The troublesome trio in veterinary orthotics: carpal hyperextension, cranial cruciate deficiency, and achilles tendon injury

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Over the past decade there has been a tremendous increase in our understanding of physical fitness for both people and animals. We now know that optimal movement and mobility can significantly impact the physical and mental health of our patients. Common orthopedic injuries in the dog that frequently alter mobility include carpal hyperextension, cranial cruciate deficiency, and achilles tendon injury; these injuries are often managed surgically. Surgical patients may be managed with external co-aptation, which may lead to significant secondary complications. Additionally, for a variety of reasons, surgery may not be the ideal therapy. Reasons may include: injury severity does not dictate a surgical approach, financial constraints of the client, patient co-morbidities, use of immunosuppressive drugs, and high complication rate for a given procedure, among others. Some alternative is needed for these patients.

Canine rehabilitation has moved to the forefront of modern veterinary medicine with the advent of the American College of Veterinary Sports Medicine and Rehabilitation. With this new paradigm comes the idea that using mechanical appliances to improve the mobility and functionality of impaired patients is no longer the purview of human medicine alone and can significantly improve outcomes for surgical and nonsurgical patients. Canine rehabilitation techniques can be directly applied to the use of these devices (orthoses).

Orthoses (braces) are defined as any medical device attached to the body to support, align, position, immobilize, prevent or correct deformity, assist weak muscles, or control and improve function. They are not necessarily a replacement for surgery, but may be complementary. Orthoses can be utilized as pre, post, or non-surgical solutions. In cases where surgery must be delayed, they can provide interim support, protect a limb, and minimize disuse atrophy.

Carpal Hyperextension
Carpal hyperextension is a common injury in sporting dogs (e.g. flyball, agility, racing), geriatric dogs, and dogs prescribed corticosteroids. The level of hyperextension varies and may include: antebrachiocarpal (%), intercarpal (%), carpo metacarpal (%). Injury is primarily due to damage to the palmar fibrocartilage and to a lesser degree to weak or damaged carpal flexors. The latter can be noted when a patient develops more severe carpal hyperextension as measured with goniometry with continued exercise throughout the day (flexor fatigue).

Severe antebrachiocarpal hyperextension is traditionally managed with pan carpal arthrodesis. This can be a very effective procedure intended to limit pain, altered kinematics up the closed kinetic chain, and the consequences of limb length discrepancy (shortening of the affected limb relative to the contralateral limb). Complications associated with this surgery include implant breakage, implant infection, failure to fuse, and cast/splint related complications.
Distal carpal joint hyperextension may not require pan carpal arthrodesis. In these patients a partial arthrodesis may be sufficient. Complications associated with this surgery are similar to those for pan carpal arthrodesis.

The mechanical consequences of arthrodesis (e.g. reduced compliance and dynamism in gaiting) may be disadvantageous when managing a less severe carpal hyperextension. For example antebrachiocarpal hyperextension of less than 45 degrees from perpendicular to the floor means that the patient can potentially create an internal moment to partially resist the bending moment (carpal hyperextension) created by the ground reaction force. In these instances creating an “arthrodesis on demand,” that is to say, providing a device that allows flexion, but limits extension, may be ideal. The result is restricted range of motion of the carpus, but NOT elimination of carpal range of motion.

From a rehabilitation and biomechanical standpoint this may provide the best of both worlds: functional range of motion with protection against excessive range of motion.

**Cranial Cruciate Deficiency**
Cranial cruciate ligament injury is the most common orthopedic injury in the dog. Surgical stabilization is the traditional approach to managing this condition. However, the ideal treatment modality for cranial cruciate ligament (CrCL) injury has yet to be determined, leading to the development of a number of surgical techniques aimed at treating CrCL instability.

Importantly, each canine patient is different in: circumstance, health status, lifestyle, environment, family objectives and limitations, and so on. A “one-procedure fits all” approach can be a disservice to our clients. Careful attention to the needs of the patient and the family dictates that the practitioner consider whether surgery of any type is the most appropriate therapy.

In the past decade use of orthoses to limit the consequences of cranial cruciate ligament deficiency has become more common. There are as yet no controlled clinical studies to support or refute this technique. An orthosis must limit internal tibial rotation and cranial tibial thrust. Through the application of force coupling a properly designed and fitted custom orthosis should provide these limitations in those patients who are not surgical candidates. Fit is critical to success in these devices.

Use of an orthosis should be coupled with rehabilitation and a proactive approach to osteoarthritis management; this is the same recommendation provided for surgical patients.

**Achilles tendon injury**
Spontaneous rupture at the distal part of the gastrocnemius tendon (GT) is the second most common non-traumatic tendon injury in dogs. Surgical and nonsurgical management of this injury is described depending on the severity of injury. Classification is described by Meustege (grades I-III).

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<th>Grade</th>
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<tr>
<td>I</td>
<td>Complete tendon rupture resulting in plantigrade stance</td>
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<tr>
<td>Ila</td>
<td>Musculotendinous rupture resulting in increased flexion of the hock, inflammation at the musculotendinous junction</td>
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Grade IIb  Tendon rupture with paratenon intact resulting in increased flexion of the hock, tense paratenon palpable
Grade IIc  Gastrocnemius tendon avulsion from the calcaneus, with SDFT intact resulting in increased flexion of the hock and excessive flexion of the digits
Grade III  Tendinosis and/or peritendinitis resulting in normal stance, but a thickened Achilles tendon

Regardless of therapeutic approach (surgical or nonsurgical), optimum tendon healing requires strain in order to achieve maximum strength in healing. Numerous studies have shown that tendon repair is positively affected by exercise and, to a degree, adversely affected by immobilization. Even so casting, splinting, external fixators, and trans tibial screws have been the standard in veterinary patients.

Management of Achilles complex injuries has been studied to a greater extent in humans than in dogs; some general standards are reported including controlled activity, partial immobilization with hinged orthoses limiting dorsiflexion at the ankle, early weight bearing (within 2-4 weeks), and early physical therapy, all of which result in faster return to function and decreased disuse atrophy. The concept of functional bracing (orthosis) as an alternative to conservative treatment for ruptured Achilles tendon in humans allows immediate weight bearing and active plantar flexion, but limits adverse consequences of early dorsiflexion at the ankle. Limited dorsiflexion of the human ankle decreases strain by shortening the Achilles complex. Use of removable orthoses allows active exercise of the ankle and subtalar joints in a non-weight bearing environment to facilitate rehabilitation including joint and tendon mobility. This is not possible in a standard cast.

If we are to use management of human patients as a precedent, it can be argued that veterinary patients are more difficult to restrict with regard to activity. As such management of surgical or nonsurgical Achilles tendon injuries with immobilization may be justified as a means of protecting surgical repair and limiting further damage to the nonsurgical injury. The traditional approaches to immobilization of the tarsus post-surgical repair include: 1. transarticular external skeletal fixator, 2. calcaneal tibial screw, and 3. splint or full cast. Typically, this degree of immobilization is sustained for 3-8 weeks (surgeon preference). A 2006 study by Nielson and Pluhar found no difference in healing time between these techniques. Frequently, immobilization via splint or cast is preferred over implants due to implant complication rate and the additional expense associated with the latter.

On the other hand, cast/splint immobilization may be problematic: cast related complications have been reported at 63% by Meeson et al 2011, reduced dorsiflexion of the digits post splinting complicates return to normal function, and uncontrolled transition to loading in a soft bandages can contribute to recurrence of injury. With this in mind, the use of a removable, dynamic, double articulated, motion-limiting tarsal orthosis to facilitate healing of acute Achilles tendon injuries may be useful as an alternative to traditional casting techniques in surgical and non surgical cases.

Summary: 6 compelling reasons to consider use of custom orthosis to facilitate healing of Achilles tendon injury in dogs
  1. There is no evidence that “complete” immobilization prevents strain on the Achilles complex
2. There is no evidence that the traditional types of immobilization utilized positively alter outcome.

3. There is strong anecdotal evidence supported by a recent study that cast type immobilization leads to a high incidence of complications, which are clinically significant, painful, and expensive. The use of a removable device facilitates early detection and management of coaptation-related complications.

4. The precedent set in human Achilles complex injury is use of partial immobilization with early weight bearing and physical therapy.

5. Use of a removable orthosis facilitates rehabilitation including arthokinematics of the tarsal joint and osteokinematics of tarsal (limited initially), metatarsal phalangeal, and phalangeal joints.

6. Use of a removable orthosis facilitates functionality of the superficial digital flexor tendon:
   a. Prevent adhesion of SDF caused by immobilization and proximity to inflamed Achilles complex
   b. Regain functional length of the SDF using a dynamic hinging mechanism and rehabilitation

References available upon request.