

Reproductive emergencies in camelids

A. Tibary, L.K. Pearson

Department of Veterinary Clinical Sciences, College of Veterinary Medicine and Center for Reproductive Biology, Washington State University, Pullman, WA

Summary

Theriogenological emergencies represent the overwhelming majority of emergencies in camelid practice. The objective of the present paper is to discuss the diagnosis, treatment and prognosis for the most common male and female camelid reproductive emergencies. Male reproductive emergencies are dominated by traumatic injuries to the external genitalia, urolithiasis, and heat stress which severely compromise future reproductive ability. In the non-pregnant female, most emergencies are related to iatrogenic trauma or congenital abnormalities. Common emergencies of genital origin in the pregnant female are uterine torsion and vaginal prolapse. Non-surgical and surgical approaches to obstetrical emergencies are discussed. Management of postpartum emergencies (i.e. uterine prolapse, vaginal prolapse and uterine hemorrhage) is also presented.

Introduction

In theriogenology practice, emergencies are defined not only in terms of concerns for the welfare of the patient but also for its future reproductive life. The challenge often faced when presented with reproductive emergencies is how to preserve the life of the patient and its reproductive ability. In the case of pregnant females, the life and welfare of the neonate are of concern. This paper presents the approach to diagnosis and clinical management of various reproductive emergencies in the male and female camelids. This review is an update on the topic and draws primarily on the clinical experience of the authors as there are very limited controlled studies on clinical reproduction and emergency care in camelids.¹

Reproductive emergencies in the male

Many acute disease processes may have some severe repercussions on the reproductive process in the male, however this review is limited to those diseases and accidents which directly affect urogenital system or associated organs. Male camelids are often presented for emergency care when there is sudden onset of visible abnormalities in the external genitalia or severe colicky behavior. Common visible abnormalities include acute preputial or scrotal swelling, preputial prolapse or paraphimosis, and external genitalia trauma (laceration and hemorrhage). Behavioral changes that may be of urogenital origin and requiring immediate care include persistent straining and dysuria, colic, downer male, or complete lack of libido.

General approach to examination of the male for reproductive emergency

History and initial physical evaluation on the farm should direct the practitioner as to whether the case can be handled on the farm, in the hospital, or referred to a specialty center. Accurate weight, body condition score and degree of dehydration are important in the assessment of the patient. In severely compromised animals or when surgical management is the only option, baseline complete blood count (CBC), blood biochemistry and urinalysis should be considered. An intravenous catheter should be placed immediately in depressed animals. Ultrasonography of the abdomen and reproductive organs should be part of the physical examination.

Acute scrotal swelling

Compromise of testicular thermoregulation should be taken seriously as its negative effect on spermatogenesis may be long lasting or definitive in the male camelid. Acute scrotal swelling is generally due to heat stress, trauma or a local or systemic infectious process. Testicular torsion and scrotal hernia are commonly considered as a differential in other large animal species but we have not encountered these situation in our in camelids practice. Practitioners should be aware that some cases

present as sudden onset of scrotal swelling just after shearing. However these cases may actually be chronic and are only noticed at the time of shearing (testicular tumors, lymphomas, etc.).

Heat stress

Scrotal and preputial edema and development of severe hydrocele are features of heat stress in South American Camelids (SAC). Factors predisposing to heat stress include prolonged high ambient temperature and humidity, inadequate shade, long fleece, dark coat color, and obesity. The risk for heat stress is exacerbated by stresses such as transportation, exercise, fighting, and breeding.² Hyperthermia results from impaired evaporative cooling mechanism particularly under humid conditions. Scrotal edema may be the first clinical sign in the male. The exact pathophysiology of the scrotal and ventral abdominal edema is not well understood. Contributing factors may include inability of the pampiniform plexus and testicular artery to cope with the fluid turnover or vascular thermal injury resulting in impaired wall permeability and extravasation of intravascular proteins, electrolytes, and fluid into the interstitium.^{1,2}

Spermatogenesis (sperm production and semen quality) is severely impaired when llamas are kept at an ambient temperature of 29°C for four weeks.^{3,4} These temperatures are common in many regions of world where SAC have been introduced. Spontaneous recovery may be observed but the male may become infertile for various length of time.⁵

Hyperthermia, increased salivation, anorexia, depression, ataxia, muscular weakness, dehydration, ketosis/hepatic lipidosis, and dyspnea/hyperpnea are seen in advanced cases.² An inflammatory or stress leukogram is almost always present and anemia may be observed secondary to hemolysis. Serum biochemical abnormalities may include hypophosphatemia, hypocalcemia, hypomagnesemia, hyponatremia, hypochloridemia, hypo- or hyperkalemia, hyperglycemia, and elevated serum aspartate aminotransferase (AST) and creatine phosphokinase (CPK) concentrations. Serum glucose concentration > 300 mg/dl has been associated with a poor prognosis. Death may ensue due to severe electrolyte imbalances, damage to the thermoregulatory center in the hypothalamus and multi-organ failure.²

The first step in stabilization of the heat stressed SAC is cooling (shearing, spraying the ventral abdomen with cold water, fan), rehydration and correction of metabolic abnormalities with oral or intravenous fluids. Intravenous isotonic sodium bicarbonate solution may be required to treat metabolic acidosis. Maintenance fluid rates in adults are 30-40 ml/kg/day and crias 80-120 ml/kg/day. Pulmonary edema is a serious risk if fluids are administered too fast (>120 ml/kg/hour). Other supportive therapies include nasal oxygen insufflation, non-steroidal anti-inflammatories, antioxidants (vitamin E and selenium) and broad-spectrum antibiotics. Steroids such as dexamethasone may be indicated in advanced cases. Therapeutic diuresis with furosemide is indicated in animals with respiratory distress due to pulmonary edema.

Heat stress is best prevented by timely shearing, adequate watering (clean, cool water), and providing shade and cooling (fans, sprinklers). Obese animals are more predisposed. Predisposing factors such transportation, excessive handling and breeding should be avoided during the hot humid days. Heat stress index (HSI), expressed as the ambient temperature (°F) + humidity (%), and is considered too high when it reaches or surpasses 160. In camels, scrotal edema may be a sign of acute trypanosomiasis.

Traumatic injuries

Traumatic injuries are usually due to fighting amongst males. Scrotal traumatic injuries are relatively rare in the wild population of camelids, probably because of the strict social organization. Severe traumatic fighting injuries are more common in camels during the rutting season. The extent of the injury may vary from scrotal skin lacerations to severe testicular rupture and hemorrhage. Testicular hemorrhage may not show any external signs of laceration and is only identified by ultrasonography of the scrotal content. Treatment protocols should be centered on reducing local swelling and preventing

infectious complications, and a booster with tetanus toxoid. Unilateral castration is the treatment method of choice for severe unilateral testicular trauma involving the tunica vaginalis and testes.^{1,6}

Orchitis, epididymitis and peri-orchitis

Inflammatory changes of the testis and associated organs are often noticed as a sudden onset of hind limb lameness, reluctance to breed or visible swelling of the scrotum. Infection spread hematogenously (*Brucella abortus*, *Brucella melitensis* and alpaca fever due to *S. equi zooepidemicus*) or may ascend from scrotal wounds.^{5,7} Treatment with systemic antimicrobials is often unrewarding and orchidectomy is the best option for the welfare of the male and salvage of reproductive ability if the affection is unilateral.

Acute preputial swelling

Acute preputial swelling may be due to complications from urolithiasis or traumatic injuries. The etiology of urinary calculi in the camelid is not well understood but is suggested to be similar to that in other domestic ruminants.^{8,9} Clinical signs include persistent straining, odontoprisis, inappetence and ileus, anorexia, dribbling blood tinged urine, and signs of abdominal discomfort.¹ More severe clinical signs ensue in cases of complete blockage and rupture of the urethra or bladder. Young males (11 to 15 months of age) may present as an emergency because of frequent straining and urine dribbling. This phenomenon is not necessarily due to urolithiasis but could be due to prostatic enlargement during puberty.

In camels, preputial swelling is a clinical sign of acute trypanosomiasis. In racing camels, the placement of a preputial ring to prevent masturbation behavior may result in adhesions and obstruction of urine flow.

Physical examination often reveals tachycardia, tachypnea and elevated rectal temperature. Complete blood count may reveal an elevated white cell count and neutrophilia with a left shift, increases in fibrinogen, increased creatinine kinase and aspartate aminotransferase activity, hyperglycemia, hypercreatininemia and increased urea nitrogen. Serum electrolyte abnormalities include hyponatremia, hypochloremia and hyperkalemia. Fluid obtained by abdominocentesis or from the preputial swelling shows increased creatinine concentration.¹

Increased serum urea nitrogen and creatinine concentrations suggest presence of uroperitoneum. Transcutaneous ultrasonography of the ventral abdomen may show subcutaneous free fluid and tissue edema in the case of urethral rupture and large volumes of free fluid in the abdominal cavity in the case of urinary bladder rupture. In the latter case, the urinary bladder may not be possible to image. Transrectal ultrasonography may reveal dilation of the pelvic urethra if the bladder is intact. Prognosis is grave in the presence of hydronephrosis and hydronephrosis.

Uroliths are often located in the distal penile urethra about 7 to 12 cm from the penile orifice but may occasionally be found immediately proximal to the sigmoid flexure. The urethral recess at the ischial arch makes catheterization of the urinary bladder impossible. Surgical management (tube cystotomy, urethrotomy) are a possibility but they carry a poor prognosis particularly for reproduction.

Preputial/penile trauma and prolapse

Preputial lacerations are usually a consequence of masturbation behavior (breeding the ground or objects) or complications from foreign objects within the prepuce. Hair rings around the penis are commonly found in llamas and Suri alpacas. Presenting complaints may be similar to those seen with urolithiasis. In some cases the only sign is preputial bloody or purulent discharge. Complication resulting in local adhesions and prevention of urination are possible.^{5,6}

The penis and prepuce are evaluated under heavy sedation or general anesthesia (Table). Early management of preputial and penile injuries should center on providing adequate protection of the traumatized tissue and prevention of infection and complication with urine scalding. Replacement of the healthy prolapsed preputial mucosa and its retention with a purse string suture is very helpful in early cases. Daily cleaning of the sheath with saline and application of local anti-inflammatory and

antimicrobial ointment for three to five days will help reduce the chance of further complications. Sutures may be removed after a week to ten days. Excessive preputial prolapse with slight necrosis requires circumferential resection and anastomosis of the prepuce. Long-standing lesions carry a poor prognosis particularly if there is overt cellulitis and tissue necrosis. Tissue necrosis is common problem with these cases and may include the penis due to pressure ischemia. Surgical debridement and or phallectomy may be required in these cases.

Rectal prolapse

Rectal prolapse is often seen in obese male camels following excessive breeding. The condition is best treated with sexual rest. Surgical management may be required for long-standing cases. Rectal prolapse may also be the consequence of excessive straining due to urolithiasis.

Soft palate prolapse in camels

The soft palate (dulla) is exteriorized frequently during rutting season in the dromedary.⁶ Impaction of this diverticulum with food or the presence of a foreign body results in entrapment of the tissue under the molars and traumatization during mastication. Onset of edema and even abscessation are a common complication resulting in a permanent exteriorization and dysphagia.¹⁰ In rare cases, the soft palate is swollen but not exteriorized and blocks the normal respiration which may lead to asphyxiation. Surgical management (i.e. palatotomy) is the best course of action. Excision of the prolapsed dulla is performed under heavy sedation or general anesthesia after ligation of the large vessels. Post-surgical management includes NSAIDs, antimicrobials and tetanus prophylaxis. Animals should be on soft food for three to four days after surgery.¹

Emergencies in the non-pregnant female

The most common reproductive emergencies in non-pregnant females are traumatic injuries during breeding or iatrogenic injuries during reproductive examinations. Severe trauma to the pelvis and genital organs may occur when heavy males breed younger or lighter females resulting in neurologic syndrome. Breeding trauma followed by excessive straining may lead to vaginal and/or even rectal prolapse. This is often seen in the case of congenital abnormalities (persistent hymen, vaginal aplasia) or vaginal/cervical adhesions.

Rectal or colonic injuries may occur following excessive transrectal palpation or ultrasonography.^{11,12} The distance between the anus and the peritoneal reflection is very small (4 cm in llamas, 2 to 3 cm in alpacas and 6 to 10 cm in camel). Complete rectal tears in camelids are rapidly complicated by peritonitis due fecal contamination. Often the only clinical sign is reluctance to stand, lethargy and progressive dehydration a few hours after a reproductive examination. Severe toxic shock and death follows within 8 to 24 hours if no medical action is taken.¹

Patients should be immediately referred to a surgical facility. Videoendoscopic evaluation after epidural anesthesia or under general anesthesia may help decide if a transanal repair is possible or if celiotomy should be considered. Transanal repair is successful if the laceration is not deep. Celiotomy with pubic symphysiotomy is the only option for caudal injuries and in particular for alpacas.¹²

Iatrogenic uterine perforations are due to aggressive placement of Foley catheters, infusion pipettes and biopsy forceps. They become an emergency if a major blood vessel is included in the injury or if an irritating substance (iodine) is infused into the abdominal cavity. Affected females present with colicky signs consistent with peritonitis or hemoperitoneum. Anemia is a feature if there is enough blood loss. Supportive therapy includes non-steroidal anti-inflammatory drugs and antimicrobials. Blood transfusion and surgical intervention may be indicated if the packed cell volume is < 8%. Vaginal perforation with severe bleeding may be controlled by vaginal compression packs.

Emergencies in the pregnant female

Camelids rely on the corpus luteum for progesterone secretion and maintenance of pregnancy. Therefore severe illness associated with an inflammatory or extreme stress response may rapidly lead to luteolysis and abortion with all its complications.

Pregnant females may present with a variety of emergency clinical syndromes including severe colic or respiratory distress, downer (lateral or sternal continuous recumbency), anorexia, diarrhea, depression, neurologic conditions, excessive straining, profuse diarrhea, severe abdominal wall edema or defects, vaginal discharge, premature lactation or vulvar dilation, and vaginal prolapse. Some of these presentations may have a genital origin. The cardinal rule in handling emergencies in the pregnant female is to perform a thorough clinical evaluation of the dam, evaluation of the fetus, and rule in or out genital origin of the presenting complaint after stabilization of the dam. The main emergencies of genital origin in the pregnant female are uterine torsion, vaginal prolapse, impending abortion and uterine rupture.

General approach to handling emergencies in the pregnant female

Clinical evaluation of the dam. Any concern on the part of the owner regarding behavior of the mid- to late-term pregnant camelid should be taken seriously. A detailed history should be obtained, including breeding dates, time and methods used for pregnancy diagnosis, history of previous illness of reproductive disorders, onset and duration of the clinical problem, and recent treatments administered. If the female is in severe distress, blood samples should be taken immediately and the female stabilized before further examination. Oxygen insufflation should be initiated and a jugular venous catheter should be placed immediately to allow fluid therapy and emergency anesthesia if needed.

Choices of drugs and dosage for sedation should take into account their effect on the fetus. Butorphanol tartrate (0.05-0.1 mg/kg IM) 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.¹³

The fetus and uteroplacental unit as well as all abdominal viscera and the peritoneal cavity, should be evaluated. Abdominocentesis and peritoneal fluid analysis should be considered. A caudal epidural block and infusion of a mixture of lidocaine and lubricant into the rectal cavity help reduce straining and facilitate per rectum evaluation for uterine torsion, presence of pelvic or abdominal masses and imaging of the bladder.

Vaginal examination may be performed on select cases (presence of abnormal discharge). Digital examination of the vagina and cervix does not present any value in the authors' opinion except when the cervix is open.

Fetal and utero- placental evaluation

Normal fetal heart rate in mid- to late-pregnancy should be between 1.6 to 1.8 times that of the dam. Fetal heart rate tends to range from 80 to 115 bpm in the last trimester of pregnancy and decreases to 80 bpm a few days before parturition. In our emergency cases, fetal stress is evidenced by a heart rate that is constantly above 130 bpm or constantly below 50 bpm. Fetal activity is maximal in the first half of pregnancy and is extremely reduced in the last two months of pregnancy.¹ Similar observations were reported recently in alpacas.¹⁴ Presence of twins is better confirmed by abdominal radiography in late-term pregnancy.

Fetal biometrics may provide an idea on fetal growth and pregnancy stage but most measurements are not very accurate in our experience. Fetal fluids are difficult to appreciate because the amount of amniotic and allantoic fluid in this species is low. Values for fetal growth in alpacas have been generated recently. Birth weight is significantly correlated to size of aorta, kidney and radius.¹⁴

The combined uteroplacental thickness (CUPT) should be evaluated in the fetal horn (left uterine horn) only, as the placenta may appear thicker in the non-pregnant horn. In the authors' experience camelids with CUPT > 8 mm in the last trimester are more prone to placental detachment and fetal compromise. In a recent study on alpacas, the mean CUPT increased from 3.8 ± 0.7 mm at 5 months to

6.1 ± 0.7 at term.¹⁴ Excessive edema of the uterine horn or premature placental detachment are relatively easy to detect and require immediate intervention if the female is at term.

Ancillary laboratory testing

Although a stress leukogram is often present in many of the presenting females, neutrophil count, immature band neutrophil count, neutrophil 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* infection. Blood biochemistry will help identify 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 old pregnant females and may be a predisposing factor to metabolic complications. In some cases the serum may be grossly hyperlipemic (white). However, lipemia and ketonemia are not always present in hepatic lipidosis. Elevated levels of non-esterified fatty acid (NEFA; > 400 µmol/L) and β-hydroxybutyrate (BHB) concentrations 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.⁸

Marginal calcium and magnesium levels or hypocalcemia may be noted in late-term pregnant females and require monitoring during the correction and convalescent period.

Specific conditions in the pregnant female

Uterine torsion. Uterine torsion is a major differential in colic or depression in the pregnant SAC. The condition is possible but not as common in camels.¹⁵ Clinical signs with uterine torsion range from mild episodes of discomfort to severe colic, diarrhea and anorexia. On physical examination tachypnea and tachycardia are common. Complete blood count 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.¹⁶

Diagnosis is based on transrectal palpation of the broad ligaments as described in other large animal species. Palpation of the broad ligament can elicit painful reaction. Diagnosis by vaginal palpation has been reported by practitioners but it is not reliable in our experience unless the torsion also includes the cervix which is rare. Diagnosis may not be possible until exploratory laparotomy 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.¹⁷ Although the majority of uterine torsions in camelids are clockwise, a significant proportion (15 to 20%) are counterclockwise.¹⁶

Uterine torsions can be corrected 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. Rolling of alpacas on the farm may be performed without sedation if help is available. Sedation or even general anesthesia may be required for llamas. The pain usually disappears immediately after correction of the torsion and females return to normal activity immediately unless they have been anorexic in which case correction of metabolic disorders (hepatic lipidosis) should be part of the follow-up plan.

Surgical correction may be performed following flank or midline laparotomy. Midline laparotomy is the preferred method in later stage of pregnancy.¹⁶

Complications of uterine torsion include uterine rupture/hemorrhage, endotoxemia and death of the patient. Splenic torsion concurrent with uterine torsion has been described in one case with persistent pain following correction.¹⁷ Progesterone supplementation after correction of the torsion is still a subject of debate.

A recent report on 60 cases of uterine torsion in our clinic showed a survival rate of 96.7% for females and 78.3% for fetuses.¹⁶ Cria survival was significantly ($p < 0.05$) higher following rolling (100%) than emergency cesarean section (70%). However, females that underwent a cesarean section had a more severe torsion. The most common blood biochemistry abnormalities were toxemia (leukophilia due to neutrophilia, with toxic neutrophils evident on a blood smear; 19.9%), hypocalcemia (<9.0 mg/dL; 5%), toxemia plus hypocalcemia (5%), toxemia plus hepatic lipidosis (3.4%), and elevated creatinine

kinase (1.7%). All cases of toxemia had concurrent hyperglycemia. The presence of toxemia and blood biochemistry changes tended to be higher with a prolonged interval to presentation.¹⁶

Uterine rupture. Uterine rupture is often due to severe or inadequate clinical management of a uterine torsion. Females usually present in advanced stages of shock and in lateral recumbency. Abdominocentesis may reveal large volumes of serosanguinous or bloody fluid. Severe pain with presence of serosanguinous peritoneal fluid may also be observed in case of splenic torsion.¹⁷ The only option is surgical intervention to remove the fetus and salvage the uterus. Complete hysterectomy should be considered if there is severe compromise of the uterus.

Vaginal prolapse. Vaginal prolapse is relatively common in all camelid species in the last two months of pregnancy. Predisposing factors include age (older females), parity, and body condition (obese and very thin females).¹

Prolapse of the entire vagina and exteriorization of the cervix is rare but possible. Prolonged periods of prolapse lead to increased inflammation of the prolapsed tissue and even severe necrosis of the vaginal mucosa. A complication with ascendant infectious placentitis is possible. In camels, myiasis of the prolapsed tissue is not uncommon. Chronic cases are at risk of abortion and/or rectal prolapse because of persistent tenesmus. Rectal and vaginal prolapse may be the only sign of uterine torsion, dystocia or abortion.

The prognosis for the life of the fetus and dam is relatively good if the condition is treated early. In camels, the vaginal tissue is maintained in place by placing a Bühner suture around the vulva. In alpacas and llamas, a shoelace suture pattern is sufficient. Sheep vaginal prolapse retainers may help in some cases in alpacas. More advanced cases of prolapsed vagina with increased tenesmus may require epidural anesthesia.

Other complications of pregnancy. Other complications of pregnancy in camelids include ventral abdominal herniation, parturition downer syndrome, metabolic diseases and premature lactation/placentitis. Hydrops of fetal fluids is extremely rare in camelids. Ventral herniation during pregnancy is often a complication of previous abdominal surgeries including cesarean section. Induction of abortion or parturition may be contemplated to save the female. Abortion is easily induced at any stage with an intramuscular administration of cloprostenol (total dose of 250 micrograms in llamas and alpacas and 500 mg in camels). The same dosage is sufficient for induction of parturition with good neonatal survival if pregnancy stage is > 330 days and there is sufficient mammary gland development and colostrum production. Abortion or parturition occurs about 18 to 22 hours after administration of prostaglandin.¹⁸ In a few situations, a second administration of cloprostenol is necessary. Clients should be warned that induction of abortion or parturition in the compromised female may predispose to dystocia. In our practice, fetal heart rate is monitored closely following induction and a cesarean section is performed if there are no signs of parturition at 20 hours and fetal heart rate is < 70 bpm.

Obstetrical emergencies

Normal parturition and proper obstetrical techniques have been reviewed by the authors in detail elsewhere.¹⁹ It is estimated that about 5% of all camelid births will require some assistance and about 2% will require advanced obstetrical expertise. Obstetrical problems are an emergency in camelid because of the relatively explosive and short stages of parturition which are similar to the equine.

Dystocia of maternal origin include: uterine inertia, uterine rupture, and failure of appropriate dilation of the cervix or vestibulum. Uterine torsion and failure of cervical dilation requires delivery by cesarean section. However it is important to confirm that the dam is at term.

Dystocia of fetal origin occurs most commonly as a result of malpositioning or malposture and to a lesser degree, presence of malformations, twins and large size fetuses. The most common fetal causes of dystocia are carpal or shoulder flexion, head deviations (lateral and ventral) and bilateral hip flexion. Transverse presentations are possible and are a common reason for cesarean section.

Fetal abnormalities causing dystocia include hydrocephalus, *Schistosomus reflexus*, contracted tendons, ankylosis of the hind limbs or neck, and conjoined twins. Other anomalies that may complicate delivery include fetal anasarca and emphysematous fetus resulting from the death and production of gas

from decomposition.

Although twinning is rare in camelids, a few twin births have been reported. Delivery of twins may be complicated by presentation of both fetuses to the birth canal at the same time or in the case of conjoined twins. In our experience all twin dystocias have required cesarean section in order to preserve female reproductive tract integrity.

General considerations for obstetrical manipulations

Three major differences between camelid and ruminants need to be kept in mind when dealing with an obstetrical situation. 1) the pelvic inlet is narrower, 2) the cervix and vaginal 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 contraction and the rapid detachment of the microcotyledonary placenta.

Most dystocias present to the practitioner during the second stage of parturition. Prolongation of the first stage of parturition is primarily due to failure of cervical relaxation or uterine torsion. Transrectal palpation and digital examination should allow diagnosis and cesarean section is the best course of action in these cases.

In the case of dystocia during the second stage of labor, assessment of cervical dilation and fetal disposition is performed following sedation and/or epidural analgesia. Guidelines for assisted vaginal or controlled vaginal (under heavy sedation or general anesthesia) delivery are similar to procedures recommended for the equine and should be kept to no more than 20 minutes. Elevation of the hind quarters may facilitate manipulation. The use of clenbuterol when available greatly reduces uterine contractions and facilitates obstetrical manipulation. The use of epinephrine for uterine relaxation has been reported anecdotally but there is no described protocol for this. In our experience, fetotomy is not an option in alpacas and most llamas and camels. Cesarean section remains the best approach if controlled vaginal delivery cannot be achieved in less than 20 minutes.

Analgesia and anesthesia for obstetrical manipulation

Most simple obstetrical manipulation can be performed without sedation. Caudal epidural analgesia is often sufficient. Sedation with xylazine has been used by the author particularly in camels. The drug is known to increase uterine artery resistance and increase myometrial contraction in ruminants leading to higher risk of fetal hypoxia. These effects have not been studied in camelids. Our group has moved away from induction of anesthesia with ketamine because it has been associated with neonatal depression. We prefer induction with propofol for cesarean section or for surgical management of uterine torsion. Because propofol is primarily metabolized by the liver, its use in females with concurrent hepatic lipidosis should be monitored. Maintenance of general anesthesia with isoflurane or sevoflurane is ideal, because these inhalation anesthetics are rapidly eliminated.

Cesarean section

Techniques for cesarean delivery in camelids have been described in detail elsewhere.^{19,20} We recommend flank approach in camels and any severely compromised SAC.

Left paravertebral (flank) approach. Most females will tolerate the operation with a line or inverted "L" block anesthesia (lidocaine diluted to 1% with isotonic bicarbonate or saline, with the total dose not to exceed 4.4 mg/kg BW) following sedation, caudal epidural and physical restraint in the sitting sternal position. After surgical preparation, an oblique incision is made extending from the angle formed by tuber coxae to the level of bottom of the last rib. The incision line should be parallel to the direction of the quadriceps when the animal is sitting in the sternal position. The subcutaneous muscle and fascia and the external oblique muscle are incised while the internal oblique and transverse abdominal muscle may be gridded along the muscle fibers. The peritoneum is incised together with the transverse abdominal muscle. The gravid uterine horn (always the left) is grasped around a fetal limb and gently exteriorized from the incision. An incision is made over the limb at the greater curvature and the fetus is exteriorized. If the placenta is still attached, it should be left in place but peeled off along the uterine incision to avoid

entrapment during closure of the uterus and dehiscence. Because of the type of placentation, mural bleeding is common and hemostasis is provided by oversewing the margins of the uterine incision using a continuous interlocking pattern using absorbable suture material (#1 chromic gut in camels or #0 polydioxanone [PDS] in SAC). The uterine wall is closed in a Cushing, Utrecht, or Lembert pattern (#0 or 1 polyglactin 910, #0 polydioxanone or poliglecaprone in alpacas, #1 chromic gut in llamas and camels). Some practitioners prefer to administer oxytocin into the uterine wall. The uterine wall and abdominal cavity may be lavaged with a warm sterile saline solution containing antibiotics (one liter isotonic saline solution containing antibiotics (potassium penicillin G 22,000 U/kg body weight [BW], sodium ampicillin 20 mg/kg, or sodium ceftiofur 1 mg/kg), antiinflammatory drugs (flunixin 1 mg/kg), and heparin (20 to 40 units/kg). Carboxymethyl cellulose (CMC; 14 mL/kg BW, intraperitoneally [IP]) may be used to prevent postoperative adhesions.

The abdominal cavity is closed in three layers using a simple continuous pattern. The suture is anchored every 2 to 3 cm to the transverse muscle to remove any dead space and prevent formation of pockets. The skin is closed using a continuous Ford interlocking suture pattern.

Ventral midline approach. Midline celiotomy approach is performed with the patient in dorsal recumbency under general anesthesia and is ideal if the uterus is compromised or need to be completely exteriorized. A midline celiotomy incision (25 to 30 cm in alpaca and 35 to 40 cm in llamas) is made through the skin, subcutaneous fat, cutaneous trunci muscle and linea alba from about 4 cm cranial to the border of the mammary gland extending towards the umbilical scar. The uterus is identified by direct palpation and exteriorized. An incision is made through the uterine wall along the greater curvature. The cria is removed and the umbilicus clamped and transected. The linea alba is closed by appositional pattern with interrupted horizontal mattress, cruciate pattern sutures, or continuous suture pattern (#2 polyglycolic acid or #1 polydioxanone or polyglactin 910). Closure of the skin may be done with staples, horizontal mattress suture pattern or preferably with subcuticular suture pattern (#2-0 polyglactin 910 or polyglecaprone).

Postoperative care, complications and prognosis. Postoperative care includes pain management using butorphanol tartrate or flunixin meglumine. Antimicrobial prophylaxis should be continued for five to seven days depending on the condition of the uterus and fetus at the time of 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 IM in SAC) every four hours during the first 24 hours after surgery.

Complications include retained placenta, incisional 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.^{21,22} The most common complications seen in 63 camel cesarean sections, performed by the author and colleagues in the field, were incisional infections (n=6), peritonitis (n=2), and herniation (n=1) (Tibary and Anouassi, personal observations).

The rebreeding success rate is excellent (>70%) and most females will be rebred at three to four months after surgery.^{21,22} The earliest successful rebreeding after cesarean section seen by the author is 45 days. We generally recommend least 45 to 60 days sexual rest.

Neonatal resuscitation following dystocia

Neonatal monitoring following dystocia is extremely important as obstetrical manipulation is the leading risk factor for hypoxia, failure of passive transfer and sepsis.^{1,23,24}

Postpartum emergencies

Postpartum emergencies are often due to complications of obstetrical situations. In addition to the main genital problems that may alarm the owner (i.e. traumatic injuries, bleeding, uterine prolapse, persistent straining and retained placenta) some of these cases present with ataxia, prolonged recumbency and various degrees of anorexia or depression as the primary complaint. Evaluation of the postpartum female should include a complete history and a detailed account of the obstetrical situation including

placental delivery. The female should be assessed by complete physical examination, CBC and blood biochemistry, transabdominal and transrectal ultrasonography and vaginal examination. Excessive fluid in the abdomen warrants abdominocentesis.

Recto-vaginal tear

Due to the small perineal body and the powerful expulsive efforts in camelids, recto-vaginal tears are common following overt obstetrical manipulations. Cases seen in our practice are often a complication of fetotomy. Recto-vaginal tears may be repaired immediately or a few weeks after second intention healing.^{5,25}

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 involution is very rapid in the camelid and small, dorsal uterine tears may heal quickly with the only sequela of infertility due to peri-uterine adhesions. Peritonitis is possible if there is severe contamination associated with placental retention.²⁶ It is not clear how uterine tears occur in camelids and although most are associated with obstetrical manipulation, we have seen cases following normal parturition.

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 tears can be repaired after celiotomy. 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

In camelids, the vascular supply to the reproductive tract presents several differences compared to ruminants and equine, characterized by prominent caudal and cranial vaginal arteries and a large arcuate cervical artery.²⁷ Most of the postpartum hemorrhage cases diagnosed by our group consist of rupture or laceration of the vaginal uterine artery. Excessive manipulation, and in particular fetotomy, 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. In many females, blood accumulates within the uterus for a few hours followed by cardiovascular collapse. In one case, the female was found dead in her stall two hours after delivery. Ruptured vaginal arteries may be sutured if easily accessible. Hemorrhage may be managed medically by administration of aminocaproic acid and placement of compresses.²⁸ Blood transfusion should be considered in females with a PCV <10%.

Uterine prolapse

Partial or total uterine prolapse can occur secondary to dystocia, manual removal of a retained placenta or excessive use of oxytocin (high dosage and frequency). Uterine prolapse is more common in camels than SAC and is often associated with hypocalcemia, selenium deficiency and retained placenta. Dairy camels seem to be more prone to uterine prolapse.²⁹ Uterine prolapse occurs generally immediately (the first 30 minutes) after parturition or abortion.

Techniques for replacement are similar to those reported in cattle and small 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 quarters 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 prolapses tend to reoccur if the uterine horns are not fully extended. Hysterectomy should be considered if the uterine tissue has sustained severe damage.¹

Rectal and vaginal prolapse

Postpartum rectal or vaginal prolapse is often associated with persistent straining after dystocia and presence of severe necrotic vaginitis or pelvic masses. Necrotic vaginitis may be so severe that urination becomes difficult. Vaginal prolapse alone can be seen up to three weeks following parturition. These are often due to a ruptured vestibulo-vaginal sphincter. A cerclage suture may help retain the vagina until complete involution occurs.

Other complications of the postpartum period

Emergency postpartum complications in camelids include a vast array of conditions which often manifest themselves as lethargy and depression progressing towards a downer female syndrome. The approach to diagnosis of the causes of downer syndrome is similar to that used in the bovine. Predisposing factors include septic metritis, necrotic vaginitis, retained placenta, hypocalcemia, dystocia, pelvic injuries, hemorrhage and presence of compressive lesions. Milk fever and toxic mastitis have been described in dairy camels but not in SAC.

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 neonate. Untreated vaginal and cervical inflammation may lead to complete vaginal 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 local application of a vaginal tampon covered with ointment (lanolin, antimicrobials) helps prevent adhesions.

Conclusion

Reproductive emergencies involve not only saving the health but also the reproductive future of the patient. Emergencies in the pregnant female present a peculiar challenge in that the fetus has to be taken into account. One of the main challenges in emergency care in camelids is the lack evidence-based scientific data on treatment and outcome assessment. Although extrapolation from other species has been possible, it is important to remember species peculiarities especially with regard to fluid therapy. Handling of obstetrical situations is particularly important as many female camelids lose their reproductive ability due to iatrogenic vaginal adhesions and cervical trauma from lengthy manipulation. Emergency drugs and protocols (Table) should be available in order to reduce the time to address critical care and improve outcome. Supportive treatment in cases of emergency should always include nutritional support and stimulation of appetite and gastrointestinal function (vitamin B complex and transfaunation).

References

1. Tibary A, Rodriguez J, Sandoval S: Reproductive emergencies in camelids. *Theriogenology* 2008;70: 515-534.
2. Middleton JR, Parish SM: Heat stress in a llama (*Lama glama*): a case report and review of the syndrome. *J Camel Pract Res* 1999;6: 265-269.
3. Schwalm A, Erhardt G, Gerken M, et al: Influence of heat stress on thermoregulation and fertility in shorn and unshorn male llamas (*Lama glama*). *Tieraerztl Prax Ausg G Nutztiere* 2008;36: 324-328.
4. Schwalm A, Gauly M, Erhardt G, et al: Changes in testicular histology and sperm quality in llamas (*Lama glama*), following exposure to high ambient temperature. *Theriogenology* 2007;67: 1316-1323.
5. Tibary A, Vaughan J: Reproductive physiology and infertility in male South American camelids: a review and clinical observations. *Small Rumin Res* 2006;61: 283-298.
6. Tibary A, Anouassi A: Male reproductive disorder and surgery. In: *Camelid theriogenology*; 1997.
7. Aubry P, Swor TM, Barrington GM, et al: Septic orchitis in an alpaca. *Can Vet J* 2000;41:704-706.
8. Van Saun RJ: Nutritional diseases of South American camelids. *Small Rumin Res* 2006;61: 153-164.
9. Gutierrez C, Corbera JA, Faye B: Obstructive phosphate urolithiasis in a dromedary camel: a case report. *J Camel Pract Res* 2008;15: 77-79.
10. Gahlot TK, Jhirwal SK, Bishnoi P, et al: Facial paralysis, glossoplegia and injured soft palate in a camel. *J Camel Pract Res* 2004;11: 157-158.
11. Steffen S, Grunert E: Perforation of the rectum in a llama mare caused by rectal palpation (veterinary expert opinion). *Dtsch Tierarztl Wochenschr* 1995;102: 330-331.
12. Stone WC, Lindsay WA, Adams GP, et al: Rectal and colonic injury in the llama anatomic considerations and surgical management in 4 llamas. *Vet Surg* 1993;22: 62-66.

13. Garcia-Pereira FL, Greene SA, Keegan RD, et al: Effects of intravenous butorphanol on cardiopulmonary function in isoflurane-anesthetized alpacas. *Vet Anaesth Analg* 2007;34: 269-274.
14. Ferrer MS, Jones M, Anderson DE, et al: Ultrasonographic parameters of fetal well-being and development in alpacas. *Theriogenology* 2013;79: 1236-1246.
15. Bolbol AE, El-Eknaah MM, Aboul-Fadle W, et al: Caesarean section in female camels. *Proc Second Sci Cong Egypt Soc Cattle Dis*; 1993. vol 1. p. 82-89.
16. Pearson LK, Rodriguez JS, Tibary A: Uterine torsion in late gestation alpacas and llamas: 60 cases (2000-2009). *Small Rumin Res* 2012;105: 268-272.
17. Smith JJ, Dallap BL: Splenic torsion in an alpaca. *Vet Surg* 2005;34: 1-4.
18. Bravo PW, Bazan PJ, Troedsson MHT, et al: Induction of parturition in alpacas and subsequent survival of neonates. *J Am Vet Med Assoc* 1996;209:1760-1762.
19. Tibary A, Rodriguez JS, Anouassi A, et al: Management of dystocia in camelids. *J Am Assoc Bovine Pract* 2008;166-176.
20. Tibary A: Surgery of the reproductive tract in camelids. In: *Current therapy in large animal theriogenology*. Youngquist RS, Threlfall WR, editors. 2nd ed. St. Louis: Saunders Elsevier; 2006. p 905-918.
21. Campbell A, Pearson LK, Tibary A: Cesarean section in alpacas and llamas at a referral center - technique, survival, and postoperative fertility: 24 cases (2000-2012). *Clin Theriog* 2013;5: 360.
22. Miller BA, Brounts SH, Anderson DE, et al: Cesarean section in alpacas and llamas: 34 cases (1997-2010). *J Am Vet Med Assoc* 2013;242: 670-674.
23. Dolente BA, Lindborg S, Palmer JE, et al: Culture-positive sepsis in neonatal camelids: 21 cases. *J Vet Intern Med* 2007;21: 519-525.
24. Tibary A, Rodriguez J, Walker P, et al: Neonatal care and neonatal emergencies in camelids. *J Am Assoc Bovine Pract* 2008;177-184.
25. Anwar S, Purohit GN: Occurrence and surgical repair of third degree perineal lacerations in adult female camels (*Camelus dromedarius*) by one-stage (Goetz) technique. *Open Vet J* 2013;3: 75-79.
26. Bedford SJ, Hawes M, Paradis MR, et al: Peritonitis associated with passage of the placenta into the abdominal cavity in a llama. *J Am Vet Med Assoc* 1996;209: 1914-1916.
27. León M E, Sato S A, Navarrete Z M, et al: Macroscopic anatomy, irrigation and venous drainage of female reproductive apparatus of llama (*Lama glama*). *Rev Invest Vet Perú* 2011;22: 1-8.
28. Pearson LK, Tibary A: Clinical management of postpartum hemorrhage following failure of cervical dialation in an alpaca. *Clin Therio* 2014.(in press)
29. Agab H: Diseases and causes of mortality in a camel (*Camelus dromedarius*) dairy farm in Saudi Arabia, *J Camel Prac Res* 2006;165-169.

Table: Formulary for emergency veterinary care of camelids

Drug	llamas and alpacas	Camels	Remarks
<i>Sedatives/anesthetics/analgesics and reversal agents</i>			
Acepromazine	0.02-0.05 mg/kg IV, IM, SQ	0.05 mg/kg IV, IM	Sedation, use with care in depression animals, hypotensive. Avoid in emergency
Butrophanol	0.05-0.1 mg/kg IM, SQ	0.05-0.2 mg/kg IM	
Ketamine	2-4 mg/Kg IV 4 mg-6 mg/kg IM	5-8 mg/KG IM	Avoid IV route in pregnant animals
Ketoprofen	2 mg/Kg IV, IM, SQ	2 mg-3 mg/Kg IV, IM	
Lidocaine 2% (caudal epidural)	1 ml /100 kg	1 ml/100 kg	For local anesthesia use to effect (toxic dose 4 mg/kg)
Talazoline	2 to 4 mg/Kg IM or SC IV slow	0.2 mg/Kg IV	Caution cardiac asystole possible
Yohimbine HCl	0.125 mg/Kg IV	0.25 mg/kg IV	Reversal agent for xylazine
<i>Neonatal resuscitation</i>			
Aminophylline	2 – 4 mg/kg SQ	4-7 mg/kg SQ	bronchodilator
Atropine	0.04 mg/kg IV, SQ	0.04 mg/kg IM, SQ	Use if bradycardia
Doxapram HCl	5-10 mg/kg IV, IM, SL	0.2- 0.3 mg/kg IV, SL	Use caution as effects do not last very long
<i>Antimicrobials</i>			
Ampicillin sodium	6-10 mg/kg IV TID	6.6 mg/Kg IV TID	
Ceftiofur (solution)	2 -4 mg/kg IV BID	2 mg/KG IV BID	
Ceftiofur (suspension)	2.2 mg/kg SQ, IM SID	1-2 mg/kg, IM SID	
Enrofloxacin	5-10 mg/Kg SQ SID	2.5 to 5 mg/kg SC or IM SID	
Florfenicol	20 mg/kg SQ q48 hours	20-40 mg/kg SQ Single dose	
Gentamicin	5 mg/kg IM, SID	4 mg/kg IM BID	Nephrotoxic
Oxytetracycline LA	20 mg/kg SQ	10-20 mg/kg IM	Every 2 to 3 days
Procaine Penicillin G	22,000 to 44,000 IU/Kg SC or IM BID or SID	22,000 IU/Kg IM BID	
<i>Hormones</i>			
Cloprostenol	250 µg IM	500 µg IM	Total dose
Misoprostol	400-600 µg cervical	1-2 mg	Topical for cervical dilation
Oxytocin	Alpacas; 5-7.5 IU IM Llama; 5-10 IU IM	20 -30 IU IM	IV drip at a rate of 1 IU per minute
Hydroxyprogesterone caproate	250 mg IM	500 mg IM	Every 3 weeks do not use in the last 4 weeks of pregnancy
<i>Anti-inflammatory drugs</i>			
Flunixin Meglumine	1.1 mg/Kg IV or SQ BID or SID		
<i>Fluid therapy*</i>			

Other useful drugs			
Clembuterol**		300 micrograms as a single dose, IM or slow IV	Obstetrical manipulations
Diphenhydramine	0.5-1mg/kg IM or IV		Anaphylactic shock
Epinephrine	1 ml/50 kgs (1:1000 dilution)	0.01 mg/kg	Anaphylactic shock, uterine myorelaxant
Vitmanin B complex**	5-10 ml adult	0.02-0.04 ml/ kg	
Buscopan (N-butylscopolammonium bromide)		4 mg/ ml 1 ml/10 kg	Spasmolytic, analgesic

*Fluid therapy, the most common balanced salt solution used are LRS and Normosol, Bicarbonate should be available to correct acidosis, dextrose can be used at 1.5% to 5% depending on degree of hypoglycemia. Fluids can be spiked appropriately to correct hypocalcemia (calcium bromogluconate) or hypokalemia (KCL) or any other metabolic disturbance.

**Clembuterol is not available in some countries including the USA,

***Each ml contains: B1 (100 mg), B2 (5 mg), B3 (100 mg), B6 (10 mg), B12 (100 mcg)