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CASE REPORT

Contributions of Motor Learning in the Physical Therapy of a Working Dog: A Case Report

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Abstract

This case report presents the unique contributions of physical therapy using principles of motor learning in the rehabilitation of a canine patient post C5-C6 ventral slot procedure and subsequent rhizotomy of C6, with a secondary central cord infarct.

This case describes an eight-year old, MN, Rottweiler who presented to the physical therapy department as tetra-paretic following a diagnosis of cervical intervertebral disc disease. Baseline assessment revealed a very low functioning dog, incapable of independent voluntary motor activity and requiring maximal assistance for all transfers and activities of daily living.

Principles of motor learning were incorporated into intense physical therapy treatments to promote neuroplasticity, including part-task practice, repetitions, specificity of tasks that are novel and challenging, and neuromuscular re-education models, such as proprioceptive, balance and perturbation training.[1] This dog returned to independence and normal activities of daily living on a horse farm with minimal residual neurologic deficits.

This report is interesting because it describes a dog with severe cervical neurological comorbidities, whose prognosis was described as 'poor' for return to function by referring veterinarians. Additional studies need to be conducted to better understand how various motor learning approaches affect neuroplasticity and affect the overall functional outcome of canine cervical patients.

Introduction

Surgical decompression is a common treatment in the management of dogs with intervertebral disc herniation (IVDH).[1-4] Rehabilitation after spinal surgery is becoming more accepted and accessible for patients; however, limited data exists on the effect of postoperative rehabilitation on functional outcomes in patients undergoing IVDH surgery.

Literature pertaining to postoperative rehabilitation outcomes focuses on patients with IVDH in the thoracolumbar spine.[5-7] These articles defined postoperative rehabilitation to include modalities (cryotherapy, laser, neuromuscular electrical stimulation), range of motion, therapeutic exercise, massage and aquatic therapy.

Information pertaining to rehabilitation of dogs after surgery for IVDH in the cervical spine is extremely limited, with recommendations employing the use of ice packs and rest for 4 weeks, followed by a month of light, progressive exercise.[8] A single article was found that reported beneficial effects of rehabilitation post traumatic cervical myelopathy.[9] Physical therapy techniques included massage, electrical stimulation, passive range of motion, therapeutic exercise and gait training.[9] At a one year follow-up examination, this patient was independent with ambulation, though continued to have severe ataxia and tetraparesis.[9] Most patients with cervical spine dysfunction are expected to walk immediately following surgery[8]; however, larger dogs (>15 kg) and those dogs that are not ambulatory 96 hours post-operative are, respectively, six and seven times less likely to recover completely.[10]

Human neurorehabilitation techniques traditionally employ several approaches, such as models of facilitation, including proprioceptive neuromuscular facilitation (PNF) and neurodevelopmental technique (NDT).[11-14] More recently, concepts of motor control and learning have been incorporated into practice to promote neuroplasticity.[15] These include whole and part practice where a task is broken down into its component parts, repetitions, specificity of tasks that are novel and challenging, and neuromuscular re-education models, such as proprioceptive, balance and perturbation training.[15]

The following case describes a dog with IVDD combined with spinal stenosis and a secondary central cord infarct at the C5-C6 cervical spinal level. Intense physical therapy techniques related to theories of motor control and learning, as well as traditional physical therapy, was implemented with an outcome that exceeded expectations.

Presentation

An eight year old, 100-pound neutered, male Rottweiler presented to a local Small Animal Teaching Hospital emergency service after a four day history of weakness in his pelvic limbs. Previously, he had been seen by his referring veterinarian who suspected a disc problem and treated him with oral steroids. The dog did not improve with medications and was transferred to the University's neurology service for a complete work-up. His past medical history included a heart murmur due to sub-aortic stenosis and allergies to penicillin, cephalosporins, and a severe allergy to food preservatives.

History and Presenting Signs

Neurological examination at the University showed that he was weak in both hind limbs as well as his right forelimb. He had proprioceptive deficits in these three limbs and decreased cervical range of motion. His responses indicated presence of neck pathology. Based on his acute history and size and age, a disc herniation was suspected and an MRI was ordered.

The MRI revealed extrusion of intervertebral disc material at the C5-C6 level and degeneration of the disc at C6-C7 was revealed. A ventral slot was performed the same day to decompress his spinal cord. Although the surgical procedure was successful, the dog sustained a large amount of blood loss and clot-promoting material was left in the surgical site to control bleeding; thus a blood transfusion was also performed during surgery. He recovered unremarkably from anesthesia and was monitored closely for continued blood loss, none of which was reported. Per medical records, he "continued to gain function more each day", though no details were provided. The dog was discharged home a few days later on Tramadol, Deramaxx, Gabapentin, Misoprostol and Sucralfate and a plan of strict cage rest.

Approximately one month later, the dog re-presented to the University on an emergency basis with his owner's complaints that her dog showed signs of excessive neck pain. He had been trying to get up at home and cried out, seemingly very painful, and then would not rise. According to the owner, he had been displaying pain in the thoracic limb since approximately one week postoperative. A second MRI showed a small degree of impingement on the right C6 nerve root; though was not suspected to be the primary cause of his extreme pain. A bone scan and orthopedic exam were performed, both with a negative result. A C6 nerve root injection of morphine, bupivacaine and Depomedrol was administered with no acute blockage of the pain. A brachial plexus nerve block was performed, again with negative results. A diagnostic electromyography showed minor changes in muscles innervated by the C6 nerve root. One week after his second admittance to the University hospital, a dorsal laminectomy with partial medial facetectomy on the right side of C5-C6 was performed to view the nerve root. The associated intervertebral foramen was extremely stenotic and the nerve root appeared atrophied for a dog of his size. Minimal disc material and a small hematoma was also visualized. A rhizotomy of C6 was subsequently performed.

According to post-operative reports, the dog was immediately more comfortable. However, a 'central-cord'-type syndrome had also developed which manifested by poor function of his thoracic limbs more than the pelvic limbs. This neurologic finding was unexpected since he was ambulatory prior to this second surgery. He was sent home on pain medications and physical therapy was recommended. Nursing care was reviewed to include position changes every 4-6 hours or when he appeared uncomfortable, offering small meals and water, bladder expression, and daily temperatures.

Treatment: Physical Therapy

Two weeks later, an initial inpatient physical therapy evaluation by a licensed physical therapist, certified in animal rehabilitation, revealed an 8-year old male, neutered Rottweiler, weighing 104 pounds. Upon presentation, he was completely dependent, requiring two people, to transfer to a cart. Vocalization and growling was heard during transfers and positioning. Minimal movement of his head and proximal pelvic limbs was noted on both right and left sides when positioned in side lying, but he was unable to maintain his head in an anti-gravity position in all other positions. In side-lying, deep pain sensation and withdrawal reflexes were present in all four limbs. He was completely dependent and displayed no motor function in antigravity positions. As expected, moderate warmth and edema surrounded the surgical site. Staples were present along the dorsum of his cervical spine with good scar mobility. He was dependent (requiring 2

people) for all transfers, and required maximal assistance (one person) to change position from a side-lying to sternal position.

Table 1 – Physical therapy treatment timeline

Weeks 0-2	Positioning and position changes; passive range of motion; joint oscillations; massage; tactile stimulation; cryotherapy; scar massage
Weeks 2-6	Transfer training; static hydrotherapy; manual cueing; weight shifts; functional strengthening and training; gait training; assistive device
Weeks 6-8	Progress transfer training, hydrotherapy, balance training, and functional strengthening and training
Return to Function	Increase difficulty of functional tasks

Physical therapy treatment included instruction of the owner in skin care, passive range of motion, joint oscillations for pelvic and thoracic limbs over a therapy ball (Figure 1), massage, tactile cervical stimulation using a brush and hands, cold pack over his incision site, and gentle scar massage. The importance of position changes every 2-3 hours from right and left sides was emphasized and demonstrated to the owners, as well as to personnel in the Critical Care Unit at the veterinary specialty hospital where he boarded each night. Hydrotherapy utilizing the buoyancy of water to facilitate movement and transfers was instituted. The dog was boarded Monday through Friday each week and returned home with his owners on the weekends. Muzzling was instituted as needed.

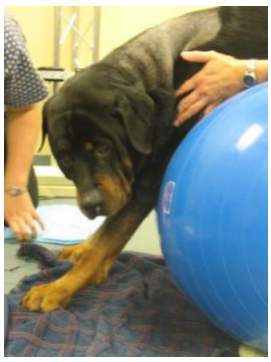

Figure 1. Joint oscillations over a therapy ball - Physical therapy treatment of a canine patient post C5-C6 ventral slot procedure and subsequent rhizotomy of C6, with a secondary central cord infarct, included motor learning concepts such as thoracic limb joint oscillations and functional strengthening for postural control over a therapy ball, with weight shifts in preparation for ambulation.

Motor learning concepts were simplified into specific tasks, working towards a progression that was functional for the animal. Progressive techniques included transfers (sidelying to sternal; sternal to sit; sit to stand); weight shifts in preparation for ambulation; functional strengthening for postural control and in preparation for gait training. As he progressed, weight shifts over a

therapy ball, transfer training side lying to sternal, and perturbations while sternal lying on a balance board were instituted. Functional training was performed, encouraging him to shift weight onto all four limbs in preparation for gait, while supported and reaching for a treat. He was fed over a therapy ball to encourage neck extension and strength (Figure 2).

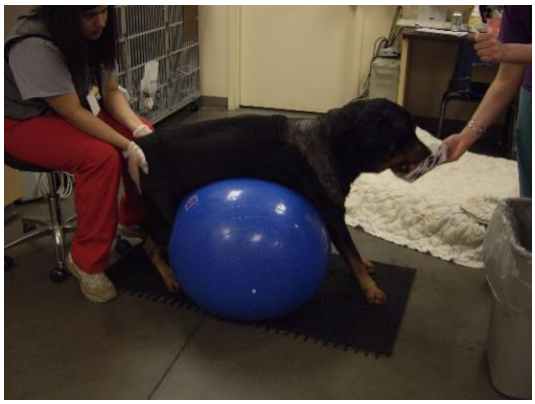

Figure 2. Functional training - Physical therapy treatment techniques of a canine patient post C5-C6 ventral slot procedure and subsequent rhizotomy of C6, with a secondary central cord infarct, included progressive motor learning concepts such as functional training, incorporating feeding over a therapy ball to encourage active weight shifts onto all four limbs and neck extension and strength in preparation for gait.

Once he was able to lie sternal independently, transfer training into sitting and then into standing, was practiced on land as well as in the water. Buoyancy of the water was used to provide standing assistance, a type of body weight support (treadmill belt was not running). Manual cues (facilitation) were given to encourage proper weight shifts and positioning of all four limbs prior to and during the task. The use of walkabout harnesses (pelvic and forelimb support harnesses) were utilized until safety of independent ambulation was assessed. Mild ataxia persisted in all four limbs as ambulation improved. Balance training using a balance board in all positions (sternal, sitting and standing), as well as on an underwater treadmill, was instituted at which time perturbations were added to challenge and promote balance. The stationary underwater treadmill also provided for distributed practice of transfer training and endurance training.

Outcome

Upon discharge at 8 weeks postoperative, he was able to ambulate independently, with mild ataxia still present during ambulation. He continued to exhibit significant core and pelvic weakness and moderate lateral pelvic sway during a walk. Clonus in his left hind limb was also evident when he fatigued. He had control over bowel and bladder function. The physical therapist monitored his program with monthly assessments for 3 months; providing the owner with instructions to increase difficulty of functional tasks in the dog's home program. This included climbing onto hay bales, jumping over and wading in small streams, herding horses, and climbing onto the couch. Gait on ramps, stairs, hills and incorporating obstacles over a course was also prescribed in his home exercise program, and these progressed in difficulty.

Because there were no published protocols for cervical IVDD combined with cervical stenosis, goals were set based on prior clinical experience and knowledge of motor learning techniques and the dog's prior level of activity. Short term goals (attained within 4 weeks) were to: 1) prevent secondary complications such as pneumonia and decubitus ulcers; 2) demonstrate increased mobility and endurance by independently sitting sternal; 3) achieve independence in

transfer side lying to sternal position; 4) hold his head independently in spinal extension to feed and drink without the concern of aspiration; 5) maintain joint range of motion throughout all four limbs.

The long term goal for him was to ambulate independently and safely across all types of terrain, including stairs, in 8 weeks.

Summary and Discussion

This case presents a complicated patient with multiple neurological disorders, including IVDD hemilaminectomy, C6 rhizotomy and a secondary central cord infarct. Baseline assessment revealed a very low functioning dog, incapable of independent voluntary motor activity. He was dependent in all transfers, required maximal assistance for position changes, urinating, watering and feeding. Due to the complexity of this case, it was not expected that this dog would return to full function after 8 weeks of physical therapy. His gait remained ataxic at discharge, which requires more energy for ambulation and potentially fatigued him faster. At 6 months verbal follow-up with the owner, it was reported that the dog 'was back to his normal self'. Minimal ataxia remained which 'didn't seem to slow him down', according to the owner and he was capable of keeping pace with his pre-injury status.

The nervous system is responsive to input and can learn after injury; though training experience is critical and must be goal-specific.[16-18] Theories of motor learning and motor control aimed at repetition and functional strategies were demonstrated in this case by applying task-specific physical therapy techniques to a non-ambulatory dog. Because neuroplasticity is activity dependent, early activities that encourage normal functional patterns were emphasized as a part of physical therapy management. Applying this model enabled this dog to recover, become independent with ambulation and return to functional activities.

This animal did not recover to 100% normal ambulation. Mild ataxia persisted even after he was discharged home at 8 weeks post-operative. To provide an analogy to human rehabilitation, some practice approaches suggest performing whole-task practice, or practicing a task in its entirety, versus part-task, or practicing component parts of a task.[15] Thus, to minimize or prevent the ataxia, should whole practice have been considered, instead of part-task practice? A question remains whether it would have been better to teach the dog to stand and walk from the beginning in a body-weight supported harness rather than breaking down the task step by step with transfer training and part-task practice. However, body weight supported gait training in a traumatic cervical myelopathy case showed an outcome of severe ataxia.[9] Additionally, a support harness was unavailable at the time and due to the weight of the dog, whole practice would have proven difficult with a single practitioner. Additional studies are warranted to determine the best course of treatment to minimize impairments.

Conclusion

Even though a few symptoms remained, this dog was independent in ambulation and function. As with any intervention, consideration of the appropriate timing and dosage was essential to optimize outcomes. If inappropriate intervention is initiated too early, could the repair of neural

tissue be hindered? Several studies have investigated the effect of rehabilitation on post-operative neurologic surgeries; however, these studies focused on the thoracolumbar region and the definition and timing of rehabilitation varied in each study.[5,7,19] Larger studies need to be conducted to better understand how various motor learning approaches affect neuroplasticity and affect the overall functional outcome of canine cervical patients, and spinal patients in general. Prognostic indicators, including average time to ambulation in tetraparetic patients, would also be important to know to determine the effect of physical therapy on recovery.

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