Contributions

New Hope for Repairing Broken Legs in Horses

Laurie McDuffee, DVM

In the past, a broken bone in an adult horse's leg often led to death by euthanasia because of the difficulty in stabilizing the bone and removing the weight carried by the animal to promote healing. The horse is an animal designed to flee from danger and by instinct, fights to avoid remaining in a recumbent position. A horse cannot support itself on three legs like a dog or cat because of its sheer size and weight. Removing the weight from one leg often causes laminitus (founder) in the opposite limb from the increased weight to bear and the subsequent changes in the blood supply to the foot.

Previous attempts to repair the bone have included casting, splints and more recently, bone plates with screws. These methods have met with limited success because of complications including bone and soft tissue infection and/or failure of the repair method (cast breaking, plates bending, etc.) The use of slings for assisted weight-bearing has also met with limited success because many horses do not tolerate the prolonged confinement necessary for orthopedic recovery. A sling designed for prolonged use is currently being developed at the University of California at Davis School of Veterinary Medicine, but it is still in the testing stages.

Because of the nature of the horse, the fracture repair method must be able to withstand very large loads, immediately after surgery so the horse can be mobile, and must withstand such loads for a long period of time while the fracture heals. The average healing time for long bone fractures in horses without complications is four to six months.

Advances in orthopedic surgery in human medicine over the last 10 years have included the development of a special metal alloy nail with interlocking screws called an interlocking intramedullary nail. This nail is used to stabilize severe fractures in long bones. As compared to plates and screws, casts, bed rest and traction, the interlocking nail has greatly improved the success rate of bone fracture repair in humans by reducing the incidence of infection and decreasing hospitalization times.

Studies conducted at other research organizations have successfully utilized the interlocking nail system for long bone fracture repairs in foals and calves. Adult horses, however, are more of a challenge because of their increased size and weight. Researchers from the University of California at Davis Equine Research Laboratory are evaluating the use of the interlocking intramedullary nail for fracture repair of long bones in adult horses.

The tibia of a horse is the long bone in the hind leg between the stifle and the hock. A tibial fracture may be fairly simple, where the bone is in two large fragments, or more complicated, where the bone is in many pieces. Tibial fractures can occur in any horse as a result of trauma (such as a kick from another horse or some kind of accidental collision). Incompletely healed stress fractures may be another cause in some racehorses. Stress fractures are caused by microfractures which arise when the rate of bone damage from fatigue exceeds the rate of bone tissue repair. Research from the racehorse necropsy program has shown that stress fractures can often result in catastrophic breakdowns.

There is little muscle or soft tissue covering the tibia, similar to a human's shin, which leaves it vulnerable to trauma injury. The lack of soft tissue also limits the blood supply to the bone which is essential for complete healing of fractures. These limitations contribute to the difficulty in repairing tibial fractures in adult horses and the poor prognosis for their survival.

The interlocking nail design offers little disruption of the soft tissue surrounding the bone because the nail is placed inside the bone through a small incision. When plates and screws are used, the tissues must be stripped from the bone

on two sides in order to attach the plates to the surfaces of the bone. The placement of the interlocking nail results in less tissue damage, a lower chance of infection and shorter surgical times as compared to plates and screws.

To test the strength of the interlocking nail system, an experiment was designed utilizing normal tibia bones from adult horses that died or were humanely destroyed for reasons not related to hindlimb lameness. A fracture was created in one tibia of each pair. The fractured tibia was then repaired with an interlocking nail and four screws. The nail that was used is the largest nail currently manufactured by orthopedic companies for human medicine called the Universal Femoral Nail by Synthes Limited in Paoli, Pennsylvania. This nail is currently used to repair fractures of human femurs (between the hip and knee). The length and diameter of this nail were compatible for equine tibias.

Each tibia was tested in a mechanical testing system (MTS) at the U.C. Davis Veterinary Orthopedic Research Laboratory. The MTS is a machine that has the ability to test the strength of large limbs and small samples under a wide range of circumstances (pushing, pulling, twisting, both separately and simultaneously) and can duplicate the gate of an animal. This is a powerful machine, both in its load capacities, and in the large variety of tests it is capable of conducting.

Previous studies by other research organizations have shown that the tibia, during normal locomotion, is subjected to various loading configurations including compression, bending and twisting. For this reason, the tibias were subjected to either compressive, bending or twisting loads in a single cycle. The single cycle represents a large load such as the load sustained when the horse stands up after surgery instead of multiple small loads such as walking around the stall daily. The average strength and stiffness of the repaired tibias were compared to the strength of the matching intact tibias from each pair. This information was also compared to previously reported loads that an adult horse is expected to place on its tibia during postoperative activities such as recovering from anesthesia, standing and walking.

Results indicated that a tibia repaired with the human interlocking nail system would most likely withstand the compressive and bending loads, but not the twisting loads sustained by a horse recovering from anesthesia. In cooperation with another human orthopediac company, Smith and Nephew Richards Incorporated in Memphis, Tennesse, ERL researchers are now designing an interlocking nail system specifically for adult equine tibias.

The nail has been modified by increasing the screw diameter and wall thickness and by removing the longitudinal slot.

Preliminary results have been very encouraging. The equine tibias that were repaired with the "Equestrian Nail" were significantly stronger than tibias repaired earlier with the human nail in all loading modes (compressive, bending and twisting) and have withstood the twisting load expected in a horse recovering from anesthesia. It appears that the tibias repaired with the "Equestrian Nail" will be able to withstand the immediate post-operative loads of the adult horse and the continuous cyclic loads that occur daily until the bone is healed. Depending on the horse's anticipated activities, the interlocking nail can be removed from an athletic horse or may remain in place in an inactive breeding horse or family pet.

The current rate of successful recovery for horses with tibial fractures is only about six percent. The "Equestrian Nail" offers promise to improve this success rate. Researchers expect to apply this repair method to more complicated shattered fractures which are not repairable with current techniques. The "Equestrian Nail" can also be adapted for use in other long bones which carry a poor prognosis for recovery such as the humerus (between the shoulder and elbow) and femur (between the stifle and hip) in adult horses. This repair method should be made available for live patients at the U.C. Davis Veterinary Medical Teaching Hospital in 1995. Research will continue using various long bones and the Mechanical Testing System to learn more about the mechanics of the interlocking nail in relation to the equine bone.

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Laurie McDuffee, DVM is a PhD student with the U.C. Davis School of Veterinary Medicine's Veterinary Orthopedic Research Laboratory in the department of Anatomy, Physiology and Cell Biology. For more information and photographs contact Laurie Fio (916) 752-4434