4 days in dairy cattle, and 10 days in beef cattle.
- The ability of the pituitary to release luteinising hormone (LH) is much slower, for although the early release of GnRH causes some rise in LH, it quickly returns to basal levels.
- A dominant follicle may emerge from the first follicular wave, but ovulation will occur only if the dominant follicle produces enough oestradiol to stimulate adequate LH secretion in the form of one pulse per hour; if this occurs, then there is a first ovulation at 21 days in dairy and 31 days in beef cattle.

Elimination of bacterial contamination

- At calving, and immediately postpartum, the vulva is relaxed and the cervix is dilated thus allowing bacteria to gain entry into the vagina,and thereafter the uterus.
- Blood, cell debris and sloughed caruncular tissue provide an ideal medium for bacterial growth; however, **in most cases the bacteria do not colonise the uterus to produce a metritis/endometritis** (why?).
- The main mechanism involved in the elimination of the bacteria is phagocytosis by migrating leucocytes; however, persistence of uterine contractions, sloughing of caruncular tissue and uterine secretions all assist in the physical expulsion of the bacteria.
- Early return to cyclical activity is probably important since the oestrogen dominated uterus is more resistant to infection.

Uterine defense mechanism:

Uterine defense mechanisms against contaminant micro-organisms were maintained in several ways:

Anatomically : by the simple or pseudostratified columnar epithelium covering the endometrium, uterine muscles, natural barrier (cervix, vestibule and valve)

Chemically :by mucus secretions from the endometrial glands and hormones (estrogen).

Immunologically: through the action of polymorphonuclear inflammatory cells and humoral antibodies, but the degree of interaction is not clear.

Disruptions of these mechanisms allow opportunist pathogens, mostly microorganisms found in the posterior gastro-intestinal tract and around the perineal area, to colonise the endometrium and cause an endometritis.

Under normal circumstances, there are several mechanisms, which prevent pathogens from colonizing the genital tract.

The major **anatomical barriers** between the contaminated world and the relatively sterile environment of the uterus, include the vulva, the vestibule (guarded by a muscular sphincter), and the cervix.

It should be noted that, although the vulva may appear of little consequences as a barrier, it is, in fact, remarkably efficient at preventing faecal contamination of the tubular genitalia. In cattle, the cervix is formidable barrier composed of series of mucosal lined collagenous rings.

In addition, the cervical-vaginal mucus (especially the scant, tenacious mucus of the luteal phase) can function as a physical barrier for organisms that would otherwise ascend the reproductive tract.

The **circular and longitudinal** layers of the uterine musculature provide physical propulsion of particular material, including microbes.

Epithelial cells are the first to make contact with potential pathogens that enter the uterus. Epithelial and stromal cells interactions are critically important for endometrial function, with stromal cells affecting epithelial cells through

both the release of soluble factors and turns over of extra cellular matrix. Conversely, epithelial cells affect stromal cells function through the release of soluble factors and cell to cell contact PGE2 regulate epithelial cells proliferation and is mediated indirectly by uterine stroma.

Estradiol and progesterone have both opposing and complementary effects on the female genital tract with estradiol stimulating epithelization (especially of the vaginal lining and endometrial gland), and vascularization of the endometrium, and increased production of cervical mucus and oviductal secretions, enhancement of uterine contractility, initiation of sexual receptivity.

Cattle are resistant to uterine infections when progesterone concentrations are basal and they are susceptible when progesterone concentrations are increased.

The high estradiol concentrations that occur at estrus and parturition cause changes in number and proportions of circulating white blood cells, with a relative neutrophilia and a "shift to the left".

Moreover, at estrus, the blood supply to the uterus is increased under the influence of estradiol, whilst at parturition there is a massive blood supply to the gravid uterus. This increased blood supply, coupled with the migration of white cells from the circulation to the uterine lumen, enables vigorous and active Phagocytosis of bacteria to occur. Estradiol also causes an increase in the quantity and nature of vaginal mucus, which also plays an important role in defense of the uterus against bacteria by providing a protective physical barrier and by flushing and diluting the bacterial contaminants.

Puerperal Metritis (Acute septic metritis)

Puerperal metritis is inflammation of the uterus which involved all layers of the uterus (endometeriom,myometeriom and serosa) and it is affect the general health of the cow and occurs within a few days of parturition.

It usually follows an abnormal first or second stage of labour, especially when there has been a severe dystocia.

Causes:

- The disease associated with parturition problems like uterine inertia, twin births, RFM, prolonged traction and damage to the vulva and/or birth canal.
- Bacteria colonize the non-involuted uterus, producing toxins which are absorbed and cause severe symptoms.
- The most important infecting organisms are *Arcanobacterium pyogenes*, group C streptococci, haemolytic staphylococci, coliforms, and Gram-negative anaerobes, particularly *Bacteroides* spp.
- In rare cases, clostridia are present which rapidly produce disease that is serious and often fatal.

Clinical signs:

- Affected animals show both local and general symptoms.
- It is very common for toxemia, septicemia and pyrexia to occur.
- The temperature of affected cows may be elevated to 40–41C, but is more often subnormal.
- There is a rapid pulse rate (in the region of 100/minute) and the respirations may be sufficiently frequent to suggest a respiratory disease.
- Animals are anorexic and dehydrated; they often have a toxemia-induced diarrhea and exhibit signs of shock.
- It is common for the infection to extend through the uterine wall into the peritoneum, causing a localized or generalized peritonitis.

- The uterus contains large volume of toxic, fetid, reddish, serous exudates, containing pieces of degenerating fetal membranes; the exudates is discharged from the vagina by frequent expulsive straining efforts.
- Vaginal and uterine exploration of an affected case causes acute discomfort and is accompanied and followed by the most severe and persistent expulsive efforts.
- The cotyledons are swollen and the fetal membranes often remain firmly attached.
- The vulva and vagina are swollen and deeply congested.

D.D.:

Puerperal metritis must be differentiated from (primary) pneumonia, traumatic reticulitis and pericarditis, and from milk fever and acute mastitis.

Many animals with puerperal metritis also develop mastitis, particularly if they are recumbent, and many also have concurrent hypocalcaemia.

Treatment:

- The treatment of puerperal metritis requires both good nursing care and vigorous medication.
- The cow should first be kept warm and made as comfortable as possible by, for example, transferring it to a well-bedded and warm loose-box.
- An attempt should be made to remove the fetal membranes by very gentle external traction, but no attempt should be made to enter the vagina and uterus with the hand.
- It should be appreciated that the uterus is particularly friable and that it contains a voluminous mass of septic material, therefore Rough attempts at removal of the fetal membranes or even careful exploration of the vagina and uterus can cause severe damage and predispose to the absorption of toxins and entry of bacteria.

- If the case is seen within 2–3 days of parturition, 50 i.u. of oxytocin by intravenous injection may cause contraction of the uterus and expulsion of fluid and debris.
- The disease is best treated by systemic administration of broad-spectrum antibiotics and supportive therapy. The choice of antibiotic and the route of its administration have been the subject of much debate.
- Intrauterine infusions of tetracyclines may be effective against mild cases of endometritis, but they do not penetrate far enough into the uterine wall to be effective against full-thickness metritis.
- Systemic broad spectrum antimicrobials, fluid therapy and nonsteroidal anti-inflammatory drugs are widely recommended.
- The use of estrogens is contraindicated in cases of acute puerperal metritis since(why) , although they potentially increase the resistance of the genital system, oestrogens also increase the blood flow to the uterus and, thereby, increase the absorption of bacterial toxins.
- Once the temperature approaches normal and the cow shows some signs of improvement, some benefit can be obtained by uterine lavage and drainage. This can be done with a wide-diameter, soft rubber tube. The perforated end is carefully inserted through the cervix into the uterine lumen and several liters of warm (49 C) sterile saline are poured down the tube through the funnel. The funnel end is quickly lowered before the tube empties, thus establishing a siphon, until the uterus is as empty as possible.
- The warm saline solution is believed to exert both a soothing and a stimulating effect on the uterus, and this, together with the evacuation of exudates, promotes involution.
- Ideally, the patient should be given daily treatment as outlined above.

Endometritis

Endometritis, which implies inflammation of the endometrium, is a common condition of the cow.

Unlike metritis, it does not affect the general health of the cow, although it does have a profound effect upon the fertility of the animal. Most of the specific pathogens which cause infertility (such as Campylobacter fetus and Trichomonas fetus) do so because of the endometritis that they produce. However, the most important cause of endometritis is non-specific, opportunist pathogens that contaminate the uterus during the calving period.

Causes of endometritis:

- The causal organisms usually reach the uterus from the vagina at coitus, insemination, parturition or postpartum, although it is possible in some circumstances for infection to arrive by the circulation.
- The great majority of cows suffer from bacterial contamination of the uterus after calving, but, under normal circumstances, this flora is rapidly eliminated. In cows that develop endometritis, the bacterial flora is not eliminated from the uterus, causing the endometrium to become inflamed.
- the pathogenesis of disease is largely concerned with the factors that impair the cow's ability to eliminate the infection, rather than with the bacteria themselves. There are therefore many factors that are associated with the development of endometritis as described below.

1- Retained fetal membranes.
2- Dystocia.
3- Management factors.(high milk yield, state of nutrition such as Overfeeding, underfeeding, hypocalcaemia

4- Season of the year cows calving during the winter or spring are more prone to endometritis than those calving at other times.
5- Return of cyclical ovarian activity.
6- Bacterial loading. The environment in which the parturient and postparturient cow is kept affects the incidence of endometritis. In particular, a dirty, unhygienic calving environment predisposes to the disease.

Clinical signs

- Clinical signs of endometritis are the presence of a white or whitish-yellow mucopurulent vaginal discharge in the postpartum cow.
- The volume of the discharge is variable, but frequently increases at the time of oestrus when the cervix dilates and there is copious vaginal mucus.
- The cow rarely shows any signs of systemic illness, although in a few cases milk yield and appetite may be slightly depressed.
- Rectal palpation frequently shows a poorly involuted uterus which has a 'doughy' feel.

Treatment :

- A wide range of antiseptics, antimicrobial agents and hormones have been used as treatments for endometritis.
- Moreover, many cases of endometritis are self-limiting and resolve after the resumption of oestrous cyclicity.
- there is a danger that non-treatment will lead to the development of pyometra.
- In the treatment of chronic endometritis with antimicrobial substances, it is preferable to administer the substance by the intrauterine route. Provided an adequate dose rate is used, this will result in effective minimum inhibitory

concentrations (MICs) reaching the endometrium and being established in the intraluminal secretions.

- Penicillins are susceptible to degradation by the large numbers of penicillinase producing bacteria that are present.
- A broad-spectrum antibiotic, such as oxytetracycline, used at a dose rate of up to 22 mg/kg, will provide effective MICs in the lumen and uterine tissues.
- Considerable concentrations of antibiotic reach the endometrium following intravenous or intramuscular injection .
- When there is a palpable mature corpus luteum on the ovary it is arguable that the best method of treating clinical endometritis is with PGF2α or its synthetic analogues. When a corpus luteum is present (i.e. during the luteal phase of the oestrous cycle or when there is a pathologically retained corpus luteum) PGF2α causes luteolysis, thereby stimulating the return of oestrus and reducing the high progesterone concentrations.
- The cow will return to oestrus 3–5 days after treatment and, unless the purulent discharge is severe, itis advisable to serve or inseminate at the induced oestrus.
- Several intrauterine therapeutic preparations also contain oestrogens, whilst the administration of oestrogens by intramuscular injection at the same time as intrauterine infusion of antibiotics has also been recommended. Such hormones increase uterine blood flow and simulate the changes that occur during the follicular phase of the oestrous cycle.

Retained fetal membranes (RFM)

Usually the placenta is passed in 3-8 hours after calving. If it has not passed after 12 hours the placenta is retained and the animal should be treated.

It is a common complication of bovine parturition and, although of little consequence per se, its role in predisposition to infections of the uterus means that retention of the fetal membranes is an important contributor to bovine infertility.

Aetiology

Detachment of placenta in the cow involves separation of the finger-like cotyledon villi from the caruncle crypts without significant tearing of either fetal or maternal epithelia.

Detachment of the fetal membranes indicates that uterine involution is progressing normally. Involution of the uterus is accompanied by a massive breakdown of collagen and other proteins. Lack of cotyledon proteolysis (collagenolysis) appears to be the underlying cause of RFM.

Retention of the fetal membranes occurs when the normal processes of dehiscence and expulsion fail to take place.

There appear to be three main factors involved in the separation and expulsion of the fetal membranes, namely:

- maturation of the placenta
- Collapse and shrinkage of the cotyledons which lead to physical separation from the maternal crypts.
- Uterine contractions.

Main causes:

1- ***Premature birth*** is very commonly associated with RFM. Cattle twins are usually slightly premature; hence, their birth is often followed by retention. heat stress can reduce gestation length and increase the incidence of RFM in dairy cattle.

2- ***Placentitis.*** Both placentitis and RFM occur in cases of abortion due to *Brucella abortus,Campylobacter fetus* and moulds such as *Aspergillus* or *Mucor* spp. Roberts (1986) considered the relationship between placentitis and RFM to be causal. Inflammatory swelling could affect the physical union between the maternal caruncle and fetal cotyledon; the involvement of the endometrium could interfere with the endocrine changes of the third stage of labour; or bacterial toxins could affect the myometrium.

3- ***Uterine inertia.*** Uterine inertia is frequently suggested as a predisposing factor for RFM (effect of uterine contractions on expulsion of the placenta afterbirth).

There are many factors can cause uterine inertia which are :

- Hormone imbalance: the incidence of RFM has been reduced by giving oxytocin or PGF2□□ in at least some studies. Sucking has been associated with a reduced incidence of retention by stimulate oxytocin releasing which has also been cited as evidence of an oxytocin-mediated stimulation of uterine contractility.
- Hypocalcaemia, particularly in dairy cattle.
- Over-stretching of the myometrium (as with hydrallantois or grossly oversized fetus).
- Degeneration of the myometrium fibers as a result of bacterial toxins.
- Dystocia, C-sections, fetotomy

Secondary uterine inertia, which results from exhaustion of the myometrium in obstructive dystocia, may also result in RFM.

4- ***The immune system.***

RFM may be related to failure of the release of inflammatory mediators , Laven and Peters (1996) stated that the primary problem in the condition is, in fact, a reduced immune response of the uterus. Deficient neutrophil phagocytic activity, decreased migration, and decreased superoxide anion production have been

proposed as factors in the pathogenesis of RFM in cattle. Moreover, leukocytes are a mobile source of collagenases and may be involved in uterine regression and release of placenta. It has been proposed that major histocompatibility complex (MHC) provides an initial trigger for expulsion of the placenta and that consequently, maternal tolerance of fetal MHC products will lead to RFM, this mediated by temporary immunodeficiency.

5- ***Other factors.***

- There is some evidence of a hereditary predisposition to RFM. Cows of the beef breeds are much less often affected than those of dairy breeds, and in the latter the incidence is higher in Ayrshires than Friesians.
- Old cows are more affected than young ones.
- Springtime calving exerts a predisposing influence.
- vitamin A , E or selenium deficiency.
- There is evidence of a high incidence of RFM in areas deficient in selenium.
- Older cows showed no benefit from the exercise.

Clinical features

- It should be noted that cows which fail to expel the fetal membranes within 36 hours or so are likely to retain it for 7–10 days.
- Myometrial contractions largely cease from 36 hours after the birth of the calf, so, if the membranes have not,been expelled by this time, freeing of the fetal villi from the maternal crypts eventually occurs as a result of autolysis and bacterial putrefaction. This process starts within 24 hours of birth but takes several days to complete.
- The toxic products of putrefaction accumulate within the uterus causing a fetid odour which pervades the atmosphere and, more importantly,taints the milk.
- Delayed involution of the uterus and a variable degree of metritis commonly accompany retention.

- RFM increased the calving to conception interval, the number of services per conception and the culling rate, whilst reducing milk yield (probably because of reduced appetite).
- When retention is accompanied by metritis, the symptoms depend upon the severity of the uterine disease. As described earlier, severe disease is accompanied by increased pulse and respiratory rates, raised temperature, anorexia, diarrhoea, depression, reduced milk secretion, straining, fetid vaginal discharge and, occasionally, laminitis.

Treatment

The treatment of animals with retained fetal membranes has long been a contentious subject.

- manual removal
- administration of ecbolic agents (oxytocin, PGF2□)
- no treatment
- treatment for metritis/endometritis, but no specific treatment of retention itself.

Manual removal. The techniques used for manual removal of RFM range from externally applied gentle traction, through to forced extraction and separation of each cotyledon and caruncle.

In this method, the post-cervical portions of the placenta were twisted together into a 'rope', then a hand was inserted into the uterus and each cotyledon was squeezed out of the base of the maternal caruncle. Continuous steady traction and rotational force were applied with the other hand to withdraw the detached membranes.

Even when this procedure is undertaken with careful cleansing of the perineum and as high a standard of asepsis as possible, it causes considerable damage to the uterus.

Most evidence shows that manual removal of fetal membranes has a detrimental effect upon fertility.

Ecbolic agents.

The most rational measure for both the prevention and treatment of RFM would be to stimulate adequate myometrial contractions so that a 'natural' dehiscence and expulsion could occur.

1- the administration of 10 ml (100 i.u.) of oxytocin.
2- In order to attempt to achieve a more reliable response to oxytocin, oestrogenic substances have also been given, in the hope of both increasing the sensitivity of the myometrium to oxytocin and enhancing the natural uterine defense mechanisms. For these reasons, the synthetic oestrogens, stilboestrol dipropionate and oestradiol monobenzoate, have been widely applied to cows with RFM in the form of parenteral injection, or uterine infusion and pessary, and their use has sometimes been followed by injections of oxytocin .
3- Prostaglandin F2□ □and its derivatives have been used as ecbolic agents. Prostaglandins may assist in detachment of the membranes through direct actions upon the placentomes rather than just by an ecbolic action.

No treatment.

Some authors were convinced, by the poor response to manual removal and the dubious effects of ecbolic agents, that uncomplicated cases of RFM require no treatment. The manual removal of the placenta can create uterine trauma and delay the return to normal reproductive status (Bolinder et al., 1988). It appears better to allow the placenta to separate of its own accord or to withdraw it gently from the uterus 7-10 days post calving.

If the cow is ill with metritis, antibiotic treatment and/or uterine drainage are probably indicated.

Treatment for metritis/endometritis.

Some degree of endometritis is invariably associated with RFM. Hence, many therapeutic regimens have been used either to attempt to prevent endometritis, or to treat it once it has occurred.

Antibiotics can be given in the form of pessaries or as infusions that have been formulated for intrauterine use.

Antibiotics that have been formulated for intrauterine infusion include oxytetracycline and cephapirin, both of which are active in the uterine environment and have a broad spectrum of action.

It has been common practice, after forced extraction of RFM, or after unsuccessful attempts at extraction, to place antibiotics into the uterus in an attempt to prevent endometritis.

Intrauterine antibiotics reduce odour, but they also reduce the rate of putrefaction of the membranes and reduce the level of intrauterine phagocytosis, thereby prolonging retention.

The use of systemic antibiotics in cows that are ill with metritis is, however, far less controversial.

Most studies agree that, where retention is associated with septic metritis or systemic signs of illness, appropriate, vigorous treatment regimens should be instituted.

PROLAPSE OF THE UTERUS

Incidence Occurs in all the large animal species. It is most common in the cow and ewe, less common in the sow and doe goat, and rare in the mare. Normally the uterus prolapses only after fetal delivery but occasionally in the sow one uterine horn may prolapse while the other – still containing a number of fetuses – remains within the abdomen. In cattle the condition seems to be more common in fat animals with excessive slackening of the pelvic ligaments and perineal tissues. 'Outbreaks' occur on some farms during one calving season and may be associated with diet, possibly with a high estrogen content.

Etiology Uterine prolapse is essentially an eversion of the organ, which turns inside out as it passes through

edematous. If recently prolapsed it is warm to the touch but later becomes cold and discolored. Occasionally the cow is found dead. Death is often due to hemorrhage from the ovarian arteries, which may rupture as a result of the excessive tension placed on them by the prolapse.

Prognosis This depends on: (1) the duration of the problem; (2) the degree of damage and contamination sustained by the uterus; (3) the degree of shock in the cow; (4) the position and accessibility of the patient.

Treatment On receiving a call, the obstetrician should give advice on first aid care. The uterus should be protected from further damage, wrapped in a clean moist sheet, and, if possible, held above the level of the vulva.

On arrival the following treatment sequence should be followed:

1. Assess the cow's general condition: if she is moribund and severely shocked treatment may not

the vagina as a prolapse. Many factors may be involved in the etiology, including:

- Poor uterine tone: uterine inertia – in cattle hypocalcemia (a cause of primary uterine inertia) may predispose. Lack of tone may allow the uterus to fold in and permit part of the wall to move towards the pelvic inlet. Straining then pushes the flaccid organ through the vagina.
- Increased straining, which may be caused by pain or discomfort after parturition.
- Other causes of increased intra-abdominal pressure, including tympany and recumbency.
- **Excessive traction at assisted parturition and the weight of retained fetal membranes have been suggested as other predisposing factors.**

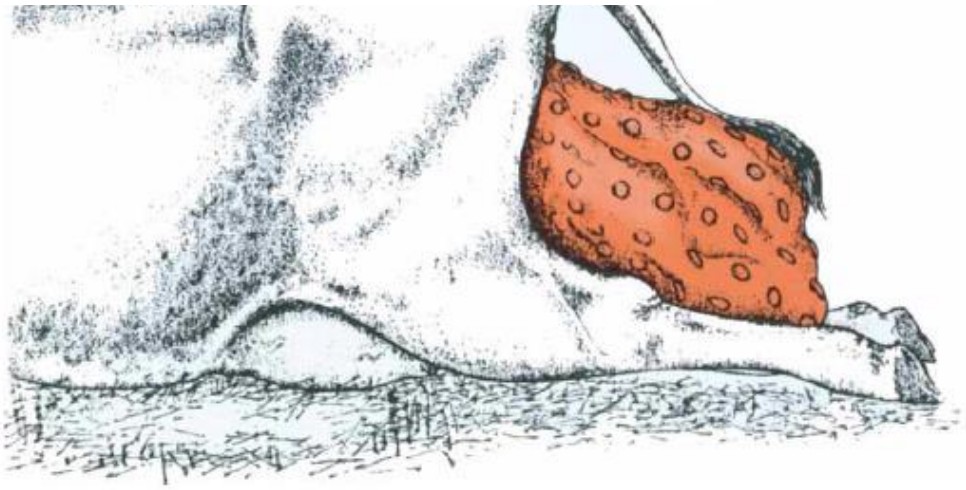
Clinical signs and treatment **These vary somewhat with the species involved and will be considered separately.**

The cow

Clinical signs **The patient is usually found with her uterus already prolapsed. One or both uterine horns may** be visible. The mucosal surface of the uterus – with its cotyledons – is visible and part of the chorioallantois may still be attached. The cow may be standing and apparently unconcerned or she may be shocked and recumbent. The uterus may be grossly contaminated with bedding and feces. It may also be lacerated, engorged, and

2. Assess the cow's position: she may be in a most unsuitable position for treatment but it may also be impossible to move her. If her hindquarters are pointing downhill it would be advisable to move her so that her head is lower than her hindquarters. Gravity would thus help rather than hinder replacement.
3. Administer an epidural anesthetic.
4. Position the cow: this is best done by the 'New Zealand method'. The cow is placed in sternal recumbency with her hindlegs pulled out behind her. Two or three assistants are required for this. If the cow is standing she must be cast on her side and the uppermost hindlimb pulled out behind her. She is then rolled on to her other side so that the second hindlimb can be secured and extended caudally. An assistant sits astride her facing backwards and lifting the cow's tail out of the way (Fig. 13.3). See below * for an alternative method if sufficient help is not available.
5. Remove gross debris from the prolapsed organ by washing with saline or a very mild antiseptic.
6. Remove the placenta or its remnants from the cotyledons – if it separates easily. If not, leave it attached.

Figure 13.3 Cow – uterine prolapse, patient positioned for replacement.



*On occasion there may be insufficient assistance on the farm to place the cow in position with her hindlegs extended. In such circumstances the obstetrician must use an alternative method of replacement. The cow is given an epidural anesthetic and the uterus is prepared for replacement as in the New Zealand method. The obstetrician, wearing a parturition overall, kneels behind the cow and takes the prolapsed organ on his or her lap. The body of the uterus is first pushed back into the vagina while an assistant, if available, helps by holding the uterine horns above the level of the vulva. Pressure is now directed onto the horns,

7. Repair any gross damage such as tearing using an absorbable suture.
8. Reducing the size of the prolapse – this is not really necessary. Some obstetricians recommend applying sugar or salt to 'draw out the edema'. The use of oxytocin *before* replacement is not advisable. The tightly contracted uterus can be very difficult to replace.
9. The prolapsed uterus is raised above the level of the vulva and eased back through the vagina. The body of the uterus is first pushed into the vagina followed by the horns. Handling the uterus may be aided by wrapping it in clean plastic and also by applying obstetric lubricant. The uterus is often very bulky and the help of an assistant in holding and replacing it is often very useful.
10. The cow is released from the sternal position and, if able, is encouraged to rise. The horns of the uterus are pushed fully back into position aided if necessary by a clean bottle used to fully invert each horn.
11. As soon as the uterus is replaced an injection of oxytocin (20–30 IU) is given by intramuscular injection. This will cause the uterus to involute and reduce the risk of recurrence of the prolapse.
12. Suturing the vulval lips should not be necessary or indeed helpful. Vulval sutures are, however, used by many obstetricians and are expected by many farmers. The suture pattern is as for vaginal prolapse (see Chapter 2).
13. Aftercare: good nursing, a light diet, and moderate exercise are required. Antibiotic cover is recommended. The vulval sutures are removed after 10 days.

If it is impossible to replace the prolapse, amputation may be attempted, although the prognosis for survival must be guarded. The prolapse is opened close to the vulva to reveal the uterine vessels lying within the tense mesometrium. These are each ligated in two places and the mesometrium severed between the ligatures. The vagina is ligated – taking care to avoid the external urethral orifice – and the uterus and cervix are removed.

Note: the general procedures such as cleaning the prolapsed organ are the same in all species.

Embryo transfer (ET)

Embryo transfer (ET) is the process of removing one or more embryos from the reproductive tract of one female to another. Transfers may be conducted by either surgical or nonsurgical procedures and may involve transferring the embryo(s) from either the oviduct or uterus of one female, known as a donor, into the oviduct or uterus of another female, known as a recipient. Embryo transfer also may involve the transfer of laboratory-

produced embryo(s), such as those made by *in vitro* or cloning procedures, into the reproductive tract of a recipient.

Superovulation

The species covered in this review include almost exclusively monotocous (horses), usually monotocous (cattle), twin-bearing (sheep and goats), polytocous with small or moderate litters (dogs and cats), and polytocous with large litters (pigs). When females of any of these species are used as embryo donors, *superovulation*, or the induction of the maturation and ovulation of more ova than normal, is usually induced with the injection of a gonadotrophin. The gonadotropin most frequently used is follicle stimulating hormone (FSH) purified from porcine or ovine pituitary glands. In some cases, equine chorionic gonadotropin (eCG), formerly known as pregnant mare serum gonadotropin (PMSG), is used, although it is less popular due to its long half-life.

Insemination

Donor females are inseminated either artificially (AI) or by natural service, depending on the species and the specific situation. For example, frozen semen is used almost exclusively for transcervical artificial insemination in cattle. In contrast to cattle, transcervical AI is very diffi cult in sheep and goats and donors are inseminated primarily by a laparoscopic approach.

Embryo Recovery

A number of different methods are employed for embryo recovery.

The use of a catheter inserted transcervically into the uterus is relatively easy and is routine in cattle and horses.

Smaller species require either laparoscopic surgery or full surgical exposure to access the uterus.

Most embryos are collected six to eight days after estrus.

1- Nonsurgical methods for collecting bovine embryos were first developed more than 40 years ago, but because recovery rates were poor,
2- surgical methods continued to be used for many years. However, even under ideal conditions for surgery, scar tissue sometimes forms in the reproductive tract, causing infertility and even sterility in some cases. In addition, surgical collections must be performed in specialized facilities with expensive equipment and supplies.

In the mid-1970s much effort was put into improving the nonsurgical methods to avoid damaging valuable donors.

Currently, virtually all embryos are collected by the nonsurgical method, which is often referred to as "flushing" embryos.

In preparation for nonsurgically recovering embryos, a local anesthetic is administered by an epidural injection into the tail head. A silicone catheter, temporarily made rigid with a removable metal stylette, is passed through the cervix into the uterus .

Some practitioners pass the catheter and inflate the balloon in one uterine horn, and following embryo collection of that side, deflate the balloon and move the catheter to the other horn, repeating the collection process. This is often referred to as a horn flush.

Other practitioners prefer to inflate the catheter just inside the internal cervical os, thus collecting from both uterine horns and the uterine body simultaneously.

Flush fluid is introduced into the donor cow either by gravity flow or by injection with a large syringe.

In gravity flow collections, flush fluid exiting the uterus passes through a 70 micron stainless steel or nylon mesh in a plastic filter.

A number of isotonic media often based on Dulbecco's PBS, and containing antibiotics can be successfully used for recovering embryos of

all the species. Embryos usually remain viable in this fluid for at least 24 hours.

Embryo Handling and Evaluation

The mammalian oocyte is the largest cell in the body. Oocyte diameters of all the species covered in this review are similar and in the range of 150 to 180 microns. Aside from the similarity in the size of oocytes at ovulation, however, there also are significant differences in early embryonic development among these species. For example, on day 8 after estrus, the cow embryo normally has reached the expanded blastocyst stage, with a diameter of approximately 250 microns, and hatches from the zona pellucida shortly thereafter.

The morulae and early blastocysts are typical of the embryos recovered on day 7 post-estrus in cattle. The expanded blastocyst is a typical day-8 embryo.

Following the embryo recovery procedure of a donor, embryos are normally located in the flush fluid with the aid of a stereomicroscope at 6× to 10× magnification, transferred to holding medium, and evaluated at 50× magnification.

Careful examination with a stereomicroscope of ova/embryos that are recovered from donors is necessary to ensure that viable embryos are not discarded, or on the other hand, unfertilized ova are not transferred or cryopreserved.

Embryo Transfer

Methods for preparing females to serve as recipients vary significantly among different species. In cattle, it often is taken for granted that females can be maintained in a group and that estrus, as manifested in mounting behavior, can be easily observed.

Induction of estrus in cows and horses is rather easy with the use of prostaglandin (PG). Controlled intrauterine drugreleasing devices (CIDR) frequently are also being used in cows, but rarely in horses, and often this includes treatment with GnRH or estrogen.

Today, cattle embryos are nearly always transferred to recipients nonsurgical.

A few embryo transfer practitioners still use surgical procedures in rare situations. Before the mid-1970s, most cattle embryos were **transferred surgically** while the recipients were secured on their backs under general anesthesia in a **surgical** facility.

Embryos were transferred through a mid-line incision made between the udder and navel to expose the uterus. While this procedure resulted in excellent pregnancy rates, it was very labor intensive and required special facilities. A simpler **surgical** approach, often called a flank transfer, was developed that involved administering a local anesthetic, making a flank incision, slightly exteriorizing the uterine horn, and transferring the embryo through a puncture wound in the uterine wall. This approach was used on cattle and horses, and still is used on horses in some cases.

Nonsurgical transfers in cattle and horses are performed with a special transfer gun, similar to that used for AI. Nonsurgical pregnancy rates in dairy heifers were reported to be similar to those achieved with surgical flank transfers, but pregnancy rates were lower with nonsurgical compared to surgical transfers in diary cows (Hasler, 2006). Most practitioners administer an epidural injection to relax the rectal muscles.

Although it is similar to artificial insemination, nonsurgical transfer of embryos is a more challenging procedure (why ?)

- First, embryos usually are transferred approximately seven days after estrus. Because the cervix is closed at this stage of the estrous cycle,

trans versing it with a transfer gun at this time is much more difficult than performing AI when a cow or heifer is in estrus.

- Second, Sanitation is also more important, because penetrating the cervix one week after estrus is more likely to lead to uterine infection.
- In addition, the embryo is transferred into the uterine horn on the ipsilateral side on which ovulation occurred, whereas semen usually is placed into the body of the uterus.

Thus, bovine ET practitioners must be able to palpate the corpus luteum (CL) of the previous estrous cycle.

The degree of estrous synchrony between the donor and recipient has been shown to have a very clear influence on pregnancy rates. The rates did not vary when the degree of estrous asynchrony between donors and recipient was no more than 24 hours plus or minus

Embryo Bisection (splitting)

Embryos from some mammalian species can be divided in two, and the halves, frequently called *demi embryos*, can potentially develop into identical twins following ET.

Embryo bisection, often referred to as splitting, is usually accomplished at the late morula or blastocyst stage prior to hatching from the zona. When bovine embryo bisection was first used commercially in the mid 1980s, it was thought that each demi embryo needed to be placed back into a zona (Williams et al., 1984). Consequently, zonas of unfertilized ova were used to provide a home for the extra demi embryos.

This approach to embryo splitting required two micromanipulators: one with an aspiration pipette attached, the other with a microsurgical blade. It was soon discovered, however, that the pregnancy rate of demi embryos was the same whether they were in a zona or not (Seike et al., 1989). In addition, pregnancy rates were similar whether embryos were divided with a glass microneedle or a metal microblade (Kippax et al., 1991).

Semen-sexing Technology

Determination of sex at the earliest stage can reduce the management cost thorough selective management of superior bulls or cows. Use of sexed semen fastens the genetic progress and allows the farm manger to increase selectively the number of heifers or steers based on the need of the farm. It also reduces calving difficulty (dystocia) in first calvers (Seidel, 2007) and reduces the replacement cost besides maintaining the biosecurity in farm. Techniques for sexing of spermatozoa has been suitably modified and are being used commercially in several countries with about 90% accuracy in cattle. The available technologies have some impediment with respect to cost of production, implementation and pregnancy rate than control sperm. Development of techniques or instruments with high sorting rate and accuracy without damaging the spermatozoa would further hasten the progress of this technology.

Basic Principles of Sex–Selection

Males produce two types of spermatozoa X or Y, when former bearing X sperm fertilizes the egg it results in formation of female and when the egg is fertilized by the Y bearing sperm it results in male offspring. Thus a pragmatic approach to sex pre – selection could be to separate the sperm population containing the desired sex and to use in artificial insemination (AI) programs. This is possible only if we realize the differences between X and Y bearing spermatozoa.

The major difference between the X and Y chromosomes, reported till date, is the

1- DNA content; the amount of DNA in X chromosome carrying spermatozoa is higher than Y chromosome carrying spermatozoa.
2- Other differences include the size of spermatozoa *i.e.* X sperm is larger than Y sperm .
3- motility (motility is reported to be higher in Y chromosome than X chromosome bearing spermatozoa) .

4- surface charges in sperm (X sperm has a negative charge and Y sperm has a positive charge) and

5- cell surface antigens .

Among these differential characteristics, differences in DNA content of spermatozoa have been shown to be the potential criteria for sorting of spermatozoa.

METHODS OF SPERM SEXING

1- **Albumin Gradient (or) Gradient Swim Down Procedure**

This method is based on the differences between the X and Y bearing spermatozoa in the ability to swim down in a gradient solution. Since Y bearing spermatozoa are smaller in size and have high motility, they exhibit a greater downward swimming velocity than X chromosome bearing spermatozoa. Thus the fractions of semen isolated from specific part of albumin gradient are expected to be either X/Y enriched fractions. Success rate in this method has been reported to be around 75%.

2- **Free Flow Electrophoresis**

This method is based on the presence of electric charges on the surfaces of spermatozoa. Surface of X spermatozoa are charged negative, while the surface of Y spermatozoa is charged positive. Based on electric field of separation, X and Y spermatozoa were separated using the differences in the surface charges.

3- **Percoll Density Gradient Method**

This method utilizes the differences in the sedimentation density between X and Y bearing spermatozoa. Due to high sedimentation density of X bearing spermatozoa, it settles in the bottom of column while Y bearing spermatozoa remain at the top of column. Success rate in this method ranged from 86% to 94% .

4- **Swim Up Procedure**

Size – mediated difference of spermatozoa was utilized by several researchers for sperm sorting through different methods. Y bearing spermatozoa are reported to swim faster than X bearing spermatozoa due its smaller size. Success rate in this method was reported to be 81%.

5- **Identification of H–Y Antigen**

Identification of surface proteins expressed in either X or Y bearing spermatozoa and using immunological methods to identify and separate X and Y bearing spermatozoa could be an option. This method of sorting can be applied in large scale sperm sorting. Using Specific antibodies against H – Y antigen (expressed in Y bearing spermatozoa) sorting of spermatozoa through affinity chromatography or magnetic bead was tried with efficacy of >90%.

6- **Sperm Sorting Based on the Volumetric Differences**

This method use image analysis of spermatozoa using interference microscopy to demonstrate a difference in sperm head volume based on the DNA content between X and Y chromosome bearing spermatozoa. A method based on this principle has been developed for sorting live spermatozoa by using interference microscopy optics with a flow cytometer. Success rate in this method has been reported to be <80%.

Flow Cytometry

Flow cytometers are the advanced cell sorters that use LASER to excite fluorescent dye that binds to the DNA in spermatozoa. The DNA percent and DNA specific dye are the major principle for sperm sexing through flow cytometry. In this method of sorting, the spermatozoa are treated with dye (*e.g*. Hoechst 33342), which is permeable to live and intact sperm membranes and binds to the DNA. Stained spermatozoa are transported to a point where they are exposed individually to a UV laser beam (wavelength of 351 – 364 nm) and the bright blue fluorescence emitted is detected and

analyzed. Due to more DNA content in X chromosome bearing spermatozoa, it takes more stain than Y sperm. On the basis of this fluorescence, spermatozoa are classified as X or Y chromosome bearing and sorted. Another dye, commonly called "red quencher food colouring dye", selectively penetrates into the damaged, dead and non – intact sperm membranes giving a red colour. Identification of live & dead sperm should be done before sorting process. Based on the excitation, spermatozoa are separated into discrete populations. In domestic animals the differences in DNA content between X and Y bearing spermatozoa ranges from 3 – 4.5% (Johnson et al., 1987; Johnson, 2000). Success rate in this method has been reported to be 85 – 95% (Pinkel et al., 1982; Johnson et al., 1989, 2000).

Among the various methods, flow cytometry based separation of sex specific spermatozoa is more popular and no other method has been consistently proven to be effective in producing offspring of the predicted sex till to date.

CLONING

Cloning is the production of a copy or copies of an individual and occurs in animals either naturally or artificially, when an embryo is split to produce identical twins.

The word "clone" has also been used to describe animals produced by nuclear transfer for the production of an unlimited number of genetically identical offspring. The first successes in cloning livestock were with sheep, by fusing a cell from a 16-cell embryo to an oocyte that had its chromosomes removed (enucleated oocyte). From that time through the early 1990s several groups began developing this technology for the commercial production of cloned beef and dairy cattle.

Presentation

Presentation is the relation of the spinal axis of the fetus to that of the dam. Presentation can be either longitudinal or transverse. The fetus' orientation is either **cranial** or **caudal** in the longitudinal presentation and **dorsal** or **ventral** in the transverse presentation. **Cranial longitudinal** is considered the normal presentation. Note the general trend away from the traditional use of the human descriptors of anterior and posterior in veterinary science.

Position

Position is the relation of the dorsum of the fetus to the quadrants of the maternal pelvis. These quadrants are the sacrum, right ilium, pubis, and left ilium. **Dorsosacral** is considered the normal position.

Posture

Posture is the relation of the fetal extremities (head, neck, or limbs) to its own body. Extremities may be flexed, extended, or retained (usually referring to the head). Retention can be to the right, to the left, or above or below the fetus.

OBSTETRIC MANOEUVRES

The manoeuvres which are practised on the fetus in manipulative obstetrics are as follows.

Repulsion

Repulsion of the fetus out of the maternal pelvis into the uterine cavity where more space is available for correction is the first step in mutation. The fetus and birth canal must be well lubricated, and 3 to 5L of a water-based lubricant can be gently introduced around the fetus through a stomach tube by means of a pump. It may be necessary to abolish abdominal straining with an epidural anesthetic, but the expulsive efforts of the dam will not subsequently be available for delivery of the fetus. In countries where it is registered for use, clenbuterol may be administered to assist in relaxation of the uterine musculature.

Care should be exercised in repelling a fetus, because uterine rupture may result from excessive pressure.

Various instruments have been used for repulsion of a fetus, the most commonly used device being the Kuhn's crutch. In general, however, use of the operator's hands and arms is recommended to reduce the risk of uterine rupture below that associated with introduction of metal instruments into the uterus. In neglected cases, the uterus may be tightly contracted around the fetus, and repulsion should not be attempted.

Rotation

Rotation is defined as turning the fetus on its longitudinal axis to bring it from dorsoilial or dorsopubic position to dorsosacral position. Partial rotation also is an essential component of the routine vaginal delivery technique to ensure that the fetal hips enter the maternal pelvis on a diagonal.

In many cases, rotation can be accomplished by the hand and arm of the operator. By grasping the humerus of the ventral limb near the shoulder joint, the operator

lifts the fetus upward and medially. If an assistant is available, traction on the dorsal fetal limb in a downward and medial direction can be applied to aid in rotating the fetus. Alternatively, the fetal limbs can be crossed and rotational force applied to bring the fetus to dorsosacral position. In difficult cases, use of a detorsion rod may be necessary, but excessive force that may result in injury to the dam and the fetus should be avoided.

Version

Version is defined as turning the fetus on its transverse axis into cranial or caudal presentation. Transverse presentation fortunately is rare in cattle but must be converted to longitudinal presentation before delivery is attempted. Extractive force is applied to the portion of the fetus closest to the maternal pelvis while the opposite pole of the fetus is repelled. Version usually is limited to 90 degrees, and attempts to convert caudal presentation to cranial presentation are not likely to be successful and will commonly result in uterine tears.-

Extension

Extension refers to the extension of flexed joints when postural defects are present. It is carried out by applying a tangential force to the end of the displaced extremity so that it is brought through an arc of a circle to the entrance of the pelvis. The force is applied preferably by hand or by snare or hook(s).

Traction

Traction means the application of force to the presenting parts of the fetus in order to supplement, or in some cases to replace, the maternal forces. Such force is applied by hand or through the medium of snares or hooks. Limb-snares are fixed above the fetlocks, and the head snare may be applied by the Benesch method, in which the loop is placed in the mouth and up over the poll and behind the ears or, alternatively, the centre of a single rope may be pushed up over the poll and behind both ears, leaving both ends of the rope protruding from the vagina. For replacement of the laterally deviated head,

where the operator's hand is insufficient, a thin rope snare applied to the mandible is essential. However, this must only be used to correct the postural defect; other traction which might be used to effect delivery must be applied using a conventional Benesch head snare. The amount of force to be applied depends on species and condition causing dystocia. **However, in general, it *should not exceed four men power in large animals***.

Mechanical devices are now used extensively to apply traction; they must always be used carefully and sympathetically since they can cause severe trauma if used inappropriately, a calving aid such as the HK calf puller or Vink calving jack (see Figure 12.2) are invaluable. The most important

Fetotomy

By definition, fetotomy (originally referred to as embryotomy) is sectioning of a fetus into two or more parts within the uterus and vagina. Its purpose is to reduce the size such that delivery through the birth canal becomes possible. Nowadays, fetotomy is applied only when the fetus is already dead.

Indications

Fetotomy is commonly utilized:

1. to correct dystocia due to fetomaternal disproportion: an oversized fetus in a normal cow or a normal size fetus in an undersized (usually juvenile) cow
2. to correct maldispositions (presentation, position, posture) of the fetus that cannot be corrected or \Vhere correction would be an unacceptable risk lO the cow
3. to deliver a pathologically enlarged fetus (emphysematous calf) or monster (schistosome, fetal dropsy).

Instruments:

•Fetotome (either the Utrecht model, which essentially is a two-barrelled flat tube, or the double-tubed Swedish modification of the original Thygesen's fetotome).

• Fetotome threader or wire introducer (Fig. 19.1) required for threading approximately 4-5 m (or four to five times the length of the fetotome) of saw wire through the tube(s) of the fetotome.

• Hand-grips or wire handles - these should permit quick and secure attaching and fastening of the wire and have a strong and comfortable grip.

• Krey- Schottler hook (see Fig. 12.1) -this double jointed hook is an essential piece of equipment. when attached to a calving rope or chain, it is used to grasp onto severed portions of the fetus, particularly the vertebral column, and to apply traction to the fetus.

• Introducer (Fig. 19.1)- also an essential piece of equipment; it is used to pass the wire-saw around or over a fetal part, typically the neck, a limb or the severed hind parts

• Curved finger knife (e.g. Unsworth's guarded knife) - this is only required for certain cuts; for example, it may be used to cut a 'notch' for the wire when removing a retained forelimb or hindlimb

• Calving chains plus handles (see Fig. 12.1) –at least one chain and handle are required; the chain is used to 'anchor' the fetotome to a limb of the fetus and the handle to facilitate removal of parts of the fetus that have been cut off

• Wire-saw - the quality varies between brands.

Spatulas or chisels, hooks and guarded knives, such as Robert's, are required for performing subcutaneous fetotomy (Fig. 19.1).

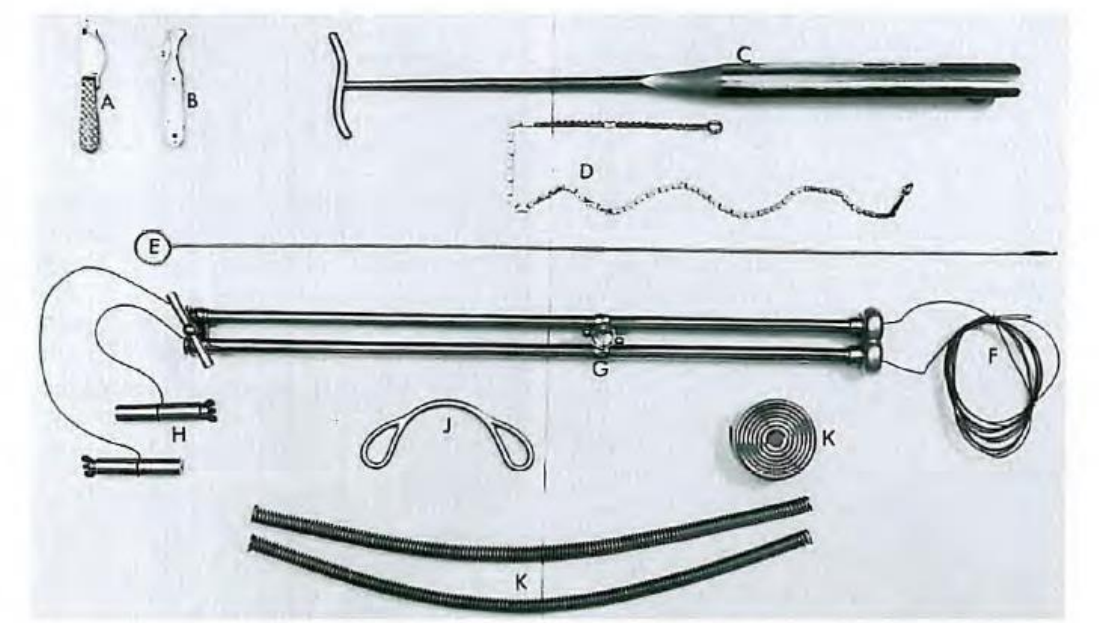


Fig. 19.1 Instruments for fetotomy: (A) Robert's guarded knife. (B) Unsworth's guarded knife. (C) Spatula for use in subcutaneous fetotomy. (D) Persson's chain-saw, now superseded by multifilament, braided fetotomy wire. (E). Fetotomy wire introducer for use with (G). (F) Multifilament fetotomy wire. (G) Fetotome (Swedish modification of Thygesen's model). (H) Fetotomy wire hand grips. (J) Shriever's wire-introducer. (K) Gättli's spiral tubes, used to protect the genital tract from the cutting wire.

There are two type of fetotomy which are:

1- **Subcutaneous fetotomy**

2- **percutaneous fetotomy**

1- Subcutaneous fetotomy: include:

a- **Removal of a forelimb (anterior longitudinal presentation)**

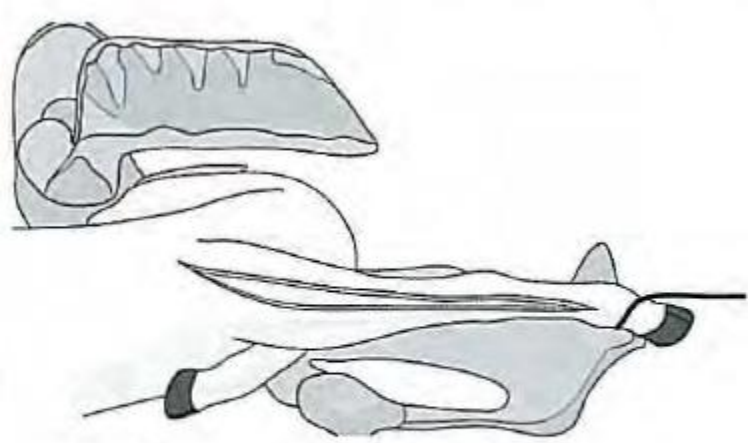


Fig. 19.2 Subcutaneous fetotomy, used to amputate the extended forelimb. Stage 1: the skin has been incised from the fetlock to the scapular cartilage using Robert's fetotomy knife.

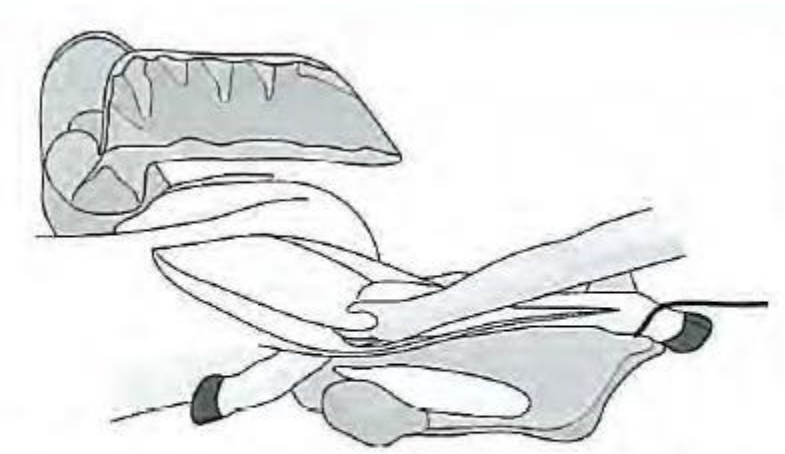


Fig. 19.3 Subcutaneous fetotomy, used to amputate the extended forelimb. Stage 2: the skin surrounding the limb is dissected from the underlying tissues, using fingers and hand and extending as high as possible over the scapula.

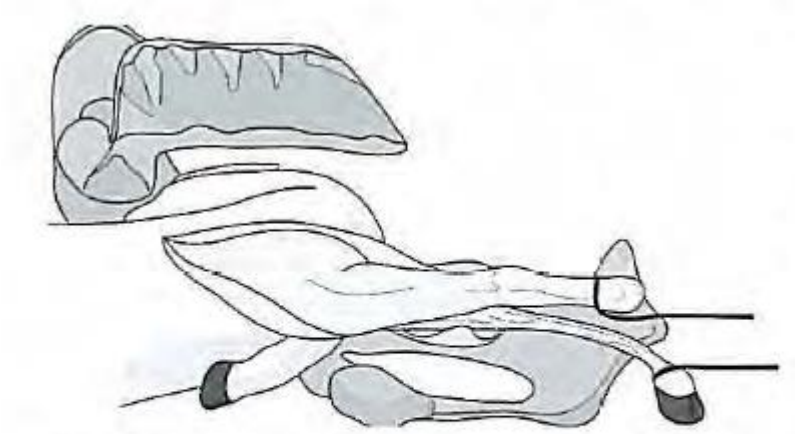


Fig. 19.4 Subcutaneous fetotomy, used to amputate the extended forelimb. Stage 3: after the attachments of the pectoral muscles in the axilla have been broken down and the fetlock joint disarticulated, traction is applied to the 'skinned' limb. Note that the digits are still attached to the skin.

b- **Subcutaneous fetotomy: removal of the hind limb (posterior longitudinal presentation}**

2- **percutaneous fetotomy**

Total fetotomy:

A- Fetus in anterior longitudinal presentation:

1. Amputation of the head.
2. First forelimb.
3. Second forelimb.
4. Thorax.
5. Lumbar area.
6. Hindquarters.

B- Fetus in posterior longitudinal presentation

1. First hind limb.

2. Second hind limb.

3. Thorax.

4. The forequarters.

Postoperative management and care

1- The fetal membranes are removed only if they can be readily detached.

2- Lavage of the uterine cavity with large volumes of warm water or a 'saline solution' (9 g of common salt per litre of water) at body temperature, using a wide-bore tube; the fluids may be fortified with povidone-iodine solution (< 1 ml per litre of fluid).

   The warm saline solution is believed to have both a soothing and a stimulating effect on the uterus, and this, together with the excavation of uterine fluid, lubricant and debris, may promote involution.

   Fluids should be infused incrementally until the effluent is free of debris and no longer cloudy. Normally 20-30 litres of water are needed and it is important that approximately the same volume of fluid is siphoned from the uterus as has initially been infused.

3- Oxytocin (20-40 Ill) and a non-steroidal anti-inflammatory agent are mandatory, and should be administered for 2 days.

4- If there is evidence of shock, fluid therapy is indicated; hypertonic saline solution (4 ml/ kg) given intravenously followed by 20-25 litres of water orally.

5- Intrauterine antibiotics are of limited value at this stage, but systemic antibiotics should be administered for at least 4-5 days.

6- In addition, the administration of calcium borogluconate should be considered to facilitate uterine involution.

Caesarean section

Caesarean section: *The delivery of the fetus usually at parturition by laparohysterotomy is called caesarean section.* The word caesarean is said to derive either from an edict by Julius Caesar that woman was about to die in advanced child birth and this operation was performed to save the child or from the Latin word *caeso matris utera* means cutting of mother's uterus.

Indications :

1. Fetopelvic disproportion, including cases of misalliance and post maturity.
2. Fetal maldisposition, which cannot be corrected by manipulation.
3. Irreducible uterine torsion.
4. Incomplete dialatation of cervix or other parts of birth canal.
5. Fetal monsters, which cannot be delivered by other means.
6. Uterine rupture or severe uterine haemorrhage.
7. Fetal emphysema.
8. hydroallantois after failure of induction of parturition by drugs.
9. Rupture of prepubic tendon.

Selection of operative site :

Large animals : The sites are

(i) Left flank.

(ii) Right flank.

(iii) Ventro-Iateral.

(iv) Ventral or mid line.

Small animals : The sites are

(i) Flank region with an oblique angle parallel to the last rib.

(ii) (ii) Midline or linea alba.

The advantages and disadvantages of the various sites may be summarized as :

advantages of flank laparotomy

1- Only local anaesthesia is required.

2- The incision may be easily extended if necessary.
3- Risk of postoperative soiling of wound or herniation is less.
4- It may be performed on the standing or laterally recumbent cow.
5- Easier correction of uterine torsion.
6- Finally, wound dehiscence is more manageable as compared with lower abdominal incisions

disadvantages of flank laparotomy

1- The uterus is often difficult to exteriorize prior to opening.
2- The peritoneum is readily contaminated with uterine contents especially if the calf is dead and/or emphysematous.

1- Left flank laparotomy:

• The risk of small intestine coming out from the site of wound is negligible.
• The rumen may cause hindrance to access of the uterus.

2- Right flank laparotomy:

• Allow good access to a calf in the right uterine horn.
• The risk of the small intestine to come out from the laparotomy wound is higher.

3- Ventro-Iaterallaparotomy:

• A ventro lateral incision is particularly indicated for the removal of an emphysematous fetus.
• The cow should be in right lateral recumbency for ventro-Iateral laparotomy.
• The advantage of this approach is that it gives good exposure of the uterus.
• Another advantage is, it minimizes the risk of contamination from uterine contents to the abdominal cavity or peritoneum.

Disadvantages:

• Repair of the abdominal muscle layers is more difficult because the muscles remain under tension and sutures may tear the muscles.
• Risk of post-operative soiling of wound is more.
• Risk of post-operative herniation is more.

4- Midline or Para median incision:

• It is not commonly used in the field condition because general anaesthesia or heavy sedation is required and respiratory function of the dam is compromised in this condition.

• Risk of post operative soiling of wound or herniation is higher.

• However this technique gives excellent access to the uterus.

Left flank incision is the most common technique and is most appropriate for the standing animal.

A right flank incision is uncommon; however, it is indicated if the left flank approach is obstructed by adhesion as a result of previous surgery.

Anaesthesia:

Sedation should be avoided (if possible) because it can cause recumbency during surgery and may be detrimental to fetal survival.

If sedation is necessary, xylazine is commonly used (0.05-0.1 mg/ kg b.w. I/M).

• For flank incision:

- **Paravertebral anesthesia:**

Paravertebral anesthesia:

• Signs of successful densensitization are warm, hyperemic and flaccid flank with no response to pain when tested with an 18 gauze needle.

• Advantage of paravertebral anesthesia is that the whole flank musculature is desensitized and flaccid which facilitates exploration of the abdomen during surgery and closure of wound.

• Disadvantage of paravertebral nerve block is that vasodilatation occurs in muscle layers which cause a greater degree of hemorrhage during surgery.

- **Inverted - L block:**

• An 18-gauge needle is used to administer 2 % lignocaine with adrenaline at several sites. The number of sites is dependent on the length of the proposed incision.

• At each point, 5 ml. of local anaesthetic is injected subcutaneously in each direction of the incision line and 10 ml. into musculature.

• Peritoneum may not be effectively anaesthetized, causing reaction by the patient when it is incised (disadvantage).

• However, this technique is quick and reliable and requires minimal training.

- **Epidural anaesthesia:**

Epidural anaesthesia is not essential but is useful to prevent straining and tail movement during surgery. Sometime it causes recumbency during surgery.

Surgical technique:

The surgical technique is performed in following steps:

1. Opening of the flank
2. Locating the uterus
3. Opening of the uterus
4. Removal of the foetus
5. Management of the placenta
6. Closing of the uterine incision
7. Closing of the laparotomy incision

1- Opening of the flank :

• An incision is made through the skin 25-30 cm. in length approximately 10 cm. below the transverse process of the lumbar vertebrae and half-way between the last rib and the tuber coxae.

• Check bleeding at every step.

• Before opening the peritoneum, the haemostats are used to control bleeding points in the muscle layers which should be removed after ligating the vessels.

• Incise the peritoneum.

2- Locating the uterus :

• The uterus lies caudal to and below the rumen.

• If uterus is not visible, then it is searched by pushing the rumen forward.

3- Opening of the uterus :

• The opening should be made over the fetal extremity in the greater curvature of the pregnant uterine horn.

• The incision should be approximately 20 cm. long in the direction of the longitudinal muscles and in between the cotyledons, otherwise profuse hemorrhage may occur.

4- Removal of the fetus:

If the fetus in anterior presentation, removed rear end of fetus first at caesarean section and if the fetus is in posterior presentation, then remove front end.

5- Management of placenta:

• If the placenta is easily and quickly detachable, it should be carefully removed from the uterus.

• If not, it should be left in the site even when the cervix is closed.

• Antibiotics bolus is kept in the uterus.

6- Closing of the uterine incision :

Uterine incision is cleaned with saline and closed with Cushing and Lambert sutures by using chromic catgut No.1 or O.

7- Closing of the laparotomy incision:

• Before the closure of the incision, a quantity of crystalline penicillin or ampicillin (1-2 gm) may be instilled into the abdomen as a soluble solution to minimize the risk of peritoneal infection.

• Abdominal incision is closed in routine manner.

Post operative care:

1. Routine antibiotic cover (with strepto-penicillin for 5-7 days).
2. Fluid therapy.

Complication of caesarian section

• Peritonitis

• Wound breakdown

• Seroma formation - A pocket of sterile serous fluid accumulates between muscle layers or under the skin. This can be confirmed when a sterile needle is inserted - serum flow-out.

• Retention of the fetal membranes

• Metritis

• Infertility

• Mastitis *(E. coli* infection)

• Sudden death.