SURGICAL PROCEDURES TO RESTORE OR MAINTAIN BREEDING SOUNDNESS IN SMALL RUMINANTS

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Surgical procedure in breeding males

Urolithiasis in breeding males

Small animal practitioners are frequently asked to provide veterinary services to owners of small ruminants. This can be a rewarding experience for the practitioner and owner. Urolithiasis is a common and frustrating problem in small ruminants for owners and veterinarians. Urethral obstruction most commonly is seen in pet goats and show lambs because of inappropriate nutrition. Although conventional management techniques often are satisfactory for treatment of urolithiasis in show animals because of their shortened life expectancy, owners of pet animals demand more sophisticated techniques that will allow for long-term survival of the patient.

Formation of urinary stones: The composition of urinary stones varies with geographic location, but the most common uroliths are calcium apatite and phosphatic calculi (calcium hydrogen phosphate dihydrate, magnesium ammonium phosphate) . Silicate and calcium carbonate stones also are occasionally seen. Formation of phosphatic calculi is encouraged by high concentrate, low roughage, low Ca:P ratio, high magnesium diets and alkaline urine. Normally, phosphorus is recycled through saliva and excreted via feces in ruminants. High grain, low roughage diets decrease the formation of saliva and increase the amount of phosphorus excreted in the urine. High phosphorus diets overwhelm the salivary excretion mechanism and result in high urinary excretion of phosphorus. High calcium diets are effective at reducing the absorption of phosphorus from the GI tract. Lambs fed high phosphorus and high magnesium diets had a higher incidence of uroliths at necropsy. Increased urine output and decreased urine pH may prevent the formation of uroliths by decreasing urine retention time and by dilution of solutes. Some breeds of sheep may be predisposed to urinary excretion of phosphorus (versus GI excretion; Texel, Scottish Blackface).

Diagnosis: Early in the onset of urolithiasis in small ruminants, patients may demonstrate hematuria, dysuria, prolonged urination, urination by dribbling, flagging of the tail, and apparent abdominal pain (stretching out all four limbs, kicking at the abdomen, looking at the side, etc). Later in the course of the disease, patients demonstrate anorexia, apparent depression, recumbency, abdominal distention or preputial swelling. Terminally, patients may seizure, suffer cardiovascular collapse, or die suddenly. Physical examination reveals tachycardia, tachypnea, and elevated, normal, or decreased rectal temperature. Digital rectal palpation reveals pelvic

urethral distention and excessive urethral pulsation. If preputial swelling is present, the skin may be hot early in the disease or cold to the touch as ischemic necrosis ensues. If abdominal distention is present, a fluid wave may be balloted. Transabdominal palpation may reveal an enlarged bladder. Serum biochemical analysis reveals elevation of BUN and creatinine, hyper- or normokalemia, hyponatremia, hypochloremia, elevated muscle enzymes (AST, CPK), and acidemia if the disease is long standing. The CBC will be normal early, but leukocytosis with a left shift will develop with time. Ultrasonography shows a distended bladder; occasionally the distended urethra can be traced distally until the urolith is encountered. Most uroliths in small ruminants lodge at the urethral process; the second most common site is at the distal sigmoid flexure.

Treatment options: Treatment of urolithiasis often is dictated by economic constraints and euthanasia may be elected by the owner. Perineal urethrostomy has been the mainstay of surgical treatment for urolithiasis for many years, but the poor long-term success of this procedure has lead to the development of alternatives. Options for medical management of urolithiasis are limited for clinically affected animals, but should be addressed for the group or herd.
Urethral Process Amputation may provide a temporary correction of urethral obstruction, but recurrence of obstruction is likely. The sheep or goat is placed onto their tailhead and the penis is extended (a preputiotomy may be needed in immature animals to provide access to the penis). The urethral process is removed using a guillotine method (tongue depressor placed beneath the process and amputation done by rapid transection with a scalpel blade). Medical treatment should immediately be begun to try to prevent re-obstruction.

Perineal Urethrostomy can be done with regional anesthesia induced by an epidural block, sedation with xylazine hydrochloride, and manual restraint. We often perform perineal urethrostomy with the patient under general anesthesia when we are treating pet animals or animals of high perceived economic value. A 6 cm incision is made on midline in the perineum approximately 4 to 6 cm ventral to the anus (sub-ischial urethrostomy). The penis is elevated to the surgical incision and stay sutures (No. 0 PDS, vicryl, or No. 1 chromic gut) are placed between the perineal fascia overlying the semimembranosus muscle and the tunica albuginea of the penis. A 2 cm incision is made on the caudal and ventral midline of the penis (overlying the palpable urethral groove). The exposed tunica albuginea is sutured to the subcutaneous tissue adjacent to the skin (No. 2-0 PDS or vicryl) and the urethral mucosae is sutured to the skin edges of the surgical wound (No. 3-0 monocryl or 4-0 PDS). Alternatively, the penis may be transected at the ventral aspect of the incision, the proximal stump is exited through the surgical wound, stay sutures are placed circumferentially around the penis from the tunica albuginea to the skin, and the urethral mucosa is sutured to the cut edge of the tunica albuginea. Perineal urethrostomy is indicated in all patients that have already ruptured the penile urethra.

Tube Cystostomy is the treatment of choice for patients for which urethral process amputation is not useful and that have not ruptured the urethra. Although a tube cystostomy may be done with sedation (xylazine HCl, 0.03 mg/kg, IV) and local lidocaine anesthesia, I prefer to perform cystostomy with the patient anesthetized. This allows optimal aseptic technique and time to perform cystotomy, evacuation of the bladder, thorough lavage and cleaning of the bladder, and placement of the tube cystostomy. Although a closed, sterile collection system attached to the exposed end of the tube is optimal, these are difficult and more expensive to maintain. In my

experience, these systems are not necessary. I leave the exposed end of the tube open with a "Heimlich" type valve attached to the end of the tube (wet Penrose drain). The tube cystostomy is maintained until urine is seen dripping from the prepuce for 48 hours. Then, the tube is clamped and urination is monitored. If the animal can urinate, is not painful, and is able to empty the bladder, the tube is removed. If the animal can only partially urinate and continues to retain urine, the tube is left unobstructed for 5 to 7 more days and the process is repeated. On average, I can remove a tube cystostomy 10 to 14 days after surgery.

Prepubic Cystostomy is reserved for patients that have had multiple perineal urethrostomies with stricture formation and re-obstruction. This procedure is a "last resort" treatment for pet animals. After induction of general anesthesia, the patient is placed into dorsal recumbency, a 4 cm incision is made on ventral midline immediately cranial to the pubis, and the bladder is exited through this incision. The bladder wall is sutured to the linea alba, a 3 cm incision is made into the bladder, and the bladder mucosa is sutured to the skin. Chronic cystitis is the principle complication of this procedure. Urethral Translocation can be attempted to "by-pass" a ruptured urethra (or failed urethrostomy). This also is a last resort procedure for pet animals. The procedure is done with the animal in dorsal recumbency and under general anesthesia. A right paramedian approach is made to the abdomen and the pelvic urethra is dissected free and transected at the most caudal location that can be reached. The distal penis or prepuce is identified and freed of surrounding soft tissues (I prefer to use the prepuce if it is long enough). This segment is translocated into the abdomen through a stab incision in the linea alba and anastomosed to the pelvic urethra (No. 3-0 monocryl or 4-0 PDS). Neurogenic bladder atony, urine stasis, and chronic cystitis are the most serious complications of this procedure.

Preservation of breeding males: Little data exists regarding the effect of urethral process amputation on fertility in small ruminants. However, minimal reduction in fertility (<10%) is expected. When urethral obstruction does not involve the urethral process, breeding bucks occasionally can be preserved using tube cystostomy to manage urolithiasis. When successful, the urethra is preserved, intact, and normal CCP and SCP filling during breeding is expected.

Prevention of urolithiasis: Male sheep or goats intended to be used as pets should not be castrated until they are 6 to 12 months old to allow for development of normal urethral diameter. All show animals that must be fed a relatively high grain diet should have salt added into the ration at a rate of 2 to 5 % (alternatively ammonium chloride can be used at a rate of 0.5 to 1 %). Horse feed should never be fed to small ruminants because the diet is not balanced for ruminants and is thus calculogenic.

Rectal Prolapse

Rectal prolapse most commonly is seen as a complication of tail amputation. Typically, the tail is amputated so short that the innervation of the anal sphincter and perianal muscles are compromised. This results on chronically progressive rectal protrusion and ultimately prolapse. The AASRP successfully passed an AVMA resolution on tail docking in sheep. This resolution recommended that tail docking not be performed shorter than the junction of the caudal folds of the tail. I strongly support this resolution.

Prolapse of the rectal mucosa also occurs following straining to defecate. The mucosa rapidly becomes edematous and often shows bleeding lesions. Many factors have been associated with the development of rectal prolapse including: genetics, being male, diarrhea, coughing, short tails, chronic water shortage. Diagnosis of rectal prolapse is not difficult, but care should be taken that the prolapse does not contain other organs.

The simplest procedure for rectal prolapse is reduction by gentle massage and retention by application of a purse-string suture pattern using 1.8 inch umbilical tape. The suture is passed in and out through the skin around the anal opening at a distance of 1 cm from the anus. A one-to-two-finger opening should be left when tying the purse string. The suture usually is left in place for 5 days. This should be done only if the rectal mucosa is viable and no laceration is present on close inspection. If the mucosa is too necrotic to replace, correction of the prolapse can be approached in different ways including surgical amputation.

For surgical amputation, required instruments are hemostats, blade, scissors, thumb forceps, two 18-gauge needles 3 or 4 inches long, suture material, and a small-diameter rubber tube. Following anesthesia, the tube is inserted in the rectum until 2 or 3 inches protrude. The tube is fixed in the rectum by inserting the two needles through the rectum at right angles to each other so that they pass through the rectum and tube and emerge from the opposite side. The dissection is started about a centimeter from the mucocutaneous border where the mucosa is still healthy, and the entire circumference of the exposed mucosa of the rectum is cut down to the serosa of the inner wall. Hemorrhaging is usually minor and controlled with gauge until all the layers have been dissected and the dorsal artery of the rectum is cut. Once the dissection is completed around the prolapse, the rectum is held in place because it is attached to the rubber tube with needles. Instead of using tubing and needles, one could use forceps applied at two or three places as the prolapsed rectum is amputated to prevent telescoping into the animal's body. To suture the ends of the rectum together, the authors suggest using size 2-0 or 0 absorbable suture material in an inside-out continuous pattern. After the simple continuous pattern has been placed around the rectum, the needles then are pulled from the tube, and the tube is removed from the rectum. The rectum then automatically retracts into place. Complications seen with rectal prolapse are bladder retroversion, eventration of the small intestine, and rectal stricture.

Surgical procedures in breeding females

Vaginal prolapse in small ruminants and camelids

Epidural anesthesia: Surgery and manipulation of the vaginal and perineal tissues is greatly improved with the use of epidural anesthesia. In small ruminants I use xylazine at 0.03 mg/kg body weight diluted to 1 cc / 100 lbs body weight with saline. In camelids, I use 0.2 mg./kg body weight in a similar volume. Addition of lidocaine will result in rapid onset of anesthesia. Xylazine alone requires 30 minutes to take full effect and lasts for approximately 2 to 3 hours. Lidocaine will take full effect in 5 minutes and last 1 to 2 hours. The combination of xylazine and lidocaine will take full effect in 5 minutes and last 3 to 4 hours.

Acute vaginal prolapse: Acute vaginal prolapse may be seen prepartum or postpartum. Animals suffering prepartum vaginal prolapse should be selected for culling after weaning the current

offspring. A plethora of techniques have been described for treatment of acute vaginal prolapse including Bruhners suture, boot lace sutures, Caslik's suture, rope slings, and indwelling pessary. Indwelling pessary and rope slings have the advantage that kids and lambs may be able to birth around the device. However, dystocia is a concern whenever these devices are left in place. Ideally, rope slings or pessaries should be removed within a few days of expected parturition. Alternatively, parturition may be induced to allow a shorter interval for close observation. In my experience, goats and camelids have extremely fragile perivaginal tissues. Thus, any suture technique has a high risk of tearing through the tissues. When necessary, I have chosen to use a 6 to 12 mm diameter rubber stent to place under sutures. I place 3 to 5 vertical matress sutures over a stent that is placed parallel to the vulva. The sutues must be placed along the hair-nonhaired margin of the vulva in order to reproduce the effect of the vestibular sphincter muscle. Placement of the sutures too superficially will result in severe tearing of the vulva.

Chronic vaginal prolapse: Although Buhner's suture and other methods of fixation give temporary relief from vaginal prolapse, chronic vaginal prolapse requires more invasive techniques to stabilize the vagina. I do not use the Johnson button or Minchev techniques because these techniques are traumatic and may result in tearing of the vagina into the abdomen because of chronic straining after surgery. I prefer to perform either cervicopexy or vaginoplasty. Vaginoplasty is extremely effective in the elimination of vaginal prolapse, but prevents the animal from being used in nature service or going through normal parturition. This technique is done with the animal standing with epidural anesthesia. A triangular segment of the dorsal lateral vaginal wall is resected on both sides with the triangles based on dorsal midline. Then, the sides are sutured closed together. The vaginal wall resection should only leave enough room for embryo flushing equipment to be passed through the vagina. Cervicopexy may be performed transvaginal or transabdominal. Two sutures of No 3 vetafil are placed through the cervix (being careful not to penetrate the lumen of the cervix) and are anchored to the prepubic tendon (being careful not to entrap the bladder, urethra, or intestines). The animal should be rested for 30 days after surgery before insemination or breeding activity is resumed. I only recommend treatment of chronic vaginal prolapse when there is a history of chronic hormonal manipulation. Other vaginal prolapses have a high concern for heritability and these animals should be culled. If the animals is to be made a pet, I recommend ovariohysterectomy if vaginal prolapse is a persistent problem.

Perineal lacerations: Perineal laceration in small ruminants and cameldis is usually caused by excessive manipulation of a fetus during dystocia. Complete perineal lacerations occur during dystocia and most commonly affect primiparous animals. Surgical correction of perineal lacerations should not be attempted until the margins of the initial wound have granulated or healed (6 to 8 weeks). Failure to reconstruct the perineum may result in permanent infertility. Surgical closure of the defect is highly successful (71 % of cows with complete laceration and 75 % of cows with recto-vaginal fistula returned to breeding soundness after surgery). Reoccurrence of the laceration or fistula is a concern, but has not occurred in our experience. Perineal repair is done in a one-stage procedure with the animal standing and epidural anesthesia. I prefer to use No 2-0 PDS or No 3-0 monocryl in an interrupted circumferential suture pattern for repair. The animal should be rested for 30 to 45 days before attempting re-breeding.

Cesarean section in small ruminants

Occurrence of dystocia

Dystocia is relatively uncommon in sheep, goats, llamas, and alpacas with fewer than 5% of parturients requiring assistance. Parturition problem may be defined as failure of transition from stage I to stage II labor or when little to no progress is made for 30 minutes or more after the start of stage II labor. In goats, dystocia most often is caused by fetal malpositioning (up to 80 % of caudal presentations in single fetus pregnancies present with a hind limb flexed), fetal:maternal disproportion, multiple fetuses within the pelvic canal simultaneously, incomplete dilation of the cervix (ringwomb), uterine torsion, and uterine inertia. One study reported the use of radiography to examine 30 West African Dwarf Goats during dystocia. The most common fetal abnormality was bilateral forelimb flexion. The most common maternal abnormality was small pelvic dimension. Thirteen of 19 dead kids had radiographic evidence of intrauterine death.

In sheep, dystocia is most commonly associated with fetal malpositioning, fetal:maternal disproportion, ringwomb, and vaginal prolapse. In llamas and alpacas, the most common causes of dystocia are uterine torsion and fetal malpositioning. Hydrallantois may occur and has been reported in a 5 year old Suffolk ewe and a 5 year old Toggenburg doe. Ringwomb occasionally occurs in sheep and goats and refers to failure of cervical dilation. The cause is unknown but ringwomb occurs most commonly in primiparous females. Although manual dilation, estrogen and oxytocin therapy, and time may relieve this problem in some ewes and does, many females require C-section to deliver the fetuses. Cesarean section was performed in 3 Dromedary camels because of dystocia caused by schistosoma reflexus, uterine torsion, and fetal malposition.

Patient assessment

Patient assessment is critical to successful alleviation of dystocia. Cardiovascular shock must be treated prior to correction of dystocia. Females having clinical signs of dehydration, hypotension, and shock should have an IV catheter placed and crystalloid fluids administered (45 to 90 ml / kg body weight / hour). Non-steroidal anti-inflammatory drugs also may be used. Once supportive therapy has been initiated in the dam, the presentation, position, and posture of the fetus should be determined. If the size of the dam precludes evaluation of the uterus or fetus, then radiographs may be done to assess the fetus. However, immediate exploratory surgery and C-section may be a more prudent action.

Decision for non-surgical treatment: Dystocia may be relieved without surgery if the following criterion can be achieved: 1) the cervix is adequately dilated and the pelvis is of adequate size to extract the fetus, 2) the pelvic dimension allows introduction of a hand into the uterus for fetal manipulation, 3) the uterus has sufficient room to grasp and manipulate the fetus, or 4) sufficient room is available for fetotomy if the fetus is dead. If these criteria can not be met, the decision to perform a C-section should be made without delay.

Decision for surgical treatment: In dystocia, if the uterus or fetus is not accessible or the cervix is closed (e.g. ringwomb) immediate C-section is indicated. Damage to the cervix or uterus is more likely when trying to force manipulation of the fetus despite inadequate space or cervical dilation. If the size of the dam (e.g. pygmy or dwarf breeds) precludes transvaginal palpation, immediate C-section should be chosen. Delay in the decision to perform surgery may result in

fetal or maternal death. In my experience, uterine laceration is more likely to occur in goats, llamas, and alpacas compared with sheep or cattle.

Cesarean section (Hysterotomy)

Cesarean section may be performed via paralumbar fossa (left > right), low flank or ventrolateral incision (left > right), lateral oblique, paramedian incision (right > left), Marcenac's approach, or ventral midline laparotomy. The uterus should be exteriorized from the abdomen if possible. This is critical if extensive attempts at manual correction of dystocia have been tried or if the fetus is emphysematous. I routinely close the healthy uterus with No 0 PDS or Monocryl in a double layer closure. De Wit performed hysterotomies in 202 cows and compared hysterotomy closure with vicryl to that using 9 metric plain cat gut (n=99). There was no difference between these two suture materials and no adhesions were detected in 45 %, slight adhesions in 38 %, and severe adhesions in 18 % of cows. The uterus should be thoroughly lavaged clean of all blood clots prior to being replaced into the abdomen. I prefer to place an OB solution into the abdomen which is composed of 1 liter isotonic saline solution containing antibiotics (K-penicillin G 22,000 U/kg, Na-ampicillin 20 mg/kg, or Na-ceftiofur 1 mg/kg), anti-inflammatory drugs (flunixin 1 mg/kg), and anticoagulants (heparin 20 units/kg) and is infused into the abdomen immediately prior to closure of the incision. Carboxymethyl cellulose (CMC 14 ml/kg body weight, IP) has been evaluated and advocated for prophylaxis against post-operative adhesions. Post-operative adhesions after hysterotomy and CMC were similar to exploratory celiotomy without hysterotomy.

Uterine torsion: Uterine torsion in llamas and alpacas usually occurs near term gestation. Camelids may show signs of abdominal pain or may simply lay down and appear to be depressed. Most (~70 %) of uterine torsions in camelids may be corrected by rolling, but surgery is indicated if correction is not achieved with 2 attempts. Uterine torsion usually occurs at the termination of gestation (81 %) in cattle, does not have a clear age or season predisposition, and can often be corrected without surgery. Clinical signs included fever, tachycardia, tachypnea, anorexia, straining, and vaginal discharge. When the uterus can not be corrected by rolling (~7 %), when the cervix does not dilate sufficiently to deliver the fetus (~20 %), or when fetal proportion or anomalies prevent delivery of the fetus (~89 % of calves are larger than average), C-section is indicated. Uterine torsions have accounted for up to 41.5 % of does requiring C-section. These typically occur in does with a single kid. I prefer to perform left paralumbar fossa laparotomy regardless of the direction of the torsion (60 to 70 % are counter-clockwise in cattle). Although many authors advocate correcting the torsion prior to hysterotomy, I perform hysterotomy immediately upon exteriorization of the uterus. I have found that, in many cases, hysterotomy is more easily performed before correction of the uterus. Cow survival is expected to be fair to good (~78 %), calf survival is expected to be poor (24 % alive, 14 % emphysematous fetus), and retained placenta is common (57 %).

Post-operative care: Antibiotics and non-steroidal anti-inflammatory drugs are administered for 3 days after surgery. Therapy may be prolonged for 5 to 7 days if uterine laceration, abdominal contamination, or emphysematous fetus were present. Close attention should be paid to the cardiovascular stability of the dam and rectal temperature should be determined daily for 5 days

to monitor for the onset of peritonitis. Antimicrobial therapy should be directed against the most common bacteria resident in the normal post-partum uterus (Actinomyces pyogenes, E coli, Fusobacterium nucleatum, Proteus mirabilis, Bacteroides melanogenicus in one study where approximately 50 % of cows were culture positive) such as procaine penicillin G (22000 U/kg, IM or sc, q24hr), Na-ceftiofur (1 mg/kg, IM or sc, q24hr), or tetracycline (20 mg/kg, IM or sc, q24hr). For cattle perceived to be of high value, I also administer flunixin meglumine (1 mg/kg, IM or sc, q12hr) for 48 hours to limit adhesion formation.

Prognosis for return to breeding soundness: Cesarean section is one of the oldest and most common surgical procedures requested for veterinarians to perform. There are three main goals of the Cesarean section: 1) survival of the dam, 2) survival of the fetus, and 3) maintenance of fertility. Cattell et al reported on results of 133 C-sections in cattle. Approximately 91 % of the cows and 95 % of the calves that were alive at the start of surgery survived. Approximately 30 % of the cows suffered an illness (poor appetite, fever, metritis, diarrhea) after surgery. Only 22 beef and 24 dairy cows were re-bred after surgery. Calving to first service interval was 81 ± 29 days for dairy cows, calving to conception interval was 99 ± 18 days for beef cows and 110 ± 43 days for dairy cows, services per conception was 1.2 ± 0.4 for beef and 2.1 ± 1.4 for dairy cows, and pregnancy rate was 91 % for beef cows and 72 % for dairy cows. Dawson reported that approximately 78 % of cows were successfully re-bred. de Kruif et al reported the results of C-section in 128 cows and incisional infection was diagnosed in 15 % of cows; irrigation of the abdominal incision with 10 % povidone-iodine solution during closure of the wound failed to prevent Incisional infection. Success rates and complication of C-section in goats, sheep, llamas, and alpacas is limited. When C-section is performed early in dystocia and sterile technique is used, the re-breeding success rate is expected to be good.

Suggested references

Urolithiasis

Cuddeford D. Role of magnesium in the aetiology of ovine urolithiasis in fattening store lambs and intensively fattened lambs. Veterinary Record 1987;121:194-197.

Haven ML, Bowman KF, Engelbert TA, Blikslager AT. Surgical management of urolithiasis in small ruminants. Cornell Vet 1993;83:47-55.

Osborne CA, Sanna JJ, Unger LK, Clinton CW, Davenport MP. Analyzing the mineral composition of urolith from dogs, cats, horses, cattle, sheep, goats, and pigs. Veterinary Medicine 1989:750-764.

Poole DBR. Observations on the role of magnesium and phosphorus in the aetiology of urolithiasis in male sheep. Irish Veterinary Journal 1989:60-63.

Rakestraw PC, Fubini SL, Gilbert RO, Ward JO. Tube cystostomy for treatment of obstructive urolithiasis in small ruminants. Veterinary Surgery 1995;24:498-505.

Stewart SR, Emerick RJ, Pritchard RH. High dietary calcium to phosphorus ratio and alkali-forming potential as factors promoting silica urolithiasis in sheep. J Anim Sci 1990;68:498-503.

Stone WC, Bjorling DE, Trostle SS, Hanson PD, Markel MD. Prepubic urethrostomy for relief of urethral obstruction in a sheep and a goat. J Am Vet Med Assoc 1997;210:939-941.

Van Weeren PR, Klein WR, Voorhout G. Urolithiasis in small ruminants. I. A retrospective evaluation of urethrostomy. Vet Quarterly 1987;9:76-83.

Surgical procedure in the breeding female

Dreyfuss DJ, Tulleners EP, Donawick WJ, et al. Third-degree perineal lacerations and rectovestibular fistulae in cattle: 20 cases (1981-1988). JAVMA 1990;196:768-770.

Drost M, Savio JD, Barros CM, Badinga L, Thatcher WW. Ovariectomy by colpotomy in cows. JAVMA 1992;200:337-339.

Ellington JE, Schlafer DH. Uterine tube disease in cattle. JAVMA 1993;202:450-454.

Leder RR, Lane VM, Barrett DP. Ovariectomy as treatment for granulosa cell tumor in a heifer. JAVMA 1988;192:-1299-1300.

Pugh DG, Elmore RG. Granulosa cell tumor in a cow. Compend Contin Educ 1987;9:F327-330.

St-Jean G, Hull BL, Robertson JT, et al. Urethral extension for correction of urovagina in cattle: a review of 14 cases. Vet Surg 1988;17:258-262.

Cesarean section

Braun W. Parturition and Dystocia in the Goat. In: Youngquist, ed. Current Therapy in Large Animal Theriogenology. WB Saunders 1997:521-524.

Campbell ME, Fubini SL. Indications and surgical approaches for Cesarean section in cattle. Compend Contin Educat 1990;12:285-292.

Cattell JH, Dobson H. A survey of caesarean operations on cattle in general veterinary practice. Vet Rec 1990;127:395-399.
Dawson J. Caesarean section - a successful method. Cattle Practice 1993;1:386-390.
De Wit F, Raymakers, J Westerbeek, et al. Een onderzoek naar vergroeiingen van de uterus na het hechten van de uterus met catgut of vicryl bij de sectio caesarea van het rund. Tijdschr Diergeneeskd 1993;118:478-479.
Elias E. Left ventrolateral Cesarean section in three Dromedary camels (Camelus dromedarius). Vet Surg 1991;20:323-325.
Elmore RG. Focus on bovine reproductive disorders: diagnosing and treating uterine torsion. Vet Med 1993:170-173.
Frazer GS, Perkins NR, Constable PD. Bovine uterine torsion: 164 hospital referal cases. Theriogenology 1996;46:739-758.
Frazer GS. Uterine torsion followed by jejunal incarceration in a pewrtially everted urinary bladder of a cow. Austral Vet J ;65:24-25.
Johnson LW. Parturition in the llama. In: Youngquist, ed. Current Therapy in Large Animal Theriogenology. WB Saunders 1997:813-817.
Kene ROC. Radiographic investigation of dystocia in the West African Dwarf Goat. Br Vet J 1991:147:283-289.
de Kruif A, van den Brand LPM, van Kuyk MMFH, et al. Wondgenezing en wondspoeling bij de sctio caesarea van het und. Tijdschr Diergeneeskd 1987;112:990-993.
de Kruif A, Mijten P, Haesebrouck F, et al. Actinobacillosis in bovine caesarean section. Vet Rec 1992;131:414-415.
Manning J, Marsh P, Marshall F, et al. Bovine uterine torsion: a review illustrated by cases from the Western College of Veterinary Medicine Large Animal Clinic. Bov Practitioner 1982;17:94-98.
Menzies PI, Bailey D. Lambing management and neonatal care. In: Youngquist, ed. Current Therapy in Large Animal Theriogenology. WB Saunders 1997:628-638.
Milton A, Welker B, Modransky P. Hydrallantois in a ewe. JAVMA 1989:195:1385-1386.
Moll HD, Wolfe DF, Schumacher J, et al. Evaluation of sodium carboxymethylcellulose for prevention of adhesions after uterine trauma in ewes. AJVR 1992;53:1454-1456.
Morin DE, Hornbuckle T, Rowan LL, et al. Hydrallantois in a caprine doe. JAVMA 1994;204:108-111.
Noakes DE, Wallace L, Smith GR. Bacterial flora of uterus of cows after calving on two hygienically contrasting farms. Vet Rec 1991;128:440-442.
Noordsy JL. Selection of an incision site for Cesarean section in the cow. Vet Med 1979:530-537.
Parish SM, Tyler JW, Ginsky JV. Left oblique celiotomy approach for cesarean section inn standing cows. JAVMA 1995;207:751-752.
Risco CA, Reynolds JP. Uterine prolapse in dairy cattle. Compend Contin Educ 1988;10:1135-1142.
Ruegg PL. Uterine torsion of 720 in a midgestation cow. JAVMA 1988;192:207-208.
Wilson DG. Surgery of the genitalia of llamas. In: Youngquist, ed. Current Therapy in Large Animal Theriogenology. WB Saunders 1997:840-843.

Wolfe DF, Baird AN. Urogenital surgery in Goats. In: Youngquist, ed. Current Therapy in Large Animal Theriogenology. WB Saunders 1997:494-498.