

Long bone fracture repair in an adult bull

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## **Introduction**

The “toughest sport of dirt” is not just tough for cowboys, but also the bovine athletes that give the sport of Professional Bull Riding its wow factor. Booming in fan following, the Professional Bull Riding organization boasts over 3 million followers -- ten times its 310,000 fans from 1995<sup>1</sup>. To support one of the fastest growing sports in America<sup>1</sup>, stock contractors are producing bucking bovine athletes who not only draw a crowd, but earn up to \$600,000 in a career, produce offspring selling for \$50-100 thousand each, and are valued upwards of \$2 million dollars<sup>2</sup>. As a result, bucking bull sports medicine and surgery has started to separate from the conventional husbandry of food animal production<sup>8</sup>.

Adult bovine long bone fractures typically warrant a death sentence due to economic burden, implant failure, and post-operative management of a typically non domesticated species. The challenges continue with limited drugs available for legal use in food animals<sup>3</sup>. Successful repairs of comminuted fractures in adult sized (>450kg) bovine are rare<sup>4, 5, 6, 7</sup>, and often do not represent the severity of fracture reported in this case. With 70% of disorders of performance age bucking bulls coming from musculoskeletal conditions<sup>8</sup>, a need presents itself to advance the conventional care of food animal sports medicine for the health of the American Bucking Bull.

## **History & Presentation**

A 6-year-old 550kg American Bucking Bull broke his leg in competition at a televised Professional Bull Riding event on January 11, 2020. Per the owner, the onsite veterinarian recommended euthanasia as the severity of the fracture appeared grave, and the supplies & facilities necessary to brace the limb were not available. Instead, the owner elected to pursue life saving measures, and the bull was loaded onto the trailer and hauled 16 hours to Mississippi State University College of Veterinary Medicine (MSU-CVM). The bull reportedly laid down

during the trailer ride. No medication was administered prior to arrival at MSU-CVM on January 12, 2020.

When the bull was off loaded from the trailer, he was non weight bearing on the right front forelimb. There was medial lateral pendulous deviation and a high degree of mobility distal to the carpus. On visual examination, no other abnormalities seemed present. The bull was Ketamine stunned (Butorphanol (0.025 mg/kg), Xylazine (0.1 mg/kg), Ketamine (0.5 mg/kg)), rope cast, and tied to allow for evaluation. There were no open wounds, the limb was warm, and digital pulses were present. A severe to marked amount of edema and hemorage could be seen below the skin. Radiographs were taken while stunned in left lateral.

### **Diagnostics / Considerations**

Radiographs revealed a closed proximal diaphyseal metaphyseal comminuted fracture of the bilateral metacarpals with fracture lines extending into the articular surface of the carpus. There was no displacement. Many large & small boney shards were scattered throughout the soft tissue surrounding the fractures. No gas tracks were visualized on radiographs. While still in an anesthetic plane, the bull was placed in a non-padded stockinette fiberglass cast extending approximately 15cm above the carpus to provide stabilization while owner communication and surgery were arranged. Given the complex nature of the multiple fractures, open reduction and internal fixation were recommended for life saving measures.

### **Diagnosis**

Closed proximal diaphyseal metaphyseal comminuted fracture of the bilateral metacarpals with fracture lines extending into the articular surface of the carpus.

## Pathophysiology

Metacarpal (or metatarsal) fractures are reported as a common cause (40-50%) of fractures in cattle of all ages<sup>9, 10</sup>. “Because of the large force necessary to cause the fracture, and the limited soft tissue supporting structures covering the bone, the fracture frequently is comminuted, and open fractures are not uncommon<sup>10</sup>.” While fractures of major long bones are not typically treated in adult cattle<sup>11</sup>, cattle make for excellent candidates due to their ability to easily laydown and rise, frequent daily resting & recumbency, rapid bone healing, tolerance of external structures, and a low rate of support limb breakdown<sup>12, 13</sup>.

As metacarpal injuries have a higher predilection for being comminuted, emergency triage to stabilize the wound and prevent a closed fracture from becoming open, is paramount; this step can make the difference between success and failure<sup>10, 12</sup>. Distal limb stabilization in large animals can be achieved with a Robert Jones bandage, fiberglass cast or any brace capable of withstanding the force exerted by an adult bovine. Inadequate placement of the stabilizing device securely above and below the affected fracture area may exacerbate the injury<sup>12</sup>.

Fractures of the axial skeleton may be treated in a variety of ways: stall rest, external coaptation – the most common – such as a splint, cast, and/or external fixation via medullary pin-cast, or internal fixation consisting of a series of plates and screws for direct bone apposition. Many factors contribute to the chosen treatment mechanism for fracture repair: soft tissue damage, vascular trauma, open or closed status, severity of the fracture, duration of injury, age and size of animal, demeanor of the patient, economic limitations of the owner, and expertise of the surgeon<sup>12, 13, 14, 16</sup>. External coaptation and/or fixation is often the most common treatment for metacarpal fractures as it is an economical and functional means of fracture stabilization. Additionally, it does not disrupt the bone stimulation proteins associated with fracture

hematomas<sup>12, 13</sup>. However, conservative treatment is not always possible. In the case of the reported patient, the severity of the fracture or obliteration of the metacarpal bones, duration of injury, age, size, and animal's demeanor, all served as negative prognostic indicators<sup>7, 12, 14, 16</sup>. The necessity for anatomic reduction of the fractures to prevent functional difficulties and complications, established the need for internal reduction, fixation, and external coaptation.

Internal fixation consists of manual reduction of the boney pieces to their most accurate anatomical position and then fixation with a series of plates and screws. Plating when compared to other reduction mechanisms provides the most rigid form of boney fixation<sup>15</sup>. Locking plate systems when compared to dynamic compression plates systems are superior in security, as they do not allow for secondary loss of reduction<sup>15</sup>. Dynamic compression systems rely on little to no movement between the bone pieces (patient compliance) and do not present as the superior mechanical choice. However, they do come with a far lesser economic burden when compared to locking screws/plates<sup>7</sup>. In larger and older adult cattle, it is if recommended after internal fixation of the metacarpal bones, temporary external coaptation such as a fiberglass cast be applied to: prevent edema, protect the incision site, and further stabilize the fracture during normal and increased weigh bearing<sup>7</sup>.

The owner in either treatment situation must have the space and finances committed to housing the animal alone in a small clean area and repeat cast changes for 3-6 months<sup>7</sup>. Adult cattle may take 8-10 weeks to demonstrate union between the fractured bones, and 12-16 weeks for clinical union, sufficient boney callus for normal weight bearing, to occur<sup>14</sup> under normal healing circumstances. The most common complications of fractures and fracture repair are related to the complications listed above and include: sepsis, nerve injury, vascular injury, incision site infection or dehiscence, sequestrum, fracture non-union, cast sores, osteopathic &

soft tissue pain, post traumatic osteoarthritis, and contralateral limb breakdown<sup>12, 14</sup>. Successful treatment of the fracture may not always be possible due to complications, animal compliance, or owner finances. In these instances, limb amputation or euthanasia must be considered<sup>12</sup>.

## **Treatment**

### Surgery

Surgery with internal fixation was elected for fracture reduction. The bull was premedicated with a Ketamine stun (Xylazine 0.07 mg/kg, Butorphanol 0.1 mg/kg and Ketamine 0.4mg/kg) and induced with Midazolam (0.06 mg/kg) and Ketamine (3 mg/kg). He was intubated, ventilated, and maintained on 5 L/minute of Oxygen and Sevoflurane gas. Intraoperatively he received a balanced crystalloid solution, intravenous Ketamine boluses as needed, three varying doses of Morphine (both intramuscular & intravenous) and intravenous Flunixin Meglumine (1.1 mg/kg).

The patient was routinely clipped, rough & sterilely prepped, and sterilely draped. A 30cm incision was made using a 10 blade over the lateral aspect of the leg from approximately 10cm above the carpus to the fetlock joint to fully expose the fracture. Multiple bone shards, pieces, and blood clots were removed. The bones were reduced using bone holding forceps and a lateral 5-hole plate was applied to the proximal lateral aspect of metacarpal four. The most proximal lateral palmar piece was stabilized with a single screw to the boney column. Lastly, an additional 5 hole was plate was applied distal to the lateral plate on the dorsal aspect of metacarpal three and four. The plates were anchored with self-tapping screws. The surgical area was lavaged with antibiotic saline. On the dorsal lateral proximal aspect of the bone between the plates where the boney fragments had been removed, an approximately 2cm by 2cm boney deficit was present; the space was filled with bone putty. The subcutaneous tissue was apposed

with 3 Vycril in a continuous pattern. The skin was closed with 3 Vycril in a Ford interlocking pattern. The leg placed in a padded fiberglass cast; methyl methacrylate was placed on the bottom of the cast.

The bull recovered in the Food Animal wing with no complications. That evening he was able to stand on the casted leg and began to ambulate. He was refed and started on Meloxicam (1.1 mg/kg) orally once daily until signs of discomfort resolved. The patient was also started on Florfenicol (40 mg/kg) every three days for 21 days (six doses).

#### *Postoperative Pain & Wound Management*

The bull began ambulating the evening after surgery with a grade 3/3 (beef lameness scoring) lameness score. The evening after surgery and the following morning, he was seen performing undesirable behavior at passersby which included limited hopping on his cast and head tossing. Despite his initial bright, albeit disgruntled, attitude, discomfort and bruxism were seen within the 24-hour post-operative period.

The bull's pain level appeared to increase over the next 3 days and Gabapentin (10mg/kg) was initiated. This medication did not immediately appear to alter the bull's comfort. He was still recorded as a 3/3 lameness with only intermittent weightbearing on the casted limb, and he appeared to hold the limb off the ground while standing. On January 18, 2020, 4 days post-op, the patient increased from moderately painful to severely painful as he no longer placed the limb completely under him while walking and begun vocalizing while laying down. He was treated with Butorphanol (0.05 mg/kg) twice daily and Acepromazine (100mg) orally once daily. On January 20, 2020, 8 days post-op, the bull's pain appeared to increase past the pain management

capacity of twice daily Butorphanol. The bull indicated pain by going off feed, decreased laying down, and increased vocalization. Additionally, his cast appeared to have loosened.

The next day, January 21, 2020, 9 days post-op the bull was Ketamine stunned for radiographic and physical evaluation of the surgical site. Radiographs showed the palmar lateral proximal bone piece with the single screw had become disassembled. The fragment appeared to have fractured in half, and the screw remained in the bone to which the piece had been affixed. The most proximal screw of the lateral plate showed mild communication with the metacarpal carpal joint. Medial lateral stabilization had been lost. There was still dorsal palmar fixation and stabilization; the hardware looked well opposed to the bone. The cast was removed. The internal bandage material was wet and fully saturated; removal of the bandage material revealed a diffusely bruised limb with a moderate amount of friable, malodorous, necrotic tissue over the entire surface of the limb. The ford interlocking suture pattern over the incision site was opposed, but the tissue was highly puckered between suture bites. The tension did not appear improved from closure 8 days prior. The leg was warm, and when scrubbed with chlorohexidine did appear to bleed on some of the sloughed surfaces. The limb was dried, covered with silver sulfadiazine cream, and Telfas were placed over the incision site. The leg was covered with stockinette, cast padding, and a non-padded fiberglass cast was placed. Possible concerns at this time included: necrosis of the leg tissue, sloughing of the distal limb, incision dehiscence, incision infection, implant infection, bone sequestrum, leg instability and breakdown, support limb breakdown, and systemic infection. Procaine Penicillin G was given intramuscularly for 3 days.

On January 24, 2020, 10 days post-op and 3 days post cast change & wound debridement, the bull's attitude appeared improved, but pain management remained difficult. The patient's



whining and vocalization, initially heard on January 18, 2020, had not subsided after his cast change & continued twice daily Butorphanol. A 15cm x 15cm area on the back of the bull's hump was clipped, scrubbed with chlorohexidine & alcohol, and left to air dry. A 100mcg (0.2mcg/kg) transdermal Fentanyl patch was applied to the prepared area and stapled into place. Butorphanol was discontinued; he remained on Meloxicam, Gabapentin, and Acepromazine. The transdermal Fentanyl patch appeared to provide adequate pain coverage in combination with the other medications as the patient was seen to have only mild pain signs, increased ambulation and quality of ambulation, and a decrease in vocalization over the next several days. The Fentanyl patch was changed every 3 days for 7 applications.

On January 28, 2020, Gabapentin was discontinued due to patient noncompliance. Meloxicam was decreased to every other day administration of January 31, 2020. Acepromazine was discontinued on February 3, 2020 after 2 successive weeks of adequate pain control. On February 4, 2020, 21 days post-op, and 14 days post cast change & wound debridement, the patient's demeanor appeared solum. He had decreased feed intake and appeared sorer as ambulation quality decreased from mild weight bearing to hopping. On February 6, 2020, 22 days post-op and 16 days post initial cast change, the bull was Ketamine stunned for a cast change and wound evaluation. The radiographs revealed fusing at the carpometacarpal joint, and some areas of bone were anticipated to not heal ideally. The skin and incision site appeared improved, and the sutures were removed. Upon recovery from anesthesia, the bull appeared to weight bear more comfortably in the new cast.

On February 12, 2020, 29 days post-op and 6 days post second cast change, the bull was seen using the limb while rising from recumbency, ambulating more efficiently, and weight shifting during eating. On February 14<sup>th</sup>, 2020, 31 days post-op, the Fentanyl patch was removed.

On February 24, 2020, 41 days post-op, the bull was walked between 2 stalls (approximately 30 feet) for the first time since arrival. He ambulated fairly well but appeared sore the following day. However, despite this, pain appeared to remain managed while only on Meloxicam.

The bull was discharged from MSU-CVM on February 27, 2020, 44 days post-op, after 45 days of hospitalization for stall rest at home.

### Patient Follow Up

On April 7, 2020, 84 days post-op, the bull returned for recheck. The patient was Ketamine stunned and the 8-week-old cast was removed. Radiographs showed a further fused metacarpocarpal joint. There was new bone formation throughout both aspects of the metacarpals where the hardware was. No sequestrums were present. On palpation, the limb was firm with minimal medial lateral instability. The incision appeared appropriately healed. A mildly ulcerative 8cm x 8cm cast sore was noted over the accessory carpal bone; it was not bleeding and had minimal discharge. A modified Robert Jones bandage was applied to the limb with Iodine impregnated salve covering the cast sore. The next day, April 08, 2020, the patient was deemed not comfortable enough in the bandage to be discharged. He was Ketamine stunned for casting. A short bandage cast was placed on the right forelimb with cast material extending from the foot, to fracture site, and up to the height of the accessory carpal bone where the cast sore resided; the upper limb was soft bandaged. The patient stood with no complications but did not bear weight on the limb. This behavior extended throughout the evening and the limb was observed to go into hyperextension at the carpus while extended and resting. The following day, April 9, 2020, radiographs revealed the top of the cast to be at the level of the most proximal aspect of the fracture, due to the fracture's articular involvement. The bone and hardware still appeared intact and unchanged from previous radiographs. On April 10, 2020, the patient was

again Ketamine stunned for a complete cast. A padded cast was placed on the limb with a 1cm firm felt pad over the ulcerated accessory carpal bone. Silver Sulfadiazine was placed on the ulcerated site, and the leg was cast approximately 20cm above the carpus. A wedge was placed on the heel of the hoof to increase surface area and reduce claw contracture. The bull was discharged to resume stall rest at home.

On June 2, 2020, 142 days post-op, the bull returned for recheck and 10 week cast evaluation. On admission he overall ambulated well despite the limitations of the cast. The cast had loosened and there was mild hyperextension at the level of the carpus. Radiographs showed callous formation occurring at the fracture site, but evidence of lysis and osteoporosis were present. The cast was bi-valved and a splint was applied to the limb. After application, there was substantial laxity in his flexor tendons. Ambulation was decreased from admission, but the patient appeared relatively comfortable. The bull was discharged to stall rest at home.

On July 8, 2020, the bull was admitted for recheck and 5-week splint removal. The next day, 176 days post-op, the splint was removed. On palpation, no instability was noted, however, severe laxity of the flexor tendons remained and causing abnormal weight bearing on the heel, upward turning of the claws, and increased hyperextension of the carpal joint. Radiographs showed new distal carpal joint arthritis and areas of lysis around the screws; it was noted the affected screws may need to be removed in the future. The bull remained in hospital for 14 days to observe his capacity to weight bear and ambulate. He was discharged on July 20, 2020 to stall rest at home, and permitted the freedom to graduate to increased turnout as he remained comfortable.

## **Prognosis**

The prognosis for the case was poor given the severity of injury, lack of triage prior to the patient's arrival at MSU-CVM, and demeanor of the bull. The owner's initial hopes and expectations of returning the bull to performance were quickly laid to rest once primary evaluation of the limb occurred. However, the aspiration to save his life at the time of discharge remained good. Utilization of the bull for live cover breeding still remains poor to fair.

## **Case Outcome**

At the time of this presentation, January 22, 2021, 374 days post-op, the metacarpal region has healed with only a mild to moderate of boney calculus grossly visible, and 95% of the hair has returned. The early posttraumatic fusion of the lower carpal joints, inability to provide physical therapy, long toe growth, and severe laxity of the flexor tendons began as a stiffened straight leg and has further progressed to a hyperextended carpal joint. The hyperextension is additionally perpetuated by the normal forces placed on it while walking. The bull reportedly has good ambulating days and bad, but overall remains happy in a small paddock inside the barn amongst his herd mates. It is the owner's aspiration that this summer the bull may progress to a larger dry turnout, and eventually a small pasture with first calf heifers for breeding. Should this not be attainable, the bull will be collected, and his semen used for artificial insemination.

The patient now lives an altered lifestyle, and his confirmation certainly no longer allows for performance as a bucking bull, but given the extreme nature of his injury, and the high possibility of failure, his recovery is nothing short of miraculous.

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