Bowed Bumble

A Case of Angular Limb Deformity in a Goat

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Introduction

Angular limb deformity (ALD) is defined as a deviation of the limb axis in the frontal plane. It is characterized by either varus or valgus deformity. Varus is defined by movement of the distal portion of the limb medially to the origin of the limb. Valgus denotes the opposite, a deviation of the distal limb laterally to the origin. Varus and valgus can also be used to describe portions of the limb as compared to a joint. For example, a forelimb can have carpus valgus deviation in which the limb distal to the carpus joint has deviated laterally but the limb proximal to the carpus does not have any deformity.[1]

Angular limb deformities are well studied and documented in foals, camelids, and sheep, but are rare in young goats. Spider lamb syndrome is a hereditary limb deformity documented in Suffolk and Hampshire sheep breeds known as spider lamb syndrome.[2] Known causes of ALD in foals include malposition in utero, nutritional factors, and most commonly, physical trauma. Nutritional causes of limb deformities have not been well studied in the foal, but it is well understood that unbalanced mineral nutrition can affect bone growth and health.[4] In camelids, occurrence appears to be linked with low levels of Vitamin D causing rickets with carpus valgus ALD. Camelid ALD prevalence has decreased with vitamin D supplementation, though.[6]

Angular limb deformity can be caused by congenital, traumatic, or developmental etiologies. Congenital ALD is caused by incomplete carpal cuboidal bone ossification, uterine malpositioning, nutritional imbalance during gestation, or ingestion of teratogenic plants such as *Veratrum californicum* (Skunk cabbage). Developmental causes of ALD can be due to nutritional imbalances during growth such as an improper calcium to phosphorus ratio, and unbalanced copper, zinc, and molybdenum amounts in feed. A report of metacarpophalangeal

valgus and metatarsophalangeal varus deformities was reported in prepartum yearling associated with excessive calcium intake and carrying triplets to term.[2]

History and Presentation

Bumble, an 18-week-old Nigerian dwarf goat, presented to Mississippi State University College of Veterinary Medicine Animal Health Center's Food Animal Services on June 18, 2018 for evaluation of bowed legs. Bumble is primarily a pet goat purchased at a young age. When Bumble was born, he was separated from the dam. At that time, Bumble was fed colostrum for 24 hours, and then supplemented with milk replace. At birth, Bumble's legs were straight with slightly longer legs than his brother. At ten weeks old, the owner noticed Bumble had a wider stance in his forelimbs. His referring veterinarian recommended supplements of Selenium, copper, and calcium.

On presentation, Bumble was bright, alert and responsive. He weighed 8.6 kg, had a temperature of 102 degrees Fahrenheit, a heart rate of 72 beats per minute, and a respiratory rate of 26 breaths per minute. He had a body condition score of 2.5 out of 5. His mucous membranes were pink with a normal capillary refill time of less than two seconds. He had normal bowel movements and normal urination. His front limbs had obvious signs of carpal varus limb deformity with abducted elbows and underrun hooves bilaterally. He had a grade two lameness and was able to walk around at normal speeds. No heat or swelling was appreciated over any joint spaces. No abnormalities were seen in Bumble's hind limbs. The rest of Bumbles initial physical exam was within normal limits.

Diagnostic Approach

Diagnoses of angular limb deformities is based on appearance, clinical signs, radiographs, and pathology. Bumble was diagnosed based on appearance and clinical signs, but

the origin of the deformity was unknown. Radiographic geometric evaluation is the preferred technique for assessing angular limb deformities. This is accomplished by drawing 2 lines on the radiograph that bisect the long bones along their long axis. One line is drawn bisecting the proximal long bone and extending it distally beyond the joint. Then a line is drawn bisecting the distal long bone and extending it proximally to the same joint. In this case, the radius and 3rd metacarpal bone is used. If there is no deviation, these two lines should meet at the joint and should form an approximately straight line. If there is deviation, the point where these two lines meet and form an angle is the point of maximal deviation. This is the point causing the angular limb deformity. In some cases, it could be pointing to an abnormality in the cuboidal bones, or it could be pointing to an abnormal epiphysis. The angle between the 2 lines can also help characterize the severity and progression of deformity. [3]

Lateral and dorsopalmar radiographs were taken on Bumbles right and left forelimb. Using the techniques described, Bumbles left forelimb had a 19 degree angulation centered on the distal radial physis. His right forelimb had a 17 degree angulation also centered on the distal radial physis. Both sides had epiphyseal narrowing on the lateral side and widening on the medial sides. Periarticular osteophytes were also present along the dorso-medial aspects of the middle carpal joints of the right and left carpus.

These findings along with our history and physical exam confirmed angular limb deformity with moderate severity. Probable causes are likely nutritional abnormalities or previous physitis of the distal radial physis, and/or suspected traumatic origin.

Pathophysiology

Angular limb deformity is caused by a defect in bone growth plates or epiphysis. Through the growing phase of young animals, bones are continuously laying down new layers of

bone. In long bones, new bone growth occurs in the metaphysis. It contains a cartilaginous component called epiphyseal plate and the bony compartment around the plate. The two portions of bone work together to lay down new bone in a process called endochondral ossification. In endochondral ossification, the cartilaginous cells called chondrocytes, mature through several phases and secrete a scaffolding matrix. This matrix allows osteoblasts invasion through new blood vessels and deposit calcium in an organized manner making a lattice of calcified cartilage. This is the fragile, chondroosseus junction in the metaphysis. Any disruption of these new cells while the physis is still proliferative and growing can result in premature closure and arrested bone development.

In the case of angular limb deformity, one side of the metaphysis is affected causing an uneven growth rate, resulting from physitis or trauma. With physitis, the growth plate is invaded with inflammatory mediators and endochondral ossification is disrupted and delayed. Similarly, with trauma to the physis the chondrocytes can become crushed and delay growth in on area of the metaphysis.[5]

Treatment and Management

Angular limb deformities can be managed with conservative or surgical options. In neonates with clear signs of limb deformity conservative management with splinting and casting into a straightened conformation can be used with strict rest. This is to manipulate incompletely ossified cuboidal bones until the ossify into the fixed conformation, which may take 10 – 14 days.

Developmental ALD, if caught very early in the progression of disease, can also be treated with conservative treatment. With early physitis, exercise should be limited, any nutritional deficits or abnormalities should be corrected, and appropriate NSAIDs administered.

In ALD patients reaching the end of their growth period and/or not responding to conservative therapy, surgical therapy is the only option. For animals with closed physis, a surgical wedge osteotomy is necessary to correct the deformation.

Angular limb deformity patients with open physis have a few options for surgical intervention including: periosteal transection and elevation, transphyseal bridging, and single transphyseal screws.

Periosteal transection is appropriate when deformities are localized and there is enough physis for growth. This process results in removing tension across the growing physis by accelerating growth on the shorter side of the long bone. An incision is made proximal to the distal physis of the affected long bone and between the common digital extensor tendon and the lateral digital extensor tendon. A T-shaped incision is made through the periosteum with the horizontal portion two to three centimeters from the physis of the radius and the vertical portion extending two to three centimeters proximally. The horizontal portions should extend one-third of the circumference around the radius. The periosteum is gently lifted with periosteal elevators and a one-centimeter portion of periosteal tissue is removed with bone cutting forceps. The remaining periosteal tissue is laid down to prevent any abnormal bone growth, external tissues are closed routinely, and a bandaged is placed. If the deformity does not heal within 6-8 weeks, more surgical techniques like transphyseal bridging may be indicated.

Transphyseal bridging is used in more progressed cases of ALD. An incision is made on the convex portion of the affected limb and proximal and distal to the affected physis. Screws are placed parallel to the physis on either side and a surgical wire is connected in a figure eight fashion between the two screws. Tissues are again closed routinely. This case slows down growth of the more active side of the physis allowing the shorter side of the physis to “catch up.”

The disadvantage of this technique comes in when the leg is straightened, and the implant must be removed to prevent over correction.[2]

Lastly and similarly to transphyseal bridging, transphyseal screw technique works to use a cortical lag screw placed across the physis to slow the growth of the faster growing (convex) side. A small incision is made proximal to the physis of the affected long bone and a hole is drilled diagonally across the open physis. The screw is then placed in lag fashion cautiously avoiding entering the joint space. And the overlying tissue is closed normally.

Case Outcomes

Bumble's angular limb deformity had progressed beyond conservative options for treatment. However, Bumble is not a production goat and is planned on being a pet goat. Therefore, his owner opted for a more conservative form of surgical option.

Bumble was prepared for surgery on June 19, 2018. A Packed cell volume (PCV) and Total protein (TP) was measured as a minor preanesthetic work up. Packed cell volume was 32 % and TP was 7 g/dl which are both within normal limits. He was given 1 mg of butorphanol and 2.5 mg of midazolam both IV as preanesthetic drugs, given 100 mg of ketamine and 20 mg of propofol as anesthetic induction, and then maintained on isoflurane gas. He was placed in dorsal recumbency with both front limbs taped up in extension and aseptically prepped for surgery. An incision was made into the right leg over the radius two centimeters above the epiphysis and extended to the depth of the bone. A small hole was the pre-drilled through the epiphysis at an angle to cross the epiphysis on the lateral side. Radiographs were taken to assure the hole was drilled through the correct landmarks. Then a 28 mm length, 3.5 mm gauge non tapping bicortical bone screw was then hand screwed into place. Radiographs were taken again which confirmed correct screw placement. The incision was then flushed with 100 mL of saline and

then closed with 2-0 PDS in a cruciate pattern. This procedure was then repeated on the right leg with a 24 mm length 3.5 mm gauge screw. Sterile bandages were then placed and wrapped with vet wrap on both limbs.

Bumble recovered from surgery with no complications and was given 172 mg of florfenicol as a prevention of infection. He was also given 9.5 mg of flunixin meglumine for pain management. The longest meat withdrawal times of these two drugs is 38 days. Nonetheless, Bumble is not allowed to enter the food chain until his metal screw implants are removed. He was sent home the following day with instructions to be under strict rest for 1 month and to watch his legs for signs of straightening. He was also given five 15 mg meloxicam tablets with instructions to orally administer one half of a tablet once per day for three days, and then one half of a tablet every other day until gone. Oral meloxicam's withdrawal time is 45 days after the last dose of administration.[7]

Over the following next 6 months, Bumbles owner reported that his legs had slowly straightened, but never fully returned to normal. By 5 months post operation, Bumble was ambulating normally and jumping over obstacles. By 7 months post operation, his legs had not changed and stopped straightening. Bumble's owners elected to not return for a recheck examination at this time.

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