Rehabilitation Modalities in the Management of Osteoarthritis

Thomas Gibson BSc, BEd, DVM, DVSC, Diplomate ACVS, Diplomate ACVSMR, Associate Professor Small Animal Surgery, Ontario Veterinary College, University of Guelph

Introduction

Rehabilitation is a relatively new pursuit in veterinary medicine with the first interest gaining momentum in the late 1980's through to the present. Many of us have experienced first hand the benefits of physiotherapy following injury and/or surgery and thus it would seem logical that our veterinary patients would experience the same benefits. That being said, there is a paucity of quality publications in the literature that provide strong evidence that rehabilitation is beneficial. With increasing client interest in veterinary rehabilitation, the availability of training courses for veterinarians and veterinary technicians and the recent formation of the American College of Veterinary Sports Medicine (ACVMSR), hopefully we see strong evidence supporting this practice.

Currently established physiotherapy techniques that are used to manage canine patients that have OA have the following perceived benefits:

- reduce pain
- resolving inflammation
- improve strength and balance
- increase range of motion
- prevent muscle spasms
- help to restore more normal joint function
- preventing or minimizing muscle atrophy
- preventing periarticular contraction
- increasing blood and lymph flow through the affected area
- providing positive psychologic effects for the patient and owner

The ultimate goal for any rehabilitation protocol would be to restore function to as close to normal as possible. In many cases, physiotherapy also helps to reduce the dose of analgesics necessary to maintain patient comfort.

Benefits of Rehabilitation

It is well established that joint dysfunction that arises from osteoarthritis can range from minor discomfort to complete debilitation. In veterinary practice we see patients all along this spectrum. In many cases OA is advanced and progressing before owners report clinical signs and many pathological changes have already occurred in both the joint and the periarticular structures such as tendons, ligaments and the joint capsule. An obvious example of this is the 'medial buttress' seen on the medial aspect of the canine stifle with cranial cruciate ligament rupture and subsequent instability and advancement of osteoarthritis. With this fibrosis and scarring we see a reduction in range of motion both from physical restriction but also from the discomfort associated with movement of the joint. This vicious spiral leads to disuse, muscle atrophy, further loss of joint support and further deterioration in the range of motion and quality of movement. Therefore the goal of any therapy should be to reduce discomfort, improve range of motion and thus quality of movement minimizing the negative effects of loss of use. It is important to realize that these periarticular structures are well innervated and must be considered a source of discomfort that are major contributors to the pain associated with OA. Anyone that has had a joint immobilized in a cast or joint surgery can attest to the discomfort associated with a joint with a reduced range of motion. This is especially apparent when the well-meaning physiotherapist uses manual stretching to help restore normal range of motion!

Rehabilitation Techniques and Modalities

Cryotherapy

tissues that are chronically inflamed, recently injured or post operatively. It can consist of ice packs, ice wraps, and cold compression wraps and can be as simple as a bag of frozen peas a Ziplock™ bag with two parts water and one part alcohol or as complicated as a Game Ready™ cold compressive therapy unit. Using compression such as an elastic wrap can further decrease the temperature of the deeper tissues. Cryotherapy is most effective when inflammation is present and some of the perceived benefits of cryotherapy include:

- Promotion of vasoconstriction and skeletal muscle relaxation and decreases nerve conduction
- vasoconstriction limits blood flow into the area, thereby reducing edema
- muscle relaxation can decrease edema formation by improving venous return and by preventing endothelial damage caused by local acidosis
- decreased nerve conduction produces mild analgesia

Moist Heat

Moist heat can be applied using warmed oat bags in a moistened towel, using commercial, microwaveable moist heat packs or using moist heat bags from a hydrocollator commonly found in physiotherapy facilities. It is best used after acute inflammation has resolved. It is very useful when applied before stretching, massage therapy, passive range-of- motion (PROM) exercises, or active exercise. The benefits of moist heat include:

- A reduction in muscle spasms and increase in blood flow to the treatment region
- Penetration to a tissue depth of 1 to 2 cm
- Causes vasodilation, mild sedation, relief of muscular pain, resorption of extravasated fluids, and increased local circulation
- Enhances local metabolism and improves the delivery of nutrients
- Increases the compliance of joint capsules, tendons, and scar tissue and reduces joint stiffness, thereby countering much of the stimulus for pain

Passive Range of Motion Exercises (PROM)

The purpose of passive range of motion activities is to advance the joint through a comfortable range of motion. This is not considered stretching and is not intended to exceed the limit of comfortable joint movement or the 'end point' as it is called. Common questions that arise related to PROM activities include use of sedation or muzzles during this activity. In the majority of cases neither is required. Animals with temperaments such that a muzzle is required may not be good candidates for this type of manipulation. PROM is intended to:

- maintain normal range of motion in joints
- prevent contracture
- improve blood and lymphatic circulation
- stimulate sensory awareness
- reduce the catabolic effects of immobility on articular cartilage

Stretching

When additional pressure is applied at the end points of the ROM then it becomes stretching. The goal of stretching is to increase tissue extensibility. These activities are ideally performed several times daily after the application of moist heat or therapeutic ultrasound therapy. Trained individuals can perform both passive ROM and stretching. Caution should be exercised when instructing owners to perform stretching exercises, as there may be some discomfort associated with manipulating a joint past it's end point if limitations in joint range of motion are present.

Massage

Massage techniques are adjunct therapy that may have direct and indirect effects on pain sensation. These techniques do not have any direct on muscle mass, strength or rate of muscle atrophy but when used in

Direct effects on pain include:

- Stimulation of sensory afferents
- Counterirritant theory
- Psychological effects

Indirect effects on pain include:

- Increasing extensibility of tight muscles, scar tissue, joint capsule, tendons, ligaments
-Assisting venous and lymphatic flow

Electrical Stimulation (EStim)

Electrical stimulation (EStim) is commonly used in human physiotherapy to increase muscle strength, improve joint range of motion, re-educate muscles, and decrease edema and pain. There are both pain management and muscle stimulation modes for this modality. Transcutaneous electrical nerve stimulation (TENS) is commonly used to treat a specific area of pain or to stimulate a particular muscle in order to combat muscle atrophy. These TENS units are readily available, battery powered and inexpensive.

Hydrotherapy

Hydrotherapy in the form of the underwater treadmill is one of the most effective methods of providing controlled and targeted therapy for our patients. It's benefits in pain relief in postoperative, neurological, and chronic OA patients are a result of the effects of buoyancy, hydrostatic pressure and temperature. It provides safe, controlled, supportive and non explosive activity that is ideal for weight loss, hip dysplasia, FHO patients. The one unfortunate drawback of underwater treadmills is the expense, space requirement and maintenance of the equipment.

Therapeutic Exercises

The true gains made in any rehabilitation protocol are made through exercise. Most of the modalities mentioned previously are intended to provide better quality and more comfortable movement allowing our patients to exercise to regain strength, range of motion and muscle mass whose loss is associated with injury, disuse or chronic conditions. Unlike the underwater treadmill, these activities can be done with little financial investment with a bit of ingenuity and creativity. Activities as simple as walking and trotting over different inclines and terrain, walking over cavaletti rails, walking with resistance provided by water, elastic bands, sand, snow and sit to stand exercises are all exercises that can be incorporated in to a dry land rehab program. Many of these activities are essential to a well-directed home exercise program. Stairs, exercise balls and peanuts, orange safety cones and broom sticks can all be modified and used inexpensively to set up a dry rehabilitation area.

Therapeutic Ultrasound (TUS)

Therapeutic ultrasound has been used widely in human rehabilitation as being an effective treatment modality for rehabilitating musculoskeletal conditions such as restricted range of motion (ROM) resulting from joint contracture, pain and muscle spasm, and wound healing.2 Many protocols for the administration of US are based on tradition or extrapolated from basic science research and remain to be tested in controlled clinical trials.3

Proposed Mechanism of Action

Energy within a sound beam decreases as it travels through tissue, because of scatter and absorption. Scattering is the deflection of sound out of the beam when it strikes a reflecting surface. The transfer of energy from the sound beam to the tissues is through absorption. Absorption is higher in tissues with high protein content and relatively low in fatty tissue. The creation of a thermal effect is a major indication for the use therapeutic US. Increasing tissue temperature may increase collagen extensibility, blood flow, pain threshold, and enzyme activity, as well as mild inflammatory reactions, and changes in nerve conduction velocity. Treatment with US for 10 to 20 minutes at high intensities, skeletal muscle temperature and blood flow increase.

periarticular structures, muscle spasm, and nonacute soft tissue injuries. Nonthermal effects of TUS can facilitate healing of acute soft tissue injuries and peripheral nerve injuries.

Treatment Variables

The following list contains treatment variables that should be considered when designing the TUS protocol. The details of treatment variables should be documented in the patient record.

1. Frequency
2. Intensity
3. Duty cycle
4. Treatment area
5. Treatment duration
6. Speed of the sound head
7. Treatment schedule

The frequency of the soundwave is the variable that determines the depth of penetration. Most commonly, a frequency of 1 MHz is utilized because it provides adequate depth of penetration and adequate heating in most situations. A 1 MHz frequency heats at depths between 2 and 5 cm. Increasing frequency decreases depth of penetration. The other commonly used frequency of 3.3 MHz (commonly referred to as 3 MHz) heats at depths between 0.5 and 3 cm. Increasing intensity results in faster heating and higher temperatures, Generally intensities required to increase tissue temperature 2° C or more vary from 1 to 2 W/cm2 continuous wave US for 5 to 10 minutes. Duty cycle refers to the fraction of time that the US is emitted from the head compared to the length of time the head is in contact with the skin. This changes when pulsed ultrasound protocols are used. The treatment area should be two to four times the size of the effective radiating area of the transducer head. If a larger area requires treatment then it should be divided. If the total treatment area is expanded beyond the recommended area, the dosage and the heating effect will be decreased. Duration of 5 to 10 minutes has been shown to produce adequate tissue heating in an area equivalent to two to three times the diameter of the sound head. The speed at which the sound head is moved over the skin is approximately 4 cm per second to achieve uniform distribution of energy to the target tissues. Treatment schedules may include daily treatment initially, followed by less frequent sessions as the condition improves. It has been recommended that daily treatments should not exceed 10 consecutive days however the scientific basis of these recommendations is not clear.

Advantages of TUS	**Disadvantages of TUS**
Local heating of tissue	Dosage is difficult to monitor
Short treatment time	Hair clipping required
	Transducer contact may aggravate irritated tissues

Low Level Laser Therapy (LLLT)

Over the past 6 or 7 years this modality has been gaining popularity for treatment of a variety of conditions in veterinary medicine. In 2015, it was estimated that close to 20% of veterinary hospitals in North America were using a therapeutic laser in their practice. This is likely due to an increased awareness and deployment of veterinary rehabilitation services, availability of educational resources on therapy lasers, and the development of products and protocols that have resulted in more consistent clinical outcomes. Laser therapy is considered a noninvasive, drug-free treatment option, providing clients with a nonpharmacologic treatment option. Quality research in the area of photobiomodulation in veterinary medicine is scarce. Much of the information advocating use of lasers is extrapolated from *in vitro* studies or from studies performed in other species. Published, well-designed studies are for the most part not available in veterinary species.

Proposed Mechanism of Action

LASER is an acronym for “light amplification by stimulated emission of radiation”. A laser produces electromagnetic radiation that is monochromatic, coherent, and collimated allowing laser light to penetrate

watts (joules/second), is the rate of energy production. Laser dosage is determined by multiplying power by time. Energy provided can then be measured in power density (W/cm2) or energy density (J/cm2). Lasr light wavelength is the parameter that determines depth of penetration. The wavelength of laser light determines the depth of penetration. Longer wavelengths are more resistant to scatter and thus tend to penetrate tissues better. Lasers are also categorized into different classes based on the potential for tissue damage. Class 1 lasers are used in audio-visual players are very mild. Laser pointers are Class 2 lasers (<1 mW), and emit light in the visible spectrum and pose little threat of eye damage. Therapy lasers begin at Class 3A lasers (1–5 mW) emitting visible light. Class 3B lasers (5–500 mW) are also used in rehabilitation and produce nonvisible light but can still result in eye injury. Class 4 lasers (>500 mW) are both therapy and surgical lasers. Class 4 lasers have potential for eye damage as well as causing tissue burns. Most lasers used in rehabilitation are low power (or cold) lasers and typically have a power of 500 mW or less.

It is proposed that LLLT modulates cellular functions by a process known as photobiostimulation. Therapy lasers induce a nonthermal interaction of monochromatic radiation with the tissues requiring treatment. The physiologic effect of this type of energy application on tissue is still not completely understood. LLLT has been reported to modulate various biologic processes, such as mitochondrial respiration and adenosine triphosphate (ATP) synthesis, to accelerate wound and joint healing, and to promote muscle regeneration. Acute and chronic pain control has been reported using this type of low-energy photon therapy. Treatment of chronic and acute edema, neurologic conditions, and postoperative care are some other popular conditions treated with laser therapy.

Indications for use of LLLT
The efficacy of LLLT remains controversial in veterinary medicine. Some veterinary studies have shown some promise for use of LLLT for preservation of cartilage properties, improvement in peripheral nerve injuries, and as a possible adjunct to managing pain in patients with osteoarthritis. Laser therapy may have some benefit in early wound healing.

Extracorporeal shock wave therapy (ESWT)
Extracorporeal shock wave therapy (ESWT) was initially introduced in human medicine in the early 1980s as a noninvasive method for reducing the size of nephroliths. Increasingly ESWT is being suggested as treatment for certain musculoskeletal conditions in humans and veterinary patients. Reported benefits include pain relief, antibacterial properties and improved wound, bone, tendon, and ligament healing.

Proposed Mechanism of Action
The exact mechanism of action of ESWT is not well understood. One theory proposes that mechanical stimulation from soundwaves results in the expression of growth factors and cytokines involved in the healing process. ESWT applied to chronically injured tissues may restart the inflammatory process and facilitate healing by causing the release of inflammatory mediators. The proposed mechanism believed to be responsible for pain relief is related to increased serotonin activity in the dorsal horn, and descending inhibition of pain signals

Indications for use of ESWT
ESWT has been reported to be beneficial as an ancillary treatment in cases of osteoarthritis. One study reported improved weight bearing and passive range of motion are similar to results expected with NSAID treatment. On occasions when NSAIDs cannot be prescribed, extracorporeal shockwaves therapy may provide an alternative for treatment of osteoarthritic conditions. Anecdotal reports indicate that conditions affecting the elbow, hip, or back treatment of conditions may be more responsive to ESTW than other joints. Other reported indications for ESWT include delayed or nonunion fractures, wound management, tendinopathies and ligament injuries.

Suggested Readings

1) Marcellin-Little DJ, Levine D and Millis D. *Veterinary Clinics of North America: Small Animal Practice: Veterinary Rehabilitation and Physical Therapy*, Vet Clin Small Anim 45 (2015)

2) Millis D and Levine D. *Canine Rehabilitation and Physical Therapy*. Second Edition, Elsevier, 2014

3) Zink MK and VanDyke JB. *Canine Sports Medicine and Rehabilitation*. First edition, Wiley-Blackwell, 2013

4) Kieves NR, MacKay CS, Adducci S et al. *High energy focused shock wave therapy accelerates bone healing. A blinded, prospective, randomized canine clinical trial.* Vet Comp Orthop Traumatol 2015; 28: 425–432

5) Leeman JJ, Shaw KK, Mison MB et al. *Extracorporeal shockwave therapy and therapeutic exercise for supraspinatus and biceps tendinopathies in 29 dogs*. Veterinary Record (2016)

6) Rogatko CP, Baltzer WI and Tennant R. *Preoperative low level laser therapy in dogs undergoing tibial plateau levelling osteotomy: A blinded, prospective, randomized clinical trial*. Vet Comp Orthop Traumatol 2017; 30