Diagnostic ultrasound of the musculoskeletal system in both human and equine medicine has been a significant component of sports medicine and orthopedics for decades. With the development of higher resolution probes, diagnostic musculoskeletal ultrasound in small animals is becoming more common and a very, welcomed tool in the world of canine sports medicine, soft tissue injury and rehabilitation. In general diagnostic ultrasound can offer a quick, non-invasive way to diagnose soft tissue injuries and accessible way to monitor them during treatment and the rehabilitation process. Currently diagnostic ultrasound can also confirm that injuries are healed and determine the appropriate time to return to sport. Advantages of using ultrasound in the diagnosis and monitoring of treatment of small animal soft tissue injuries include the ability to visualize soft tissues and certain structures in dynamic form during movement, which may aid practitioners in their complete evaluation and ultimate decision on outcome of treatment and rehabilitation. In addition, most exams do not require anesthesia and it is offered at a lower cost than MRI, which allows for easy and more frequent/affordable rechecks. The ability to monitor musculoskeletal healing more closely offers the practitioner and therapist the ability to change programs to accommodate the precise stage of healing. Unfortunately, some disadvantages include a steep learning curve for the veterinary practitioner, the equipment can be expensive and the limited availability of adequately trained musculoskeletal ultrasound practitioners in general. This also reveals a drawback of all diagnostic ultrasound which is most ultrasound imaging is operator dependent in addition to acquiring and analyzing the images correctly. This emphasizes the importance of finding a veterinary practitioner that is experienced, in addition to being well trained, in the art of musculoskeletal ultrasound, well versed in orthopedics and sports medicine and preferably board certified in either radiology or the American college of veterinary sports medicine and rehabilitation.

In addition to using musculoskeletal ultrasound for scanning for tendon, ligament and muscle injuries, common orthopedic applications include aid in analyzing joints and uses as a guide in joint injections, identifying miscellaneous, sports related soft tissue problems, and ultrasound guided injections, often regenerative medicine (stem cell therapy and platelet rich plasma).

In numerous, older research projects, initial ultrasound studies used lower powered probes which provided unclear, hard to read images. Many of these used were 7.5 MHz linear transducer probes because of its flat application surface and its resolving power. Currently, higher resolution transducers between 10-20 Mhz linear probes are the most popular used. These are the same scanning probes used on our elite human athletes to pinpoint and diagnose their injuries in order to secure a proper treatment and rehabilitation plan.

Simple scanning principles are discussed during this lecture and include familiarity with the local anatomy, using the opposite limb as comparison for any questionable tissue changes or peculiarities and whenever possible obtaining radiographs to use in addition to ultrasound to aid in a final diagnosis.

Diagnostic ultrasound is valuable for assessing joint disease. Joint effusion, thickening of the joint capsule and cartilage defects can be identified sonographically. It is frequently possible in certain instances to detect bone destruction and inflammation around the bone. Instabilities of tendons and ligaments are, too, often recognized with the aid of a dynamic sonographic analysis. Partial or complete muscle or tendon tears can be distinctly and accurately identified and differentiated. Once the diagnosis is obtained, the appropriate treatment can be initiated. Then, the healing process can be monitored and rehabilitation exercises and activity can be adjusted accordingly. Instead of guessing and estimating tissue integrity, ultrasound gives a noninvasive look at the recovery process. This allows your veterinary practitioner to properly inform and advise your therapist to adjust the patient’s rehab program more accurately for the individual’s stage of healing.

Most injuries in the area of the shoulder, flexor carpi ulnaris, iliopsoas, stifte or the Achilles tendon can often be classified and differentiated by ultrasound. These injuries often include disruption of the tendon fibers, lesions within the tendon, older injuries with scar tissue or calcification, or active tendonitis. This capability to accurately identify the precise damage that has occurred, ultimately helps to determine to correct course of treatment and avoids the common misconception of “rest and NSAIDS” should fix the problem. Often times this type of “non-precise” treatment to soft tissues injuries only end up delaying the correct course of treatment and ultimately getting your athlete back to sport and competition.

Presently, the new and most effective soft tissue trauma treatment involves regenerative medicine and the ability to place this treatment directly into the damaged tissue. Regenerative medicine, such as stem cell therapy or platelet rich plasma, can be introduced via ultrasound-guided injection into the precise areas of need. It then can be followed for the appropriate healing indications such as reduction in swelling or thickening of tendons and ligaments, increased blood supply, increased normal tissue regeneration, and eventually resolution of the primary injury. In addition, prognosis and healing advancement can be reported and followed by
subsequent ultrasound scans. This data can ultimately help determine what percentage the patient has of successfully returning to function and sport.

**References**
Sports related injuries in the canine front limb, unfortunately, are quite common. Each joint has its share of common injuries. Of the most commonly seen shoulder issues; supraspinatus tendinopathy, infraspinatus contracture, teres minor tendinitis, bicipital tenosynovitis and injury to the medial shoulder compartment can be identified in all breeds and sports. In the elbow the most common issues seen are fragmented coronoid process (elbow dysplasia), jump down syndrome and cartilage defects. The carpus also is affected by sports related injuries including carpal hyperextension and flexor carpi ulnaris strains.

Initial rehabilitation exam and measurements
As with all initial exams, it is important to start with a thorough history including how injury occurred, sports played, general attitude and energy level of patient. Next is a complete patient examination in order to determine primary injury, secondary compensatory issues and gather as much objective information as possible in order to document their progress and improvement through the rehabilitation plan. Goniometric measurements and documentation of all joints, muscle mass record of all four limbs, radiographic illustration of status of injury if it applies and a list on secondary or compensatory issues needing to be addressed. These parameters should be re-measured at least every four weeks in order to monitor the progress of the patient in order to determine if they meet the parameters to move into the next phase of rehabilitation.

Overview of shoulder rehabilitation
Supraspinatus tendinopathy, infraspinatus myopathy, bicipital tenosynovitis and medial shoulder syndrome are all common sports related shoulder injuries usually related to repetitive type action and can be, at times, difficult to rehabilitate. Common secondary, compensatory issues noted along with shoulder injuries include contralateral limb muscle trigger points and carpal laxity, and generally scapula restrictions (especially with hobbles for medial shoulder syndrome (MSS), triceps trigger points, paraspinal tension and diagonal hind limb sartorius and hamstring stiffness.

Phase I usually lasts about four weeks in most shoulder conditions. Symbols of shoulder conditions seen at this time include restricted ROM, discomfort on ROM, direct palpations and static stretches of the muscle/tendon primarily involved. The patient often has a short strided gait in front including a reduced reach with the affected limb. Manual therapy in the acute phase includes passive range of motion (PROM) aiming to retaining the current ROM. Grade I and II joint mobilizations are allowed to help increase circulation, proprioception, neuromodulate pain and by stimulating type I and type II articular receptors. An exception to this rule is when medial shoulder syndrome (MSS) is present and has been corrected by radiofrequency (RF). ROM and joint mobilizations of the treated shoulder are prohibited until eight weeks post-operative to allow tissue to heal enough for manipulation. Hobbles can be removed in order to perform ROM on all other joints. Massage is used to aid in trigger point release and to primarily relieve secondary muscle tension.

Phase I modality therapy includes the use of cryotherapy for the first 72 hours post-surgery or injury. After inflammation is relieved, heat can be used to increase circulation or to heat up tissue prior to PROM. Cold laser is a very common modality used in shoulder injuries and is applied to the primary joints and muscles affected to reduce inflammation, stimulate cartilage synthesis, trigger points and support healing. When dealing with MSS any modality decreasing inflammation should be avoided on the treated shoulder. Inflammation is required to aid the tissue in its healing process when RF is used to treat MSS. Therefore modalities are contraindicated on RF treated shoulders for the first eight weeks. Therapeutic ultrasound is an excellent modality to treat tendon injuries. These modalities can be used weekly to twice weekly. In any type of injury, if regenerative medicine or stem cell therapy has been used, therapeutic ultrasound and electrical stimulation should be avoided until eight weeks post injection, including MSS.

Phase II or intermediate phase usually occurs between 4-7 weeks post op (8-11 weeks post op MSS). This phase initiates when the patient exhibits good range of motion with minimal pain or spasm of the affected limb. At this stage, especially if the patient has been receiving rehabilitation from the start, there should be less secondary issues noted and they should be more easily resolved, such as scapular restriction and contralateral limb biceps and triceps tension etc. Manual therapy is similar to phase I except we can add in greater extents to our PROM and grade III joint mobilizations to stretch the capsular tissue and approach end range. Lower grade joint mobilizations and gentle PROM is now initiated in MSS shoulders treated with RF.

Cold laser can be used throughout the rehabilitation process and is a key utility in healing and maintaining the rest of the patient through its healing process. Weekly to twice weekly cold laser is now introduced to MSS shoulders that have received RF, to help resolve any residual inflammation. During this second phase, if the patient has improved and has met its criteria, weaning off the therapeutic ultrasound is suggested, otherwise they would stay with phase I regime. If therapeutic ultrasound does not appear to be improving this condition, shock wave or surgery should be considered at this time. On the other hand if the case is challenging due to inflammation such as bicipital tenosynovitis and we are not seeing significant improvement, phonophoresis with dexamethasone and...
lidocaine can be used. Pulsed electromagnetic field has also show to have good overall healing qualities but in general modality and manual treatment can be reduced to weekly.

Increased leash walks and intensity can be increased, usually following a guideline of five minutes every 3-5 days. The owner should only increase the walks if the patient is not showing any lameness at the end of the walk and does not show any restriction or discomfort on ROM. Running, jumping, playing or plyometrics should not be allowed. Hydrotherapy often begins during this phase and should begin at two weeks post absence of any muscle spasm and general resolution of lameness. Again due to the slow, intense rehabilitation program for MSS patients, all hydrotherapy is restricted until hobbles are removed completely, usually occurring at 12+ weeks post-operative.

Phase III or advanced strengthening phase for the shoulder occurs between week 7 and 11 (week 12-16 for MSS). This phase initiates there is full ROM and no spasm of discomfort on ROM or direct palpation of the primary injury. The patient should have a normal gait at this time and approaching a full weight normal stance. Muscle mass needs to be at least 70% of the contralateral limb. If these criteria are met, then hobbles can be removed from MSS patients.

Manual and modality therapy at this time is focused more towards maintaining what has been accomplished thus far. Frequency can be decreased to every other week and often is replaced by an increase in hydrotherapy. Hydrotherapy is a key tool during this phase to help strengthen and prepare for the next phase. Increasing speed, time and lowering the water height in the underwater treadmill all can increase the intensity and aid in restoring normal gait animation. MSS patients begin underwater treadmill therapy at this time. If there are no complications then swimming can be introduced in the next 2-3 weeks.

Phase IV in shoulder rehabilitation therapy is the return to activity phase. In most cases this occurs after 12 weeks of controlled rehabilitation but in the case of MSS this is usually delayed until 16 weeks post-operative. In any case, this phase initiates when the patient has full or accepted range of motion of the shoulder with no abnormalities noted on direct palpation or full stretching of the shoulder components. There should be a normal gait with no evidence of lameness and equal muscle mass of the front limbs.

Therapeutic exercise at this stage is used to address any lingering deficiencies or to continue to support any inherent insufficiencies known to the patient such as lack of core strength, etc. Exercise restrictions are gradually uplifted and the owner/therapist should reintroduce free running over a two week period of time. Once this is accomplished sport specific retraining can be started. Hydrotherapy can be continued as a method of conditioning or ongoing strengthening.

Overview of elbow rehabilitation
One common sport related injury to the elbow is traumatic fragmented medial coronoid process or “jump down syndrome”. Yet other elbow issues including elbow dysplasia (fragmented coronoid process, un-united aconeal process, OCD, etc) affect many of our sporting breeds. Surgery is required for proper resolution of all of these conditions and the postoperative rehabilitation program follows similar guidelines. Unfortunately elbows are the most unforgiving joints in the canine patient. Therefore an active rehabilitation program is most important in trying to give these patients every opportunity to return to function. Phase I in elbow conditions usually incorporates the first four weeks post-operative. Physical exam findings in this stage include reduced ROM especially elbow flexion. Discomfort is usually seen on end range flexion. The gait is usually very stiff, with circumduction of the affected elbow and significant lameness.

Acute phase manual therapy includes PROM and stretching to retain current ROM and to aid in reducing secondary compensatory issues seen in the shoulder. Grade I-II joint mobilizations are highly recommended to stimulate healing within the affected elbow. Deep massage is needed to treat trigger points seen in triceps and other secondary compensatory issues such as hind limb and paraspinal stiffness seen from the change in posture and gait.

Phase I modality therapy focuses on cryotherapy to reduce inflammation in the elbow and soft tissues and cold laser therapy to stimulate cartilage synthesis and reduce elbow effusion. Pulsed magnetic field can also be added in to promote healing and these modalities can be performed once to twice weekly depending on post op status of patient.

Phase II or intermediate phase usually occurs between 4-8 weeks post-operative. This phase usually initiates when there is full range of motion but elbows typically take longer to regain this and sometimes have long term remaining restrictions, especially in flexion. There should be less sensitivity on end range flexion, minimal muscle spasm, and reduced limb circumduction and more elongated stride. Elbow effusion should also be reduced to enter this phase but some patients tend to retain a moderate amount of effusion through to phase II-IV. As long as lameness is decreasing and there is increased weight bearing at the stance, this effusion should not prevent moving into phase II.

Phase II manual therapy should be increased to aid in restoring full range of motion. Joint mobilizations are increased to stretch capsular tissue at end range in order to reduce and prevent range of motion restrictions. Modality therapy is adjusted in frequency dependent on effusion, lameness and ROM.

Phase III usually transpires 7-11 weeks post-surgery. Typically the parameters to move into this phase include full range of motion, no discomfort on end range elbow flexion, no effusion, normal gait, approaching normal stance and 70% muscle mass improvement.
Phase III manual therapy is primarily used to maintain improvements and address any issues noted with increased activity. Trans electrical neuromuscular stimulation (TENS) can be added in at this time if significant effusion is still present. Microcurrent can also be used during massage and joint manipulations to decrease effusion and aid in pain management. These electrical modalities should be avoided until eight weeks post injection if stem cell therapy was used. Hydrotherapy, specifically underwater treadmill, is introduced at this time. Speed and time usually start slow but increase quickly with water level at shoulder to reduce impact on the elbow. Swimming should still be avoided due to the high intensity of forelimb work.

Phase IV, return to function, usually occurs 12+ weeks post op in elbow cases. Depending on the degree of initial cartilage defect (grade III-IV), this may be delayed or additional therapies, such as intra-articular steroid injections, may be needed to get the patient comfortably to this stage. Returning to function should be dependent on equal and good muscle mass in front limbs, no discomfort on ROM or direct palpation, minimal lameness and normal stance.

Overview of carpal rehabilitation

Carpal injuries usually involve flexor carpi ulnaris strains or chronic carpal breakdown due to weakening of flexor tendons and ligaments. Severe cases often lead to carpal fusion, which makes it very difficult to return to sport due to biomechanical changes. This section will just discuss carpal strains and sprains since they carry the best probability to return to sport.

Most carpal injuries involve some form of immobilization such as neoprene carpal wrap, +/- rigid thermoplast, depending on extent of injury. This causes increased secondary/compensatory changes due to the temporary change in biomechanics of the forelimb. It is important to monitor and treat these as they are found to avoid additional injury to the other aspects of the forelimb.

Phase I in carpal injuries usually last about four weeks but can be longer dependent on the extent of the tendon ligament injury and will be prolonged if regenerative medicine is used. They are usually placed in a supportive wrap, inducing a more upright stance with more rigid support as the grade of the injury increases. Moderate swelling of the carpal area and tendons is usually noted. Acute phase manual therapy is similar to the sections described above but end range carpal extension should be avoided as to not affect the tissue healing. Since these patients are usually in a significant brace, focusing on restoring carpal flexion is imperative. Modality therapy includes cryotherapy, preferable with compression, in order to acutely reduce inflammation and joint effusion. Cold laser stimulates collagen synthesis and is the modality of choice in the acute phase.

Phase II starts usually between 5-8 weeks post injury and initiates when there is decreased inflammation and healing is evident by a decreased extension goniometric measurements. Dynamizing the brace to a more correct standing angle and eventually removing rigid support occurs at the end of this phase. Manual therapy proceeds to increasing range of motion during PROM with the brace off. Therapeutic ultrasound in a pulsed setting can be introduced to aid in healing tendons, in addition to cold laser. If regenerative medicine was used, this cannot be used until eight weeks post injection.

Phase III initiates when there is no swelling or inflammation, absence of discomfort on full ROM or direct palpation of carpus or tendons, approaching normal stance angle and increased muscle mass of affected limb. Modalities are used when necessary to combat any resilient inflammation or issues arising with increased controlled exercises.

Phase IV, returning to function, is mainly determined by the degree of initial injury and rehabilitation and healing process. This can occur in as little as 12 weeks post injury (normal tendon healing time) or may take 16+ weeks to reach enough stability to train with a brace and perform without one exclusive of significant negative impact. Any activity should first be introduced with the light neoprene brace on and then weaned off. Swimming is also an excellent way to strengthen the carpal flexors without weight bearing.

References


Sports related injuries in the canine hind limb, unfortunately, are quite common. Each joint has its share of common injuries. Physical rehabilitation has become increasingly essential in providing the best opportunities for our dogs to recover from orthopedic surgery, soft tissue injuries, and overcome the pain and immobility that arthritis causes. The common hind limb conditions that will be covered are iliopsoas strains, stifle injuries, Achilles tendon issues, and hip osteoarthritis. Information on the iliopsoas and stifle will be covered in this text.

**Iliopsoas**

Acute, stretch induced muscle injuries are estimated to account for over 30% of injuries seen in a typical human sports medicine practice and have been reported to be the most common injury seen in human general practices. Until recently, however, acute muscle injuries were rarely reported in the small animal veterinary literature, and most discussion of chronic muscle disorders in dogs continues to be limited to a handful of classical syndromes or inflammatory conditions. Given the similarities between the human and canine musculoskeletal system, it’s not hard to see why common injuries in humans would not also be common in the canines. More likely, the low reported prevalence of muscle injury in dogs is actually due to a failure to diagnose the condition.

Hips with iliopsoas strains commonly have a history of limping in one of their back legs that worsens with activity. These dogs are often reluctant to jump on to furniture or into the car. When examining a dog with this injury, we can detect pain and spasm in the affected muscle. We may also find pain and spasm when stretching the muscle by either placing the hip in extension, by moving the limb out to the side, or by simultaneous extension of the hip with internal rotation of the hind limb.

While X-rays are of little value in the early phase of the strain, they can sometimes reveal mineralization in chronic cases. The use of advanced imaging techniques to identify lesions of the affected muscle and/or tendon can increase confidence in a veterinarian’s diagnosis. Ultrasonography is a relatively inexpensive, non-invasive imaging modality for canine orthopedic evaluation with the additional advantage that general anesthesia is not required. This imaging modality is particularly dependent on the expertise of the operator, which may limit the ability to get a definitive diagnosis.

Acute iliopsoas strains should be treated conservatively. Muscle relaxants may be prescribed in severe cases to reduce pain and muscle spasms. Medical management may also include non-steroidal anti-inflammatory drugs (NSAIDs), laser therapy (ice therapy) and restricted or controlled activity. Fortunately, rehabilitation therapy can be very effective in treating iliopsoas strains. Treatments may include cold laser therapy to increase circulation, remove waste products and promote healing. Pain-free passive ranges of motion and home exercises are also recommended. Active range of motion exercises, transelectrical neurostimulation (TENS), stabilization exercises, and gradual increases in weight bearing activities are usually prescribed. Active range of motion and strengthening exercises are added later in the healing process. Strengthening exercises might include three legged standing, para-standing (lifting both the front and hind limbs simultaneously while the dog balances on the other two limbs), paws on the counter, and the use of a wobble board. Like in humans, acupuncture may also be helpful to assist with pain control and to promote healing.

The risk of re-injuring a previously strained muscle is well established in human patients when a previous minor injury often predates a major strain injury. The risk of more significant strain is increased when pre-existing strain injury has not completely healed. This also appears to be the case in canine patients, in whom pain from iliopsoas strain injuries may recur.

**Cranial cruciate ligament (CCL)**

Rupture of the cranial cruciate ligament (CCL) is the most common orthopedic injury and cause of lameness in dogs. Partial or complete CCL disruption causes stifle joint instability, leading to a cascade of inflammatory and pathologic changes resulting in synovitis, osteoarthritis, meniscal injury, and altered stifle kinematics.

Caudocranial and mediolateral radiographs are used to stage any associated osteoarthritis, lend support to a cranial cruciate ligament pathology diagnosis, and screen for complicating or coincident pathology. If these tests alone are not completely diagnostic, MRI or arthroscopic evaluation of the joint and structures may be recommended. Unlike radiography, MRI allows visualization of the
CCL and meniscus, so it may be used to detect more subtle pathology. Arthroscopy of the stifle may be used not only as a diagnostic test, but also therapeutic tool.

Indications for conservative treatment of CCL injuries can be established for grade I or II sprains (partial tears). While it may be possible to rehabilitate grade I sprains back to full function, there is a great likelihood that a partial tear may progress to full grade III sprain (complete tears) over time. For dogs with early mild partial tears, strategies are focused on controlling the effects of inflammation (pain, effusion, loss of motion, and muscle atrophy). Ice, laser therapy, TENS and non-steroidal anti-inflammatory drugs (NSAIDs) can assist in counteracting the effects of inflammation. Rehabilitation therapy for early partial tears may include various techniques for strengthening of the hamstrings and quadriceps muscles, including isometric, isotonic, isokinetic and eccentric exercises, once pain and inflammation are relieved.

For dogs with grade III sprains (complete CCL tears) who are not candidates for surgical intervention due to significant concurrent medial conditions, advanced age, or owner financial constraints, long-term success has been obtained with the use of a custom stifle brace created by a certified orthotist.

Surgically stabilizing the stifle is indicated in most patients with cranial cruciate ligament pathology. Traditionally, surgical treatments have sought to passively constrain the stifle joint by substituting the CCL with autologous tissue (ie., intra-articular graft) or synthetic materials (ie., extracapsular stabilization). More recently, the tibial plateau leveling osteotomy (TPLO), Tight Rope Technique and tibial tuberosity advancement (TTA) procedures have been described, which render the CCL unnecessary by altering the mechanical forces acting on the stifle.

There are numerous studies indicating the positive benefits of rehabilitation therapy following CCL surgery. In summary, rehabilitation therapy has been shown to improve muscle mass and attenuate muscle atrophy that occurs in the post-operative period, increase stifle joint ROM, especially extension, improve weight-bearing as measured by force plate analysis, and reduce the progression of osteoarthritis. Rehabilitation guidelines following stifle surgery are structured to direct the clinician in returning dogs to pre-injury activity levels as quickly and safely as possible. Criterion-based protocols eliminate subjective progression through rehabilitation by dictating the milestones that must be reached in order to progress to the next phase. The rate of progression can differ between dogs and is dependent on the individual rate of healing and the demands of the dog’s activity level. Prescribing therapeutic interventions in a ‘cookbook’ fashion for each particular diagnosis is committing a disservice to the patient.

Three phases of rehabilitation are included for recovery in dogs: the acute phase, advanced phase, and return-to-play phase. In the acute phase of rehabilitation, strategies are focused on controlling the effects of inflammation (pain, effusion, loss of motion, and muscle atrophy). The goal of the acute phase is to revise full range of motion, reduce effusion, retard muscle atrophy, and ambulate without assistance. Cryotherapy, Laser therapy, NMES, TENS, passive range of motion, and compression of the affected limb can assist in counteracting the effects of inflammation and edema. A combination of low-load sustained stretching, joint mobilizations of the patella and tibiofemoral joints, and modalities to control pain and resultant muscle spasm are commonly performed following CCL surgery.

Cryotherapy (ice compresses) following CCL surgery provides an excellent method to help control pain and inflammation in the immediate postoperative period. The effects of cryotherapy include vasoconstriction, decreased blood flow, reduced cellular metabolism and permeability, attention of traumatic or exercise-induced edema, and decreased muscle spasm. Cryotherapy following CCL surgery can be accomplished by placing crushed ice in a sealed plastic bag and then wrapping the bag in a thin towel. Apply the cold compress for 15 to 30 minutes three or four times a day. Monitor the patient for discomfort, and assess the tissues periodically for signs of adverse effects such as white or pale areas.

L.A.S.E.R. (Light Amplification by Stimulated Emission of Radiation) therapy is a modality that is commonly used in our practice during the postoperative period. Laser therapy, also known as phototherapy and low level laser therapy, involves the application of low power coherent light to injuries and lesions to stimulate healing and reduce pain. It is used to increase the speed, quality and strength of tissue repair, resolve inflammation and give pain relief. The main advantages of the use of Laser therapy following CCL surgery is due to its benefits of enhanced wound care and tissue repair, anti-inflammatory properties, and ability to assist with pain control. Following CCL surgery, laser therapy is typically performed daily for the first 24-72 hours followed by weekly treatments and is targeted to the incision as well as the stifle joint.

Neuromuscular electrical stimulation (NMES) is another modality which is useful following CCL surgery. NMES is a therapeutic modality indicated for treatment of muscle atrophy, pain, edema, muscle spasm, increasing ROM, muscle strengthening and re-education. NMES is used to strengthen healthy muscle or to maintain muscle mass during the early post-operative period, maintain or gain range of motion, facilitate voluntary motor control and temporarily reduce spasticity. Neuromuscular stimulation is achieved by sending small electrical impulses through the skin to the underlying nerves and muscles to create an involuntary muscle contraction. NMES may be performed up to 2-3 sessions per week if needed. NMES should be used as an adjunct to rehabilitation therapy and not in place of rehabilitation therapy.

Range of motion deficits should also be resolved in the acute phase of rehabilitation. Most often, regaining stifle extension is more difficult, so priority should be placed on achieving extension is more difficult, so priority should be placed on achieving extension. A

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combination of low-load sustained stretching, joint mobilizations of the patella and tibiofemoral joints, and modalities to control pain and resultant muscle spasm are commonly performed following CCL surgery. These exercises help prevent adhesions between soft tissues and bone, improve muscle extensibility, and prevent further injury to joints, ligaments, tendons, and muscles. Additional benefits from range of motion and stretching exercises are pain reduction, enhanced blood and lymphatic flow, and improved synovial fluid production and diffusion of nutrients.

One of the most beneficial activities in a rehabilitation therapy program following CCL surgery is therapeutic exercises. In the early postoperative period relatively slow and low impact exercises are initiated. As limb use and patient comfort allow, more advanced exercises should be instituted. It is beneficial to have the owner practice the exercises on the patient with the therapist so that there is no confusion when performing the exercises at home. It is important to remember that there is no “cookbook” approach and each patient will progress through the rehabilitation program at a different rate. In all cases, the stage of healing and the strength of tissues must be considered so that excessive exercise forces are not placed on healing tissues, causing tissue damage.

One of the main exercises for patients following CCL surgery is slow, short, controlled leash walks. It is important to instruct the owner how to perform this exercise correctly as most owners lead the patient too quickly. Slow walks increase stance time, flexibility, strength, and weight-bearing. Additional examples of therapeutic exercises for the acute phase of rehabilitation therapy include torso strengthening, cookies at the contralateral hip, sitting exercises, three leg standing, paws on the counter, and hair scrunchy on the contralateral paw.

The advanced phase of rehabilitation is initiated when range of motion is full and effusion and lameness controlled. The goal of this phase is to increase muscle strength and endurance. Higher intensity training can be initiated and should include exercises for all muscles of lower extremity. If the intensity of therapeutic exercises creates an increase in effusion and or lameness, intensity levels are reduced to the previous level. Progression to higher activity is dictated or restricted by the presence of lameness after exercise.

In addition to the exercises listed, under water treadmill therapy is an excellent means of increasing strength and endurance and may be initiated during the advanced phase. The benefits of UWTM therapy following CCL surgery include assisted weight bearing, improved strength and endurance, cardiovascular fitness, range of motion, agility, balance, and proprioception; as well as decreased joint effusion and peripheral edema. These benefits are due to specifically to buoyancy, hydrostatic pressure, viscosity, resistance, and surface tension. Buoyancy decreases the amount of weight placed on the affected limb and therefore, decreases stress at the surgical site. Hydrostatic pressure provides constant pressure to the affected limb submerged in water which may aid venous and lymphatic drainage from an edematous surgical site. Hydrostatic pressure has also been reported to decrease pain by providing a phasic stimulus to the sensory receptors to decrease pain perception. The viscosity of water provides resistance which may help to strengthen muscles and promote cardiovascular fitness. Surface tension aids in strengthening as the joint undergoes increased motion and work to break through the water’s surface.

Progression of aerobic condition often includes hill walking and an underwater treadmill therapy program that is usually initiated in this phase of rehabilitation. Bone healing is usually sufficient at 8 to 12 weeks. Return of muscle mass is usually sufficient at 12 weeks as long as an appropriate post-operative rehabilitation therapy program was followed.

References
Rupture of the cranial cruciate ligament (CCL) is the most common orthopedic injury and cause of lameness in dogs. Partial or complete CCL disruption causes stifle joint instability, leading to a cascade of inflammatory and pathologic changes resulting in synovitis, osteoarthritis, meniscal injury, and altered stifle kinematics. It is for this reason we will use CCL injury in the dog as an example in a rehabilitation protocol and its importance for a successful long term outcome in the canine patient.

There are numerous studies indicating the positive benefits of rehabilitation therapy following CCL surgery. In summary, rehabilitation therapy has been shown to improve muscle mass and attenuate muscle atrophy that occurs in the post-operative period, increase stifle joint ROM, especially extension, improve weight-bearing as measured by force plate analysis, and reduce the progression of osteoarthritis. In addition, this lecture will discuss the current findings of a retrospective study performed at VOSM on the effects of post-operative rehabilitation therapy in decreasing the probability of CCL disease on the contra-lateral limb.

Rehabilitation guidelines following stifle surgery are structured to direct the clinician in returning dogs to pre-injury activity levels as quickly and safely as possible. Criterion-based protocols eliminate subjective progression through rehabilitation by dictating the milestones that must be reached in order to progress to the next phase. The rate of progression can differ between dogs and is dependent on the individual rate of healing and the demands of the dog’s activity level. Also, clinicians should prescribe therapeutic interventions within each phase that are tailored to the patient’s needs. Prescribing therapeutic interventions in a ‘cookbook’ fashion for each particular diagnosis is committing a disservice to the patient.

Orthopedic rehabilitation can be broken down into four phases. Each phase has an approximate time frame that is changed by the injury at hand. There are several goals of each phase that must be met before the patient can proceed to the next phase. Even though each injury is different, this general plan can be applied since the guidelines must be met for each individual before moving onto next phase.

Phase I or the acute phase is considered the immediate motion phase or approximately 1-3 weeks post-surgery or injury. The objectives of this phase is to minimize the effects of immobilization, promote and protect the healing of the injured tissue, decrease pain and inflammation, re-establish non-painful range of motion (ROM), restore weight bearing to injured limb and impede muscular atrophy.

Phase II or the intermediate phase, usually occurs between the 4-6 week post injury mark. This phase initiates when full or injury appropriate range of motion is achieved, there is minimal pain and inflammation, improved lameness and the surgical site, if applicable, is without complication. The goals of phase II include enhancement of joint and patient mobility, improved muscular strength and endurance, and re-establishment of neuromuscular and proprioceptive control of injured limb.

Phase III or the advanced strengthening phase usually is accomplished between 7-11 weeks post injury/surgery. This phase initiates when there is full, or as much as expected, non-painful range of motion of limb, no pain or tenderness, the strength and muscle mass is 70% of the contralateral limb and the implants are static and the injury/surgery is approaching a healed status. The goals of phase III is progression of activities and exercise to prepare for return to off lead activity and sport and increased strength, power, endurance and neuromuscular control of injured limb.

Phase IV or the return to activity/sport phase, usually occurs 12 plus weeks after injury or surgery. This phase initiates when there is full non painful range of motion, no pain or tenderness with exercise, equal limb muscle mass and symmetry, no lameness at walk, trot or in tight circles and surgical site is healed. The goals of this final phase are progressive return to full off lead activity and sport or competition where applicable. The therapist should use a gradual interval return to sport program to avoid re-injury. Finally sport specific functional exercises should be used to prepare for the stress involved with each particular activity or sport.

In the acute phase of rehabilitation, strategies are focused on controlling the effects of inflammation (pain, effusion, loss of motion, and muscle atrophy). The goal of the acute phase is to revise full range of motion, reduce effusion, retard muscle atrophy, and ambulate without assistance. Cryotherapy, Laser therapy, passive range of motion, and compression of the affected limb can assist in counteracting the effects of inflammation and edema. A combination of low-load sustained stretching, joint mobilizations of the patella and tibiofemoral joints, and modalities to control pain and resultant muscle spasm are commonly performed following CCL surgery.

Cryotherapy (Ice compresses) following CCL surgery provides an excellent method to help control pain and inflammation in the immediate postoperative period. Not only is cryotherapy beneficial in the acute phase of tissue injury and inflammation, it is also advantageous after exercise and throughout rehabilitation when inflammation occurs. The effects of cryotherapy include vasoconstriction, decreased blood flow, reduced cellular metabolism and permeability, attention of traumatic or exercise-induced...
edema, and decreased muscle spasm. Another primary effect of cryotherapy is analgesia, which is thought to be a result of decreased sensory and motor nerve conduction velocity that occurs when nerve fibers are cooled.

L.A.S.E.R. (Light Amplification by Stimulated Emission of Radiation) therapy is a modality that is commonly used in our practice during the postoperative period. Laser therapy, also known as phototherapy and low level laser therapy, involves the application of low power coherent light to injuries and lesions to stimulate healing and reduce pain. It is used to increase the speed, quality and strength of tissue repair, resolve inflammation and give pain relief. Using photochemical processes, laser light inserts bio-photons into damaged cells. The cells begin to produce energy (ATP), which improves their function and assists their division. Laser therapy promotes healing in the postoperative period because it penetrates the skin, increases the ATP and activates enzymes in the targeted cells. Laser therapy has been shown to stimulate growth factor response within the cells and tissue as a result of increased ATP and protein synthesis. It has also been shown to improved cell proliferation. The effect of pain relief is due to a result of increased endorphin release. Laser therapy has also demonstrated the ability to strengthening the immune system response via increasing levels of lymphocyte activity. The main advantages of the use of Laser therapy following CCL surgery is due to its benefits of enhanced wound care and tissue repair, anti-inflammatory properties, and ability to assist with pain control. Following CCL surgery, laser therapy is typically performed daily for the first 24-72 hours followed by weekly treatments and is targeted to the incision as well as the stifle joint.

Range of motion deficits should also be resolved in the acute phase of rehabilitation. Most often, regaining stifle extension is more difficult, so priority should be placed on achieving extension. The clinician should evaluate the numerous possible sources contributing to a restricted range of motion including: decreased patella mobility, poor quadriceps strength, decreased accessory motion of the tibio-femoral joint, and muscle guarding and tightness. Interventions should be chosen that address the specific cause of restricted range. A combination of low-load sustained stretching, joint mobilizations of the patella and tibio-femoral joints, and modalities to control pain and resultant muscle spasm are commonly performed following CCL surgery. These exercises help prevent adhesions between soft tissues and bone, improve muscle extensibility, and prevent further injury to joints, ligaments, tendons, and muscles. Additional benefits from range of motion and stretching exercises are pain reduction; enhanced blood and lymphatic flow, and improved synovial fluid production and diffusion of nutrients.

It is possible to objectively assess improved range of motion by using a goniometer. The measurements may be recorded in the patient’s medical record and followed over time. The unaffected contralateral stifle can often be used as a reference. It is important to remember that improvements achieved with range of motion exercises will be slow and gradual. Another important factor is safety, and it is recommended to have an assistant restrain the patient during the initial sessions.

One of the most beneficial activities in a rehabilitation therapy program following CCL surgery is therapeutic exercise. In the early postoperative period relatively slow and low impact exercises are initiated. As limb use and patient comfort allow, more advanced exercises should be instituted. These exercises are demonstrated to the owners on the patient at the time of discharge by the therapist. It is beneficial to have the owner practice the exercises on the patient with the therapist so that there is no confusion when performing the exercises at home. Although the tables are set to a timeline (weeks post-operative) it is important to remember that there is no “cookbook” approach and each patient will progress through the rehabilitation program at a different rate. Therefore, the exercises will need to be tailored based on the patient’s status during each in-hospital session. In all cases, the stage of healing and the strength of tissues must be considered so that excessive exercise forces are not placed on healing tissues, causing tissue damage.

One of the main exercises recommended for patients following CCL surgery is a slow, short, controlled leash walk. It is important to instruct the owner how to perform this exercise correctly as most owners lead the patient too quickly. Slow walks increase stance time, flexibility, strength, and weight bearing. Once the patient shows the ability to use the affected hind limb consistently at a slow walk, faster walks may be used which can further develop endurance, strength, balance, coordination, and proprioception. Additional examples of therapeutic exercises for the acute phase of rehabilitation therapy include torso strengthening, cookies at the contralateral hip, sitting exercises, three leg standing, paws on the counter, and hair scrunchy on the contralateral paw.

Phase II or the intermediate phase is similar to phase I but continues to build on the patient’s joint wellness/healing and overall mobility. During this phase, the practitioner should also focus on increasing muscular strength, start on muscle endurance and re-establish neuromuscular and proprioceptive control of the hind limb. This can be accomplished by manipulating the modalities and exercise described in phase I.

The advanced phase of rehabilitation (phase III) is initiated when range of motion is full and effusion and lameness controlled. The goal of this phase is to increase muscle strength and endurance. Higher intensity training can be initiated and should include exercises for all muscles of lower extremity. If the intensity of therapeutic exercises creates an increase in effusion and or lameness, intensity levels are reduced to the previous level. Progression to higher activity is dictated by the presence of lameness after exercise.

An example of therapeutic strengthening exercises that may be used in the advanced phase of therapy, which will help to improve strength and endurance, is walking on inclines. Walking on inclines provides a low-impact method to strengthen the gluteal muscles as well as the cranial and caudal thigh muscles. It is best to start with small inclines and progress as the patient is able. Walking downhill may also result in increased hock, stifle, and hip flexion during the stance phase of gait because the limbs are advanced further.
cranially under the body as the dog walks downhill. Although walking results in some joint motion, the joints do not undergo their maximum range of motion, therefore, it is important to perform ROM exercises are previously described. Often, exercises designed to improve dynamic stability are added in this phase. Although there is no literature to support the inclusion of such exercises, there is a theoretical framework for including such exercises based on basis science and applied research. Balance exercises using unstable surfaces (wobble boards) are included.

In addition to the exercises discussed, under water treadmill therapy is an excellent means of increasing strength and endurance and may be initiated during the advanced phase. The benefits of UWMT therapy following CCL surgery include assisted weight bearing, improved strength and endurance, cardiovascular fitness, range of motion, agility, balance, and proprioception; as well as decreased joint effusion and peripheral edema. These benefits are due to specifically to buoyancy, hydrostatic pressure, viscosity, resistance, and surface tension. Buoyancy decreases the amount of weight placed on the affected limb and therefore, decreases stress at the surgical site. Hydrostatic pressure provides constant pressure to the affected limb submerged in water, which may aid venous and lymphatic drainage from an edematous surgical site. Hydrostatic pressure has also been reported to decrease pain by providing a phasic stimulus to the sensory receptors to decrease pain perception. The viscosity of water provides resistance, which may help to strengthen muscles and promote cardiovascular fitness. Surface tension aids in strengthening as the joint undergoes increased motion and work to break through the water’s surface. The specific details of UWMT therapy can be found elsewhere in this text.

Progression of aerobic condition often includes hill walking and an underwater treadmill therapy program that is usually initiated in this phase of rehabilitation. To start increased controlled active exercise, the dog’s injured side quadriceps strength must be restored to at least 80% of the uninvolved side, and sufficient healing of the injured structure must have occurred (e.g. TPLO approximately 8 weeks). Bone healing is usually sufficient at 8 to 12 weeks. Return of muscle mass is usually sufficient at 12 weeks as long as an appropriate post-operative rehabilitation therapy program was followed.

The goal of the return-to-sport phase (phase IV) is to prepare the canine athlete to return to the demands of the competition. The dog is allowed to enter this phase when instance resistance training and a running program do not increase effusion or lameness. Therefore, exercises should attempt to mimic the demands of activities required for the canine athlete to successfully return to sport.

Agility training and sport-specific exercise characterize the return-to-sport phase. Less complex agility drills should be used initially, moving to more complex agility drills. The volume of agility activities should be graded by frequency, duration, and intensity. Only one variable should be modified at one time, otherwise it is difficult to determine what was the factor that caused an adverse response to the treatment (increased pain or effusion). Sport-specific activities are introduced and progressed in the same manner. Practice drills are started, leading to competition level activities. Canine athletes are cleared to return to sport when they have progressed through all phases of rehabilitation without symptoms and have met the criteria of return-to-sport testing. Return-to-sport testing involves symmetric thigh circumference, strength testing and gait analysis.

References
The most common hind limb orthopedic/sports medicine conditions afflicting active dogs are iliopsoas strains, cranial cruciate ligament (CCL) insufficiency, and gracilis and semitendinosus contracture. The most common orthopedic injury that presents to Veterinary Orthopedic & Sports Medicine Group (VOSM) is a rupture of the cranial cruciate ligament. Of the hind limb muscular injuries iliopsoas strain is, by a considerable margin, seen more frequently than gracilis and semitendinosus contracture. Because contracture of the gracilis and/or semitendinosus is less common, it is often undiagnosed until significant pathology is established. Diagnosis and treatment in early stages of the disease process can significantly inhibit progression.

**Iliopsoas strains**

Iliopsoas strains occur as the result of excessive force acting on this muscle, and are commonly associated with highly athletic activities such as agility. These injuries often occur at or near the muscle-tendon junction, which is the weakest part of the myotendinous unit. Eccentric contraction, in which the muscle is activated during stretch, is known to be an important factor in the development of these acute strain injuries. Traumatic incidents that result in active eccentric muscle contraction, such as slipping into a splay-legged position, jumping out of a vehicle, aggressive agility training, or roughhousing with other dogs are often suspected in precipitating acute lameness. It is not uncommon to find dogs with iliopsoas strains that have other concurrent orthopedic problems, or that have recently undergone surgical treatment for another orthopedic condition, such as cranial cruciate ligament rupture.

Dogs with iliopsoas strains commonly present with a history ranging from a subtle intermittent offloading of the hind limb to significant unilateral hind limb lameness that is exacerbated with activity. On direct palpation, discomfort and spasm of the myotendinous unit may be noted. Pain and spasm will also be noted when stretching the myotendinous unit by either placing the hip in extension with abduction, or by simultaneous extension of the hip with internal rotation of that pelvic hind limb.

Radiographs are of little value in the early phase, but may reveal mineralization just cranial to the lesser trochanter in chronic cases. The use of advanced imaging modalities to demonstrate lesions of the affected muscle and/or tendon can increase confidence in the diagnosis. Ultrasonography is a relatively inexpensive noninvasive imaging modality for canine musculoskeletal evaluation with the additional advantage that general anesthesia is not required. This imaging modality is particularly dependent on the expertise of the operator, which may limit its practical application in some settings. Advanced diagnostics such as CT (computerized tomography) scan and MRI (magnetic resonance imaging) may be used to identify iliopsoas strains.

Acute iliopsoas strains should be treated conservatively. Skeletal muscle relaxants may be administered in severe cases to reduce pain and muscle spasms. Medical management may also include NSAIDs, cryotherapy and controlled activity. Rehabilitation can be very effective in treating iliopsoas strains. Treatments may include laser therapy to increase circulation, remove waste products, and promote healing. Pain-free PROM (passive range of motion) and high-repetition exercise also are recommended. Core strengthening is essential in the return of the athletic dog to competition and a pain free lifestyle. Since the origin of the iliopsoas is the lumbar spine, the lumbar spine and lumbosacral area may need to be treated in acute cases. Acupuncture may be helpful to assist with pain control and to promote healing, including the lumbar and lumbosacral region. Joint mobilization and other manual therapy may also be needed to assist with the lumbar range of motion and motion of the coxofemoral joint.

Surgical treatment is warranted for those that do not respond to conservative medical management and rehabilitation therapy. In these cases, where there are irreversible changes to the myotendinous unit, such as fibrosis (forming excess fibrous tissue while healing) of the muscle-tendon junction, surgical treatment by tenotomy/tenectomy (releasing the tendon) or reattachment may be indicated. Surgical intervention should be considered when the strain injury recurs at regular intervals or does not respond to medical treatment or rehabilitation therapy, although the lesion should be first confirmed with ultrasonography, CT, or MRI imaging.

**Cranial cruciate ligament insufficiency**

Although the knee joint in dogs is similar to humans, the forces applied to the joint during weight bearing are vastly different. Our hip, knee and ankle joints are perpendicular to our weight bearing surface, our feet. When we stand, there is minimal stress to the ligaments in our knee. Dogs, however, stand on their toes with the ankle elevated and the knee forward. The top of the dog’s tibia (tibial plateau) is sloped and weight bearing creates a force that pushes the femur down the slope of the tibia. This force is called “tibial thrust” and it is the job of the cranial cruciate ligament (CCL) is preventing this motion. Each time the dog bears weight, the CCL is called to work. If you think of the tibial plateau as a hill and the femur as a car parked on the hill, the CCL is the break. If the ligament ruptures, it allows the femur to slide down the slope or, in our example, the break releases and the car rolls down the hill.
When the ligament is ruptured, each time the dog bears weight this motion occurs and causes discomfort. Within the joint, there will be inflammation and swelling, referred to as synovitis and effusion.

Rupture of the CCL can occur in several different ways. There may be a single incident which causes a sudden complete rupture of the ligament. The rupture can also occur over time. Dogs with a high tibial plateau angle (greater slope) have greater stress to the CCL and the ligament can tear incrementally. Dogs can also partially tear the ligament due to an incident. The majority of partial ruptures will progress to a complete rupture within weeks to months. Common causes of partial and/or complete ruptures include hyperextension and internal rotation of knee from sudden turns or stepping into a hole; jumping if force of cranial tibial thrust exceeds breaking strength of CCL; repetitive normal activities; and degeneration with aging. Obesity can increase the risk of a rupture as can the “weekend warrior” routine, in which the pet is relatively inactive during the week but very active on weekends. Dogs that have ruptured their CCL in one knee have a 50% - 70% chance of rupturing the CCL in their other knee. Therefore, surgical correction is recommended as soon as possible to decrease the stress placed on the uninjured CCL, thereby, decreasing the risk of CCL rupture to that knee.

If the CCL rupture is complete and acute, often the pet will be non-weight bearing lame. However, in the case of a partial or gradual rupture, the pet will be weight-bearing lame or have an intermittent lameness. Lameness will often worsen with activity. Stiffness upon rising and/or a stiff gait is another common complaint. You may note that the dog sits with the affected leg out to the side. He or she may have difficulty rising and be less active. Physically, you may note a swelling or thickening of the knee and muscle atrophy (wasting) in the affected limb. Dogs which have ruptured the CCL in both knees do not routinely carry or off-load a particular limb since they do not have a good limb to stand on.

Diagnosis of CCL injury can be determined on palpation (cranial drawer test and/or cranial tibial thrust test). Partial CCL ruptures can be identified by thrust or drawer while the stifle is in flexion. In addition, the McMurray test may be performed to assess for meniscal injury. Radiographs are typically obtained and will reveal effusion and peri-articular osteophytosis (depending on the chronicity). If these tests alone are not completely diagnostic, arthroscopic evaluation of the joint and structures may be recommended. If arthroscopic evaluation reveals the ligament is injured, a stabilizing procedure can then be performed.

Treatment for Grade 1 sprains of the CCL may include rehabilitation therapy, a hinged functional stifle brace and in some cases regenerative medicine (stem cell therapy). Dogs with complete CCL ruptures who are not surgical candidates due to financial constraints, concurrent medical issues, etc. may also benefit greatly from rehabilitation therapy and a functional stifle brace.

There currently is no “best” CCL repair technique. There is however, a “best” technique for each individual patient based on certain variables. These variables include the patient’s age, breed, size/weight, tibial plateau slope, activity level and desire for return to work/sport. Current surgical options include the lateral suture technique (extracapsular stabilization); TightRope stabilization (TR); Tibial tuberosity advancement (TTA); and the tibial plateau leveling osteotomy (TPLO). Each of these procedures has its advantages and disadvantages.

There are numerous studies indicating the positive benefits of rehabilitation therapy following CCL surgery. In summary, rehabilitation therapy has been shown to improve muscle mass and attenuate muscle atrophy that occurs in the post-operative period, increase stifle joint ROM, especially extension, improve weight-bearing as measured by force plate analysis, and reduce the progression of osteoarthritis. Rehabilitation guidelines following stifle surgery are structured to direct the clinician in returning dogs to pre-injury activity levels as quickly and safely as possible. Criterion-based protocols eliminate subjective progression through rehabilitation by dictating the milestones that must be reached in order to progress to the next phase.

**Gracilis and semitendinosus myopathy/contracture**

Canine muscle contracture is reported to affect several different muscles, is associated with a number of predisposing factors, and a varying prognosis depending upon which muscle is affected. Most patients suffer some form of trauma weeks to months before the contracture is present. The clinical signs include: lameness, pain, weakness, decreased range of motion, a firmness noted throughout the entire muscle, and usually a characteristic gait. Contractures of the gracilis and semitendinosus may be concurrent or found individually. History associated with a contracture of the gracilis and/or semitendinosus typically consists of a single or repeated strain injury with a gait abnormality developing afterwards. Gait abnormalities usually start abruptly and progress over a period of six weeks to months, at which time it becomes static. There does appear to be some breed and age predilection, however, the sex of the animal does not have an appreciable influence. Gracilis muscle and semitendinosus contracture most often affect highly active German Shepherd Dogs and Shepherd related breeds between the ages of three and seven years. The suspected cause in the working and performing German shepherd is repetitive strain injury leading to secondary contracture.

Fibrotic myopathy or muscular contracture is a chronic, progressive disorder of severe muscle contracture and fibrosis. The fibrotic myopathy may result from acute trauma, chronic repetitive trauma, autoimmune disease, drugs reactions, infections, neurogenic disorders and vascular abnormalities. Ischemia secondary to indirect trauma may also lead to fibrosis and contracture. Histologically, muscle is replaced by dense, collagenous connective tissue. Muscle strains are caused by excessive force or stress on the muscle that induces tearing of muscle fibers or, most often, tearing of the musculotendinous junction. The type and severity of injury determines
whether the muscle heals predominately by regeneration of functional myofibrils or by scar formation. Severe damage to a muscle is followed by fibrosis and contracture, with minimal regeneration. Although fibrous scar tissue provides tensile strength and plays a part in normal muscle healing, excessive scar tissue impedes muscle fiber regeneration and interferes with muscle contraction and relaxation, resulting in varying degrees of mechanical lameness.

Most contractures have a history of acute injury or lameness weeks to months before the onset of contracture. The lameness and initial swelling usually subsides with supportive treatment, however, clinical signs of the contracture present a few weeks later. Dogs typically have a hind-limb gait abnormality characterized by a shortened stride with a rapid, elastic medial rotation of the paw, internal rotation of the hock and external rotation of the calcaneus [corrected] and internal rotation of the stifle during the mid-to-late swing phase of the stride.

Physical exam may be normal, except for a firm mass within the gracilis and/or semitendinosus muscle(s). Typically, a taut, firm band is palpable in the caudo-medial aspect of the thigh. A complete chemistry panel and CBC are usually within normal limits; however, creatinine phosphokinase (CK) may be elevated. Radiographs of the hind limb are typically normal, however an increased radiopacity may be observed between muscle and the lower tendon junction in some cases. Ultrasound may be a useful diagnostic tool and may reveal a slightly echogenic muscle. MRI may also be useful for diagnosing this condition in both the acute and chronic phases. Histopathology of the contracted muscle typically shows replacement of degenerating myofibers with connective tissue. The findings are consistent with primary myopathy due to polyphasic muscular damage (degeneration, segmental necrosis, phagocitosis, and fibrosis).

Rehabilitation therapy is currently the treatment of choice. Rehabilitation therapy may consist of continuous ultrasound therapy, manual therapy and a home therapeutic exercise program including massage and stretching. While rehabilitation therapy may significantly improve the gait abnormality and function of the hind limb in chronic cases it rarely leads to complete resolution of clinical signs.

References


How to Incorporate Platelet Rich Plasma Therapy into Your Practice
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The use of regenerative medicine has become increasingly popular in both human and veterinary medicine for multiple disease processes. Platelet rich plasma (PRP) is a regenerative medicine therapy that is believed to aid in tissue healing. While PRP’s first clinical applications were limited to dentistry and maxillofacial surgery to improve bone healing, PRP presently has much broader clinical applications, extending to orthopedic surgery and sports medicine. PRP is currently used in both people and animals to help with healing in numerous tissues. Recent studies have shown PRP to be both efficacious in managing numerous orthopedic conditions, including osteoarthritis and soft tissue injuries (tendon and ligament injuries), and to mediate healing by supplying growth factors, cytokines, chemokines, and other bioactive compounds.

Platelets are cells that circulate in the blood stream and play roles in both hemostasis and wound healing. Platelets contain two types of granules. The first type increases permeability of blood vessels to allow for access of inflammatory cells to the site of damage and contributes to blood clot formation. The second type of granule releases growth factors that stimulate other cells of the body to migrate to the area of trauma, thus facilitating tissue healing. It is the growth factors contained within the platelets that are of significance for tissue healing. These growth factors include platelet-derived growth factor (PDGF), transforming growth factor-β1 (TGF-β1), transforming growth factor-β2 (TGF-β2), vascular endothelial growth factor (VEGF), basic fibroblastic growth factor (bFGF), and epidermal growth factor (EGF). Many of these growth factors have been shown in recent studies to act either individually or synergistically to enhance cellular migration and proliferation, angiogenesis, and matrix deposition to promote tendon and wound healing, aid in cartilage health, and counteract the cartilage breakdown that is associated with osteoarthritis. Platelets have also been shown to recruit, stimulate, and provide a scaffold for stem cells. Thus, PRP has been used as a regenerative medicine therapy to aid in tissue healing.

Platelet rich plasma (PRP) is an autogenous fluid concentrate composed primarily of platelets and growth factors. On average dogs have 200,000 to 500,000 platelets per microliter. Platelet rich plasma (PRP) is made by processing a patient’s own blood sample. The goal is to obtain the highest concentration of platelets and growth factors, while removing the other components of the blood such as the red and white blood cells, which can cause pain and inflammation. To make PRP, a sample of blood is obtained from the patient, mixed with an anticoagulant, and processed either manually by spinning it in a centrifuge to separate its components (centrifugation) or through an automated system. This process concentrates the platelets as well as growth factors, amplifying healing properties.

There are many commercial systems available to concentrate platelets. At Veterinary Orthopedic and Sports Medicine Group (VOSM), we have performed a prospective analysis of the commercial systems available to determine which system achieves the highest platelet concentration with few red and white blood cells. Studies show that red blood cells in the PRP product can damage cartilage and synovium, increase concentrations of unwanted inflammatory mediators (IL-1 and TGF-α), and can cause significantly more synoviocyte death. Studies also show that white blood cells in the PRP product can increase concentrations of MMP-9, which degrades collagen and other extracellular matrix molecules, and increase concentrations of unwanted inflammatory mediators (IL-1β, TNF-α, IL-6, and IL-8). Therefore, the ideal PRP product has minimal red and white blood cells. The systems used at VOSM is not only validated for use in dogs but also yields platelet counts five to nine times above normal, with minimal red and white blood cells in the product.

PRP therapy is often performed as a series of one to three injections with two weeks between each injection. About 50% of dogs require more than one injection for significant improvement. PRP therapy is a minimally invasive procedure that typically can be performed on an outpatient basis. Approximately 30 to 60 milliliters of blood is obtained, processed, and prepared for injection. Once the PRP is processed, the area that is to be treated is clipped and aseptically prepared. Sedation or general anesthesia may or may not be required, depending on the location of the injection. For osteoarthritis, PRP joint injections are usually performed without sedation; however, some joints such as the hip require sedation and may also require advanced imaging (fluoroscopy) for guidance. For soft tissue injuries, ultrasound guidance is used to ensure accuracy of the injection as PRP is most effective when administered directly into the site of injury. Sedation is often required. Mild discomfort has been reported for the first 24 to 72 hours following the injection and can be managed with cold compressing and pain medication. Nonsteroidal anti-inflammatory medication and steroids are avoided during the post-injection period unless there is inflammation (joint flare) following the injection. A dedicated rehabilitation therapy program is often recommended for 8 to 12 weeks following PRP therapy, depending on the diagnosed condition. Additionally, a brace or support wrap may also be recommended. The most common side effect is discomfort associated with the injection, which typically resolves within 12 to 24 hours of the injection.

Recent studies have shown PRP combined with stem cells to be advantageous, allowing the PRP to aid in stem cell recruitment and activation and act as a scaffold, and have been used to manage numerous orthopedic conditions, including osteoarthritis and soft tissue...
injuries. Deciding when to use PRP or stem cell PRP combination therapy is important as the biology of healing is complex and has many stages, and it may be more beneficial in some tissues over others. Timing of their application is also critical.

References
How to Incorporate Stem Cell Therapy into Your Practice
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Soft tissue injuries and osteoarthritis are common conditions afflicting active dogs due to the repetitive forces placed on the joints. Microtrauma to the tendons, ligaments, and the articular surfaces of joints can occur, creating an environment for osteoarthritic development. Once the degenerative cascade of this condition is initiated, its progression can be insidious. Therapies for this debilitating condition have focused on treating the symptoms or slowing the progression of the disease. Regenerative and stem cell therapy may not only treat symptoms and slow the disease but could help to induce repair of the underlying damage that initiated this cascade. Regenerative medicine technology gives new hope for extending the careers and improving the quality of life of the canine athlete.

Stem cells are characterized by their ability to self-renew and differentiate along multiple lineage pathways. Stem cells contribute to generating new tissue, are chemotactic for progenitor cells, supply growth factors, make extracellular matrix, angiogenesis, are anti-apoptotic, anti-inflammatory, and anti-fibrotic. Stem cells contribute to the regeneration and replacement of injured and diseased tissue via cell differentiation, modulation of signaling pathways via cytokines to decrease progression of disease, and aid in resident stem cell activation and recruitment. Stem cells for regenerative medicine applications should be found in abundant quantities (millions to billions of cells), harvested by a minimally invasive procedure, differentiated along multiple cell lineage pathways in a regulated and reproducible manner, safely and effectively transplanted to either an autologous or allogeneic host, and manufactured in accordance with current Good Manufacturing Practice guidelines.

Currently, both bone marrow and adipose tissue are canine sources of autologous stem cells, where tissue is harvested, and cells are isolated, expanded, and then returned to the patient. Bone marrow aspirate contains hematopoietic stem cells, which can form all the types of blood cells in the body, and mesenchymal stem cells (MSCs), which can generate bone, cartilage, fat, and connective tissue. Bone marrow aspirate can be processed in-house through a series of steps of centrifugation to yield bone marrow aspirate concentrate (BMAC), and can be used for culture expansion. Bone marrow derived stem cells are more commonly clinically used in horses. Adipose tissue contains MSCs, with the ability to generate bone, cartilage, fat, and connective tissue. Adipose derived stem cells can be processed in-house through a series of steps involving enzymatic tissue digestion and centrifugation to obtain the stromal vascular fraction (SVF), and can also be culture expanded. Adipose derived stem cells are more commonly used in dogs and humans. Allogeneic stem cell therapy consists of cells isolated and expanded from harvested donor tissue that is returned to a different person or animal. Cell markers are changed when cultured to allow the immune response to be disabled. Allogeneic cells are available for use more quickly, since they must only proliferate for a few days rather than weeks after harvest, but are considered a drug by the FDA. Stem cell therapy may be used in the canine to promote tissue regeneration in areas of limited healing capability. Indications include osteoarthritis, tendon injury, ligament injury, and spinal cord injury. Contra-indications include neoplasia.

Recent studies have shown autologous and allogeneic stem cells to be a successful adjuvant therapy for osteoarthritis, and suggest intra-articular injections are safe and well tolerated. Several studies utilizing stem cells for ligament injury also demonstrate the success of intra-articular bone marrow stem cells as an effective treatment for partial ACL rupture. At Veterinary Orthopedic and Sports Medicine Group (VOSM), we have utilized stem cell – platelet rich plasma (PRP) combination therapy for early partial CCL tears (<25-50% rupture of craniomedial band) diagnosed via arthroscopy. Culture expanded adipose derived stem cells with PRP or BMAC with PRP used in conjunction with rehabilitation therapy and a functional stifle brace (for severe cases) have yielded excellent results. CCL regeneration is confirmed via a 90 day second look arthroscopy and improvement is noted using objective gait analysis. Recent studies have also shown that both autologous and allogeneic MSC transplantation could be clinically useful therapeutic approaches for treating spinal cord injury. A recent study at VOSM found that of 55 dogs that had adipose-derived stem cells with PRP to treat unilateral supraspinatus tendinopathy, 88% were sound on objective gait analysis, and 12% were improved but not sound at 90 days. Adipose-derived stem cells combined with PRP may be considered a treatment option for supraspinatus tendinopathy in the canine.

Regenerative stem cell therapy can be incorporated into practices by several means. Adipose derived SVF can be obtained by taking a sample of 10-50 grams of subcutaneous adipose tissue and process the sample either in-house or by sending out to a commercial laboratory, where the cells are enzymatically and/or mechanically isolated. The falciform is this author’s recommended location to obtain a sample, as there are less complications and morbidity than other locations, and adequate samples can be obtained from lean dogs as well. Residual cells can bebanked for future use. Point of care extraction of SVF and automated characterization of cells can be done in-house using a fully automated, closed system, utilizing an easy to use, rapid processing (<60 minutes) system. The systems used at VOSM yield 20% mesenchymal cells from SVF, compared to <0.5% in bone marrow. Culture expanded adipose derived stem cells require 10-20 grams of adipose tissue, and is shipped in fed-ex in premade packaging on ice. MSCs are isolated, cultured, and returned in 10-14 days for injection. Residual cells are banked for future use. To obtain BMAC, 30-60 ml of bone
marrow is obtained from the femur, ilium, or humerus (proximal femur is this authors preference), and either processed in-house or sent out to a commercial laboratory, where the cells are mechanically isolated. Advantages of in-house SVF and in-house BMAC include same day treatment, no shipping issues, less expensive, and no cell manipulation; while disadvantages consist of minimal validated systems, heterogeneous population, lower cell counts, safety and controlled standards, less objective data, and typically no banked cells. Advantages of culture expanded adipose stem cells and culture expanded bone marrow stem cells include validated techniques, homogeneous population, higher cell count, more objective data, safety and controlled processing standards, and banked cells; while disadvantages consist of longer turnaround time, shipping issues, more expensive, and cells may be considered a drug in the future by the FDA. Cells are administered via routine intra-articular injection using aseptic technique and may or may not require sedation depending upon the patient and treatment location. Cells may be administered via landmark guided blind injection, fluoroscopic guided or digital radiography guided. Cells are administered with ultrasound guidance with sedation or a brief anesthesia for soft tissue (tendons and ligaments) using the fenestration technique.

Recent studies have shown PRP combined with stem cells allows for optimal tendon regeneration. PRP has positive effects on angiogenesis and extracellular matrix remodeling, aids in stem cell recruitment and chemotaxis, cell proliferation and differentiation, is a potent source of growth factors important for the regenerative process, and provides fibrin for a matrix/scaffold to provide a template for cell attachment. Combination therapy has been used to manage numerous orthopedic conditions, including osteoarthritis and soft tissue injuries. Deciding when to use PRP or stem cell PRP combination therapy is important as the biology of healing is complex and has many stages, and it may be more beneficial in some tissues over others. Timing of their application is also critical. Stem cell therapy may be considered as a treatment option for orthopedic conditions in the canine. The goal of therapy for the canine athlete is to not only to improve comfort but return these athletes to performance level. There is an increased need for training and proficiency in canine musculoskeletal ultrasound and intra-articular injections to utilize these treatment options in veterinary clinics around the world.

References

Diagnosing and treating forelimb conditions in dogs can be very challenging. Many dogs present with a similar history including minimal response to rest, non-steroidal anti-inflammatory drugs, and increased lameness following exercise and heavy activity. It can be difficult to localize the lesion on palpation as many dogs may show increased sensitivity in the shoulder and elbow from referred pain and compensation. To further challenge the veterinarian, it is not uncommon for diagnostics such as radiology to be within normal limits due to the soft tissue nature of these injuries (tendon, ligament, and cartilage). Fortunately, with the availability of advanced diagnostics (arthroscopy, MRI, CT scan, ultrasound, etc.) the definitive diagnosis can be determined and an appropriate treatment plan created. Depending on the diagnosis (tendon, ligament, cartilage lesions, etc.) treatment options may include arthroscopic treatments, stem cell therapy (SCT), platelet rich plasma therapy (PRP), rehabilitation therapy and medical management.

**Supraspinatus tendinopathy**

Supraspinatus tendinopathy is a common cause of forelimb lameness in performance, working, and active companion dogs. The condition involves injury to the supraspinatus, a major tendon responsible for shoulder extension (reaching forward during walking, trotting, or running). Supraspinatus tendinopathy is a common condition in human medicine as well, particularly in sports involving repetitive overhead motion. As in humans, supraspinatus tendinopathy can be challenging to diagnose and treat, with common recurrence of pain or lameness.

In dogs, the most common cause of supraspinatus tendinopathy is over-use due to chronic repetitive activity. Activities such as landing a jump with outstretched forelimbs, quick turns and jump-turn combinations can place the soft tissue structures of the shoulder joint under extreme stress. Repetitive activity puts increased biomechanical load on the tendon, eventually leading to a strain injury. Repeated strain causes disruption of the tendon fibers, creating a core lesion. In chronic cases, two findings may be present: mineralization within the tendon and/or bony remodeling at the point of insertion.

Patients with supraspinatus tendinopathy may or may not present with forelimb lameness. They may present with more subtle changes, such as shortened step or stride length or changes in performance. Other patients may present with a weight-bearing lameness that is exacerbated with exercise and heavy activity. Most often, the patient is only lame on one forelimb. At Veterinary Orthopedic & Sports Medicine Group (VOSM), a retrospective six-year study of 122 supraspinatus tendinopathy patients revealed a 2-to-1 ration of unilateral to bilateral lameness, respectively. Often, lameness worsens with activity and does not improve with rest and non-steroidal anti-inflammatory medications. For 42.2% of the patients, prior rehabilitative therapy failed to resolve the discomfort and lameness. Study results also confirmed that 75.9% of dogs failed to respond to rest and NSAID therapy.

An orthopedic evaluation should be performed by a specialist trained in veterinary sports medicine. Upon physical examination, discomfort is noted during shoulder flexion, which stretches the supraspinatus, and upon direct palpation of the tendon. Shoulder flexion and/or extension may cause tendon spasm. The supraspinatus may also be atrophied, especially in chronic medial shoulder syndrome is present. At VOSM, we perform objective gait analysis (GaitRite/GAITFour) as part of our comprehensive orthopedic evaluation. The orthopedic evaluation also includes shoulder and elbow radiographs (x-rays).

VOSM uses diagnostic musculoskeletal ultrasound to definitively diagnose supraspinatus tendinopathy. Because it can be challenging to identify the lesion, it is imperative to have a board certified specialist experienced in small animal musculoskeletal ultrasonography perform the ultrasound. We prefer diagnostic ultrasound to MRI because we are able to perform serial evaluations without sedating the patient and it is much less costly. Throughout treatment, serial ultrasound rechecks allow us to objectively measure response to treatment and best customize the patient’s rehabilitation therapy program.

Arthroscopy is also an excellent diagnostic modality for patients with supraspinatus tendinopathy. In our study, 91% of dogs presented with concurrent shoulder pathology that cannot be identified on ultrasound but can be seen arthroscopically. We also found that 75% of dogs had concurrent elbow pathology, which also cannot be identified on ultrasound.

Conservative management – rest, non-steroidal anti-inflammatory medications and rehabilitation therapy – often fails as a treatment option. We have successfully adopted regenerative medicine as a treatment option for supraspinatus tendinopathy. Regenerative medicine includes stem cell therapy, the act of using cells from the patient’s own body to help decrease pain and inflammation and allow injured tissues to heal through regeneration with targeted treatment directly to the lesion.

Rehabilitation therapy is vital for enabling a return to full function following stem cell therapy. It focuses on preservation of range of motion, addressing not only the tendinopathy, but any compensatory issues as well. Once the tissues have healed, rehabilitative therapy focuses on muscle strengthening and reconditioning for long-term protection from re-injury. Some common rehabilitative modalities (i.e. Class IV laser therapy, shock wave therapy, therapeutic ultrasound, and the use of NSAIDs) are contraindicated for
regenerative medicine patients because they can inhibit stem cell growth and/or decrease response to treatment. Because of this, only a certified rehabilitation therapist and/or board certified specialist should oversee the patient’s rehabilitation therapy program.

**Medial shoulder instability (MSI)**
The exact cause of Medial Shoulder Instability (MSI) in dogs is unknown, although it is suspected to be related to chronic repetitive activity, or overuse rather than trauma. Overuse of the shoulder support structures leads to degeneration of the tissues, lowering the tensile strength of the tissues predisposing them to fraying, disruption, and eventually complete breakdown.

Sporting athletes that participate in activities such as agility, undergo extreme stresses on their muscles, ligaments, and tendons. Repetitive activities such as jump-turn combinations and weave poles are performed regularly during practice and at weekend trials. These routine maneuvers place the shoulder near its end range of abduction, stressing the soft tissues of the medial shoulder complex. Over time, there may be a cumulative effect of the micro trauma occurring to the ligaments, tendons and joint capsule, leading to a decrease in performance.

Dogs with MSI may present with a varying degree of history and clinical signs. The history may range from dogs that are missing cues or refusing tight turns during performance to dogs with intermittent unilateral forelimb lameness. Affected dogs often place the carpus in an exaggerated valgus position when sitting or standing, and circle the foreleg outward and move the elbow away from the midline during the swing phase of the stride. The history of dogs with more chronic condition typically includes a non-responsive effect to rest and non-steroidal anti-inflammatory drugs (NSAIDS) and dogs that are commonly worse after exercise and heavy activity.

Gait analysis may range from a mildly shortened stride in the affected forelimb at a walk and a trot to a significant weight-bearing lameness. Depending on the chronicity, atrophy may be noted in the affected shoulder on physical examination. Forelimb circumference may be decreased in the affected forelimb when compared to the contralateral unaffected forelimb. Dogs with MSI typically have a restriction and decreased range of motion in extension. When placing the shoulder into abduction spasm and discomfort are almost always noted. If a concurrent supraspinatus tendinopathy is present pain may be noted when placing the shoulder into flexion (direct stretch of the supraspinatus) or on direct palpation of its point of insertion.

In addition to history, signalment, gait analysis, physical examination, orthopedic and neurologic examinations, and abduction angle tests, further diagnostic tests used to differentiate causes of shoulder pathology. Current imaging modalities include radiographs, computed tomography (CT), ultrasonography, magnetic resonance imaging (MRI), and arthroscopy. However, arthroscopic evaluation of the shoulder joint of dogs allows for direct observation of all major intra-articular structures with magnification, "dynamic" evaluation of tissues during shoulder range-of-motion tests, and "palpation" of intra-articular tissues using arthroscopic instrumentation. Arthroscopic exploration with evaluation of intra-articular structures provides a definitive diagnosis of MSI.

Based on the results of the orthopedic examination, abduction angle tests, and arthroscopic scoring, patients are placed into one of three treatment categories; mild, moderate, or severe. For patients with abduction angles of 30º - 45º and arthroscopic findings consisting of mild pathology patients are placed in shoulder support system/hobbles and entered into a rehabilitation therapy program. Dogs with moderate pathology typically have abduction angles that range from 45 º - 65º. Dogs in this category are typically treated arthroscopically with radiofrequency (RF) treatment and/or imbrication, or tightrope stabilization. Dogs are placed in hobbles for 12 weeks and entered into a rehabilitation therapy program. Dogs with severe MSI typically have shoulder abduction angles greater than 65º. Fortunately, severe cases are less common and are usually due to trauma rather than repetitive activities as seen in the mild and moderate categories.

**Traumatic fragmented medial coronoid process**
Traumatic fragmented medial coronoid process (TFMCP) is a condition in the elbow joint of dogs that appears to occur commonly in performance dogs. Unlike the classic condition of fragmented medial coronoid process (FMCP) affecting the elbow joints of skeletally immature large to giant breed dogs; jump down syndrome appears to have no age or size limitations. The cause and pathogenesis of TFMCP are poorly understood. It is possible that abnormal repetitive loading may lead to micro fractures of the bone underneath the cartilage. Dogs may be further predisposed to this condition if they have elbow dysplasia. Dogs with elbow dysplasia had asymmetric growth of the radius and ulna during development, resulting in elbow joint incongruity. Regardless of the etiology, if left untreated, secondary osteoarthritis may progress.

Dogs with TFMCP may present with a history ranging from a subtle intermittent offloading of the forelimb to significant unilateral or bilateral forelimb lameness. Affected dogs often place the carpus in an exaggerated valgus position when sitting or standing, and circle the foreleg outward and move the elbow away from the midline during the swing phase of the stride. The history of dogs with TFMCP typically includes a lack of response to rest and non-steroidal anti-inflammatory drugs (NSAIDs). On physical examination discomfort is usually noted on direct palpation of the medial compartment of the elbow joint, specifically the medial coronoid process. Discomfort may also be noted on hyper flexion of the elbow. Most dogs with TFMCP are reluctant to allow for full end range flexion.

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Crepitus may be noted when placing the elbow through range of motion. Joint effusion may be detected as a fluctuant swelling beneath the lateral or medial epicondyle of the humerus. Depending on the chronicity, atrophy may be noted in the affected forelimb.

In addition to history, gait analysis, physical examination, orthopedic and neurologic examinations, further diagnostic tests used to differentiate causes of elbow pathology currently consist of hematology, biochemical profile, urinalysis, arthrocentesis, imaging modalities, and arthroscopy. Unfortunately, radiographs have been shown to be of little value because of difficulty identifying the fragment or line of separation using standard radiography. In some chronic cases, however, radiographs may reveal secondary evidence of bony remodeling consistent with osteoarthritis. Advanced diagnostic imaging modalities such as CT scans, MRI, nuclear scans, and arthroscopy may allow confirmation of the condition. Arthroscopy is an excellent modality for diagnosing TFMCP as well as a minimally invasive means of treatment. Arthroscopic removal of the fragments is recommended not only to remove the inciting cause of lameness but also to help prevent/slow the progression of osteoarthritis. Arthroscopy is not only a great diagnostic modality, allowing for superior visualization of structures within the joint, but also has less soft tissue trauma, shorter surgery and hospitalization times, decreased risk of infection, and shorter recovery times compared to the traditional surgical approach of fully opening the joint (arthrotomy).

Following arthroscopic treatment, dogs are typically prescribed NSAIDs for 14 days to help decrease inflammation and discomfort. In addition, an oral joint protective agent such as glucosamine, chondroitin sulfate, and avocado/soybean unsaponifiables (ASU), is recommended as a daily supplement for life. The anti-inflammatory properties and pain-reducing effects of these supplements have been well-documented. There is also evidence that they may have a cartilage protective effect. In addition a rehabilitation therapy program is recommended following elbow arthroscopy.

References