Ruminants are large animals with similar bone structure to equine species. Long bone fractures are common in these species and the primary cause of fractures in these species is thought to be traumatic in origin. The decision to treat a fracture in ruminants is made by evaluating the severity, the cost, success rate and the economic value/genetic value of the animal after repair. Once a fracture is suspected, further traumatization to the fracture site should be prevented by stabilization of the fracture. Stabilization will prevent further trauma to the fracture itself as well as the surrounding soft tissue. Compromise to all these structures can have a significant impact on the success of the fracture repair and may change the way you are going to approach your fracture repair.

The basic principles of fracture healing are similar to other species such as equine species. Fracture healing is associated with factors associated with the fracture itself as well as patient factors. Fracture configuration, stability and presence of infection as well as age of animal, body condition, temperament, and pregnancy can influence the healing of a fracture. Therefore, the healing of any fracture can vary tremendously between animals. Fractures in young animals have a tendency to heal faster than fractures in older animals.

When selecting the type of fracture repair there are certain factors to keep in mind such as location and type of fracture, degree of soft tissue damage, patient temperament, budget and the experience of the veterinarian. For example, open fractures have a more guarded prognosis than closed fractures. In some patients, a successful treatment of the fracture is not possible due to severity of trauma or overwhelming contamination/infection of fracture site. In these cases, euthanasia of the patient or limb amputation might be considered.

The methods of repair can be divided into external fixation methods and coaptation methods and internal fixation techniques. External fixation/coaptation methods are casts, cast bandages, splints, transfaction pin casts and external skeletal fixators. Internal fracture fixation can be accomplished with intramedullary pins and cerclage wire, intramedullary interlocking nails and bone plates and screws.

Not all fracture configurations can be repaired with each technique. Plus, each of these techniques has its advantages and limitations. In some cases, a combination of techniques might be used for a successful outcome. External fixation methods can cause malalignment, delayed union and non-union of the fracture site. Intramedullary pins have been reported to be limited primarily to humeral and femoral bone fractures. Short oblique, transverse, comminuted or segmental fractures are also not candidates for this type of fracture repair. The intramedullary interlocking nail construct is best applied in femoral, tibial and humeral fractures. This technique most likely requires the most specialized surgical skill and equipment. Fracture repair with bone plates and screws is similar to the technique in other species. Whatever technique is used for fracture repair, once the fracture is healed the orthopedic implants typically do not need to be removed unless they cause lameness or other problems.

In conclusion, the choice of repair of fractures in ruminants depends on many factors; however, we feel that external fixation techniques are often an economical and sufficient way to stabilize fractures in ruminants. Internal fixation provides more stability and allows near perfect anatomical reconstruction of the bone, which favors healing with minimal complications.
Dairy practices perform fewer cesarean sections compared to beef practices where they are numerous and more frequently in late winter and early spring compared to all year round. The basic goal of a cesarean section is preservation of the dam and calf and ensure a future reproductive efficiency for the dam.

Cesarean section
Indication for c-section
The indications for c-sections can be divided into maternal reasons and fetal indications. The main maternal indication/reasons for a c-section are inadequate dilation of the cervix, abnormalities to the dam’s urogenital tract, immature heifer, uncorrected uterine torsion, uterine tear, hydrops, prepartum paralysis and elective c-section. Fetal indications that could require a c-section are disparity between the fetus and the pelvis, irreducible malpositions and pathologic fetal conditions.

Surgical procedure for c-section
A c-section can be carried out under field conditions as occurs in many large animal practices. Patient positioning and approach is decided by the veterinarian based on a number of factors, such as patient attitude, facilities available, conditions of the fetus (position, viability and such).

Surgical procedure
There is not one best approach to perform a c-section. A clinician chooses the best approach for the present circumstances and what they are comfortable with at that time.

The main option to choose from first is whether to perform the c-section standing or in recumbent position. If standing is elected, the left paralumbar fossa approach is the most common approach to perform a C-section. With this approach the intestines are retained by the rumen and the uterus is easily accessible. A right paralumbar fossa approach or a left oblique paralumbar approach have also been described.

A recumbent approach can be on ventral midline, paramedian, low flank or paramammary approach to the abdomen. The paramammary approach can be useful in dairy cows because it avoids the caudal epigastric veins ad the ventral edema. The midline approach requires the longest incision since the linea alba is very inflexible.

Also due to the dorsal recumbency the respiratory ability is reduced due to the fact of the heavy gravid uterus being pressed on to the diaphragm and aspiration of rumen content may be a concern.

The surgical technique for performing a c-section are well described. Some important things to remember are:

A small abdominal incision increases the level of difficulty in removing the fetus as well as increases the risk of subcutaneous emphysema. Therefore, it is important to make a large enough incision in the abdominal wall.

Breech of posterior presentations may require larger incision due to difficulty of exteriorizing the uterus. During ventral approaches the greater omentum has to be retracted cranially.

The incision in the uterus should be made along the greater curvature to avoid blood vessels and caruncles.

A small uterine incision increases the risk of uterine tears. The umbilical cord should be stretched and ruptured in a controlled fashion to allow contraction of the umbilical arteries.

Umbilical complications in calves are seen approx. in 30% of calves delivered by c-section.
Always check for a second calf and remove placenta only if it readily detaches from the caruncles.

The uterus can be closed in one or two layers. The abdominal wall can be closed in two to three layers.

Post-operative care
Antimicrobials are frequently given for prophylactic and therapeutic reasons, especially under field conditions. The most common organisms to be encountered during a c-section are susceptible to procaine penicillin G, oxytetracycline and ceftiofur sodium. Post-operative pain management is frequently done and the most familiar agent is flunixin meglumine. The appropriate milk and meat withdrawals need to be followed when giving any medications in cattle.

To help with the involution of the uterus and passage of the placenta oxytocin (10-20 IU) is administered.

Standing flank paralumbar incisions require far less postoperative care and attention compared to ventral approaches.

Complications
Development of complications have been reported and the list is extensive. The complications can be categorized into pre-operative, operative, post-operative and long term complications. More details will be discussed during the presentation.
Outcome

Important in the outcome after a c-section is the case selection. When a c-section is considered a last resort as a treatment option, a negative outcome is more likely. If a c-section is chosen early on in a dystocia case, the procedure might be more rewarding. The condition of the cow at the time of surgery is another major factor to determine outcome.

The overall pregnancy rate in dairy and beef cattle that had a c-section has been reported to range from 72%-91%. Beef cattle in general tolerate surgery better than dairy cattle and their outcomes are more likely better. The effect of a c-section on milk production is difficult to assess due to numerous confounding variables. In dairy cattle it is believed that lactation after a c-section to be reduced by 80-1500L compared with their previous lactation. The overall risk of being culled in dairy cattle is higher for cows which have undergone a c-section compared to control cows (cows with no c-section).
Field Anesthesia in Cattle

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Inhalation anesthesia is seldom feasible and economically justified in the field, so therefore injectable field anesthesia in different forms has been used extensively to perform surgical procedures in ruminants.

Pre-anesthetic preparation
Before a ruminant is anesthetized there are some considerations to keep in mind. A physical examination should always be performed before any surgical procedure, especially if anesthesia is involved. This examination helps to determine if the animal is suitable for field anesthesia and will help to reduce the complications.

The site of the surgery should also be carefully selected. The site should have good footing, free of hazards in all directions, calm environment and close to water, electricity or your vehicle if necessary.

Placing an intravenous catheter before anesthetizing an animal is advisable, but it might not always be possible or necessary depending on the procedure. The catheter will give you easy access to the vein during the procedure and will already be present in case complications are encountered.

Ruminants produce a significant amount of saliva when they are anesthetized. During field anesthesia certain reflexes such as eye and laryngeal reflexes are still present and care should be taken to position the head that saliva can run out of the mouth rather than pooling near the larynx.

Oxygen supplementation is generally not required in field anesthesia since the duration of the anesthesia is usually short-term. Eye protection and muscle /nerve protection are recommended. Eye protection can be performed by placing ophthalmic ointment in both eyes and in addition protecting the down eye with a towel or a thin pad. By paying attention to detail during the positioning of the animal before surgery, muscles and nerves are protected to reduce the risk of muscle or nerve damage.

Fasting of the animal before surgery is not always feasible either, especially in emergency situations. Withholding food for 12-24 hrs. and water for 12-24 hrs. in elective surgical procedures will decrease the severity of the tympany and therefore reduce the negative effects on the cardiorespiratory system. Withholding food does not greatly affect the volume of the rumen content in small ruminants but it is more appreciated in larger ruminants such as cattle. Therefore, it might be better to fast an animal in cattle if the procedure is an elective procedure to decrease the complication risk.

Endotracheal intubation is preferred if injectable anesthesia is maintained for longer than 10 minutes, especially if dorsal recumbency is necessary for the surgical procedure. Intubation will prevent aspiration of saliva and ruminal content.

Anesthesia methods

Local and regional anesthesia with/without sedation
Regional anesthesia with or without sedation is a popular and useful anesthetic method in ruminant practice. Regional anesthesia is low in cost and there is no need for extensive equipment. If no or minimal sedation is used, the cardiovascular and respiratory changes are minimal, the procedure can be performed in the standing animal so the risk for regurgitation and aspiration is low as well.

The simplest method for regional anesthesia is to infiltrate the surgical site with the anesthetic. This is effective for procedures in the superficial layers of the tissue; however less effective for procedures such as abdominal surgery which require anesthesia of the whole body wall. In these circumstances inverted L blocks and paravertebral blocks are preferred. Lidocaine 2% is the most commonly used anesthetic, but Mepivacaine 2% can also be used and has a longer lasting anesthesia. It is advised to not exceed 10 mg/kg body weight.

The most common drug used for sedation in ruminants is xylazine an α2 agonist. Other α2 agonists such as detomidine, medetomidine and romifidine are also used but to a lesser extent. These sedatives have analgesic as well as muscle relaxant properties, but an additional regional block is necessary to achieve full analgesic effect for a surgical procedure. When administering a α2 agonist, certain adverse effect can be noted depending on the dose of the sedation. Respiratory depression, hypercapnia, hypoxemia, bradycardia and increased urine production can be seen after administration of a α2 agonist in an animal. Therefore, extreme caution should be used in animals with preexisting cardiopulmonary disease, hypovolemia or urinary tract obstruction. Xylazine should also be avoided during the end of pregnancy in animals because xylazine has an oxytocin effect on the uterus and can cause abortions. Luckily the α2 agonist effects can be reversed; however, the analgesic effects will also be reversed at that time.

Other agents used for sedation, especially in young calves are the benzodiazepines such as diazepam and midazolam. They have mild sedative, muscle relaxant and anti-convulsive properties; however not any analgesic properties. Therefore, an additional regional block is important for the surgical procedure. The cardiorespiratory effects of benzodiazepines are minimal and transient. These sedatives are excellent to use in animals with cardiopulmonary disease or compromise.
Injectable anesthesia can be used for short-duration anesthesia and animals may be premedicated with drugs used for sedation in smaller doses. Ketamine is commonly used either by itself but more often in a combination with α2 agonists or benzodiazepines. The combination with a α2 agonist or benzodiazepine improves the muscle relaxation and sedation, plus facilitates the placement of an endotracheal tube if necessary. The choice of which specific combination of drugs to use depends on duration of anesthesia required for the procedure, the degree of the analgesia required and the physical condition of the animal. Adding a small dose of ketamine to a more traditional chemical restraint combination can greatly enhance the cooperation of an animal. This technique is also known as the “ketamine stun”.

Propofol can also be used to maintain injectable anesthesia. This drug is mainly used in calves and small ruminants for induction and maintenance of general anesthesia. This can be with a single dose (3-7mg/kg) for a 5-10-minute anesthesia or with a constant infusion to maintain a longer anesthesia (0.3-0.6 mg/kg/min). The advantage of propofol is that it is noncumulative and the recovery is rapid and smooth; however no analgesic effect is noted. Side effects that can be seen with propofol are respiratory and cardiovascular depression. Apneu is noted with rapid IV administration and hypoventilation, hypoxia and hypercapnea have been noted when anesthesia was maintained with propofol. Endotracheal intubation with supplemental oxygen is advisable when using propofol in injectable anesthesia conditions.

Guaiifenesin is not an anesthetic but is a centrally acting muscle relaxant with minimal cardiovascular and respiratory depression. It is not used alone in ruminants, but is used in a combination with ketamine (a double drip) or in a solution of xylazine, ketamine and guaifenesin. The latter is also referred to as a triple drip used for a constant rate infusion. The guaifenesin solution should be a 5% solution to avoid hemolysis and tissue necrosis in case of a perivascular injection.

Recovery period
Recovery of ruminants from surgical procedures in the field is usually uneventful. The animal should recover in a comfortable, dry and warm setting and preferable under supervision until most of the anesthetic is worn off. The duration of recovery depends on the type of drug used and the amounts that were used of that particular drug. If a procedure was performed in dorsal or lateral recumbency, the animal should be placed in sternal recumbency to avoid ruminal tympany and regurgitation during the recovery period. If an endotracheal tube was placed, it can be left in place until the coughing and swallowing reflexes are present.

In conclusion, anesthesia of ruminants in the field is frequently performed for routine small surgical procedures and with low risk with good preparatory work. If, however a complicated surgical procedure or a high-risk animal is considered, inhalation anesthesia in a clinic environment is preferable.
Teat injuries are common in dairy cattle. The injuries can be divided into external and internal injuries. These lesions can have greatly interfere with milk production and in some cases can compromise the production of the quarter or the whole gland. Therefore, it is important to treat these type of injuries appropriately and promptly. Teat injuries can be challenging to address; however in bovine practice this is a valuable service to offer to your clients.

**Diagnosis**

Diagnosis of a teat injuries when there is an external laceration is easy; however, for an internal injury some additional diagnostics might be of use. A step by step examination protocol can involve one or all of the following:

- Visual examination of the teat and description of the lesion if visible.
- Palpation of the gland and the individual teats.
- Insertion of a teat cannula if an obstruction is suspected internally in the teat.
- Milk cultures and sensitivity
- Additional imaging modalities such as ultrasound examination, radiography with and without contrast, theloscopy.

**Internal injuries of the teat**

**Atresia congenital or acquired**

Atresia is the obstruction of a duct or orifice. This can be present at birth (congenital) or acquired after an infection or traumatic incident. It may be present at the end of a teat, but could potentially extend into the gland itself. Treatment can be simple by opening up the skin with a needle or blade at the tip of the teat or may be more involved such as thelotomy.

**Fibrosis of furstenburg rosette**

Lesions in this are of the streak canal will result in a reduced milk flow. Depending if the fibrosis is associated with a tight streak canal, mucosal default or a total obstruction of the rosette, the diagnosis and treatment can be more or less complicated and challenging.

**Localized hemorrhage**

Self injury to the distal portion of the teat can cause damage to the vascular plexus in the teat. This damage will result in a local hematoma that can obstruct the outflow of milk while the teat appears swollen, painful and bruised. Conservative anti-inflammatory treatment should be started immediately together with a temporary dry period. After the acute inflammatory phase, the teat should be evaluated again and further treatment options such as partial teat amputation discussed.

**Fibrosis in the teat wall**

Fibrosis of the teat wall can be caused by previous trauma to the wall or from infection of a chronic nature. The cistern of the lumen can become so narrow that it is almost nonexistent. In these cases, contrast radiography can be extremely helpful. Surgical treatment is in most cases the treatment of choice. This can range from teat theloscopy to a vertical thelotomy depending of the extent of the fibrosis.

**External lacerations of the teat**

External lacerations are classified according to their duration, localization, conformation and thickness of the injury. It is important to take some time to make this evaluation since the prognosis of the injury is depended on this.

All teat lacerations are considered contaminated, so therefore cleaning of the injury is important. Before surgical repair a dose of antibiotics and pain medication is also recommended. Repair of teat laceration can be challenging, but with appropriate material/instruments and a good knowledge of the anatomy, practitioners can be very successful at it. During this presentation, we will discuss more in detail some of the aspects to keep in mind with these type of injuries to the teat.
The external umbilical cord consists of one vein, two arteries and one urachus. The umbilical vein joins the left portal vein and carries oxygenated blood during fetal life. The umbilical arteries originate from the internal iliac arteries and carry deoxygenated blood to the placenta. The urachus connects the fetal bladder to the allantoic sac, which contains diluted urine and other excretory products.

At birth, elongation of the cord breaks the umbilical cord and a stalk of 6-10 cm remains outside of the abdomen. A calf delivered by c-section has a shorter umbilical cord which could become a cause for complications. The umbilical cord shrivels in 3-4 days and should be totally gone by 3-4 weeks.

The umbilical vein becomes the round ligament of the liver. The paired umbilical arteries form the lateral or round ligaments of the bladder. The urachus atrophies and leaves no identifiable structure in later life.

**Conditions affecting the umbilicus**

**Hemorrhage**
Hemorrhage from the umbilicus can occur immediately after birth. It occurs more commonly after the cord is cut and tied than if it were allowed to contract naturally due to stretching.

**Patent urachus**
This condition is not something that is often seen in cattle. There may be a congenital or acquired condition. Animals with the congenital condition are clinically normal and the urachus failed to close at birth. Animals with an acquired form of patent urachus, the urachus opens up after a few days or weeks of age. This may be due to illness or improper care of the umbilical cord after birth.

**Umbilical hernia**
This condition may also be congenital or acquired as a result of an umbilical infection. Most of the hernias are notices days or weeks after birth. It is the most congenital defect in cattle and in Holstein cattle it may be hereditary.

Uncomplicated umbilical hernias should be differentiated from an umbilical infection on the basis of clinical signs. The hernia most commonly contains the omentum, followed by the abomasum, rumen and small intestine. In longstanding cases adhesions may develop between structures in the hernia sac and the sac itself. Strangulations occur rarely in cattle due to the fact that the cavity is blocked off by the omentum. Bovine hernias < 5cm can often be treated conservatively. Multiple conservative treatment options will be discussed during the presentation. Bovine hernias > 5cm should be repaired surgically under sedation with a local anesthetic or general anesthesia. The open and closed technique of herniorrhaphy will be discussed more in detail during this presentation.

**Umbilical abscess**
This condition is frequently a sequel to an omphalitis in calves. Improper care of the umbilicus after birth, environmental contamination or failure of passive transfer are considered predisposing factors. Calves are less likely to develop septicemia. Calf usually had an enlarged cord after birth and slowly a swelling developed that is large, warm and may or may not be painful. Diagnostics such as ultrasound may help to determine the nature of the swelling and its contents. Treatment is to lance the abscess and flush the cavity. Many animals with a defect in the body wall and extension of the abscess into the abdomen will develop a hernia.

**Infected umbilical remnants**
The history in calves is usually of an infected, draining umbilicus starting at 1-2 weeks of age. An enlarged external mass may develop over the following weeks as well. It is important to assess the whole animal with these conditions since the affected calves are often unthrifty and have other problems such as diarrhea, fever pneumonia or joint infections. A good physical examination and ultrasonographic examination are key elements in the diagnostic work-up. An ultrasound exam in 2 planes (transverse and longitudinal) can help identify the structures of the umbilical cord that are affected.

Surgical resection of the infected umbilical remnants under general anesthesia is strongly recommended. In young calves it may be attempted under sedation with local anesthetic and rope restraint; however, I would not recommend this since some of these surgeries can be quite involved and take longer than 1 hour. The majority of the calves undergoing surgery will be female because of economic considerations. During surgery there will be a rich blood supply since you are operating on inflamed tissue. The approach for the different structures as well as the marsupialization of the umbilical vein will be discussed in more detail during this presentation.