Joint mobilizations

When doing joint mobilization, one bone of the joint is stabilized while the second is motioned in specific patterns with a specific amount of pressure. Two terms are commonly used when describing what is going on, arthrokinematic and osteokinematic motion. Osteokinematic motion describes the big picture of what the bones are doing (i.e. flexion, extension, abduction, adduction) where as arthrokinematic motion is what the bones are doing at the joint and depends on which bone is stable and which is having pressure applied to it. If the convex bone is stable and the motion is from the bone with a concave surface, the arthrokinematic and osteokinematic motion is in the same direction. If the bone with the concave surface is stable and it is the bone with the convex surface the arthrokinematic and osteokinematic motion are going in different directions and so the force you are applying is applied in the opposite direction you want the bone you are motioning to go. The easiest way to remember this is “males go the wrong way”. An example of this would be glide at the hip, because you are motioning the bone with the convex surface to improve hip extension, the force applied to the great trochanter would be cranial (the “wrong way” from the direction you want the femur to move).

Joint mobilizations can be separated into roll, glide, and spin. Traction can also be used to stimulate inhibitory nociceptive receptors, diminish pain, and move the synovial fluid in the joint to enhance joint nutrition. The amount of pressure or traction applied and the amount of motion at the joint are other important aspects that we will review. We will discuss each of these individually.

A consideration has to be when will joint mobilization and soft tissue techniques be appropriate or inappropriate. The first step is to define “End Feel”. End feel is what happens when you reach an end of range of motion. For simplicities sake, we will only cover four of these. The first is “firm” which has some spring at the end and is secondary to stretch of tendon, ligament, and joint capsule. An example of this would be felt on extension of your metacarpo-phalangeal joint. The second is “soft” which is when muscle restricts further motion. An example would be flexion of the stifle of a well-muscled mastiff. It is the physical presence of muscle that is stopping the motion of flexion. The third is “bony”, which is when bone physically stops the joint motion. This can be normal as felt when extending your elbow, or secondary to osteophytes surrounding a joint. The last is “empty”, where there is no physical structure that stops motion, it is purely a pain response.

Maitland Joint Mobilization Grading Scale is based on amplitude of movement and where the force is applied within available ROM. Grade I is a small amplitude rhythmic oscillating movement at the beginning of range of movement that is used to manage pain and spasm. Grade II is a larger amplitude rhythmic oscillating movement within midrange of movement that is used to manage pain and spasm. Grade I and II are often used before and after treatment with grades III and IV. Grade III is a large amplitude rhythmic oscillating movement up to the point of limitation in the range of movement that is used to gain motion within the joint by stretching the joint capsule and connective tissue structures. Grade IV is a small amplitude rhythmic oscillating movement at very end range of movement that is used to gain motion within the joint when resistance limits movement in absence of pain. Grade V is a thrust technique or manipulation that is a small amplitude, quick thrust at end of range that is often accompanied by a popping sound. This technique would be considered a chiropractic motion and should not be performed without specific chiropractic training.

Indications for grade I and II joint mobilization are for pain and stiffness and can be done daily. Grades III and IV mobilizations are primarily used to increase motion at the joint. Stiff or hypo-mobile joints can be treated 1-3 times per week. This should be used in conjunction with active motion exercises. Do not treat hypermobile joint actions with actions that will stretch structures that increase instability, treatment options include improving normal motions if there are restrictions in a different direction and then strengthening the muscles, tendons, and ligaments that support that joint. An example would be carpal hyperextension, improving restricted flexion, while not stressing extension, will allow more normal ROM so the supporting structures can be strengthened without destabilizing the joint further.

Roll is the movement that occurs when equidistant points on the moving surface come into contact with equidistant points on the opposing joint surface. These motions would include flexion, extension, abduction, and adduction of the shoulder, elbow, carpus, hip, stifle, and tarsal joints. If this motion is uncomfortable, often doing other motions in a small oscillating fashion within the patients “comfort zone” (grade I &II mobilizations) allows roll to become pain free.

Glide is the movement that occurs when the same point on a moving surface contacts with a new point on the opposing joint surface. We use this often in ball and socket joints like the shoulder and hip, but also use it in the stifle, carpus, tarsus, and digits. When this motion is done, one bone stays stationary and the other is motioned. At the hip the pelvis is stationary and the femur is motioned. We look at the arthrokinematic motion and will follow the rule of thumb that “males go the wrong way”. The hip is held in a somewhat neutral to flexed position. The femur is held approximately parallel to the cranial border of the wing of the ilium and gently oscillated 15-20 times. Pressure is applied in a cranio-dorsal, cranial, and cranio-ventral motion. This is not three different
directions, but a continuum of motion. With the shoulder, the humerus can be stabilized and the scapula mobilized or visa-versa. If the humerus is stabilized it is the concave or female joint surface that is being motioned. The action that is usually restricted is extension of the shoulder. The scapula, female or concave joint surface, would be motioned cranially (the “right” way for the direction you want the bone to move for correct osteokinematic motion). We can perform the exact same joint surface motion by stabilizing the scapula and mobilizing the humerus, but the motion would be caudally. As with the hip, there is a continuum of motion in a semicircle of direction to find the joint capsule restriction and correct it.

At the carpal joint, stretching the joint capsule of the inter-carpal and carpo-metacarpal joints aids in improving restricted carpal flexion and diminishing pain at the joint. By placing caudal pressure on the radial carpal bone and ulna carpal bone, the female surface of the inter-carpal joint, we can increase carpal flexion if the joint capsule is part of the cause of the restriction. We can also oscillate the 2nd through 4th carpal bones caudally, the female surface of the carpal-metacarpal joint, to further enhance carpal flexion.

A glide of the accessory carpal bone can be performed by placing the joint in a neutral position and motioning the accessory carpal bone medially, laterally, proximo-lateral to disto-medial and back, and proximo-medial to disto-lateral and back.

Glide can also be used in the stifle as long as there is not compromised stability (i.e. injured cranial cruciate ligament). In this instance the female surface is the tibia. The femur is stabilized the motion of the tibia would be cranially to increase extension and caudally to increase flexion. The most common time I work with the stifle is when there is loss of extension after cruciate rupture and surgery so this technique would not be performed until the patient is completely healed from the surgery (usually 8-12 weeks).

Another, less commonly thought of place to use glide in the canine patient, but one that is extremely helpful is at the radio-ulna-interosseous joint. By stabilizing the ulna and motioning the radial head at a 60 degree angle caudo-lateral to cranio-medial, with a component of proximal to distal, flexion, extension, pronation, and supination can be improved as well as comfort.

When gliding digits for either restricted flexion or extension, the proximal bone is stabilized and the distal bone is motioned. As the convex and concave surfaces are present but minimal, I will often move the distal bone cranially, caudally, medially, and laterally. This usually improves motion, but must be done very gently.

Another joint mobilization technique is spin. Spin is the motion of a point on the moving bone surface creating an arc of a circle on the stationary bone surface as the moving bone spins. This motion is demonstrated by internal and external rotation of the limb at the hip and shoulder joint, but can also be used in the digits. Spin can be visualized best with a ball and socket joints. If the proximal bone is stationary and the distal bone rotates around the center axis the joint capsule is stretched evenly, which is different then some of the other techniques we have discussed. Spin can be applied with or without traction. Spin and Traction are the two most important joint mobilizations to treat pain and are frequently used to treat the joint before the other motions are implemented.

Traction is extremely useful for painful or arthritic joints. The direction of traction is extremely important in some of the canine joints. For instance, if the elbow was held in a straight position and traction was applied by pulling on the radius and ulna, an excessive force is placed on the anconeal process. If the same joint is placed at a 90 degree angle and the radius and ulna are pulled down the line of the humerus, the joint capsule can be stretched effectively to decrease discomfort at the elbow without any abnormal forces. The hock should also be stretched at a 90 degree angle with the pressure following the line of the tibia to stretch the fibro-talus joint. Traction can be applied to the toes both in a straight motion or applied in a circular manner stretching the dorsal surface of the joint. Straight traction is beneficial for dogs that have sensitivity or pain at the toe joints. Toe traction can be taught to some owners to be used daily, especially before walks. Straight traction of the toe joints involves placing one finger or thumb behind the pad and another dorsally and applying gentle traction straight out from the foot. Circular traction involves the same hand position but the dorsal joint surface is stretched more by placing downward pressure with the finger above the toe causing the toe to “curl” around your finger. This is beneficial for dogs that have restricted flexion at the digits. For carpal traction, one hand is placed above the carpus to stabilize the limb and the other hand is below the carpus applying gentle traction. Many dogs have discomfort at the carpal joints as well as restricted flexion due to fibrous tissue. Traction not only relieves discomfort, but can be one of the methods used to remove the fibrous tissue. The hip, shoulder, and stifle are placed in a neutral position, as though the dog were standing, when traction is applied.

Contraindications for joint mobilization include: active inflammatory arthritis, malignancy, ligamentous rupture, herniated disks with nerve compression, bone fracture, some congenital bone deformities, joint effusion (may use type I & II mobilizations to relieve pain), bacterial infection, sutures over the area, cellulitis, fever, hematoma, open wound at the site, hyperesthesia, and constant severe pain.

Precautions include: osteoarthritis, pregnancy, severe scoliosis, poor general health, hypermobility, and anticoagulation therapy or the patient’s inability to relax. Grade III and IV mobs are contraindicated in artificial joints.

Treating a patient
When approaching a patient we have to assess each joint before treating, even if we have seen this patient recently, as its circumstances can change from day to day. By taking the joint through range of motion in normal active directions as well as in other directions (ALWAYS while in the comfort zone of the patient) we are stretching the joint capsule, mixing the joint fluid to enhance
cartilage nutrition, and stimulating conscious proprioceptive and nociceptive (pain) receptors in the joint capsule and surrounding fibrous structures (ligaments and tendons).

Starting with the toes (front and rear are treated the same), each digit is flexed and extended. If a restriction is found, traction and/or spin of the joint that is restricted are often enough to break up the fibrous tissue and improve or normalize motion. If pain is found, straight traction will often relieve the discomfort, allowing the examination of flexion and extension. Metacarpals and metatarsals can be motioned by stabilizing one bone at the distal aspect and motioning the adjacent one dorsal and ventral. If there is a restriction, stabilizing one and mobilizing the adjacent one will break up the fibrous tissue allowing normal motion. Loss of flexion at the carpus is a common finding. Mobilization of the accessory carpal bone, cross friction massage to remove fibrous tissue over the metarsals can be motioned by stabilizing one bone at the distal aspect and motioning the adjacent one dorsal and ventral. If there is a restriction, stabilizing one and mobilizing the adjacent one will break up the fibrous tissue allowing normal motion. Loss of flexion at this joint. Another technique utilized more for pain can be done by stabilizing above the carpus with one hand and grasping the metacarpals with the other, compressing the joint, and while compression is maintained, motioning the joint so that the tips of the toes make large circles and there is minimal motion at the joint itself. If the major part of the motion is at the joint, and not the toes, the joint will have a “grinding” effect that can be painful and not beneficial for the joint. When done correctly, this can relieve pain and enhance joint nutrition as well as aid in proprioception.

Loss of elbow flexion is often seen with fibrous tissue buildup at the medial joint surface, enthesopathy. Traction with the joint at a 90 degree angle, cross friction massage directly over the fibrous tissue, traction with your fingers as a fulcrum creating a long lever technique to stretch the caudal aspect of the joint, and grade III joint mobilization at the radial ulnar interosseous joint can all relieve pain and enhance joint motion. True shoulder extension, when the scapula is stabilized, can be restricted by the joint capsule (which can be mobilized as described previously) or by excessive tightening, spasms, or knots/trigger points in the triceps or deltoid muscles. Manual therapy techniques can be utilized for the muscle issue to increase mobility. Once true shoulder joint restrictions have been addressed, the musculature around the scapula needs to be evaluated. With the dogs back straight and the head at a 90 degree angle, the forelimb should be able to be brought forward to touch the medial canthus of the eye. When the limb is stretched back, the forelimb toes should be able to come to the stifle when the rear limb is in normal standing position. If this is not possible there are multiple muscles that can be restricting this motion. We will review how to assess each muscle noting that the stretch for each muscle as well as the manual therapies described above can be used to enhance flexibility, allowing for more normal motion. Straight abduction with the limb in neutral evaluates/stretches the pectoral muscle. With the shoulder and elbow flexed and the limb externally rotated, the subscapularis muscle is evaluated/stretched. With the elbow and shoulder in extension, the limb is internally and externally rotated evaluating the caudal and cranial trapezius muscle respectively. If the forelimb is brought back and the scapula rotates on the body wall but the elbow does not extend fully, the biceps brachii muscle is the restricting muscle. These motions are repeated after each manual therapy until all motions move fluidly and without pain.

Flexion of the hock can be affected by multiple factors. Although most of the motion is at the tibio-talus joint, mobilizing the other joints can affect the overall flexion and health of the joint. Stabilizing the tarsal bones and supinating and pronating the foot motions the tarsometatarsal joints. Stabilizing the tarsal bones and “wiggling” the calcaneous bone evaluates and stretches the talus-calcaneous joint and capsule. Mobilizing the tarsal bones with cranial to caudal and caudal to cranial motions as done with the carpus (intertarsal joint capsule stretch) are all indirect ways to affect the joint. One way to affect the tibio-tarsal joint directly is to stabilize the tibia with the hock at a 90 degree angle and to mobilize the talus by holding the limb below the hock and oscillating it cranially 15-20 times and then caudally 15 to 20 times. The other method, a Mulligan technique, stabilizes the tibia with the tarsus in a neutral position, internally rotates the foot below the tarsus, and flexes of the tarsus repeatedly feeling tension with each oscillation. After about 15-20 oscillations, the tarsus should be fully extended and then fully flexed and then flexion can be re-evaluated. Soft tissue manual therapy techniques can be used if there is excessive tightening of the gastrocnemius, superficial digital flexor, or deep digital flexor muscles. Loss of flexion at the stifle can be affected by fibrous tissue restricting patellar glide. If this is the case, it can be detected and corrected by placing the stifle in full extension and mobilizing the patella medial to lateral, proximo-medial to disto-lateral, and proximo-lateral to disto-medial. Loss of flexion can also be caused by muscle problems in the quadriceps femoris or sartorius muscles. Manual therapy techniques can be used to restore motion if this is the case. It is very common to have muscle issues cause loss of extension of the hip. The sartorius, rectus femoris of the quadriceps, pectineus, and tensor fascia lata muscles are the most likely muscles, but the ilioisquial muscle can also play a role. The ilioisquial muscle is evaluated by extending the hip and internally rotating the limb. If this is uncomfortable, the iliopsoas is the culprit. The pectineus is palpated by abducting the limb. If this is restricted, manual therapy can be used to improve first abduction and then indirectly, hip extension. If the muscles are normal, the joint capsule is the most likely problem. A glide can be done by placing the femur parallel to the wing of the ilium and oscillating the greater trochanter toward the ilium from the caudal to cranial. Often the direction of the restriction can be felt and corrected by moving the oscillating contact point up and around the greater trochanter. Hip extension should then be improved and pain resolved. If hip extension is still painful, slight abduction and rotation of the limb (internally and externally) creates a spin that can relieve pain. Extension should be re-evaluated after this has been done several times. The next position to evaluate is to see if there is a restriction when the rear limb toes are brought to the elbow. The lumbar spine must remain in a straight position when this is evaluated or you
can put abnormal stress on the lumbar spine and not be stretching any of the muscles you want to evaluate and treat. The muscles that can be restricting this motion may be one of the hip extensors (biceps femoris, semimembranosus, semitendinosus, or gracilis muscle), the middle gluteal muscle, or the iliocostalis muscle. Each needs to be palpated during the stretch to be evaluated. Manual therapies can be utilized to restore motion if there is a muscle problem. The ilium may also have restricted motion on the sacrum affecting the toes reaching the elbow. The ilium can be evaluated and treated by motioning it cranial-caudal along the line of the ilium, clockwise, and counter-clockwise. When rotating the ilium it must be understood that there is a 20 degree angle between the sacrum and the ilium and if you do not take this into account you can cause more restrictions then are currently present.
The musculoskeletal exam
A thorough musculoskeletal exam begins with a thorough history and a general physical exam to identify or rule out physical ailments that may be mistaken for a musculoskeletal condition. In the history it is important to identify the duration of the problem, the progression (is it getting better, worse, or staying the same), what the patient can do (i.e. climbing stairs, jumping or climbing on the couch and/or bed), and what the patient does each day (walks- how frequent and how long, crate vs. free reign of the house, how often are they trained if they are a working dog…).

Digits
The forelimb toes are examined by assessing the digits for bony or soft tissue swelling, previous fractures, or pain on palpation, extension or flexion. The second and the fifth digit should flex to the same position while the third and fourth digit should flex to the same position, and all should be able to flex to be perpendicular to the line of the metacarpal or metatarsal bones. The most common condition seen at the digits is osteoarthritis with secondary restricted joint motion, flexion or extension, with or without pain.

Metacarpo-phalangeal joints
The metacarpo-phalangeal joints may hyperextend if the animal chronically pulls their weight forward, has chronically long nails, or if there is a metabolic ailment causing a generalized ligament laxity. The 2nd and 7th sesamoid bones are the most likely to be fractured. Clinical findings include thickening of the second or seventh sesamoid that correspond to the second or fifth digit. Surgical removal frequently destabilizes the digit and so support and strengthening are the treatment of choice. These joints will be chronically thick, but can become pain free and may have full range of motion with rehabilitation. Restricted flexion of the metacarpo-phalangeal joints can also be seen with osteoarthritis and immune mediated polyarthropathy.

Carpus
The majority of carpal joints issues commonly seen are loss of flexion secondary to chronic hyperextension and acute traumatic hyperextension injuries commonly seen from jumping off of heights. Hyperextension can be seen when standing or by assessing extension manually, making sure the elbow in extension when evaluating the carpus. Flexor carpi ulnaris tendon injuries may include strains, core lesions (significant thickening), calcification from chronic repetitive injuries, complete disruption or avulsion. Grade 1 strains are tender with out palpable thickening; Grade 2 strains are thickened, tender acutely on palpation and tender on stretch when chronic. Grade 3 strains are a full rupture and will need surgery.  With the carpus in flexion the edges of the carpal bones should be easily palpated. If not, either there is synovitis, thickening of the joint capsule with a firm, thick texture, or effusion with a fluctuant texture.  It is also common in carpal injuries to have edema in the extensor tendon peritendinous sheath. Diagnosis is achieved when tubular structures running parallel to the antebrachium are palpated across the joint.

Elbow
Elbow Dysplasia (ED) is, by definition, abnormal formation of the elbow joint and encompasses 3 three etiologies including fragmented coronoid process (FCP), ununited anconeal process (UAP), and osteochondrosis (OC). FCP of the ulna has a genetic component with the most common breeds affected being Labrador Retrievers (18-50%), Bernese Mountain Dogs, and Rottweilers. FCP occurs bilaterally in 50-90% of dogs where one side is affected and can be seen with OC in 60% of cases. Dogs usually present with discomfort at either 4-12 months of age or later in life secondary to osteoarthritis. When dogs have clinical signs at a young age they typically include a lameness aggravated by activity where the dog shifts weight off of the more severely affected limb and may hold the limb in external rotation.

There may be muscle atrophy in the forelimb and hypertrophy in the rear secondary to a caudal weight shift. Effusion, which would be found on the lateral aspect of the joint, is rarely present. Pain can usually be elicited in these cases by supinating the antebrachium and flexing and extending the elbow. Another common finding is pain on deep palpation over the insertion of the biceps brachii tendon at the medial aspect of the ulna. Chronic signs include fibrous thickening of the medial aspect of the elbow, crepitus, and loss of both flexion and extension of the elbow. Even when pain is resolved, a mechanical lameness may persist due to the inability to fully extend the elbow. Clinical signs for FCP and OC are identical and x-rays of the elbow are not sensitive to identify FCP, therefore, if these clinical signs are present and the owner wants to pursue surgical treatment, arthroscopy +/- CT or MRI are the diagnostic tools of choice. In a study comparing arthroscopy with conservative treatment (NSAIDs and exercises), where objective gait analysis was used to evaluate outcomes, at 4 and 8 weeks the dogs that had surgery had significantly worse limb function.
compared to the rehab group. At 6 and 12 months there was no significant difference between groups suggesting that a rehabilitation approach is superior to a surgical approach in these cases.

UAP is not as common as the other causes of ED and is only found in large breed dogs, as small breed dogs do not have a separate center of ossification of the anconeal process. Clinical signs include lameness between 5-20 months of age with palpable crepitus on flexion and extension of the joint and effusion at the lateral joint surface.

Traumatic fragmented medial coronoid process (TFMCP) or “jump down syndrome” is the most common elbow injury seen in performance, working, or highly active dogs. This may be caused by repetitive subchondral micro-fractures from abnormal jumping or a repetitive pull of the distal biceps tendon where it inserts on coronoid process causing it to medially rotate into the radius causing micro-damage to the subchondral trabecular bone. Another theory is that these dogs are predisposed due to an incongruity in the elbow where the ulna is longer then the radius. This would cause more pressure at the coronoid-trochlear articulation, leading to fracture of this process. OA is inevitable as there is a continuum of cartilage softening, fibrillation, fissures, erosions, and subchondral cracks. Just as with FCP, there is an intermittent lameness exacerbated by exercise, but it is uncommon to be bilateral. The lameness progresses and is not responsive to NSAIDs and rest. Patients can be painful on direct pressure over the coronoid process, resist full or hyper-flexion of the elbow, are painful on carpal flexion with external rotation while extending the elbow (this puts load on the medial compartment), and/or have joint effusion at the lateral joint surface.

**Shoulder**

Trigger points and excessive muscle tightening can be identified in the biceps brachii, triceps and deltoid muscles. Trigger points are commonly found in the triceps muscles, especially in working dogs, and can be palpated as either bands of tight tissue or round hard areas in the long or lateral head. The biceps muscle is palpated while in a shortened position as well as during stretch. The muscle should be taunt on full stretch. If it is taunt before getting to a full stretch it indicates an abnormality in the tissue. To stretch the biceps brachii the shoulder is flexed and then the elbow is extended. The forelimb toes should touch the stifle if the rear limb is in a neutral standing position. If the scapula rocks back on the body wall, but the elbow does not extend, the biceps brachii muscle is affected. If the elbow extends all the way but the scapula does not rotate on the body wall, then the problem may be in the pectoral, brachiocephalicus, trapezius, rhomboids, or subscapularis muscles. When the pectoral muscle causes the restriction the limb will not be able to abduct easily. If the dog picks up its head each time the limb is rotated caudally, the brachiocephalicus muscle is affected. Locking the shoulder joint in extension and internally and externally rotating the forelimb will stretch the trapezius muscle, valuating it. The scapula should “rock off the body wall” at its cranial and caudal border. Tight bands in the trapezius of muscle will hold it down on the body. These bands can be palpated, stretched, massaged, or treated with laser to allow normal motion. The rhomboideus muscle is evaluated by moving the scapula dorsal and ventral on the body wall. Rhombooid muscle tension can be eliminated with a quick stretch in the direction of the greatest restriction. The subscapularis muscle is evaluated by flexing the shoulder and externally rotating the forelimb, assessing if the distal aspect of the scapula can rock off the body wall. Massage, stretching, and laser therapy can bring this muscle back to normal length improving “Reach”. The most common shoulder lameness causes include the supraspinatus tendinopathy, biceps brachii tendinopathy, medial shoulder syndrome (MSS), OC of the humeral head, and infraspinatus fibrotic contracture. Supraspinatus tendinopathy is considered an overuse condition due to the loss of elasticity with discontinuous and disorganized tendon fibers and no active inflammation. These fibers, on diagnostic ultrasound, appear hypoechoic and are termed “a core lesion”. Mineralization may be observed on radiographs, but it cannot be differentiated from mineralization of the biceps brachii tendon. Supraspinatus muscle atrophy can be present if the condition is chronic. Lameness is usually a drop in the shoulder during the stance phase of gait, is exacerbated with exercise, and is non-responsive to NSAIDs. The tendon can be thickened on palpation and pain may be elicited on palpation of the tendon as the shoulder is flexed. Biceps tendinopathy may be primary, secondary to impingement from the supraspinatus or referred elbow pain from the muscle pulling at the point of insertion. This is also a repetitive, overstretch strain injury that can lead to degeneration of the tendon. Common clinical signs associated with biceps tendinopathy are trouble jumping, inability to “wrap”, or make tight turns, trouble with two-on-two-off contacts, and knocking bars with the forelimbs. Lameness may be intermittent subtle to severe and is exacerbated with exercise. Palpation of the biceps tendon usually elicits pain and the tendon itself is thickened. The biceps muscle belly is usually thickened, lobular, and unable to stretch; shoulder flexion with elbow extension.

If the shoulder flexes, the elbow extends, and the forelimb toes are able to be brought up above the dorsal surface of the back, a bicipital tendon tear or superglenoid tubercle avulsion fracture is diagnosed.

Medial Shoulder Syndrome (MSS), a cause of lameness especially in working dogs is defined by either a partial labral or capsule tear, ligament disruption, or subscapularis tendinopathy. This is considered an overuse or repetitive use injury and as such the lameness may be intermittent to constant, and exacerbated by exercise. To assess for MSS the shoulder is locked in extension, the scapula is stabilized, and the forelimb is abducted. If pain, spasm, or increased lameness after this test is performed, then MSS is likely.
Osteochondrosis (OC) of the shoulder is found on the caudal aspect of the humeral head in medium, large and most commonly giant breed dogs. Clinical signs typically appear between 4 and 8 months of age. Radiographs are typically diagnostic.

Infraspinatus fibrotic contracture is most commonly seen in hunting and working dogs and may be traced to an earlier short-lived lameness. Typical clinical signs include shoulder abduction with restricted extension, antebrachium external rotation, a mild lameness with the limb advancing via circumduction of the limb and the paw flipping into extension before striking the ground.

**Tarsus and musculature**
The tarsal joint is evaluated for joint effusion and soft tissue swelling. If joint effusion is present at the cranial surface, acute trauma, tick born, and autoimmune diseases should be considered. Testing for crepitus is most sensitive when pressure is applied between the talus and the tibia and full flexion and extension is performed.

Superficial digital flexor (SDF) luxation is a condition where the tendon luxates, usually laterally, off of the calcaneal bone causing lameness. Clinical signs may include swelling over the calcaneus and a “pop” as the tendon luxates upon flexion of the tarsus. This is most common in young Shelties and there may be a concurrent bursitis associated with it.

Damage to the common calcaneal tendon is usually traumatic in nature and can be a partial or full tear. The SDF is intact with a tear of the gastrocnemius when the tarsus is close, but not touching, the ground and the toes are in constant flexion. If the gastrocnemius has a partial tear at the origin there will be heat and a palpable hematoma or ball of fibrous tissue depending on chronicity. A full tear of the common calcaneal tendon will result in a plantigrade stance.

Hyperextension of the tarsus is found with dogs with chronic stifle disease or primary tarsal disease. The clinical appearance of the patient is a dog that stands with the pelvis tucked, the hips and stifles in flexion, and the tarsal joints in extension to hyperextension. During the stance phase of the stride the tarsal joint may extend past 180 degrees. This leads to lumbar pain in conjunction with the limb joint pain (tarsus, stifle, +/- hip).

**Stifle and musculature**
The patella is evaluated for medial and lateral luxation on extension of the stifle. Effusion at the stifle can create a temporary luxation, therefore if it is present when luxation is diagnosed, this should be controlled and the stifle reassessed. Medial patella luxation is more prominent than lateral in both small and large breed dogs, is bilateral in 50% of dogs, and is more prevalent in females then males. To establish luxation with the least amount of pressure the tibia is rotated externally when evaluating for medial luxation, and internally when evaluating for lateral luxation. Clinical signs of patella luxation include intermittent skipping and having the dog trying to replace the patella by extending the limb out behind it. There are four grades to patella luxation: In Grade I the patella is in the groove, can be manually luxated, but reduces as soon as the pressure is removed; in grade II the patella moves in and out of the groove (out during flexion and in during extension); in grade III the patella is luxated most of the time but can be manually reduced; in grade IV the patella is outside of the groove and can not be manually reduced.

Anterior drawer and cranial tibial thrust are tests to identify CCR. In an anterior drawer assessment the proximal hand stabilizes the femur with the thumb and middle finger behind the femoral condyles and the pointer finger on the patella. The distal hand is placed with the thumb and middle finger on the caudal surface of the tibia with the pointer finger on the tibial crest. The proximal hand stabilizes the femur while the distal hand places the stifle at an approximate 120 degree angle and attempts to displace the tibia cranially. This is repeated with the stifle in flexion to assess for a partial CCR. If motion is found the cruciate may be ruptured. If there is a minimal amount of motion it should be compared to the opposite limb.

Cranial tibial thrust is performed with the proximal hand stabilizing the femur with the thumb and middle finger behind the femoral condyles. The pointer finger barely touches or is a hair width away from the tibial crest, the distal hand cups the tarsus in the palm and while keeping the stifle at the same angle, flexes the tarsus. If the tibial crest moves cranially into the pointer finger, the cranial cruciate ligament is compromised. The most common errors made during this assessment are allowing the stifle angle to change while assessing the joint and pressing/holding the tibial crest in place with the proximal hand pointer finger. This motion should be assessed in multiple positions. This test is more comfortable for the patient with a CCR then anterior drawer.

**Hip and musculature**
Quadriceps contracture is characterized by scarring of the muscle causing shortening and an inability to flex the stifle. It can be seen after a distal femoral fracture in a young dog, especially if the limb is immobilized in extension with a cast or splint. Fibrosis of the quadriceps may take place in as little as 5-7 days. Other causes of quadriceps contracture include Neospora and severe muscle trauma.

Sartorius and tensor fascia lata muscle trigger points should be assessed with the hip in extension as these are hip flexors. Lack of flexibility in these muscles can prevent full hip extension in the absence of hip joint disease. Once restricted hip extension secondary to muscle involvement is ruled out, pain on motion of the hip, sacro-iliac (SI) joint, and lumbosacral joint can be assessed. To isolate each of these areas, first the tuber ishii is stabilized while the hip is extended, isolating the hip joint. Pressure is maintained on the femur as the stabilizing hand moves from the tuber ishii to the sacrum and the femur is further caudally rotated, isolating the SI joint.
Pressure is maintained on the femur again as the stabilizing hand moves from the sacrum to L7 and the femur is further caudally rotated, isolating the lumbosacral joint.

The hip can be evaluated for luxation with two special tests. The first is performed by placing a finger between the greater trochanter and the tuber ishii and externally rotating the limb. In the normal hip the finger is displaced by the greater trochanter. The second test looks at the shape of the triangle formed by the most dorsal aspect of the tuber ishii, greater trochanter, and wing of the ilium. Presenting clinical signs of hip luxation typically include a dog with a non-weight bearing lameness with external rotation and adduction of the limb. Frequently there is a firm palpable swelling above the hip joint; this is the displaced greater trochanter. The cranial dorsal movement of the greater trochanter is secondary to the pull of the iliopsoas and the gluteal muscle groups that attach to the lesser and greater trochanter respectively. Hip luxation is common and usually secondary to an automobile accident though may be chronic and secondary to severe hip dysplasia.

A sensitive test to assess hip laxity can be performed by having the dog laying in lateral recumbency, lightly placing the center of the palm of the proximal hand over the most dorsal aspect of the greater trochanter, stabilizing the stifle and preventing limb abduction with the distal hand, and creating a long lever lateral force. The top of the greater trochanter should not move into the palm of the hand, if it does, there is laxity. Laxity is to be expected in puppies under 4 months of age and old lean dogs where there is not enough muscle to hold the femur in place. Laxity in any other dog is considered abnormal. With exercise, this laxity may disappear.

Evaluation of the deep and middle gluteal muscle is performed by assessing for consistency in shape from the wing of the ilium to the greater trochanter. It may be convex or concave, but not a combination, as this would indicate a trigger point.

The Ortolani test is another test to check for hip laxity. This test is performed by placing the limb in adduction, applying pressure dorsally, and then slowly abducting the limb. A positive test is if the head of the femur pops back into the acetabulum on abduction. This test is only valid for dogs under 6 months of age and the research shows that if the test is positive there is only a 50% chance of dysplasia on OFA radiographs at 2 years of age. 50% of dogs that have a positive Ortolani sign at 6 months of age have no dysplasia via OFA radiographs at 2 years of age. This is a test that should be done under sedation or anesthesia, as it can be very uncomfortable.

The pectineus muscle is just cranial to the adductor muscle and can be palpated as a tight band on the medial thigh when the rear limb is abducted and should soften with adduction. This is one of the major hip stabilizer muscles, along with the gluteal muscles, and when over worked, can have trigger points (palpated as peas in a pod) or be very tight. In some animals it may spasm and cause pain with ambulation.

Contracture of the semimembranosus, semitendinosus muscles, and/or gracilis muscles, aka Fibrotic Myopathy is commonly seen in German Shepherd Dogs that are competitive athletes or working dogs, especially police dogs and dogs trained in Schutzhund. This is a disease where micro tears are evident in the muscles leading to scar tissue formation and the inability of the muscle to stretch fully. This can be a crippling disease. Diagnosis is by not being able to stretch these muscles and having them have a fibrous feel, even when not in a stretched position.
Assistive devices can be extremely beneficial

Independent locomotion is critically important in dogs. In fact, companion animals that have lost the ability to walk independently are at risk of being euthanized. Many geriatric patients are at greater risk and can benefit from assistive devices. Some can be as simple as boots that help prevent slipping on a home’s tile floors, others can be as complex as carts for dogs that can no longer use two or even four limbs optimally or prosthetics to allow arthritic dogs to ambulate after a partial amputation. Assistive devices may decrease complications present in recumbent patients including decubitus ulcers and urine scald. Assistive devices can give back independence for dogs that have lost the endurance, strength, or neurological capacity to ambulate fully on their own. These devices can be used to motivate dogs that are weak to allow them to build the strength to once again walk, run, or even jump again. Some devices are designed to prevent pressure sores or allow them to heal. They can also be an aid to pet owners to decrease risk to their bodies by allowing proper body position while assisting their pets. Some devices can be easily purchased by clients on the internet, but some require significantly more training and expertise. In order to succeed with prosthetic and orthotic devices, accurate assessment and a comprehensive knowledge of rehabilitation, orthopedics, biomechanics, and prosthetics is required.

Carts – pros of individual carts

Walkin’ Wheels make carts in two sizes, below 20 pounds and 20-180 pounds. They are adjustable and can be used in the clinic for many sized dogs. They are lightweight, allow the dog to use the rear limbs, and can be adjusted to almost any dog. They have the ability to be counter balanced to allow the cart to take the weight off of the front limbs if they become weak as in a dog with degenerative myelopathy. Eddie’s Wheels is custom made to the individual pet and very specific measurements must be made and sent in to the company. They are able to make carts for dogs with problems utilizing the forelimbs, rear limbs, or all four limbs. They also have a cart that can be used over a land treadmill to support the dog’s weight while they use their limbs to ambulate. Doggon Wheels are also custom built carts that can be utilized for dogs with problems utilizing the forelimbs, rear limbs, or all four limbs. They have a neoprene saddle to decrease the chance of abdominal skin burn from rubbing. Dewey’s carts are less expensive custom made carts that also have a neoprene saddle for the dog to sit in. K-9 Carts were one of the first companies to produce carts for dogs. The saddle the dog sits in is a foam covered metal support. Evan’s Mobility Carts are made of PVC pipe and have different types of wheels. Some people even home make their own carts out of various materials due to the cost of the custom built carts. There are several sites on the internet that show how to make carts for the mechanically inclined. Many companies allow you to purchase used carts and then have them retrofitted to a new patient.

Harnesses

The Help-em-up harness is a great tool to have in the clinic as well as to send home with patients. There is a front and a rear piece, each with a handle, and each can be used independently or they can be connected together. It is easy to put on and take off and usually clients can easily adjust the straps for a good fit. If the patient is a male and the under piece affects the prepuce, there is a male adaptor piece that can be purchased that displaces the abdominal support to a different location for patient comfort. The Solv-it is less expensive, less physical material, and harder to figure out. It can be a good alternative when finances are an issue and the client is willing to work a bit harder at fitting and dressing the dog. The Ginger lead has a sling like base that attaches to the collar to aid in staying in place. As in all sling like devices this may put pressure on the prepuce, unintentionally express the bladder, and if too much upward pressure is applied, lifting the dog, places the spine in extension at the cranial border and flexion at the caudal border. The walk-a-bout sling design allows the rear limbs to go through the neoprene device, lifting the dog by the pelvic floor rather then by a section of the spine. This is a better option then a sling for dogs with IVDD or who have weak bladders that are easily expressed when a sling or towel is used to support weight. Bottom’s Up devices wrap around the rear limbs applying slight lateral pull slightly abducting the rear limbs. This may be beneficial for neurological patients that cross over in the rear limbs. In The Company of Dogs catalog there is a harness that has a handle in the thoraco-lumbar region allowing the handler to lift from the middle of the dog. This is beneficial if both fore and rear limbs are affected. There are also many homemade slings and harnesses that can be found on the internet with instructions on how to create your own.

Other aids

Stair lifts are available for sale, made by the people that build them for people, but they may be cost prohibitive.

Show foot is a spray that creates a slightly sticky surface when sprayed on the pads of the feet preventing or diminishing slipping. This usually has to be applied every 3-4 days or if the dog is in a frequently wet environment, more often. Rubberized socks and boots
can also help prevent skipping on slippery surfaces. Yoga mats can be laid down in slippery areas or, if bought by the role, can cover an entire floor surface.

Long nails increase the chance of slipping as well as damage the tendons and ligaments in feet leading to an inability to flex the toes and grip surfaces. If nails are trimmed and there is still an issue with sliding of the feet on slick surfaces, Dr Buzby’s Toe Grips may reduce sliding.

If the patient is small, unable to use the rear limbs, creating drag sores, and there is no hope that function will return, Drag Bags may prove helpful. This should not be utilized if there is hope of return of any function, as it will stifle it.

There are many types of boots, each situation needs to be evaluated for the best product for that patient. Some are heavy but take a long time do wear through, some are light weight and thin so the patient can easily pick up the foot, some are breathable to decrease moisture buildup and dermatitis, and some have significant traction to aid in slipping or to allow then patient to ambulate over rough terrain.

If lateral sliding of the fore limbs, medial shoulder instability, hygroma, or ulceration of the elbows are an issue, Dog Legges products may be beneficial. They cover and cushion the elbow and can be connected ventrally to prevent abduction of the forelimbs which is imperative post medial shoulder instability surgery.

Human or Doggy diapers may be used as a bellyband or to go around the back end. If human diapers are used for fecal incontinence then a tail hole must be added. If urine scald is present, there are multiple ointments available over the counter. Zinc oxide ointments (diaper creams), thought toxic in large doses, can be applied sparingly for quick results.

Orthoses may be used to prevent hyper-extension of carpal, tarsal, or stifle joints, add length to a short limb, or add dynamic pressure to a restricted joint. They can be made with a hinge to enhance functionality.

Dorsal tarsal flexion assist devices can cue timing for muscle contraction by applying a variable tension that stimulates flexion of the tarsus upon initial swing phase of the stride. These can be attached from the most distal aspect of the foot to the proximal tarsus or to the harness. Using a cord with rubber bands is a quick and inexpensive way to determine if these devices will be beneficial. This is not a long term solution as they can stretch the digital flexor muscle and tendons and create discomfort if left on too long.

Air splints are utilized to maintain one or multiple joints in a stable and continuous position to allow a weight bearing stance when the dog would otherwise be unable to prevent buckling of the limb.

Elevated feeders are beneficial to dogs that have cervical pain, weakness, or neurological conditions that make lowering the head to the floor difficult or uncomfortable. Stairs or ramps can allow dogs that are weak or unable to jump to get on furniture independently.

Compression wraps and Thunder shirts can be beneficial for geriatric patients with cognitive dysfunction syndrome that become anxious when left alone or in new situations. An inexpensive alternative that sometimes works is using an Ace bandage in a cross-over pattern. This design is a Tellington Touch method that can have great results in some dogs.

Cooling mats, ones that contain water to conduct heat away from the dogs’ body can help dogs that are routinely hot and want to lay on the cold floor, but are stiff upon rising. Fans on the floor, especially in front of the air conditioning vent, allow dogs to cool off when they want and walk away if they get too cold. Bedding can also warm dogs that seek heat and create a soft comfortable place to relax. Some beds have a porous surface for those pets that are urinary incontinent. In these cases pee pads can be placed under the cot to absorb any urine that leaks during slumber.

References
Working dogs can be injured in many ways. Understanding what was injured, how it heals, and how to strengthen it to prevent re-injury, is extremely important. Sprains, strains, and tears are common injuries that once the healing begins, can be re-injured unless the damaged tissue can heal and then be strengthened fully before the canine patient is allowed to go back to a full work load. A sprain, by definition, is damage to a ligament secondary to a stretch or tear of the ligament without an associated bone fracture or joint dislocation. Studies on ligaments show that at one year post injury the tensile strength is only about 80% of its original strength. Therefore when a ligament is injured, the rate of exercise intensity is much slower then if a muscle or tendon is injured. A muscle heals faster then a tendon as it has a significantly higher blood supply. A muscle strain, or muscle pull, is damage to a muscle or its attaching tendon, usually as a result of a strenuous activity. A strain can be accomplished during sports or during a course of normal daily living activities. As most working dogs are high drive, even going out to run in the back yard can be strenuous. A severe muscle strain can result in a muscle tear. The tearing of the muscle can also damage small blood vessels, causing local bleeding (with or without bruising) and pain (caused by irritation of the nerve endings in the area). Strains are graded on degree of damage to the muscle. A Grade 1 strain is mild damage (less then 5% of the fibers damaged) where there is pain at the muscle on palpation but no gross lesions are found. There is minimal loss of strength and motion. These injuries generally take about 2-3 weeks to heal. A Grade 2 strain is more extensive with more muscle fibers disrupted and a significant loss of strength and motion. These injuries may require 2-3 months to heal and come back to normal function. A Grade 3 strain is a complete rupture of the muscle or tendon. These may present with a palpable defect in the muscle or tendon, acutely a hematoma, or an area of thick fibrous tissue. Caught early, these may be surgically corrected.

The body’s reaction to an injury is to lay down fibrous tissue, first in an unorganized fashion, and then, if proper stretch and blood flow are available, to organize into a stronger bonded area. Depending on the degree of injury, this area may never have the strength of normal healthy tissue, but by building up the strength of the tissue around it, we can decrease the chance of the injured area being stressed to the point of re-injury.

There are changes that can be seen in muscle tissue with exercise. These changes take 3-4 weeks to start to be observed. In contrast, it takes 3-4 months to start to strengthen ligaments. One time when we see injury is when the dog starts to gain strength in the muscles, after the first four weeks of exercise, and before the twelve week period, when the tendons and ligaments gain strength to catch up to the muscles. We commonly see carpal hyperextension injuries or ligament stretch injuries during this time.

Type I muscle fibers are fibers that are considered slow twitch, oxidative (aerobic) fibers that are slow to contract. They are used in low intensity exercises such as light resistance work, used for muscular endurance and long duration aerobic activities like long runs (for example - field work). They have a slow contraction time, but are quite resistant to fatigue. Type I muscle fibers have a high mitochondria and capillary density. To strengthen Type I muscle fibers endurance, aerobic, exercises are performed. Endurance or aerobic exercises, over time, have local and systemic effects. At a local level, endurance exercises strengthen the Type I muscle fibers, increase fiber capillary density, increase oxidative enzymes in the muscle fibers, and increased lactate threshold in the muscle (intensity of exercise where lactic acid starts to accumulate). Systemically, endurance exercises improve cardiovascular and neurological efficiency. Adaptations include: lower resting heart rate, increased interventricular septal thickness and heart weight, stronger connections between neurons with enhanced firing frequency and spinal reflexes, improved VO2 max (maximal O2 consumption, the point at which O2 consumption remains the same even when workload is increased). Exercise is considered endurance work if the dog is trotted for at least 20 minutes or swims continuously for 5 minutes. The ideal gait for endurance ambulating is a trot (diagonal limbs move together), as this works the limbs evenly. A soft, forgiving surface (dirt, wood chips, or a rubberized track) should be used to decrease the chance of repetitive motion joint injuries. Land treadmills can be used as long as the length of the tread is at least 2.5 times the length of the dog. As the treadmill requires less muscle activity then running on land, treadmills should not be the only endurance exercise for athletes that require significant endurance in their sport (mushing, field work, and herding). Swimming can be done in a pool or lake with the dog staying in the water to retrieve or swim along with the owner. The underwater treadmill is a cross between the two with added buoyancy, but significantly more resistance then trotting in air. Even for dogs whose job it is to do short bursts of activity (utilizing Type II muscle fibers), it has been shown that endurance exercise makes them more competitive and less likely to be injured. When these muscles are the predominant muscle fibers we see small circumference high tone body musculature, much like we would see in a marathon runner. This is in comparison to when Type II muscle fibers are the predominant strengthened fibers where the body appearance shows significant hypertrophy with increased muscle circumference, as seen in body builders. It has been shown that no matter what the sport, a degree of cross training improves performance and decreases the chance of injury.
Type II fibers are fast twitch, high force, high power, high speed contractions with low endurance. The energy used by these fibers is anaerobic or glycolytic. With exercise, the local effect is an increase in glycogen storage in the muscle fibers to allow increased glycolysis. These exercises can be performed by having the dog perform repetitions of an exercise or by doing an endurance exercise with resistance of an external force. Exercises that can be done as repetitions for strengthening can be grouped by body part.

Examples of strengthening exercises for the trunk and neck include: Sit Up And Beg, Snoopies, Roll Over, Crawling, Balance Beam Or Blocks, Wobble Board, Backing Up on an Incline and then Decline. Exercises to strengthen the forelimbs include: high 5’s (straight and with abduction and adduction), play bow, digging, swimming, backwards crawling, and low tugging. Exercises that specifically strengthen the rear limbs include: Dance; Ball Work with the forelimbs on the ball, walking the ball forwards, backwards, and sidestepping around it; Beg-Stand-Beg; Sit-to-Stand on a Hill (facing left right and up); high tugging, and jumping. Examples of resistance training would be accelerating uphill against gravity, wearing an appropriate harness and pulling a cart or weights, moving with resistance (in water or against therapy bands), and braking against momentum (acceleration/deceleration exercise). The purpose of this training is to gradually and progressively overload muscle tissue to improve strength, often observed as improved muscle tone and hypertrophy.

Balance and proprioception exercises also decrease the chance of injury by allowing the athlete to barely clear a bar and land correctly as they are twisting for the next obstacle, wrap around a pole, and take off using just enough expenditure of energy to accomplish their goal. Proprioception, knowing where the body is in space, comes from information provided by both the sensory neurons in the inner ear, and the stretch receptors in the muscles and ligaments that support the joints. Connections between neurons can be strengthened, and the number of synapses increased, improving proprioception and balance to decrease the chance of injury. Examples of exercises that work on proprioception and balance include: walking over poles laid out in different directions and at different heights; using a wobble board; and having the dog walk over a ladder. This type of work will allow the dog to be able to perform complex tasks for longer periods of time without fatigue.

Skill training is training of the specific acts the dog will need to perform to compete in their sport. This may be long or high jumps, weaving, pulling a cart, running over a dog walk or A-frame, jumping off a wall, balancing on small surfaces or any other activity needed for their sport. It is important to remember that if a dog is injured or away from their sport for a significant length of time that they will need time to work back to their competitive level in their skill, not just in endurance and strength. Even if they remember how to do it, they will need to practice it multiple times before they compete so they can do it with agility, not with reckless abandon.

Rest and recovery is also essential to preventing injury. Warming up the muscles decreases the chance of injury and improves performance, proprioception, and flexibility. The warm up should mirror the activity that the dog will be performing in their sport. Perrier showed that active stretching is superior to passive stretching to improve athletic performance in sports that involved flexibility and jumping. For agility dogs, start with trotting, juiking (abrupt side to side motions), tugging, bows, spins in both directions, and beg or beg-stand-beg to prepare for using the trunk for balance and the rear limbs for propulsion. Cool down should consist of a trot, followed by a walk, to aid the body in preventing lactic acid build up in the muscles. This should be followed by a massage and passive stretching to also decrease lactic acid build up in the muscle fibers.

Overtraining in humans has been shown to increase the chance of injury, reduce resistance to infection, decrease performance, and increase depression. This has also been shown to affect performance horses. The variables we examine to classify proper training vs. over training include intensity, volume, and frequency. Intensity is the amount of work required to perform a task. Volume refers to the repetitions per set and the number of sets given in a specific workout. Frequency refers to how many training sessions are done in a given time period. To prevent overtraining, if we significantly increase one of these variables we need to decrease one or both of the others. If these variables are not kept balanced the results can be chronic soreness, general lethargy, illness, or acute trauma such as avulsion fractures. One common formula to prevent over training is to have one variable high, one medium, and one low.

Another recommendation is to alternate the level of the three variables, give the dog one day a week off, and one month a year off.

Specific injuries can be grouped into muscle and tendon injuries or ligament injuries. Some muscle injuries rules of thumb include: gently stretch a chronic repetitive injury where fibrous tissue has been laid down and needs to become organized, do not stretch an acute injury as you may reinjure the tissue or prevent stabilization of the tissue, and do not stretch a hypertetension injury. Exercises can be broken down into concentric, isometric, and eccentric. Isometric exercises are those that the muscle is firing, but the fibers are not changing in length. These are the safest exercises post injury and should be what a patient is started with. Examples of isometric exercises include standing/weight bearing, rhythmic stabilization, standing with all four or front feet on a ball, sitting on a hill (facing up, left, and right), diagonal leg lifts (Snoopy), rocker and wobble board. Eccentric exercises are those that the muscle lengthens as it fires. These exercises build muscle the fastest, but are also the most likely to cause injury and should therefore be the final exercise utilized post injury. Concentric exercises are when the muscle shortens as it is firing. These would be the intermediary exercises. The force of gravity is the largest force on the body, therefore our muscles are used to fight gravity, pushing up off the ground. Muscles lengthen and shorten constantly, but when an added force (gravity, weight bearing, or resistance) is added, there is more energy/work needed to perform that movement. To determine which exercise to choose for each patient it is important to know
what the muscle that is injured does. Examples of common muscle that are injured, with concentric and eccentric exercises for each one, are listed below.

- **Flexor carpi ulnaris**
  - Concentric – up hill walking, stairs, digging, swimming, pulling a cart, bike…
  - Eccentric – down hill walking, walking backwards, tug of war

- **Triceps**
  - Concentric – walking, digging, stairs, swimming, pulling a cart…
  - Eccentric - down hill walking, walking backwards, tug of war

- **Biceps brachii**
  - Concentric – walking up a hill, hi 5’s, swimming
  - Eccentric – walking down a hill, cavaletti poles

- **Supraspinatus**
  - Concentric – walking up a hill, hi 5’s, swimming
  - Eccentric - walking down a hill, cavaletti poles

- **Infraspinatus**
  - Concentric – walking up a hill, swimming, crawling, cavaletti poles
  - Eccentric – walking backwards

- **Subscapularis**
  - Concentric – sidesteps to the ipsilateral side, medial leg lifts
  - Eccentric – sidesteps to the contralateral side, weave poles

- **Gracilis**
  - Concentric – sidesteps to the ipsilateral side, sit to stand
  - Eccentric – backwards walking

- **Sartorius**
  - Concentric – backwards walking, swimming,
  - Eccentric – walking, stairs, sit to stand

- **Longissimus and transversospinalis**
  - Concentric – sit up and beg, beg-stand-beg, crawling, stairs, weave poles, spin and twirl
  - Eccentric – stepping from one small surface to another, crawling

**References**

Soft tissue manual therapy utilizes stretching and massage of the muscles, tendons, ligaments, and joint capsule to relieve pain and enhance range of motion and flexibility. Soft tissue manual therapy can be used to eliminate or diminish trigger points, fibrous tissue, or edema in the surrounding structures of the joint, and relieve excessive muscle tightening. Fibrous tissue is produced by the body in an attempt to stabilize the joint when it senses joint instability, but it causes secondary restriction of motion in the joint. By reducing motion at the joint, the muscles stabilizing and moving that joint can not contract or stretch fully. By limiting the amount the muscle can stretch and extend the muscle can shorten, and strength is reduced. Tendons and ligaments can be strengthened or become weaker, but strengthening them is a significantly slower process then strengthening muscle. Loss of strength of the muscles, tendons, and ligaments lead to more instability. Pain can be associated with joint instability as there are nociceptive pain fibers in the joint capsule and surrounding structures. Weakness and pain, leading to inactivity and atrophy, can perpetuate a cycle of restriction and instability. By breaking down the fibrous tissue, reducing trigger points and tendon sheath or joint capsule edema, pain is diminished, often immediately, and the contractility of the muscle is restored allowing the patient to begin to increase muscle mass and strength. The stronger muscles, tendons, and ligaments improve joint stability, slowing down the progression of secondary degenerative joint disease. Due to less pain and secondary joint disease the patient often experiences improved quality of life.

This lecture will discuss muscle techniques or massage. Massage has many techniques and forms, we will discuss some science and some techniques so you can have a better understanding of what is going on in the tissue, what you can and can not alter, and what kind of results to expect. There are many forms of massage or manual therapy and each form of massage has its own techniques. There is not one right technique, many techniques may be beneficial. They are like tools in the toolbox, the more you learn the better able you are to treat the patient in front of you.

Massage comes from the Arabic word mass which means “to press.” In the human medical field massage is considered standard therapy for pain management and decreased mobility as well as preventative therapy for competitive athletes. Chiropractors, Physical Therapists, and Doctors of Osteopathy frequently incorporate massage into their work.

Massage has an effect on multiple tissues: skin, fascia, muscle, tendon, fibrous/scar tissue, joint capsule, lymphatic and vascular circulatory vessels and, in some cases, periosteum. The main type of tissue in all of these structures that we will be working with is collagen. Type I collagen are long crimped fibers that resist axial tension, gives support, resists tension and behaves following the stress-strain curve. It is found in the dermis and fascia. Most of the effect massage has on collagen is in the toe region of the stress-strain curve (The very beginning of the stress-strain curve, just where the crimps are being straightened, and way before there is damage to the fibers.)

Tissue has the properties of viscosity and elasticity. Together these properties form the viscoelastic property that accounts for the fact that the response of the tissue to loading depends on how quickly the load is applied or removed. The faster the loading and unloading, the stiffer the tissue behaves. Rapid loading and unloading creates friction, energy that dissipates as heat when the tissue returns to its original length. It is important to understand this as massage can affect the stiffness of the tissue. If there is a low constant pressure or repetitive load applied over a long period of time, there is “creep” or elongation of the tissue. Massage should be able, with low loads and some repetition, to create a non-permanent “creep,” which is what we are looking for. Rapid loading creates the undesirable effect of tissue stiffness.

The pressure of the massage therapist increases pressure in the tissue that causes pressure gradients in the tissue, lymph and blood vessels. During the massage fluid is pushed from the vessels in to the tissue, and from the tissue into the vessels, at many depths and in multiple directions, allowing significant fluid interchanges. This fluid exchange creates a flushing effect in the tissue bringing it more nutrients. Human studies have shown that chemical irritants (Substance P and prostaglandin) decrease the pain threshold by sensitizing the nerve endings. Flushing these substances can thereby reduce this effect, allowing a higher threshold (less chronic pain). Massage in young animals resulted in redaction of stress as shown by a reduction in the output of adrenocorticotropic hormone. Resistance to infection later in life can be beneficially influenced by cutaneous stimulation at a young age. It has also been shown that young animals that receive massage learn faster and have more advanced neural development then non-handled animals. Changes in blood constituents following massage provides us with some of the information of the biochemical changes happening in the tissue as a result of massage. In a human study it was found that post massage the pain threshold was significantly elevated suggesting that massage can be used to treat pain and soreness.

**Techniques**

**Efflurage** is a technique where the massage therapist employs unbroken long or short, slow rhythmic, light or heavy pressure in a straight or circular manner with the finger tips, thumbs, knuckles, or palms of the hands, conforming to the surface of the underlying...
structures. This technique is used at the beginning of the massage to evaluate the tissue and at the end of the massage to help flush lactic acid from the tissue. It stretches the muscle fibers when the stroke runs parallel to the fibers and diminishes adhesions when the stroke runs perpendicular to the muscle fibers. One benefit of effleurage is an increase in circulation and lymph flow.

**Pettrissage** is a technique of kneading, pressing, wringing, lifting, and squeezing with the intent of pulling the tissue away from the body to improve blood and lymph circulation, tissue elasticity, and to relieve tension. It increases circulation, mechanically relaxes muscles, reduces stiffness, loosens adhesions, releases analgesic chemicals into the body, and stimulates the nervous system. Strokes can be longitudinal (with the muscle fibers), cross fiber (perpendicular to the muscle fibers), diagonal or circular.

**Friction** is a technique that is used to increase circulation, break up fibrous tissue leading to reorganization of collagen, and it provides pain relief via stimulating inhibitory nociceptor receptors. It is used to treat tendonitis, release trigger points, and to aid in stretching and broadening muscles.

**Tapotement** - a technique of percussion that can be fingertip tapping or coupage. Finger tip tapping is used to stimulate muscles to fire when done for a short time or it can be used to create relaxation or muscle fatigue with a longer treatment time.

**Vibration** can be a very small amount of motion in a specific muscle or it can be as large a motion as rocking of the whole animal. It increases circulation, stimulates muscle spindles causing tiny contractions that lead to relaxation of the muscle, relieves pain, releases trigger points, and relaxes myofascial tissue. One of the ways vibration is used in soft tissue manual therapy is shortening and lengthening a tight muscle in a rhythmic motion by moving it side to side. It can also be used in diagnosis as if a muscle is tight due to the animal being stressed, vibrating the limb will immediately relax it. If the muscle is tight due to over or abnormal use, vibration will not cause immediate relaxation.

**Ischemic Compression** is a technique applying 1-2 pounds of steady pressure (8-12 seconds) to the center of the trigger point, in effect squeezing out the blood from the tissue in an area of local hyperactivity. When pressure is released, blood flows back into the tissue stimulating the golgi tendon organs, frequently relieving the trigger point or area of spasm. It is also felt that this technique reduces overall muscle tension and promotes healing.

**Strain Counter-strain** is a technique utilized to stretch a tight muscle. The muscle is placed into full stretch, in order to do this you need to know action of the muscle as the stretch is the exact opposite motion. In a muscle that crosses more then one joint, the stretch should affect the part of the muscle that is the most tight. Once the muscle is stretched and held for 15-20 seconds, full shortening of the muscle is performed, not just allowing it to go into neutral position, and then re-stretch the muscle while massaging the tightest point of the muscle. This process may need to be repeated up to four times to relieve the muscle tightness. With these techniques and precisely timed stretching and shortening of the muscles, ROM and flexibility can be improved, pain can be relieved, and the animal’s quality of life can be greatly enhanced. Once comfortable with these techniques, some can be taught to your “hands on” clients so they can perform them at home as well. Discernment is important in these instances.

**Myofascial Release** is a technique where the fascia is addressed. It releases tension in the fascia that is there secondary to trauma, posture, or inflammation. Fascia surrounds the muscles, bones, nerves, and organs of the body. When there is restriction of this tissue there can be pain and restricted motion. Freeing this tissue relieves pain and allows normal motion. This technique involves applying gentle sustained pressure into the Myofascial connective tissue restrictions to eliminate pain and restore motion. It is a low load (gentle pressure) applied slowly into the tissue to allow a viscoelastic medium (fascia) to elongate. By putting pressure into the tissue and then applying directional pressure, in the area of greatest restriction, the fascia stretches and the flexibility of the muscle may be returned to normal.

**Patient evaluation**

The first step to evaluating a patient or pet is to know what is normal. By finding a young healthy dog and looking at an anatomy picture you can get a feel for the direction of the muscle fibers, the topography of the muscles, and a feel for what the muscles should feel like. You will feel the muscle issue the most when the muscle is in stretch. The most common muscles that I find issues in are the:

- Triceps - caudal aspect of the humerus; stretched by flexing the elbow and then extending the shoulder.
- Biceps brachii - cranial aspect of the humerus; stretched by flexing the shoulder and then extending the elbow.
- Gracilis - most medial muscle of the inner thigh; stretched by extending the stifle and then flexing the hip (abduction can be added).
- Sartorius - most cranial muscle of the thigh; stretched by extending the hip.
- Tensor facia lata - directly caudal to the sartorius; stretched by extending the hip.
- Pectineus - medial and adjacent to the femur; stretched by abducting the rear limb.
- Gluteal muscles - Proximal and cranial to the greater trochanter; stretched by flexing the hip and adducting the rear limb.
Favorite massage techniques

- T-Touch circles and long dorsal midline strokes on the face.
- Thumb over thumb of the neck, in the neck triangle.
- Big hand circle petrissage down the spine with alternating hands.
- Gentle traction of the tail.
- Longitudinal strokes down the back, the limbs and on either side of the scapula spine.
- Cross fiber/perpendicular massage of the limbs and either side of the spine (apply even pressure to both sides at the same time).
- Rolling down the limbs.
- Fingers together, circles over the long thin muscles.
- Traction and medial and lateral circles at the toes (just the top of the foot if they are hypersensitive).
- Distal to Proximal effleurage flushing of the limb as the final act of touch for that limb.
- Skin rolling and cross fiber (crabs) of the body wall skin.
- Circles over the gluteal muscles.

References
Working dogs can be thought of in several different categories. Protection or aggressive working dogs, service and guide dogs, hunting and field dogs, bomb, search and rescue and detection dogs, and herding dogs. They all have their own “language” and inherent traits. We will look at behavior, injury, and common modalities for each group.

Potentially aggressive dogs
Protection dogs, Police K-9s, military dogs, or dogs that you may have difficulty handling may have issues because of being taught not to take food from anyone other then their handler, taught to bite if someone besides the handler approaches them, may either have a vast vocabulary (police dog or war dog) or none (junk yard guard dog). Your choice with these dogs is either to let the handler do any close work with them or to build a rapport with them. Before you choose the latter, make sure you trust the handler. A handler that doesn’t know their dog well or has trouble controlling their dog can put you into a dangerous situation with these dogs. An example of how to work with one of these untrustworthy dogs is a dog that I worked with that was a protection dog that was owned by two police officers that had not established dominance, or a healthy relationship, with their 7 year old intact male German Shepherd Dog. The way I was able to work with this dog was that “dad” would come in leather gloves, stand behind and to the side of the dog with his leg pushed into his neck, and hold onto the dogs pinch collar with both hands. “Mom” would hold a pillow next to the dog’s head on the opposite side as dad, and I would come from behind and only be able to work from the upper thoracic spine back. We were able to do laser, acupuncture, chiropractic therapy, and massage. This therapy regime allowed the dog to regain strength and stamina to pace the property at home each night for two years. When the dog was not able to rise independently he was euthanized because he would not allow assistance in rising from the owners.

If possible become involved with the police dogs in your area before they initiate or complete “bite” training. If they meet you and know they can get love and cookies from you before they start their bite training, working with them when they are injured is significantly easier. Injuries in these dogs are usually acute trauma when they are younger and of spinal nature when they are older. Putting a maintenance program together to keep them in shape allows them to stay on the force until they are 11 or 12 years old versus 8 or 9 years of age without it. Modalities that can be done with the highly aggressive dogs should be hands off as much as possible. This is less of a problem if you have been working with the dogs from a young age. When there is an acute injury, cryo-therapy, laser and Assisi are some of the safest modalities. Ice or moldable gel packs can be given to a handler and if necessary a “demo dog” can be used to show the handler how and where to apply the pack. There are wraps or devices that can hold gel packs in place. Canineicer.com has devices to hold ice receptacles for multiple joints so the handler does not need to be holding the ice on the dog for any length of time.

Laser therapy can often be done with little or no contact to the patient. If contact is recommended, an increased power can be used to make up for the increase in reflection secondary to holding the probe off of the skin surface. Be careful if you are used to touching the surface that you do not hold the angle of the probe at greater then a 30 degree angle as this is the tipping point for significantly increasing reflection and thereby significantly decreasing penetration even into skin level tissue. Laser improves blood flow and can decrease pain and inflammation by decreasing Cox-2, IL-1, and TNF-α.

An Assisi ring, targeted Pulsed Electromagnetic Field Therapy (tPEMF) can be used to increase blood flow (angiogenesis) and decrease pain. The mechanism for decreasing pain is by increased Ca+/Calmodulin binding leading to increased short bursts of eNOS.

If Neuromuscular electrical stimulation (e-stim) is indicated, always do this before active exercises as it prepares the muscles for stronger contractions. When performing e-stim on aggressive dogs having them stand over a peanut ball if they are able to stand. Applying the pads to muscles of the rear limbs and paraspinal muscles offers a better contraction while they are standing. Most handlers that own a protection or other aggressive dog prefer that their dog not be shaved if possible. If there is a short coat (Rottweiler, Pitbull or Doberman) then don’t shave. If Ultrasound or e-stim is indicated and there is long hair, shave, but not down to the skin. Use a blade that will cut the hair to less then 1 cm in length and use enough gel to allow transmission of the electrical or sound energy through the remaining coat.

Instead of passively stretching these animals it is often easier to have them do active stretching if possible. In cases of Fibrotic Myopathy, this is not possible, as you need to be stretching the affected musculature as you laser or ultrasound the tissue. The underwater treadmill is a great tool for strengthening these dogs and it can also be used to somewhat “tire them out,” to take the edge off, before working with them. If the dog is trained in another language, it is worth your while to learn certain words to be able to communicate what you would like them to do.
**Service and guide dogs**
The most common issue seen with service and guide dogs is a propensity to become overweight. Frequently these dogs have restricted exercise as their “person” frequently does not live an active lifestyle. Introducing these dogs to a land treadmill, teaching them and their handler how to use it, and helping the client pick out and purchase an incline treadmill for “at home” use is often all that is needed. Sometime diet restrictions or diet changes may also necessary. Back issues are the most common issue I see with these patients. Laser and manual work (massage, chiropractic, or other manual therapies) are frequently done at the clinic and an Assisi loop is sent home for when there is pain and the client can not come in right away.

**Hunting and field dogs**
Hunting dogs and field dogs commonly have the opposite living situation as the therapy dogs. Instead of sleeping in the bedroom with their people, they sleep outside in a run. If they are not the most valuable dogs in the pack, you are not likely to see them. The dogs that are highly prized are dogs are frequently brought to the surgeon or rehab facility and left there until they can be returned to work. These dogs need to be brought to full endurance and skill training before being returned to their handler or they may be put in a position to be re-injured. This may mean they have to work up to being at a fast trot on the incline treadmill for one to one and one half hours as they may go in the field for 3-6 hours of intermittent hard running when they return home or to the trainer’s facility. These dogs frequently do not understand typical “commands” and yet may have high drive personalities. Hunting and field dogs usually do not like to lie down or be still. Ways to help calm these dogs to allow you to work with them include: applying essential oils (lavender, Peace and Calming…), flower essences like Rescue Remedy (ingested or, if you can not get it in the mouth, then applied topically into the ear), a T-Touch Wrap (an Ace Bandage wrapped from the breast plate, over the back, around the chest, and back up over the lumbar spine tied in a knot, creating a compression “suit” to sedate the nervous system), or a Thunder Shirt (same principle as a T-Touch wrap). Laser is a better tool for the common muscle and tendon injuries then ultrasound as there is less likely hood of heating bone or damaging tissue if they are attempting to struggle as you treat them. These dogs are easiest to treat when they are tired, hungry, or distracted. Toys that they only see at your clinic may distract them, especially if they have an oral fixation (Labrador Retrievers and Field Golden Retrievers). These toys should be machine washable and washed between patients unless the handler brings the dog’s own toy. The owner/Handler can skip feeding them at home and bring their meal for you, the owner, or an assistant to feed as you work with them. This food or treats can be frozen in a mug or “Kong”, fed piece by piece if it is a kibble diet, used as a distraction, used to mesmerize the dog as each piece is offered, or held in a hand, to be licked at through a hole made in the fist by the thumb and pointer finger. If you have healed the patient and are now working on strength rebuilding, then exercising for endurance (running, swimming, underwater treadmill) should be done before the manual or modality treatment. This will tire them our both mentally and physically allowing you to have a calmer working environment.

When a dog has had a muscle, tendon, or ligament injury we will treat them with laser until there is no pain, not only after the treatment, but also when they come in for their next visit. At this point we start introducing exercising back into their schedule. Laser has been shown to decrease IL-1, COX-2, and TNF-α, three important inflammatory mediators. By decreasing these mediators after exercise we can speed healing by preventing the damage that would ensue after their release. It also allows us to see them at their most tired, both from a medical prospective (are they lame after exercise?) and a treatment prospective (they will lay down and rest because they are tired, allowing us to do what needs to be done to help them). Manual therapy is usually performed after the laser therapy as this can be done on a standing dog, though frequently the dog will relax and laydown while this is being done. Strength and skill training should be done after manual therapy, when their body is “aligned” and the nervous system is functioning optimally. Active exercises are best with these patients. We will frequently use a peanut butter mug to guide or drive the dog through the strength training exercises. These mugs have peanut butter spread evenly on the inside surface and have been frozen. This creates a continuous positive reinforcement as well as attention getting device.

Jumping, when reinitiated into the training program, should be done on a leash if the dog does not have a superior recall. This is a time when the dog feels “free” and may hold onto the “free” feeling and take off, potentially doing activity to re-injure itself. Beside laser, the Assisi unit is another modality frequently used by my sporting clients as they can purchase them and have them in their emergency kit to use in the field. Anytime they feel heat or see swelling, this can be applied for 15-30 minutes up to four times a day.

**Bomb, search and rescue, and detection dogs**
Bomb dogs can be usually trained so that they are only fed when they make a “find,” and then only a small portion of their daily ration. Though they are mostly finding explosive materials that have been hidden by their handler, in their mind they are doing their job 10-20 times a day. That being said, since these are the rules, food cannot be used as a distraction or a lure. These dogs do usually have a large vocabulary and respond very well to “sit” and “down, stay” making treating them with modalities easy. As this population of dogs are not high drive and are not asked to do crazy or fast, agile exploits, they are much less likely to have acute injuries. They are more likely to have back pain on examination. Laser and manual therapies are most likely the treatment of choice for these patients.

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Herding dogs

Herding dogs are a cross between the aggressive dogs, only in that they are high drive and may or may not have an “off” switch, and the bomb and detection dogs, as they don’t have to perform sharp turns and huge jumps. This population of dogs is more likely to have chronic repetitive type injuries. Spinal, carpal and hip pain are common with the occasional stifle or elbow injury observed. The best words I learned to communicate with these dogs are “that’ll do.” That is universal for “you have played enough, now settle down.” The other thing that works well for these dogs is the frozen peanut butter mug trick mentioned above. Manual therapy and laser are frequently the modalities of choice for these dogs. If there has been a surgery or significant injury requiring more then 2-3 weeks of restricted activity, then underwater treadmill and exercises to bring them back to full strength, endurance, and skill training is a must. These dogs will injure themselves and frequently not even show it until they are done working or done working, slept, and then will get up lame.

Different types of dogs with different mindsets, body builds, and work ethics have been bred for different jobs. Understanding what they do, what they can and can’t do, how they do or do not communicate, where their common injuries lie, and what modalities may work best for them should aid you in your journey into working with the working dogs.