Physical Rehabilitation of the Canine Neurologic Patient

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- Canine physical therapy

Rehabilitation following neurologic injury or disease is established in people and animals[1–4] and is a key part of recovery. The few papers published in the veterinary literature support the usefulness of rehabilitation in recovery from neurologic injury and nonsurgical management of neurologic conditions. Several neurologic problems are amenable to rehabilitation, including, but not limited to: paresis, muscle atrophy, muscle contractures, pressure ulcers, and pain. For example, passive range of motion in a nonambulatory patient can help maintain joint health and prevent muscle contracture from immobilization.

Initiating rehabilitation in dogs with neurologic conditions should include a comprehensive physical examination and medical history. Although not all conditions are surgical, the most common cases presented for rehabilitation in dogs tend to be postoperative cases. Assessment of the patient includes a thorough orthopedic, neurologic, and physical examination, as concurrent medical or orthopedic disease (such as severe hip osteoarthritis) may have a significant impact on the design of a rehabilitation program. This article will focus mainly on the nursing care, specific exercises, and current therapies in dogs with neurologic disease.

EVALUATION

A thorough history of the patient's previous activity, home environment, and temperament, and the client's expectations are essential. For example, was the patient a working dog that the client wishes to return to field work? Or is the patient a family companion that only needs to walk outside to defecate and urinate? Housing plays a key role in determining how much function is necessary to achieve

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a positive outcome. One must ask whether the patient lives primarily indoors or outdoors, what kind of flooring will the patient need to negotiate (hardwood/tile or carpet), and if the patient is expected to manage several stairs and if so, can the owner assist the patient during the recovery. The temperament of the patient often dictates which treatments and exercises are realistic. If a patient is aggressive or excessively fearful, it may be difficult for the owner or veterinary professional to perform complex exercises.

The referring veterinarian often has performed a comprehensive neurologic examination, as most canine rehabilitation clinics operate on a referral basis. The rehabilitation practitioner, however, also should perform a neurologic examination to document the current neurologic status and become familiar with the patient's responses to measure progress. Neurolocalization, severity of the lesion, and pain status are the primary focus of the examination. Deep pain sensation, ability to stand and support weight, duration of disease, and presence of motor function and bowel/bladder function are key factors influencing prognosis for recovery.

Presence of deep pain sensation is the most important prognostic factor.[5,6] Loss of deep pain perception indicates a severe spinal cord injury and guarded prognosis. In general, the first 2 weeks of recovery following loss of deep pain after intervertebral disk extrusion and repair indicate whether return to function will occur. Loughin and colleagues[7] examined 34 dogs with loss of deep pain perception at the time of surgery and found that the 21 of 34 cases that recovered function had deep pain perception at 2 weeks following surgery. Although this is a good guideline, there may be cases that are exceptions. It is important to note, however, that recovery is extremely prolonged in cases where deep pain returns greater than 2 weeks postoperatively and that functional recovery may be limited. It is of utmost importance to perform deep pain testing correctly. One must differentiate conscious recognition of pain versus reflexive movements. A strong stimulus should be applied to the distal phalanges using a large hemostat or needle drivers (taking care not to damage the skin) while the patient is distracted, and the patient should be observed for vocalization, head turning, evasive behavior, or other behavioral indications of cortical perception. Withdrawal of the limb, even progressing to strong kicking, does not indicate deep pain perception. Anecdotally, the author also has noted that the character of the deep pain response also may indicate how a patient may recover. For example, patients with sharp vocalization and quick response to deep pain testing often have a faster recovery compared with those with a delayed and slower head turn without vocalization.

Gait and stance should be noted upon presentation. Patients should be classified as ambulatory (voluntary motor function present) or nonambulatory (eg, tetraparetic, paraparetic, hemiparetic). Ability to stand is described further based on the amount of support needed. The amount of body weight support needed to stand can be described subjectively as maximal support (100%), maximal to moderate (75%), moderate (50%), moderate to minimal (25%) or limited to no support (less than 25%). A neurologic grading scale (independent of deep pain perception) is used by the author during evaluation as a global score of function.[8] Once ambulatory, the patient's gait should be described further, noting any ataxia, nail scuffing, limb circumduction, knuckling, unilateral strength, or any abnormal limb rotation. As the patient advances through recovery or if the neurologic deficits are mild, one should evaluate the patient's gait during functional tasks such as sitting, rising from a sit or down position, stair climbing, ability to maneuver obstacles, circling, and ability to walk on slippery surfaces.

DESIGNING A REHABILITATION PROGRAM

During the initial evaluation, one should determine whether an owner is capable of performing rehabilitation exercises at home and whether the client prefers outpatient or inpatient therapy. For example, large and giant breeds often require several people to assist in the acute nonambulatory period, and many individuals do not have the ability to move a patient that may be 100 pounds or more, even with assistive devices. The author typically develops a protocol that addresses the initial short-term problems and long-term goals separately. This section will be divided following this concept.

Initial Short Term Protocols for Nonambulatory Patients

Early intervention within the first 2 weeks of recovery following spinal cord injury in people has been shown to improve motor function.[3] The goals of the acute phase of rehabilitation in patients that are nonambulatory upon presentation focus on basic functional tasks and maintaining musculoskeletal health. Standing exercises, range of motion, pain control, toe pinch exercise, aquatic exercise, and basic nursing care are routine parts of the protocol at this stage.

Standing exercises focus on strengthening hip and stifle extensors and start re-educating muscles needed for balance and proprioception. Several approaches can be used to facilitate standing. Assistive devices such as slings, physiorolls, wheelchairs, or Hoyer lifts may be used to maintain a large patient in a standing position (**Figs. 1** and **2**). In smaller patients, the therapist can support the patient manually to maintain a standing position (**Fig. 3**). Variations of this exercise are static standing and sit-to-stand exercises. Static standing typically is performed three to five times daily for 2 to 5 minutes or until the patient fatigues. Support the patient under the ischiatic tuberosity and on the cranial aspect of the stifles to facilitate a normal standing angle of the pelvic limbs (**Fig. 4**). Conversely, two people often are required to maintain limb position in a tetraparetic patient, even with abdominal support from a physioroll or sling system. It is important to maintain normal foot position at all times

Fig. 1. Assisting a tetraparetic patient with a Hoyer lift (Guardian Products Inc, Simi Valley, CA). Frequently patients with cervical lesions will have weak trunk and abdominal support, and will need additional slings for support. The Hoyer lift also can be used as a wheelchair for giant breeds and is an extremely versatile piece of equipment.

Fig. 2. Assisting a tetraplegic patient with the use of another type of Hoyer lift and physiorolls and physioballs for standing.

during this exercise (prevent knuckling and encourage weight bearing). Perform standing exercises at the time of eating or drinking, as standing often is improved while the patient is distracted by the act of eating and drinking.

Sit-to-stand exercises can be performed manually or with a sling depending on patient size. This exercise is most beneficial if there is some tone in the affected limbs; otherwise static standing is more applicable. Initially, assist the patient into a standing position and have them maintain this position until they begin to sink back into a sitting position. Hold the patient in a normal sitting position for 10 seconds, and then assist

Fig. 3. Assisting to stand and performing passive range of motion on a smaller patient manually. Smaller-sized patients can be held in a standing position with one hand while the other hand is used for passive range-of-motion exercises. Sometimes an additional person is needed to maintain the patient in place.

Fig. 4. Manual technique to hold a patient in a standing position. The thumbs are placed on the ischiatic tuberosities to lift the pelvis, and the fingers are held on the cranial aspect of the thigh and stifle to maintain extension. In larger patients, this positioning is still possible, but may require the use of the therapist's body or arms to help support the patient.

them into a standing position again. Repeat this cycle 10 times or until the patient immediately fatigues upon standing. If the patient is attempting to stand, allow it to try and stand on its own. Often the patient is able to initiate standing or begins pushing up with the affected limbs, but is unable to stand up completely. While in the standing position, it is valuable to incorporate weight-shifting exercises to work on muscles needed for stabilization and proprioception. Shift the patient's weight side to side and front to back to increase weight bearing on the affected limbs.

Passive range of motion (PROM) maintains joint health when a patient is unable to move its limbs voluntarily, but has no effect on muscle atrophy. PROM exercises can be performed while the patient is in lateral recumbency or in a standing position. The latter is much easier with smaller patients and should be done only if the patient can be supported properly. Two approaches can be used for PROM, moving joints individually or simultaneously. It is the author's preference to place all joints of the affected limb through ROM simultaneously and in a bicycle or gait-simulating pattern. Repetitions of 10 to 20 times, three to five times daily are recommended. If there is a particular restriction in any direction (eg, abduction, hip extension), one can use stretches of 10 to 30 seconds to address the restrictions.

Toe pinch exercises may be combined with PROM exercises, and use the flexor reflex to stimulate limb withdrawal (**Fig. 5**). Although not an active exercise, stimulation or pinching of the toes will activate muscle contraction and potentially stimulate sensation. To combine with PROM exercises, begin with the limb in a neutral position and stimulate full limb flexion. Hold the limb in flexion for 1 to 2 seconds, then bicycle through the normal range of motion mimicking a normal gait pattern, finishing back to the neutral resting position. The flexor reflex will fatigue over time, so once flexion is stimulated, the pressure on the toes should be released and the foot held in a normal position (digits slightly extended) during the limb movement. Occasionally, one may need to provide resistance in extension to stimulate the flexor reflex, resulting in a tug-of-war type exercise. In cases when the reflex is very weak, visualization of muscle fasciculations or contractions may be the end point rather than full limb flexion. In this instance, the practitioner should flex the limb fully for the patient once the muscles are activated.

Massage is useful to warm up tissues before PROM, and stretching exercises help reduce damage to tissues, relax the patient, and loosen tight muscles that may result

Fig. 5. Toe pinch exercise. This can be combined with passive range-of-motion exercises in a bicycle fashion.

from excessive extensor tone. A full body massage often facilitates better participation by the patient. To begin, gently stroke the body and limbs for 1 to 2 minutes parallel to muscle bellies and with the lay of the hair coat to warm the tissues. Next, a slightly deeper stroke can be used on the affected limbs, employing a kneading stroke parallel to the muscles. A light massage also can be performed following exercise as a cool-down exercise for muscles and to leave the patient relaxed following what is often an exhausting session of exercise.

Aquatic exercise can be initiated once incisions have sealed at 3 to 5 days postoperatively, or by surgeon preference. Underwater treadmill is generally the most useful, as swimming is more effective once motor function returns. The properties of water have many desirable effects including support through buoyancy, relaxation of muscles with warm water, and edema control via turbulence and vasodilation in warm water. Even though the patient may be nonambulatory outside of the water, often motor will be noted first in the underwater treadmill, because water at the level of the greater trochanter decreases weight bearing in the pelvic limbs by 67% and thoracic limbs by 34%,[8] allowing easier movement of limbs. Also, a tail fractioning technique, whereby the therapist pinches and massages the distal end of the tail in effect to stimulate the periosteum, can stimulate movement of the pelvic limbs. It is unknown what mechanism controls this function, but it is theorized to be a reflex arc similar to spinal walking or perhaps the scratch reflex. Frequently, this stimulation of walking can transition into voluntary movement. Some patients appear to be unaware that they can move their legs, and once a gait pattern is established they are able to consistently move their limbs voluntarily. Additionally, gait patterning, where the therapist moves the affected limbs for the patient, can be performed easily for paraparetic and paraplegic patient in the underwater or land treadmill (**Fig. 6**). For tetraparetic and tetraplegic patients, it is difficult to manually move all four limbs at once, so it is recommended to focus on the thoracic limbs or pelvic limbs individually. The author uses a canine life preserver and is present in the underwater treadmill for all neurologic patients when initiating aquatic therapy, not only to prevent drowning, but also to help move and manage the patient in the water. Initially, short bursts (1 to 3 minutes, repeated three to four times) of walking or gait patterning should be employed, as endurance is compromised significantly in the early recovery period. Allow adequate rest period of 2 minutes between walking periods. To maximize the session, PROM, standing and weight-shifting exercises can be performed during rest periods. If swimming is employed, the therapist should be in the pool with the

Fig. 6. Gait patterning on the land treadmill in a tetraplegic patient. This can be performed in either the underwater treadmill or a land-based treadmill. In this case, it was more effective for the therapist to perform gait patterning on the land-based treadmill compared with the underwater treadmill.

patient, as patients are often unable to maintain an upright position and tend to roll to one side. PROM and gait patterning also can be facilitated in a swimming pool, and exercise of the core stabilizer muscles can be achieved while swimming a paraparetic or paraplegic patient.

Nursing care is extremely important for nonambulatory patients (**Fig. 7**). Prevention of urine scald and decubital ulcers is crucial, as these secondary problems can take a significant time to treat. Patients should be turned routinely every 4 to 6 hours, and bedding changed immediately if soiled. Thick padding with blankets, foam, or commercially available dog beds that are easily washed and dried is indicated to prevent pressure sores. If decubital ulcers occur, commercially available products are effective in protecting and allowing for ulcers to heal, especially over elbow and tarsal joints. Decubital ulcers over the hip and pelvis are more difficult to cover with bandages, and are managed best with thick cushioned bedding, tie-over bandages, and a regular turning schedule. Urine scald is managed by frequent bedding changes and bladder expression or urinary catheterization every 6 to 8 hours. If urine scald is already present, the area should be cleaned thoroughly and dried daily until resolved. There are also barrier films that help protect against urine and fecal scald. Diaper rash ointment is effective in cases of fecal incontinence.

Initial Short-Term Protocols for Ambulatory Patients

Weakly ambulatory patients can benefit from the previously mentioned exercises, but they should have additional exercises focusing on walking and advanced proprioception also. Sling-assisted walking, foot protection, cavaletti rails, and physioroll balancing are used commonly for these patients.

Sling-assisted walking for short periods three to five times daily is useful for strength and coordination during recovery. The type of sling depends upon the amount of support needed. The most commonly used slings are legged slings for full support or an abdominal sling made of cloth or a piece of Theraband (The Hygenic Corporation, Akron, Ohio). Walking should be performed on a nonslip surface, and the feet should be protected from scuffing. Close attention should be paid to foot position. If the patient is not yet able to place its feet appropriately, a specially designed boot or white medical tape can be used to maintain correct foot position and dorsiflexion.

Fig. 7. Severe urine scald and decubital ulcers from poor nursing care. Proper bladder care and a regular turning schedule must be instituted to prevent urine scald and decubital ulcers.

Excessive weight on the foot, however, can limit the patient's ability to advance the limb if it is significantly weak. Care should be taken to walk slowly so the affected limbs are able to move as normally as possible. For example, it is common that paraparetic patients will drag their hind limbs if allowed to walk too quickly in the initial recovery. A harness is useful to help slow the patient down, prevent excessive pulling on the neck, support tetraparetic patients, and shift weight onto the hind limbs. As the patient improves, the sling can be used to challenge the patient's balance while walking by slightly pulling the patient to one side, causing it to become off balance and regain a straight line while walking. The author's preference is to use a Theraband resistance band for this phase, as it provides support to prevent falling while the patient does most of the work to maintain balance.

Cavaletti rails help strengthen hip and stifle flexors while improving neuromuscular coordination. Cavaletti rails can be purchased or made by the therapist. Typically, the height of the rails is at the level of the carpus and rails are spaced 12 to 18 inches apart. The amount of disability, however, may change these guidelines. For smaller dogs, poles or lengths of PVC pipe simply can be laid on the ground and anchored with a weight to maintain position. Four to eight rails are used most commonly, with repetitions of 5 to 10 times, twice daily. Often, special materials do not need to be purchased by clients, as creativity is the only limitation to building a set of cavaletti rails. Old broomsticks or PVC pipe and bricks or cinder blocks are some of the simplest ways to make a set of cavaletti rails.

Physioroll balancing is useful for neuromuscular coordination and proprioceptive re-education. The author prefers physiorolls to physioballs, as they are easier for the

patient to stand on. One can either place the patient on the physioroll or just the thoracic limbs or pelvic limbs depending on the patient's disability. If the patient is standing on the physioroll, a technique called rhythmic stabilization can be employed where a gentle bouncing is used to strengthen muscle stabilizers and build core strength. If the thoracic limbs are placed on the physioroll, the roll can be rocked forward and back to stimulate the patient to take small steps and shift its weight. Typically this exercise is performed for 5 to 10 minutes three times daily depending on the patient's tolerance. It is recommend to use treats for reward and encouragement initially, as most patients are not familiar with this form of exercise.

Middle- to Late-Stage Protocols

As the neurologic condition improves, exercises are advanced accordingly. Stair climbing, carrying or pulling weights, walking on foam or sand, hill climbing with or without weight, leg weights, trotting on a long lead or land treadmill, resistance band walking, swimming against resistance, advanced sit to stands, weaving and figure 8s, and exercises specific to the home environment are designed for this phase of rehabilitation. Many dogs must return to using stairs to have normal function at home. Even two or three steps can be challenging for patients even though they may walk without assistance on flat surfaces. Start with three to five small stairs, and graduate to full flights of stairs once the patient is able to maneuver small steps easily. Repetitions of 10 passes, or until the patient fatigues, one to three times daily are recommended. Sling assistance may be required initially. The patient is walked slowly at first so that it does not hop or jump up or down stairs. Again, harnesses are useful to give the handler additional control, particularly with larger dogs. Walking backward down a few small steps is also useful as it provides eccentric loading of thigh muscles and improves neuromuscular coordination. Once the patient is able to handle a full flight of stairs without problem, trotting or a faster pace of climbing should be encouraged. Often at this point, the patient is off exercise restrictions, but may require a leash to control their speed during this exercise.

Carrying and pulling weight engages pelvic limb muscles more than normal walking. Several brands of backpacks are commercially available. Check to make sure there is a sufficient amount of padding on the backpack to prevent rubbing or pressure spots. Begin with weights that are 3% to 5% of the patient's weight as tolerated. If deficits are more prominent on one side, the weights can be packed asymmetrically so that the weaker side has slightly more weight. Bags of sand or coins, soda cans, rocks, or other weighty items can be placed in the backpack. Weighted backpacks can be used during daily walks, starting with 10 minutes twice daily. Alternatively, the patient may wear the backpack around the house for no more than 15 to 45 minutes per day. It is not necessary to use a specially made pulling harness for weight pulling, but as the amount of weight increases, a padded harness is recommended. Initially, a simple nylon harness can be attached to a lightweight wagon or hardware dolly for the patient to pull. The wagon or dolly should be attached to the sides of the harness, so that the weight is distributed evenly. Children's sleds are another option, and additional weight is placed easily on top of the sled. The heavier the weight, the shorter the duration of pulling. Watch the patient closely to avoid excessive fatigue. Initially start with short, straight-line distances in repetitions of 5 or 10 sets three to five times weekly.

Challenging the footing of an ataxic patient will exacerbate the ataxia and challenge core stabilizer muscles. Differing heights of foam with different thicknesses are useful for this exercise. If a playground or beach is available, walking on sand is another option, as it causes patients to constantly maintain their balance while walking. Once the patient masters these surfaces, they can advance to trotting and running.

Initial session are 5 minutes or less, but these are increased rapidly as the patient becomes steady on the foam or sand.

Incline walking and trotting are other key exercises, as many patients will be required to maneuver hills in their daily activities. If going up or going down a hill particularly challenges a patient, a zigzag pattern should be used initially. Begin with gentle inclines, working toward steeper inclines that may be challenging even for the handler. Typical duration starts at 5 to 10 minutes and increases based on the patient's endurance. Adding a weighted backpack increases the challenge of this exercise.

Leg weights and resistance band walking are particularly useful if one leg remains weak or if there is a unilateral condition. Commercial leg weights for people are frequently too heavy and do not conform well to a canine leg. There are some canine-specific weights available (Canine Icer, Charlottesville, Virginia), but these may be made at home if one is adept at sewing. Rice, coins, or fishing sinkers are placed in a sock or pouch and tied around the leg at the level of the hock on the affected limb if the patient is weak when advancing the limb. If the patient is having difficulty placing weight on the affected limb, the weight may be placed on the unaffected limb. As a general guideline, 2–4 ounces/5 kg of body weight are used initially depending on the severity of weakness, and worn for 10 to 15 minutes daily. Leg weights can be worn during other therapeutic exercises or on daily walks. Resistance bands (Therabandhio) can be used to correct for excessive abduction, circumduction, or toe scuffing. In combination with a harness, the resistance band may be very effective in helping to advance the limb(s) in paraparetic patients. A lighter weight band should be used initially according to patient size, and used on daily walks or during other therapeutic activities once the patient has mastered those activities.

Trotting on a long lead may be challenging sometimes for the handler and the patient. Often it is easier to work on speed transitions with a longer lead. Retractable leashes are useful for this activity, as they lessen the workload on the handler. If a patient will not trot out on its own, the handler can vary the speed for 30 to 90 seconds, ranging from a brisk walk or jog to a very slow walk to stopping altogether. Often it is easier to perform trotting activities on a ground treadmill, common in many households. It is recommended to use a harness rather than a collar to prevent choking in case of misstep or other accidents. Occasionally, the patient may not trot, but walk very briskly, which is also acceptable. Speed transitions also can be performed with a ground treadmill. One advantage to ground treadmill walking is that it provides a smoother gait pattern because of the friction of the treadmill belt, which will increase hip and stifle extension. Begin with sets of 5 minutes, with 1 minute walking, 2 minutes trotting, and 2 minutes walking variable speeds. Increase times with each session as tolerated by the patient.

Swimming with resistance is an excellent way to improve strength and conditioning (**Fig. 8**). Swimming in rivers, oceans, or some lakes can provide resistance. A life preserver is recommended to ensure safety, particularly in weaker patients. Safety should be the first priority, and patients should not be asked to swim in swift currents or rip tides. Alternatively, an endless pool or pool with resistance jets may be more desirable, if available, as the conditions can be controlled more precisely. Patients should be trained to the pool first, then introduced slowly to the jets, as some dogs may be fearful of the jets. Again, a life preserver is recommended, particularly because a leash can be attached to provide additional resistance. Respiratory rate is one of the best indicators of fatigue in patients that are swimming in advanced conditions.

To advance the simple sit-to-stand exercise, the patient may be placed on an incline and asked to sit and stand in each direction on the incline. For example, the patient may do 10 repetitions facing north, south, east, and west. This may be particularly

Fig. 8. Swimming against resistance jets. It is important to note that this exercise is only beneficial if all limbs are being used. Often, dogs will use predominantly or even exclusively their thoracic limbs to swim without moving the pelvic limbs. Resistance jets can stimulate pelvic limb movement, but all limbs should be evaluated for functional use during exercise for maximal effect.

challenging for a patient, and the patient may need encouragement with treats, as sitting sideways on an incline is often a new experience. Sit to stands on level ground or facing uphill while wearing a weighted backpack is another advanced version of the sit-to-stand exercise. If a patient has the propensity to splay or sit very wide-based, resistance bands can be used to ensure a normal sitting position.

Circles, figure 8s, and weave exercises are useful for side-to-side stability and work as an additional proprioception challenge. With weave exercises, cones or trees can be used or a set of agility training weave poles if available. Resistance bands also can be added in these exercises. For example, patients with cervical lesions often have a wide-based stance in the pelvic limbs. Resistance bands may be applied in a hobble fashion between the pelvic limbs while performing circles or figure 8s to retrain the gait in a normal position.

Some patients require unique tasks to perform when they return home. Specifically, dogs that are expected to use a doggie door often can walk without much difficulty on stairs or slippery surfaces, but are not yet coordinated enough to use their doggie door. It is simple to build a simulated doggie door with plywood and a thick piece of rubber or plastic. Additionally, some working dogs may have tasks that are extremely difficult and far more advanced than the average canine companion. Creativity is essential in designing a program for dogs that have unique and specific tasks that they are expected to perform upon return home or to the working environment.

MODALITIES IN NEUROLOGIC REHABILITATION

Electrical stimulation (e-stim), ultrasound, cryotherapy, and heat therapy are the most commonly used modalities in neurologic rehabilitation. These are useful in adjunct to a strong therapeutic exercise program, but they should not take the place of active exercise. E-stim is categorized broadly as neuromuscular electrical stimulation (NMES) or transcutaneous electrical nerve stimulation (TENS). NMES is used to stimulate a muscle contraction, whereas TENS is used primarily for pain. Although NMES is used primarily for slowing muscle atrophy, there is also a component of pain control. Conversely, although TENS primarily addresses pain control, fine muscle fasciculations can be attained using TENS. In the acute phase, TENS can be used around incision lines if they are painful or edematous. NMES can facilitate tetanic contractions that can simulate walking motion if applied in an alternating contracting fashion (**Fig. 9**). Additionally, NMES can be combined with active exercise to maximize muscle contraction. For example, in paraparetic patients, electrodes may be applied to the quadriceps and hamstring muscles to further increase the strength of the muscle contraction during this exercise. Typically, treatments are applied for 20 minutes, three to five times daily for strengthening protocols, and one to two times daily or until adequate pain control is achieved for TENS protocols.

If muscle or joint contracture is a barrier to recovery, therapeutic ultrasound may reverse or lessen tendon, ligament, and joint capsule contractures. A continuous ultrasound protocol for heating is needed. Intensity depends on the size of the patient, and frequency is based on the depth of penetration needed. The duration of treatment is determined by the size of the treatment area. In general, it takes 4 minutes per sound head area to heat tissues effectively. For example, if using a 5 cm sound head to treat the thoracic limb flexor tendons of a medium-sized dog (approximately 12 cm in length), the duration would be approximately 10 minutes. The treatment area should be no larger than four times that of the sound head; otherwise there will not be sufficient tissue heating. Clip all hair with a #40 blade and apply conductive get to prevent superficial thermal burns. Thermal burns also may occur if there is not good contact across the sound head. In areas that are round or unevenly shaped, a gel standoff pad may be used to create a flat surface.

Cryotherapy and heat therapy are useful in the immediate postoperative period. Cryotherapy is used during the first 48 to 72 hours to reduce inflammation, pain, and swelling. Additionally, many patients with neurologic conditions have concurrent

Fig. 9. Tetanic reciprocal contraction of the right and left hamstrings in a tetraplegic patient using NMES to simulate walking. In this photo, left pelvic limb flexion is being facilitated manually by slight pressure on the ventral paw for full limb flexion.

osteoarthritis, so cryotherapy may help relieve the exercise-induced pain and inflammation that occurs after rehabilitation sessions. Cryotherapy may be applied using commercial gel packs, crushed ice, or frozen towels. Cold packs are applied for 15 to 20 minutes, two to six times daily or following exercise. Do not apply for longer periods, or there is a risk of skin damage. A very thin, damp towel should be applied to protect the skin but not limit the conduction of the cold pack. Heat therapy is particularly useful before stretching or for treating seromas. Moist heat is most desirable, and professional hydrocollators are the most suitable moist heat packs. Many clinics and most clients, however, will not have access to hydrocollator hot packs, so microwavable moist heat packs may be substituted. Additionally, a thick towel that is partially moistened and warmed in the microwave is also effective. Heat therapy should be applied for 20 minutes three times daily for seromas or pain from muscle spasm. If using heat therapy before PROM or stretching, 3 to 5 minutes of application are sufficient.

SUMMARY

Neurologic rehabilitation can be among the most challenging and rewarding work for the veterinary team. Determining time for recovery is often the most difficult task. It is important to remember that recovery times can be extremely variable, and are intrinsically linked to the neurologic condition, underlying medical conditions, and neurologic status upon presentation for rehabilitation. This article presented various exercises and modalities that can be used for rehabilitation in common canine neurologic conditions. One must take into account time available for treatment, both of the veterinary team and the owner, as it is often not feasible to perform all exercises and modalities in a single patient. Also, some exercises may not be applicable or plausible for some patients. In short, each patient requires a rehabilitation protocol that is specifically designed for the patient's neurologic condition, owner expectations and level of participation, and expertise of the veterinary team.

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