One Tough Cookie

Katie Zornow

Mississippi State University

College of Veterinary Medicine

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Advisor: Michael Pesato, DVM, DABVP (Food Animal Practice)

Introduction:

Coxofemoral luxation is the most commonly diagnosed lameness of the hip in cattle. Luxation of the coxofemoral joint usually occurs as a result of trauma. In adult cattle, this injury often occurs around parturition when the animal is weakened by metabolic, neurologic, or muscular abnormalities. It may also be seen in adult cattle that are mounted during estrus. In calves, coxofemoral luxation typically occurs with the application of excessive traction during a dystocia. Cattle with this injury most often present with a minimally weight-bearing lameness. While all injuries of the coxofemoral joint are considered serious in cattle, prompt treatment and diagnosis can significantly improve the animal's prognosis and return to function.

History and Presentation:

Cookie, a one-week-old Belted Galloway crossbred heifer, presented to the Mississippi State University College of Veterinary Medicine (MSU CVM) Food Animal Medicine and Surgery Service on December 10, 2020 after a round bale fell on her and she was attacked by a farm dog. Cookie was reported to be a previously healthy calf that was born to a first-calf heifer. Her dam did not have a dystocia, and both dam and calf had been doing well before that day. She was living on pasture with 27 head of cattle, and it was unknown how long Cookie had been trapped beneath the round bale before she was found; however, it was suspected to have fallen on her on the day of presentation.

Upon initial presentation to MSU CVM, Cookie was bright, alert, and responsive; however, she quickly became depressed and lethargic during the physical exam. She weighed 23kg and was in good body condition for a one-week-old calf. Rectal temperature was 103.2^{o}F. Her heart rate was mildly elevated at 150 beats per minute, and her respiratory rate was within normal limits at 32 breaths per minute. No heart murmurs or arrythmias were auscultated, and she had normal

bronchovesicular sounds upon auscultation of her lungs. Cookie's umbilicus was clean, dry, and free of any gross abnormalities. Abdominal ultrasound did not reveal any abnormalities. She was unable to stand on initial presentation, exhibiting pain, weakness, and decreased withdrawal reflexes in the right front and left rear limbs. Palpation of her left hip revealed a dorsally displaced greater trochanter relative to the tuber coxae and tuber ischii. The remainder of her physical exam was within normal limits.

Pathophysiology:

In cattle, coxofemoral luxation is most frequently a result of trauma. Coxofemoral joint stability is mainly dependent on the joint capsule, the ligament of the femoral head, and the massive muscle mass formed by the gluteal muscles and deep hip muscles.[4] The bovine hip has distinctive anatomic characteristics that predispose it to luxation including a small femoral head, a shallow acetabulum, the presence of notches at the acetabular ring margin, and minimal ligamentous attachments. [3, 4] As compared to other species, the ligament of the femoral head in cattle is smaller and less resistant to force and the accessory ligament is absent, making lateral motion more likely. [4] Given this anatomy, cattle primarily rely on muscle tone to maintain an intact coxofemoral joint.

In mature ruminants, coxofemoral luxation is often related to peripartum events—such as hypocalcemia and obturator nerve paralysis—or estrus behavior (i.e., being mounted).[4, 6] These conditions, especially in combination with slippery flooring, predispose these animals to go down with both hind legs abducted (also known as "splay"). Coxofemoral luxation may develop immediately after the initial trauma of the fall or while the animal struggles to stand.[4] In calves, coxofemoral luxation is typically a result of iatrogenic trauma during dystocia. This is seen in calves with caudal presentation combined with the application of excessive traction on the hind

limbs.[6] While the practice of using excessive force during dystocia should be addressed, it is arguably more valuable to decrease the incidence of dystocia.

Coxofemoral luxation is described by the position of the femoral head relative to the acetabulum. The four possible directions for luxation include craniodorsal, caudoventral, caudodorsal, and cranioventral. Craniodorsal luxation is by far the most common, accounting for 48-73% of bovine hip luxations.[2] Caudoventral luxation is the second most common at 23-53%.[2] A common comorbidity with this injury is femoral head and neck fractures, especially with caudoventral luxation.[3] This must be kept in consideration when managing a patient with suspected coxofemoral luxation.

Diagnostic Approach:

History and signalment are invaluable information when trying to diagnose a coxofemoral luxation. A high degree of suspicion should be held in animals with a history of splaying or a reported difficult extraction during a caudally presented dystocia. As with any lameness exam, the animal should first be observed at a distance. Patients with craniodorsal luxations are usually minimally weight bearing with a grade 4-5 out of 5 lameness, and those with caudoventral luxations are usually unable to rise. Cattle with craniodorsal coxofemoral luxations will stand with their stifle and digits rotated outwards and the hock rotated inwards.[4] The affected limb will appear shorter than the normal hind limb, and this contributes as a mechanical cause of their lameness. Cattle with caudoventral luxations, if able and willing to rise, will hold their limb in abduction, it will appear lengthened, and the greater trochanter will not be seen or able to be palpated.[2] Because their femoral head frequently luxates into the obturator foramen, they may be in extreme pain and will most likely be down.[2] Most cows affected with ventral luxation are presented down (68%-83%)—as compared with dorsal luxation (6-43%).[2]

Once the lameness is localized to a particular limb, the limb should be examined distally to proximally. After ruling out more common, distal causes of hindlimb lameness, the hip may be fully evaluated. Although it is not definitive, palpation of the greater trochanter, tuber coxae, and tuber ischii is the most straightforward way to diagnose coxofemoral luxation. The relative position of the greater trochanter to the other two bony landmarks should be determined while the animal is standing or in lateral recumbency. Ease of diagnosis is dependent on the size and amiability of the animal. Normal positioning of these landmarks will form a "triangle", with the tuber coxae and tuber ischii in line with one another and the greater trochanter located ventrally between them.[4] If these landmarks are aligned with one another, it is highly suggestive of coxofemoral luxation. If these landmarks are unidentifiable due to local soft tissue swelling or direction of the luxation, palpation per rectum may be attempted. This is most useful for the diagnosis of caudoventral luxations, as the femoral head can be palpated within the obturator foramen.[4]

While it is possible to further evaluate the hip with the animal standing, it is ideal to have them in lateral recumbency with the affected limb up. Depending upon the patient's demeanor, sedation or anesthesia may be necessary. The hip should be taken through its full range of motion, taking care to isolate movements to the joint that is being evaluated. If present, crepitus that is felt in association with coxofemoral luxation is described as a "soft" crepitus, as opposed to a "harsh" crepitus that is felt with a fracture.[3] Another useful diagnostic technique is to rotate the animal's leg while placing the hand or several fingers between the greater trochanter and tuber ischii. In a normal leg, this rotation will displace the hand or fingers. With luxation, the hand or fingers will force the greater trochanter to displace.[3]

Diagnostic imaging is required for definitive diagnosis. Radiographs should be performed to rule out fractures of the pelvis and the femoral head and neck. Ventrodorsal and lateral pelvic radiographs should be taken for this study. These will yield information regarding the direction of luxation, which is especially valuable for surgical planning. This can also aid in determination of prognosis as it relates to the luxation and any comorbid fractures. If indicated, repair of any identified fractures may be performed at the same time as surgical correction of the luxation. More recently, ultrasonography has been used as an independent or complimentary imaging modality. In one study, ultrasonography proved to be a simple and effective, non-invasive examination technique for the diagnosis of coxofemoral luxation.[6] This is particularly of value in adult cattle that are not amenable to high quality pelvic radiographic imaging and in follow-up imaging of post-operative hip patients. It can be performed without sedation, either standing or in lateral recumbency, and without putting strain on the injured joint, making it an ideal imaging modality in the bovine patient.

Treatment and Management:

In any animal with concurrent metabolic disturbances, namely the post-partum cow, it is important to address these medical needs before attempting to correct the coxofemoral luxation. Any animal that is too weak to stand is liable to fall again, and it will likely reinjure itself. Although it is beyond the scope of this paper, appropriate down-cow management should be performed to mitigate the risk of secondary conditions such as bloat and decubital ulcers. In young calves, it is especially important to address nutrition and dehydration.

Except in cases with concurrent fractures, closed reduction is always the first treatment attempted for coxofemoral luxation. It produces the best result when performed within 12-24 hours after the injury occurs, with success rates of 43-75% in dorsal luxations.[2] However, if the

luxation is not addressed until after 24 hours of occurrence, the probability of successful closed reduction is increasingly poor, and open reduction should be considered. This is exacerbated by the presence of joint capsule strands, blood, or soft tissue debris in the acetabulum that can hinder the ability of the femoral head to seat properly.[4] Additionally, soft tissue damage to the surrounding musculature and rupture of the joint capsule compromise the bovid's main stabilizers of the coxofemoral joint.

Closed reduction is performed with the animal in lateral recumbency with the affected limb uppermost. This procedure is most easily facilitated by sedation. In adult cattle, this process is performed with the use of ropes, however in calves, manual restraint and retraction may be feasible. In adults, a rope is placed around the limb at the level of the groin and then fixed to a solid object to stabilize the pelvis.[4] A second rope is tied to the distal metatarsal area. Then, "while traction is applied to the second rope, the femur is rotated by pushing down on the craniolateral aspect of the stifle and by lifting up on the hock".[4] An audible click is usually heard when reduction occurs. After reduction is believed to be obtained, the ropes are removed, and the leg is rotated through full range of motion to confirm reduction.[3] Recurrence of luxation is common following closed reduction. This can largely be attributed to the formation of a fibrin clot in the joint capsule, muscular damage, and entrapment of the labrum between the acetabulum and femoral head.[1]

In animals that fail closed reduction or have gone greater than 24 hours without treatment for a coxofemoral luxation, open reduction is the treatment of choice. The animal's positioning and the securing of ropes is performed in the same way as for closed reduction. The affected leg is routinely clipped, prepped, and draped. A craniolateral approach is used, and the skin incision is centered over the greater trochanter.[3] An incision is made through the fascia lata along the

cranial border of the biceps femoris.[3] A partial tenotomy of the vastus lateralis is often necessary to reach the joint capsule. Once access is gained, the acetabulum must be cleaned out of all fibrin, blood clots, and remnants of the round ligament.[3] With the acetabulum cleaned out and the femoral head located, traction—with or without rotation of the limb—is applied until reduction of the coxofemoral joint is achieved.[3] Reduction of caudoventral luxations is considerably more difficult than that of craniodorsal luxations. In cases of caudoventral luxation, use of a bone skid or a Steinmann pin inserted into the greater trochanter may facilitate elevation of the femoral head into the acetabulum.[3] Once reduced, the limb should be moved through a full range of motion. If it re-luxates, this indicates that debris is remaining in the acetabulum, and it must be addressed. Closure of the joint capsule is normally not possible in large animals, as it is usually shredded by the luxation. All muscles and fascial planes are apposed with absorbable suture in simple interrupted patterns, the skin is closed with nonabsorbable suture, and a stent bandage is placed.[3]

When definitive treatment has failed, femoral head ostectomy—a salvage procedure—can be considered. As with open reduction, a craniolateral approach is made, with the incision overlying the greater trochanter. As described by K. Squire, the incision is then extended through the superficial gluteal muscle to expose the ventral border of the middle gluteal muscle.[5] Retraction or partial incision of the middle gluteal muscle exposes the deep gluteal muscle. With the deep gluteal muscle exposed, it can then be partially incised to expose the dorsal portion of the coxofemoral joint capsule and the neck of the femur.[5] At this point, the head of the femur can be located and isolated for removal with an osteotome or obstetrical wire. The transected femoral neck must be smoothed and rounded with rongeurs or bone rasps. All debris, including blood clots, fibrin, and the ligament of the femoral head, should be removed from the acetabulum

before closure. As previously stated, it is unlikely that the joint capsule will be able to be closed due to the nature of this injury. However, when possible, it should be closed to provide padding between the femur and acetabulum. This is thought to improve patient comfort post-operatively. The incision may be routinely closed as previously described. As it heals, fibrocartilage forms between the femur and acetabulum, resulting in a pseudoarthrosis, which allows the animal to walk.

Post-procedural care is similar across all methods of treatment. Routine medical care including appropriate pain control should be provided, with antibiotics used as clinically indicated. To prevent abduction of the rear limbs during initial recovery, hobbles should be applied for approximately 1 week after closed or open reduction. The hobbles should allow the hindlimbs to spread no more than 18 inches apart.[3] This allows for locomotion while preventing significant abduction, which could result in re-luxation. Alternatively, for calves that underwent closed or open reduction, an Ehmer sling may be used. This causes the femur to be internally rotated, and it prevents weight-bearing immediately after reduction. The Ehmer sling promotes healing of the joint capsule, and it should be applied for 2-4 weeks after reduction.[2] Post-procedurally, these animals should be stall rested and bedded on deep straw or other flat, non-slip material for 8-12 weeks.[1,4] In patients that underwent femoral head ostectomy, return to function should be encouraged early in the recovery period. It is important to mitigate muscle atrophy and to promote formation of the pseudoarthrosis. In K. Squire's study, patients were exercised with light hand-walking, which was gradually increased to five-minute increments, as dictated by patient performance.

Case Outcome:

Cookie's left hip was reduced with manual traction and rotation at the time of presentation, on December 10, 2020, then hobbles were applied. She was able to stand and bear weight on the limb, and she could rise on her own. Unfortunately, Cookie's hobbles came off several times over the following 48 hours, and each time that her hobbles were found to be off, her left coxofemoral joint was noted to have re-luxated. Radiographs confirmed a craniodorsal luxation and ruled out any fractures. After three successful closed reductions, she re-luxated her left coxofemoral joint once again. Although it was able to be reduced a fourth and fifth time, it almost immediately re-luxated both times. At that point, surgery was discussed with her owners. Due to financial constraints, Cookie's owners elected to donate her to MSU CVM to facilitate her medical care.

Cookie underwent a femoral head ostectomy on December 15, 2020 without complication. She was maintained on flunixin meglumine, followed by meloxicam, and florfenicol. Although she had a moderate amount of swelling around her surgical site in the early post-operative period, a combination of time, non-steroidal anti-inflammatories, and cold packing helped the swelling to resolve quickly. Her incision healed well, and her sutures were removed approximately 14 days post-operatively. At a slow, controlled walk, Cookie willingly bore weight on her surgical limb as early as one day post-operatively. As time went on, she grew more confident on her surgical limb, and she tolerated a slow, steady increase in the duration of her walks. However, when she got excited and would start moving faster, she would switch to a "bunny hopping" gait, which is common in patients that have had a femoral head ostectomy.

It was elected to adapt a canine post-operative femoral head ostectomy rehabilitation program to suit Cookie. For the first 7 days post-operatively, her surgical site was cold packed for 10-15 minutes three times daily. Starting one day post-operatively, December 16, 2020, her physical

therapy regimen grew to include passive range of motion, massage, and 5 minutes of slow, controlled walking three times daily. Cookie was not halter-broken at the time that her physical rehabilitation program was started. However, after some habituation to the halter, she tolerated it well, which facilitated her slow, controlled walks. Starting eight days post-operatively, December 23, 2020, her regimen changed again. At that point, it grew to include heat packing for 10-15 minutes before exercise, followed by hip stretches, and "bicycle" exercises for 2-5 minutes; in addition to passive range of motion, massage, walking (increased to 7 minutes), and 10-15 minutes of cold packing at the end of each session. This routine was performed 2-3 times daily. Cookie tolerated these treatments well, however when she would become resistant to any of these treatments, she was given a break, and that exercise would be discontinued for the remainder of that treatment session.

Cookie was moved to an outdoor calf hutch on December 21, 2020, and her physical therapy sessions became weather-dependent for the sake of patient comfort. Additionally, her physical rehabilitation program was reduced to mainly walking at that point, because she was less inclined to remain recumbent outdoors, which was necessary for most of her exercises. On January 27, 2021, Cookie advanced from a calf hutch to a small pen of her own, marking the end of her stall rest period. It was elected to separate her from the bull and steer calves in the usual turn-out pen to protect her from being mounted while her limb was still healing. The duration of her walks continued to be slowly increased weekly, eventually ending at 30 minutes of controlled walking twice daily, incorporating walking on hills.

Cookie was very tolerant of her physical rehabilitation program which allowed an early return to function. She has continued to do exceptionally well since her surgery and completion of her rehabilitation regimen. Given a compliant patient, manual physical therapy techniques are a

viable and valuable option for large animal patients. Due to her femoral head ostectomy, Cookie's left hind limb is shorter than her right hind limb, and this contributes to a persistent mechanical lameness. However, Cookie is believed to be comfortable on her surgical limb, and she is reported to be doing very well ten months post-operatively at her new home, where she is kept as a pasture pet.

Conclusion:

Coxofemoral luxation in the bovine patient should be identified and treated promptly. Although open reduction is considered the treatment of choice, closed reduction is almost always attempted first. Femoral head ostectomy is a worthwhile salvage procedure in cattle that fail closed reduction. Although, after femoral head ostectomy these patients will likely have a characteristic lameness associated with their shortened limb and pseudoarthrosis, locomotion is uninhibited. In K. Squire's study, cattle that underwent femoral head ostectomy were found to be productive for 1 year or more after surgery.[5] These animals were able to breed, calve, and sustain lactation without reported complications.[5] While coxofemoral luxation may always be considered serious in the bovine patient, Cookie's case shows that pursuit of treatment is worthwhile.

References

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