Management of Dystocia in Camelids

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Abstract

Dystocia is the most common emergency in camelid practice. The aim of the present paper is to review the most important clinical features of normal parturition and to discuss obstetrical situations in camelids and their non-surgical and surgical management, including prepartum and term uterine torsion. This clinical review includes both Old and New World camelids.

Résumé

La dystocie est la situation d'urgence la plus fréquemment rencontrée en pratique des camélidés. Le but de cet article est de faire le point sur les facettes cliniques les plus importantes associées à la parturition normale. Nous discutons aussi des problèmes obstétriques rencontrés chez les camélidés, incluant la torsion utérine avant et durant la parturition, et de leur régie chirurgicale ou non-chirurgicale. Le point clinique inclus à la fois les camélidés sud-américains et les camélidés d'Afrique et d'Asie.

Introduction

Dystocia is without doubt the most common emergency in camelid practice and has been recognized as one of the leading causes of mortality and reproductive losses.[1,3,4,30] Prompt diagnosis and management of obstetrical situations is critical for the survival of the newborn, as well as for the prevention of further complications that can be life threatening or terminate the female's reproductive career. Although many of the examination techniques and obstetrical procedures used in camelids are similar to those used in other large animal species, a few peculiarities do exist for camelids that the practitioner should be aware of. The objective of the present paper is to give an overview on the normal parturition process in camelids and to discuss obstetrical situations and their non-surgical and surgical management. In this discussion, which includes all domestic camelids, we will refer to the bactrian and dromedary camels as camels and llamas and alpacas as South American camelids (SAC).

Normal Parturition or Eutocia

Pregnancy length and premonitory signs of parturition
Pregnancy length in camelids presents significant variability. Pregnancy length in SAC has traditionally been reported to be 340 ± 5 days (335 to 359 days).[22,33] However, our clinical observations show ranges from 330 to 380 days (Table 1). In rare but documented cases, pregnancy length may reach 400 days. Pregnancy length in camels varies from 315 to 440 days.[28] In our camel embryo transfer program, gestation length in recipients ranges from 332 to 404 days (Table 2). Factors affecting

Table 1. Variation of gestation length of pregnancy in alpacas delivering normal cria in a US herd.

	N	Mean (days)	SD	Minimum	Maximum
Males	49	342.9	9.8	314	367
Females	64	348.2	10.4	329	372
Total	113	345.9	10.5	314	372

Table 2. Variation of gestation length in recipient camels (*C. dromedarius*) with normal delivery following transfer of day 7.5 embryos (Anouassi and Tibary, unpublished).

	N	Mean (days)	SD	Minimum	Maximum
Males	127	378.4	12.9	332	404
Females	115	376.4	12.3	339	404
Total	242	377.9	13.0	332	404

pregnancy length include breed, sex of the fetus, season, nutrition, sire and dam effects. In alpacas, pregnancy length is on average 12.5 days longer in spring-mated than in fall-mated females.[9] Therefore, precise records on breeding and pregnancy diagnosis dates may be helpful in predicting a due date, but often the exact timing of parturition cannot be predicted without close observation of the dam's behavioral changes. Disorders that have been suspected as contributing factors in increased pregnancy length include fescue toxicosis and intrauterine growth retardation due to congenital fetal hypothyroidism, placental and endocrine abnormalities, and severe nutritional deficiencies. The wide range of pregnancy length precludes a decision for induction of parturition in camelids based on this parameter. Other parameters such as fetal well-being, colostrum secretion and relaxation of the perineum and vulva should be taken into account.

Parturition in camelids is short in duration.[22,28] Premonitory signs of parturition include development of the mammary glands, relaxation of the sacro-pelvic ligaments and development and relaxation of the vulva. However, none of these signs can precisely predict the time of parturition in these species. Mammary gland development occurs during the last month of pregnancy. Udder enlargement becomes obvious within the last two weeks preparturition, especially in multiparous females. Primiparous females may not show significant udder development until a few days after parturition. Excessive mammary edema extending cranially to the xyphoid area may be seen in some females. Other females may show ventral edema, swelling of the teats, and waxing a week before parturition. Colostrum is detected six days and four days before parturition in pluriparous and primiparous animals, respectively.

Relaxation of the sacrosciatic ligament starts two weeks before parturition. In camels, this is recognized by the presence of two shallow grooves, one on each side of the sacrum. In SAC, relaxation of the pelvic ligament results in frequent bulging of the perineal area when the female is sitting, defecating, or urinating. The vulva shows a slight edema a few days before parturition, especially in the primiparous females, but dilation (elongation) is often not observed until the day of parturition.

Stages of parturition

To allow better monitoring of the preparturient female, the tail of the female should be wrapped as soon as dilation of the vulva is noticed. Tail wraps should not be tight and should be changed every other day. In the traditional South American rearing systems, the majority (93.5%) of births takes place between 7:00 am and 1:00 pm, and none are observed at night.[16,22] This is probably an adaptation feature of these animals to ensure birth of the young (cria) in the most favorable time of the day for ambient temperatures and protection against predators. This is not always true under North American conditions. In the dromedary, parturition can occur at any time of the day but this distribution could be affected by management and especially feeding time.

Duration of the first stage of labor varies greatly. It can be as short as three hours and as long as 48 hours, and is affected by environmental as well as individual factors. This stage is characterized by increased restlessness and anxiety. The female will usually seek isolation from the herd and may stop eating. However, normal appetite may be present throughout parturition. SAC tend to show increased visits to the "dung pile". The female shows signs of discomfort and frequently alternates between a standing and sitting position or walks in circles. These signs intensify with dilation of the cervix and until rupture of the allantochorion. Towards the end of this stage, straining becomes more frequent, occurring at the rate of three times per six minutes. Some females may go off feed and show signs of colic. Excessive signs of rolling, kicking at the belly and vocalization or grunting should be taken seriously, as they may signal an abnormal situation such as in the case of uterine torsion.

The second stage of labor (from rupture of chorioallantoic sac to the complete expulsion of the fetus) is very short in duration and is completed within 15 minutes on average (range five to 90 minutes). In primiparous females, expulsion of the fetus may last longer (up to 80 minutes). Nearly all fetuses are born in an anterior longitudinal presentation and dorso-sacral position, with the chin resting on the carpus. The amniotic sac traverses the cervix and vagina, forming a whitish/bluish bag at the vulva. At this stage, the head of the fetus can be easily palpated within the pelvic inlet. The nose appears first at the vulva, followed shortly thereafter by one foreleg. Three to five minutes after the rupture of the sac, the other leg appears. Stretching of the vulva increases progressively by the combined movement of the fetus and the forceful abdominal contractions. The forelegs are extended either above or below the head at this stage. The head and forelegs up to the carpal joints should be out within five to 10 minutes of rupture of the amniotic sac. The female may stand at this stage with the head, neck and forelegs of the fetus exteriorized. Powerful abdominal contractions are needed to push the fetus out at the level of the shoulders and thorax. The umbilical cord ruptures soon after birth (about 15 to 20 cm and 3 to 15 cm from the fetal abdominal wall in camels and SAC, respectively). A twisted portion of 30 to 35 cm in camels and 10 to 20 cm in SAC is seen hanging from the vulva of the dam. In SAC, most (65 to 73%) of the fetuses are delivered while the dam is standing.[5]

In camels, expulsion of the fetus occurs predominantly with the female in a lateral recumbency.

The third stage of parturition (expulsion of the placenta) lasts, on average, 40 minutes. The placenta appears at the vulva shortly after expulsion of the fetus. It is noticed as a bluish sac which becomes bigger and distended with fluid as the uterus contracts. The placenta is expelled rapidly by a combined action of uterine contractions and the gravity of its weight. Placental delivery may take up to four hours, however more than 80% of the placentae are delivered in the first 60 minutes after parturition.

Examination of the fetal membranes is very important in order to detect if there are any infectious processes that might compromise the neonate and to ensure that there is no partial retention (Table 3). In camels, the normal placenta ranges in weight from 6.6 to 19.8 lb (3.0 to 9.0 kg) (average 11.4 lb [5.2 kg]). In alpacas, the placenta weighs between 0.99 to 4.6 lb (0.45 to 2.1 kg). The chorionic surface usually has a dark red (burgundy) color and a velvety aspect due to the presence of microvilli. The placenta may show areas with reduced microvilli along the bifurcation and at the tip of the horns. Although not always present, hippomanes (one or two) may be found in the allantoic sac of the camelid.[22,24]

Induction of parturition

Induction of parturition may be indicated when the dam's health is in jeopardy or if the fetus is showing obvious signs of stress. Induction of parturition should not be attempted unless uterine torsion is ruled out. The best chances for a good outcome for the neonate (reduce the risk of neonatal maladjustment syndrome) is to induce only when breeding dates are precisely known, the stage of pregnancy is adequate (minimum 330 days for SAC and 350 days in camels) and there

is obvious colostrum secretion in the mammary gland. Because camelids rely primarily on progesterone from the corpus luteum to maintain pregnancy, induction is easily achieved by administration of a luteolytic dose of prostaglandin F2 alpha (Dinoprost tromethamine, IM, 5 mg in SAC and 25 mg in camels or its analogue cloprostenol (250 µg in alpacas and 500 µg in camels). Caution should be exercised when using dinoprost because it may cause severe respiratory distress and pulmonary edema in compromised females. In the author's experience, the interval from treatment to parturition is 20 hours on average but ranges from eight to 30 hours. In our protocol for management of high-risk pregnancies, the fetus is evaluated at 12 hours and at 20 hours post-treatment and if the fetus shows signs of distress or is not delivered by 24 hours after induction, a cesarean section is performed.

Incidence and causes of dystocia

The incidence of dystocia in camelidae is low (2 to 5% of all births).[24,28] In the authors' practice, dystocias requiring major obstetrical intervention represent less than 1% of all births. However, early diagnosis of dystocia is very important because it can evolve rapidly to a critical situation endangering the lives of both the fetus and the dam. Monitoring of parturition in valuable animals can be done using electronic means such as closed-circuit video monitoring. In camels, we have successfully used devices than can sense vulvar stretching and passage of the amniotic sac or fetal limbs (Foalalert®).

Dystocia should be suspected if the first stage of labor exceeds six hours or if the second stage of labor does not progress normally within 10 minutes of the rupture of the aminiotic sac. Dams may show signs of distress, with frequent alternation between standing and sitting positions with frequent side-to-side rolling and excessive straining. Many dromedary females will show diarrhea and frequent vocalization in the case of dystocia. Abnormal (bloody or purulent, smelly) discharge in a term female warrants immediate obstetrical evaluation.

Dystocias of maternal origin are due to a displacement of the uterus (torsion), uterine inertia or disproportion between fetal size and size of the pelvic canal. Uterine torsion and failure of cervical dilation are the most common causes of dystocia of maternal origin.[22,24,28] Failure of cervical dilation has been associated with long-term progesterone supplementation during pregnancy. Dystocia due to small size of the dam is uncommon if breeding management is adequate and the females are not bred until they reach the appropriate size (65% of adult height and weight). Although rare, cases of feto-maternal disproportion have been described in the dromedary and particularly in racing

Table 3. Placental weight in alpacas and camels (*C. dromedarius*) after normal parturition.

	N	Mean (days)	SD	Minimum	Maximum
Alpacas*					
Males	49	0.86	0.27	0.54	1.99
Females	64	1.04	0.64	0.45	4.43
Total	113	0.95	0.49	0.45	4.43
Camels**					
Males	124	5.22	0.99	3.0	9.0
Females	119	5.19	0.92	3.0	7.50
Total	243	5.21	0.96	3.0	9.0

* data from a single US herd
** data from recipients in an embryo transfer program

camels.[28] Management of this type of dystocia consists of evaluating the birth canal and helping the vulva to stretch or practicing an episiotomy. If these procedures are unfruitful and the fetus is alive, the female should be immediately prepared for a cesarean section. Dystocia may be due to weak or absent uterine contractions (uterine inertia). This is occasionally seen in old animals or animals with prolonged pregnancy. Hypocalcaemia may also be involved in secondary uterine inertia. A case of maternal dystocia in a camel with pelvic fracture has been observed in our practice.

Dystocia of fetal origin is generally due to a fetal abnormality or to an abnormal presentation or posture. The most common fetal malpositions or postures are carpal flexion, lateral or ventral deviation of the head, and unilateral or bilateral (breech) hip- and hock-flexion in posterior presentation. Feto-pelvic disproportion, fetal monsters and transverse presentations are rare.[22,28] Dystocia of fetal origin due to oversized fetus is relatively rare in camelids. Dystocia due to schistosoma reflexus, ankylosis and hydrocephalus have been reported in dromedaries and alpacas.[28] Other anomalies causing dystocia include fetal anasarca, or emphysematous fetus resulting from death and putrefaction.

Abnormal presentations, postures or positions of the fetus are the most common causes of the dystocia of fetal origin in camelids. This is due to the long neck and limbs of the fetus in these species.

General Approach to Dystocia in Camelids

Three major differences between camelids and ruminants need to be kept in mind when dealing with an obstetrical situation: 1) the pelvic inlet is narrower; 2) the cervix and vagina are more prone to laceration and severe inflammation, often leading to adhesions; 3) risks for neonatal hypoxia and death are increased by the forceful uterine and abdominal contractions and the rapid detachment of the microcotyledonary placenta. Three main conclusions stem from these important differences; 1) early recognition of dystocia is paramount, 2) obstetrical decision and manipulation should be kept rapid, and 3) supportive care should be provided to the dam and the fetus (if alive) before and during manipulation.

Patient examination
Behavioral assessment may be conducted while taking history unless the female is obviously depressed or in pain. If the female is in obvious distress, blood samples should be taken immediately and the female stabilized before further examination. Oxygen therapy may be indicated for severely compromised females. A jugular venous catheter should be placed immediately to allow fluid therapy and emergency anesthesia if needed.

Sedation may be needed for some females in order to complete the evaluation. Choices of drugs and dosage for sedation should take into account their effect on the fetus. Butorphanol tartrate (0.05-0.1 mg/kg) provides good sedation and has minimal effect on the cardiovascular system. However, a mild decrease in systemic vascular resistance has been observed that can be of consequence if the blood flow to the uterus is already restricted.[12]

Transabdominal ultrasonography should be performed in order to determine fetal well-being as well as uterine and placental integrity.[30] In addition to scanning the reproductive organs, the clinician should also evaluate abdominal viscera and the peritoneal cavity for any significant deviation from the norm.[6] Following transabdominal ultrasonography, the female should be palpated (if possible) and scanned transrectally.

Transrectal palpation may add further stress on the animal and needs to be performed cautiously. Examination of the parturient camelidae should be performed with extreme care so as not to cause injuries to the birth canal or the rectum because of the reaction of the female with expulsive efforts during manipulation. Administration of an epidural block and infusion of a mixture of lidocaine and lubricant in the rectal cavity may reduce straining, provide some relaxation and facilitate the examination in SAC. Epidural anesthesia may be performed in the sacrococcygeal space (high) or between the first and second coccygeal (low) vertebrae. In camels, we recommend the use of low epidural in order to avoid ataxia and risk of injury when the animal attempts to stand. The intervertebral space is easily identified by palpation. An 18-gauge, 1.5-inch needle is placed on dorsal midline with the bevel facing cranially and at a 60-degree angle to the tail head. Duration of analgesia depends on the drug used. In the case of lidocaine 2% (0.2 mg/kg with a maximum 1 ml per 50 kg of body weight), onset of analgesia is seen five minutes after administration and lasts about one to one and one half hours. Administration of xylazine (0.1 mg/kg) provides up to three hours of anesthesia and the association of xylazine and lidocaine provides up to six hours of analgesia.

The primary objective of transrectal palpation is to determine the location and direction of the broad ligaments (rule in or out uterine torsion) and evaluate the caudal abdomen for any masses or abnormalities of the pelvic area, kidneys and bladder. Transrectal palpation in the female sitting in a sternal position may offer some challenges to the inexperienced practitioner. The quantity and quality of fecal material in the rectal cavity should be appreciated. Severely stressed camelids may present profuse diarrhea. Absence of fecal material and/or presence of mucoid content may be due to intestinal transit disorders or tenesmus.

Vaginal examination should be performed aseptically with a speculum after thoroughly cleaning the perineal area. The speculum should be advanced slowly as the clinician is examining the vagina for any abnormalities. The cervix is evaluated for the degree of relaxation and opening. The cervix of the late-pregnant llama and alpaca is often difficult to visualize, but should be obvious if it is open. Manual examination of the vagina and cervix may be indicated in some cases, but this procedure is often limited by the size of the hands of the examiner in SAC, and in particular alpacas.

In alpacas, abdominal/pelvic radiography may be helpful in determining position, posture and number of fetuses.[22,28]

Ancillary laboratory testing

A baseline evaluation of severely depressed or colicky pregnant females should include complete blood count (CBC), blood chemistry and fibrinogen. Evaluation of peritoneal fluid (abdominocentesis), fecal evaluation and urinalysis should be considered in some select cases. Although a stress leukogram is often present in many of the presenting females, neutrophils count, immature neutrophils count, neutrophils morphology, packed cell volume and fibrinogen concentration are very valuable in evaluating inflammatory and toxic states. Anemia may be due to blood loss or onset of other problems such as *Mycoplasma hemolamae*. Blood chemistry will help determine electrolyte imbalances and detect risk for hepatic lipidosis, which is the major concern in stressed pregnant females that are anorexic. Hypoproteinemia is often found in older pregnant females and may be a predisposing factor to metabolic complications. In some cases, the serum may be grossly hyperlipemic. However, lipemia and ketonemia are not always present in hepatic lipidosis. Elevated levels of non-esterified fatty acid (NEFA) (> 400 µmol/L) and ß-hydroxybutyrate concentrations (BHB) are significant indicators of stress and liver compromise. Liver compromise is also indicated by elevated bile acids, gamma-glutamyl transferase and aspartate transaminase, and sorbitol dehydrogenase.[30,31] Marginal calcium and magnesium levels or hypocalcemia may be noted on late-term pregnant females and require monitoring during the correction and convalescent period.

Obstetrical manipulations

Treatment of dystocia in camelidae is difficult because of the length of the fetal limbs and neck and the narrowness of the birth canal, especially in young dromedaries and SAC. Techniques used for the treatment of dystocia in camelids are similar to those used in other large animals. They include: correction of position or posture by repulsion, rotation, assisted vaginal delivery and forced extraction, fetotomy and delivery by cesarean section. However, fetal manipulations should be kept to no more than 15 to 20 minutes because of the high risk of vaginal tears, adhesions and the rapid onset of fetal hypoxia. A different approach should be taken if fetal position, presentation and posture suggest that manipulation is not possible or if manipulations are not fruitful after 15 minutes.

Repulsion can be obtained by direct manual pressure on the fetus or by using a repulsion rod. It is easily accomplished if the animal received tocolytic medication or epidural anesthesia before manipulation. Elevation of the hind legs while the female is in sternal sitting position may be helpful for repulsion of the fetus in camels and llamas. However care should be taken as to not put too much pressure on the diaphragm.

Rotation of the fetus is used to align parts of the fetus that are most likely to lock inside the birth canal (hips in posterior presentation and shoulders in anterior presentation), with the largest diameter of the pelvis. Shoulder lock is the most common problem in camelids, especially in the case of feto-maternal disproportion. To relieve this situation the fetus should be first rotated in such way that its greatest width at the withers will be in the same alignment as the largest diameter of the pelvis. This rotation is usually between 45° and 90°, and must be done before engagement of the shoulders in the birth canal. If this has already occurred, it may be necessary to repulse the fetus before proceeding with the rotation and traction. In posterior presentation, locking usually occurs at the hip. In these cases, the fetus should be rotated 45°, preferably with the dam in lateral recumbency.

Forced extraction or fetal traction is probably the most frequently used technique to resolve dystocia. This approach should be used with care to avoid damage to the birth canal and the fetus. It is very important to make sure that the birth canal is well dilated. Traction should be applied to each forelimb separately in an alternating fashion to minimize the width at the shoulders.

Fetotomy should only be considered in camelidae if the birth canal is sufficiently wide to allow easy manipulation of the fetotome. This is not always possible, and most veterinarians practice only partial fetotomies, usually involving the head or one limb, in order to have sufficient space for direct manipulation of the fetus. We consider that fetotomy is not an option in alpacas and small llamas and camels. Surgical relief of dystocia (cesarean section) remains the best approach if controlled vaginal delivery cannot be achieved in less than 20 minutes.

Regardless of the type of obstetrical intervention, adequate oxygen delivery to the uterus is essential for the birth of a healthy neonate. Reducing uterine blood flow or oxygen-carrying capacity of the blood is liable to harm the fetus and may increase fetal or neonatal

mortality. In most species, uterine blood flow is reduced when the dam is exposed to pain or stressful conditions. Sedatives, analgesics and anesthetics may all have a negative effect on cardiac output, and therefore decrease blood flow to the fetus. In addition, some drugs or drug combinations may further decrease uteroplacental perfusion due to their tonic effect on the myometrium. There are no studies on the effects of anesthetics on the uterus and fetus in camelids.

Xylazine, a drug of choice for sedation of camelids in the field, has been shown to markedly reduce blood flow (by as much as 59%) and availability of oxygen to the uterus. Xylazine increased the uterine artery resistance by 165% five minutes after administration. Xylazine has also been associated with increased myometrial contractions in ruminants and could cause increased fetal morbidity and mortality, at least in these species.[13,18] This effect has not been found significant in mares. There are no studies on the effect of xylazine on uterine perfusion in camelids.

Obstetrical manipulation may be facilitated by administration of utero-relaxants. Clenbuterol is the drug of choice for uterine relaxation and has been used extensively by the authors in camels. Unfortunately, it is not available in the US.[11] Administration of epinephrine (1:1000 USP, 5 mL in SAC and 10 mL in camels) provides some uterine relaxation.

Specific Obstetrical Situations

Uterine torsion

Uterine torsion is the main genital cause of colic or depression in the pregnant SAC. There are no detailed studies on the epidemiology of this disorder of pregnancy. It is important to note that uterine torsion is not common in camels (A. Tibary personal observations) or in llamas and alpacas in South America (J. Sumar, personal communication). This raises questions about the possibility of involvement of factors such as nutrition and body size.

In our experience, stage of pregnancy at presentation presents two modes:8 to 10 months and at parturition. Clinical signs with uterine torsion are quite variable and range from mild episodes of discomfort to severe colic, diarrhea and anorexia. Assessment of the female may reveal signs of depression, pain, circling, kicking at the belly, lateral recumbency and excessive vocalization. On physical examination, tachypnea and tachycardia are very common. CBC and blood chemistry changes are consistent with a stress leukogram with various metabolic changes (hepatic lipidosis), depending on the duration and severity of the problem.[7]

Diagnosis is based on transrectal palpation of the broad ligaments, as described in other large animal species.[7,22] Clockwise torsion is indicated if the left broad ligament is stretched across midline to the right and over the uterus, while the right ligament is shorter and pulled ventrally and medially under the uterus. Palpation of the broad ligament may elicit severe, painful reaction. Difficulties encountered in per rectum evaluation for uterine torsion include physical limitations particularly in alpacas (tight anal sphincter, narrow pelvis and size of the hand and arm of the examiner) as well as lack of experience in palpation of the late-pregnant camelids in a sternal position. Diagnosis by vaginal palpation has been reported by practitioners, but we find it unreliable unless the torsion also includes the cervix or the female is at term. In some pre-term cases, diagnosis may not be possible until exploratory laparatomy in case of severe colic. Alternately, the female could be palpated under general anesthesia, which provides more relaxation of the anal sphincter and perineal area.[20] Transrectal ultrasonography may sometimes show increased dilation of the blood vessels. It was reported that the majority (>90%) of camelid uterine torsions are clockwise.[7] Although clockwise uterine torsion predominates, our experience shows that counter-clockwise torsions are not rare, and direction of the torsion needs to be ascertained before attempting non-surgical correction.

Correction of uterine torsion can be accomplished non-surgically by rolling, or surgically after celiotomy. Both techniques are very efficient. Rolling should be considered only if the uterus and its vasculature are not compromised, as determined by transabdominal ultrasonography. Rolling may be performed under general anesthesia, sedation or without sedation. The female is placed in lateral recumbency on the side of the direction of the torsion and rolled while the fetus is maintained in position with a small plank or with the fists.[7,22] The pain usually disappears immediately after correction of the torsion, and females may return to normal activity immediately unless they have been anorexic for some time, in which case correction of metabolic disorders should be part of the follow-up plan. Surgical correction may be performed following flank or midline laparatomy. Midline laparatomy is the preferred method in later stages of pregnancy.[3,14,20,23] The success rate of both rolling and surgical correction is very high, as is survival of the fetus. No special management is needed if the torsion has been diagnosed and corrected early. In severe cases, anorexia and pain may onset hepatic lipidosis, in which case the patient should be placed on broad-spectrum antimicrobial therapy.[20] Monitoring progesteronemia is recommended if available in-house. The need for progesterone supplementation after correction of the torsion is still a subject of debate. Long-acting (slow release) progesterone should not be used past 300 days of pregnancy. Term uterine torsion cases with live fetus are preferably relieved by rolling while

the fetus is maintained stable by vaginal manipulation or by cesarean section.

Complications of uterine torsion include abortion, uterine rupture/hemorrhage, endotoxemia and death of the patient.[7,14] Splenic torsion concurrent with uterine torsion has been described in one case, with persistent pain following correction.[20]

Corrections of dystocia of fetal origin

Limbs crossed above the head: This posture is characterized by the forelimbs crossed above the head with only the nose apparent at the vulva. It is the leading cause of perineal lacerations. Correction of this form of dystocia is relatively easy using fetal repulsion followed by correction of position of the fetal limbs. The vulva is often incompletely dilated and it is important to allow this dilation.

Head and neck deviations: Deviation of the head is probably the most common cause of dystocia in camelidae. This is due to the long and flexible neck in this species. It is sometimes complicated by shoulder or carpal flexion of one or both forelimbs. Deviation of the head can be lateral, dorsal or ventral. Correction of head deviation may be difficult because of the long neck. If attempts to correct head deviation fail, the practitioner should suspect the presence of congenital anomaly. In these cases, delivery by cesarean section may be the only possibility.

Forelimb flexion: Forelimb flexion can occur at the level of the shoulder or carpus in anterior presentation. Correction of carpal flexion is relatively simple and relies on repulsion of the fetus and progressive traction of the flexed limb. Partial fetotomy is indicated if the fetus is dead and there is sufficient space in the pelvic canal for manipulation of the fetotome.

Breech presentation: Breech presentations are relatively rare in camelidae, but are very serious when they occur. This dystocia can lead quickly to the death of the fetus because of the pressure on the umbilicus. A case of breech presentation was described in a Bactrian female, which was successfully treated by fetotomy. Fetotomy was performed in this case in two parts – First at the level of the hock joint then at the level of coxo-femoral joint – no retained placenta manipulation was done after sedation with acepromazine 100 mg + xylazine 500 mg IM.

Twins: Although rare, most twin pregnancies end with a normal delivery due to the small size of the fetus, however, the practitioner should always keep in mind twinning as a possible case of dystocia. Often in these situations, the birth canal is too edematous by the time of identification, which indicates use of cesarean delivery.

Medical management post-dystocia

Medical management post-dystocia should be aimed at reducing any chances of complication from infections, reducing tissue inflammation within the vagina and correcting any metabolic disorders. Endotoxic shock is the most serious of dystocia complications, particularly following removal of a dead, putrified or emphysematous fetus.

Fluid therapy is indicated in an animal showing signs of severe dehydration or hepatic lipidosis. Antimicrobial therapy may be indicated if the female is compromised, fails to deliver the placenta or if there is evidence of contamination. Broad spectrum antibiotics, such as ceftiofur, are generally a good choice.

Cesarean Section in Camelids

Indications

Delivery by cesarean section is the option of choice when the female is in the first or second stage of labor and there is a fetal or maternal emergency. Fetal emergency in our hospital is characterized as a live fetus with constant tachycardia (> 130 bmp) or bradycardia (<50 bpm) or evidence of placental separation. The decision for c-section should also take into account the duration of manipulation prior to referral. The most common indications for cesarean section are failure of cervical dilation, severe uterine torsion at term, twinning, severe fetal malpostures or presentations (breech, excessive head deviations, transverse presentation).

General considerations

Techniques for cesarean delivery in camelids have been describe in detail elsewhere.[23,26] The two main approaches utilized for cesarean section in camelids are the ventral midline approach and the left paralumbar approach.[23,26] We recommend flank approach in camels and any severely compromised SAC. This technique does not require deep general anesthesia and can be performed under sedation and regional block, which is a good choice for the field. Midline celiotomy approach is ideal if the uterus is compromised or needs to be completely exteriorized, such as in the case of uterine torsion, or in case of suspected twins.[23,26]

Ventral midline approach

The ventral midline approach allows simple access to the abdominal cavity and complete exteriorization of the uterus with minimal hemorrhage. Anesthesia is generally induced with propofol and diazepam (0.5 mg/kg IV) or guaifensin and maintained by isoflurane in oxygen. Ketamine should be avoided as a preanes-

thetic, as it has been associated with severe depression in neonates.[29] The patient is placed in dorsal recumbency and the ventral midline prepared aseptically. A midline celiotomy incision (25 to 30 cm in alpacas and 35 to 40 cm in llamas) is made through the skin, subcutaneous fat, cutaneous trunci muscle and linea alba from the cranial border of the mammary gland extending cranially. The uterus is identified by direct palpation and exteriorized from the abdomen.

An incision is made through the uterine wall over the hind legs along the greater curvature. The cria is removed and the umbilicus clamped and transected. If the placenta is still adhered to the uterine wall, it should be left in place but peeled off along the uterine incision to provide adequate hemostasis and closure. Because of the type of placentation, mural bleeding may be a problem. The margins of the uterine incision are oversewn with a continuous interlocking pattern using resorbable suture material (No. 1 chromic gut in camels or No. 0 PDS in SAC) to control bleeding prior to closure of the uterus. The uterine wall is closed in a Cushing, Utrecht or Lembert pattern (0-vicryl, No. 0 polydioxanone or polyglecaprone in SAC, No. 1 chromic gut in llamas or No. 2 chromic gut in camels). Some practitioners prefer to administer 10 to 20 IU unit of oxytocin into the uterine wall. The uterine wall and abdominal cavity may be lavaged with warm saline solution containing antibiotics (one liter isotonic saline solution containing antibiotics (K-penicillin G 22,000 U/kg body weight, Na-ampicillin 20 mg/kg, or Na-ceftiofur 1 mg/kg), anti-inflammatory drugs (flunixin 1 mg/kg), and heparin (20 to 40 units/kg). Carboxymethyl cellulose (CMC 14 ml/kg body weight, IP) may be used to prevent postoperative adhesions.

The linea alba is closed by appositional pattern with interrupted horizontal mattress, cruciate pattern sutures or continuous suture pattern. In SAC, different suture material may be used including No. 2 polyglycolic acid or No. 1 polydioxanone or polyglactin 910 or No. 1 vicryl. Closure of the skin may be done with staples, or No. 1 PDS horizontal mattress suture pattern or preferably with subcuticular suture pattern (No. 2-0 polyglactin 910 or polyglecaprone).[23]

Paralumbar (Flank) technique

The flank approach for c-section is preferred in the field and when the dam is severely depressed. This is the best approach for any c-section in camels. Most females will tolerate the operation with a line or inverted "L" block anesthesia following sedation and physical restraint in the sitting sternal position. Local blocks are usually performed for abdominal surgeries with lidocaine 2% HCl. It is generally recommended to dilute this drug to 1% using isotonic bicarbonate or saline. The total dose should not exceed 4.4 mg/kg body weight (1 ml of 2 % lidocaine /5 kg of BW) to prevent lidocaine toxicity.

Epidural anesthesia may help restrain the animal in selected cases. The surgical site is clipped or shaved over an area extending vertically from the processes of lumbar vertebrae down to the ventral abdomen and horizontally from the last rib to the hip and inguinal area. The skin incision is made oblique extending from the angle formed by the hip to the bottom of the last rib. The incision line should be parallel to the direction of the thighs while the animal is sitting in the sternal position. The muscle layers are opened by blunt dissection in a grid fashion. The peritoneum is incised and the hand of the operator is introduced into the abdominal cavity and directed caudally to the pelvic region where the uterus is identified by direct palpation. The gravid uterine horn (always the left) is grasped around a fetal limb and gently exteriorized from the incision. Uterine incision and exteriorization of the fetus, as well as uterine closure are conducted in the same manner described above.[23]

The abdominal cavity is closed in three layers with a simple continuous suture. The suture is anchored every 2 to 3 cm to the underlying layer to occlude any dead space. The skin is closed using a continuous interlocking suture pattern.[23]

Post-operative care and complications of cesarean section

Postoperative care includes pain management using butorphanol tartrate (0.05 mg/kg, IV) or flunixin meglumine (1 mg/kg IV, once daily) and antimicrobials in the form of benzylpenicillin (20 mg/kg IV four times daily), gentamicin sulphate (6.6 mg/kg IV once daily) or ceftiofur sodium (5mg/kg IV twice daily). Flunixin meglumine is continued for three days. Antimicrobial prophylaxis should be continued for five to seven days, depending on the condition of the uterus and fetus at the time of surgery. Ulcer prophylaxis (e.g. omeprazole, 2 mg/kg, po, q12-24h x five days) are routinely administered after surgery. Fluid therapy may be indicated in some cases. The dam should be monitored for postpartum metritis and toxemia. The placenta is generally expelled within a few hours if the cervix is open or two to four days if it was closed at the time of surgery. Oxytocin may be administered (20 IU, IM in camels and 5 to 10 IU in SAC) every four hours during the first 24 hours post-surgery.

Information regarding success rates and complications associated with C-section in llamas and alpacas is limited. Some of these complications include incision infection, hernia, peritonitis, intestinal adhesions and infertility. However, these complications are very minimal when the surgery is performed early in dystocia and sterile technique is used. The most common complications seen in 63 camel cesarean sections, performed by the authors in the field, were incision infections (6 cases), peritonitis (2 cases) and herniation (1 case) (Tibary and Anouassi, personal observations). The re-breeding suc-

cess rate is excellent and most females will be rebred after three to four months post-surgery. The earliest successful re-breeding post c-section seen by the authors is 45 days. We generally recommend at least 45 to 60 days sexual rest.

Complications of Dystocia

Retained placenta

The placenta is considered retained if not delivered after six hours. Retained placenta is generally managed as in the equine (oxytocin therapy, preferably slow drip, uterine lavage). However, the condition is not as life-threatening and resolves progressively within the first 24 to 48 hours. Oxytocin may be used every four to six hours (5 to 7.5 IU in SAC and 20 IU in camels). Females experiencing placental retention should be checked for hypocalcemia (camels particularly) and uterine rupture. Retained placenta becomes a serious condition if it is due to uterine rupture or complete failure of cervical dilation. Cervical dilation may be obtained manually two to four hours following direct application of prostaglandin E (Misoprostol, 0.5 to 1 mg in SAC and 2 to 4 mg in camels).

Uterine rupture

Uterine rupture is often due to severe or inadequate clinical management of a uterine torsion or a prolonged dystocia. The first sign is generally anorexia, mild colic or simply reluctance to stand. Females usually present to the veterinarian in advanced stage of shock, in lateral recumbency. Abdominocentesis may reveal a large amount of serosanguinous or bloody fluid. Severe pain with presence of serosanguinous peritoneal fluid may also be observed in case of splenic torsion.[20] The only option is surgical intervention to remove the fetus and salvage the uterus. Complete hysterectomy should be considered if the uterus is severely compromised.

Rectal- vaginal tears and perineal lacerations

Due to the small perineal body and the powerful expulsive efforts in camelids, rectal vaginal tears are common following overt obstetrical manipulations. One common reason for these tears is the hasty vaginal delivery of the fetus without sufficient preparation of the vulva and vestibular area. Episiotomy should be considered in females with insufficient dilation of the vulva, particularly in maiden females. Cases seen in our practice are often a complication of fetotomy or forceful fetal extraction. Rectal vaginal tears may be repaired immediately or a few weeks after second-intention healing.[23]

Uterine bruising and tears

Postpartum uterine tears are not as dramatic as in the equine species unless there is involvement of a large vessel or severe contamination of the uterus and peritonitis. Uterine tearing may be present following what appears to be a completely normal parturition. In this situation, the only clinical signs may be retained placenta, anemia or slow deterioration of the health of the female due to peritonitis. Uterine bruising is often seen following excessive obstetrical manipulation and particularly fetotomy. Uterine involution is very rapid in the camelid and small, dorsal uterine tears heal without problems, with infertility as the only sequela due to peri-uterine adhesions. Complications from uterine tears are often due to severe contamination, either during obstetrical manipulation or consequent to a partial or total retention of the placenta.[2] Initially, these females may appear comfortable, then slowly progress towards a full fledged peritonitis. Clinical signs of toxemia may appear within the first 24 hours, but it may take up to three or four days for the clinical pictures to become recognizable. It is important that these cases be stabilized and antimicrobial and anti-inflammatory therapy be initiated immediately at the first sign of compromise. Uterine lavage should be considered only after verification of the integrity of the uterine wall, and should be monitored by transabdominal ultrasonography to make it easy to visualize placental remnants. A case of complete passage of the placenta into the abdominal cavity was described in a llama, with progressive deterioration of health which eventually succumbed to peritonitis 11 days after a dystocia.[2]

It is not clear how uterine tears occur in camelids, and although most are associated with obstetrical manipulation, we have seen cases following normal, easy parturition. This stresses the importance of monitoring every female for placental delivery and inspection of the placenta for completeness. The camelid placenta is epitheliochorial, microcotytledonary and is rarely retained more than 36 hours, even after dystocia.

If a uterine tear is detected in the early postpartum period by direct vaginal palpation, an attempt could be made to induce uterine prolapse after treatment with epinephrine and epidural anesthesia. Alternately, the uterine tear can be repaired after celiotomy. If the placenta is still present, it should be peeled off from the endometrium around the tear before suturing. In cases of unexplained fever, abdominal pain or anorexia in the postpartum female, exploratory celiotomy or laparoscopy should be considered. Adjunctive therapy for peritonitis is indicated and should include abdominal lavage and systemic broad-spectrum antimicrobial and anti-inflammatory therapy, along with fluid therapy for cardiovascular support.

Postpartum Hemorrhage

Postpartum hemorrhage of the uterine artery is not common in camelids. Most of the postpartum hemor-

rhage cases diagnosed in our clinic consist of rupture or laceration of the vaginal branches of the internal pudendal artery. The major vaginal artery is easily recognized by palpation per vaginum during obstetrical manipulation, and is peculiarly large in camelids. Excessive manipulation, and in particular fetotomy or aggressive uterine lavage, may cause sufficient erosion of the mucosa and laceration of the artery. Unfortunately, many of these hemorrhages are missed as no outward signs are noted until it is too late. Blood accumulates within the uterus for a few hours, followed by cardiovascular collapse. The only warning sign may be intermittent discharge of blood clots from the vagina. In one case, the female was found dead in her stall two hours after delivery. Ruptured vaginal arteries may be sutured if accessible. Females with suspected severe hemorrhage should be confined in a calm area with minimal intrusion. Circulating volume fluid replacement and plasma expansion therapy should be initiated as soon as possible (Hypertonic saline followed by LRS). Hetastarch may be a good choice, but has not been sufficiently evaluated in camelids. Blood transfusion should be considered in females with a packed cell volume <10%. Hemorrhage may be controlled in some cases by packing the vagina with compresses (tampons), or a device similar to the "umbrella pack" used in humans may be helpful. Aminocaproic acid administration has been used by the authors in a few cases, but data are not sufficient as to dose and frequency of administration recommended.

Uterine prolapse

Partial or total uterine prolapse occur secondary to dystocia, manual removal of a retained placenta and excessive use of oxytocin (high dosage and frequency). Uterine prolapse is far more common in camels than in llamas and alpacas and is often associated with hypocalcemia, selenium deficiencies and retained placenta.[19,28] Dairy camels seem to be more prone to uterine prolapse.[1,8,10,15,17,32] Uterine prolapse occurs generally immediately (the first 30 minutes) after parturition or abortion.[28]

Techniques for replacement are similar to those reported in ruminants under sedation and epidural analgesia. The placenta is often easily peeled off and should be removed if possible before replacement of the uterus. The female is positioned in sternal recumbency with the hind quarter slightly elevated. The uterus should be inspected for any lacerations or hemorrhage. The area of major risk for hemorrhage is located near the cervix where the uterine artery may be exposed. The uterus is cleaned with warm dilute povidone iodine solution before replacement. A Bühner suture is used in camels and a shoelace pattern can be used around the vulvar lips in alpacas and llamas. Uterine prolapse tends to re-occur if the uterine horns are not fully extended. Hysterectomy

should be considered if the uterine tissue has sustained severe damage.[22,25]

Other complications of dystocia

A multitude of conditions which often manifest themselves as lethargy, depression and progress towards a downer female syndrome may follow a dystocia, or even sometimes what appears to be a normal, easy delivery. The approach to diagnosis of the causes of downer syndrome is similar to that used in the bovine.[21] Predisposing factors include septic metritis, necrotic vaginitis, retained placenta, hypocalcemia, pelvic injuries, hemorrhage and presence of compressive lesions. A milk fever syndrome, similar to the condition in dairy cattle, is also observed in dairy camels. Toxic mastitis has been described in dairy camels but not in SAC.[27] Post-parturient sepsis and death has been associated with severe *Streptococcus equi zoopidemicus* in alpacas (alpaca fever).

In addition to physical evaluation, complete blood count and blood biochemistry, the evaluation of the downer postpartum camelid should include transrectal and transabdominal ultrasonography and even possibly spinal fluid analysis. More advanced imaging techniques may be required in some cases in order to detect neoplastic masses. Although, retained placenta is not usually an emergency in camelids, failure of delivery of the placenta following a cesarean section may lead to severe complications.

Severe swelling of the vulva and vagina are painful conditions associated with overt obstetrical manipulation. Females experiencing these complications may show persistent straining and abandon their neonates. Untreated vaginal and cervical inflammation may lead to complete adhesions and development of pyometra. Females with severe inflammation of the birth canal should be treated with systemic and local anti-inflammatory drugs. Daily application of cold compresses and treatment with an ointment containing anti-inflammatory and antimicrobials may reduce the inflammation and prevent adhesions.[4]

Conclusions

Although dystocia is not as common in camelids as in ruminants, the explosive nature of parturition in this species, the type of placentation (microcotyledonary diffuse which is easily detached) and the narrowness of the birth canal render choice of obstetrical manipulation critical for the survival of the dam, neonate and preservation of the future reproductive ability. Practitioners familiar with obstetrical procedures in ruminants should be aware of the high risk for uterine torsions, particularly in SAC, and the predisposition of camelids to develop severe adhesions following lengthy obstetrical

manipulations. Surgical management of dystocia may be the preferred method particularly in alpacas, even if the fetus is already dead. Flank approach to cesarean is the most recommended technique in the field. Outcome of dystocia depends on the time from recognition to resolution and state of compromise of the dam.

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