Physical Agent Modalities in Physical Therapy and Rehabilitation of Small Animals

June Hanks, PT, PhD, DPT, CWS, CLT\textsuperscript{a},
David Levine, PT, PhD, DPT, CCRP, Cert. DN\textsuperscript{b,}*,
Barbara Bockstahler, Dr Vet Med, DVM, PD, CCRP\textsuperscript{b}

INTRODUCTION

Physical agent modalities (PAMs) have been used in rehabilitation and physical therapy for centuries to reduce swelling, relieve pain, enhance healing, increase muscle strength, improve muscle tone, and affect the elasticity of connective tissue. Often used as a complement to therapeutic exercise in addition to medical and surgical interventions, PAMs assist to limit impairments and disability and to maximize function. The mechanism of action and depth of penetration varies with the method of application and the form of energy used. For example, direct contact between objects of

\begin{itemize}
  \item Superficial heat
  \item Cryotherapy
  \item Ultrasound
  \item Physical agent modalities
  \item Electrotherapeutic modalities
  \item Electrical stimulation
  \item Cold packs
  \item Hot packs
\end{itemize}

KEY POINTS

\begin{itemize}
  \item Physical agent modalities are a useful adjunct to medical and surgical interventions, exercise, and manual therapy in the rehabilitation of animals.
  \item The most appropriate modality depends on the diagnosis, stage of healing, and treatment goals.
  \item Cold therapy is indicated in the management of acute injury or inflammation and for pain.
  \item Superficial heating agents such as hot packs penetrate to a tissue depth of approximately 2 cm, whereas deep heating with ultrasound can penetrate up to 5 cm.
  \item Heating agents are useful to increase tissue pliability and to decrease pain and muscle spasm.
\end{itemize}
different temperature can lead to thermal energy transfer through direct interaction of the molecules (conduction, as with hot/cold pack), through movement of fluid or air molecules across tissue interfaces (convection, as with hot or cold whirlpool), or through the transformation of nonthermal forms of energy such as sound waves to heat (conversion, as with ultrasound [US]). Electrical stimulation (ES) is used primarily to treat acute and chronic pain and muscle atrophy. The purpose of this article is to review the use of cold, superficial heat, therapeutic US, and ES in small animal rehabilitation.

COLD (CRYOTHERAPY)

Basic Properties

Cryotherapy is the therapeutic application of cold in rehabilitation and physical therapy. Cold can be applied through a variety of mechanisms including cold packs, ice massage, cold water baths, mechanical and electrical compression units, and vapor-coolant sprays. Cryotherapy can be used throughout the rehabilitative process to mitigate negative effects of inflammatory responses. Physiologically, local application of cold causes many changes, including temporary decreases in:

- blood flow to the area
- edema formation
- hemorrhage
- histamine release
- local metabolism
- muscle spindle activity
- nerve conduction velocity (NCV)
- pain

In response to cooling, acutely inflamed tissues exhibit a slowed metabolic rate, inhibition of inflammatory enzymatic reactions, and reduced release of histamine. These physiologic responses serve to limit tissue damage. The vasoconstriction associated with cold application limits edema formation and hemorrhage. Pain may be lessened by reduced pressure on nociceptive receptors through edema reduction, and through reduced NCV. In general, cold compresses should be applied for 10 to 20 minutes for therapeutic benefit.

Indications

Cold is typically indicated in small animal rehabilitation for the management of acute injury or inflammation. PRICE is an acronym commonly used for acute injuries, and stands for Protection, Rest (to halt further injury), Ice (to decrease tissue metabolism and minimize tissue damage), Compression (to decrease edema), and Elevation (to decrease edema). In animals with acute injury, rest and ice can be readily used. Compression bandages may be applied to certain sites, such as a limb or distal joint such as the elbow, carpus, or stifle. Elevation is possible by keeping the edematous side up when in lateral recumbency. Application of cold to minimize postsurgical swelling is also recommended.

The reduction in pain and inflammation with cryotherapy may lead to increased range of motion (ROM) in affected joints. Local cold application may reduce spasticity in spinal cord disorders. Cooling may inhibit the extension of tissue damage with thermal burns, with greatest benefit occurring when a coolant is applied immediately after burn injury. For treatment of burn injury, the temperature of the coolant should be considered. In a study of induced dermal burns in pigs, cool water
(temperature of 12°C–18°C) was of greater benefit than cold water (temperature 1°C–8°C) in limiting tissue damage.\(^{14}\)

Several studies have examined the effectiveness of cold application following surgery. One study demonstrated superior edema reduction with cold application with and without bandaging compared with bandaging alone during the 72 hours following surgical repair of the cranial cruciate ligament.\(^ {9}\) Another study demonstrated reduced pain and swelling and increased motion in the stifle joint with cold application following tibial plateau-leveling osteotomy in dogs.\(^ {11}\)

**Contraindications and Precautions**

There are relatively few contraindications (never use it) and precautions (use it with caution) for cryotherapy. The primary precaution is avoidance of frostbite. It is difficult to check skin color on dogs because of pigmentation and hair coat. To be safe and avoid prolonged application, inspect the skin every few minutes. Cryotherapy is rarely applied directly onto the animal, owing to possible discomfort and/or tissue damage. The use of a towel between the cold pack or ice pack and the skin is recommended. The towel may be either dry or moist; if moist, it will cool to a greater extent as liquid is a better thermal conductor than air. More research is needed in dogs to document the amount and duration of tissue cooling with various forms of cold application. The insulating effect of the hair coat in dogs may be a factor to consider, although one study indicated that the extent of caudal thigh muscle cooling was similar with clipped and unclipped hair coat when cold packs (2 parts ice, 1 part isopropyl alcohol) were applied.\(^ {15}\) Other precautions and contraindications include the presence of cardiac or respiratory disease, uncovered open wounds, and ischemic areas.

**General Guidelines for Application of Cold**

During cold application, the treated tissue should be observed periodically to assure that the tissue is not being damaged. Color changes in the skin include redness (normal response) and blanching or whitening (sign of vasoconstriction and potential tissue damage). The recommended method of cold application depends on the therapeutic goal, stage of healing, location and size of the area to be treated, and practicality.

**Cold packs/ice packs**

Many types of cold packs are commercially available (Fig. 1). Ice packs can be made placing crushed ice in a moist towel or in a plastic bag wrapped in a moist towel. An ice pack that conforms easily around irregularly shaped body parts such as a limb can be made by placing a mixture of 3 parts water to 1 part rubbing alcohol in a plastic bag and then in the freezer. Although the cooling effect is significantly greater with a 20-minute application of a cold pack, a therapeutic amount of cooling may occur within 10 minutes.\(^ {8}\)

The effect of cold compresses (−16°C [3°F]) was studied on epaxial muscles in dogs.\(^ {8}\) The compresses were applied for 5, 10, and 20 minutes in random fashion, and temperature changes at 0.5, 1.0, and 1.5 cm of tissue depth were measured. At 10 minutes, the cold decreased tissue temperature at 0.5-, 1.0-, and 1.5-cm depths 7°C, 4.7°C, and 4°C, respectively. At 20 minutes the cold further decreased tissue temperature to 8.2°C, 6.5°C, and 4.7°C at the respective depths. The differences between the 10-minute and 20-minute applications were significant, with the 20-minute treatment being greater, but applications of 10 minutes were sufficient for therapeutic cooling. Dogs used in this study were of ideal body condition, making the results a good guide, but not applicable to overweight or underweight dogs.\(^ {8}\)
Cold-compression units
These commercially available devices consist of a sleeve with tubing running throughout that alternately circulates cold water and air. The combination of compression and cooling is effective in treating tissues in the acute phase of healing.

Cold immersion
In this type of application, the patient typically stands with the affected limb immersed in a container of cold water (2°C–16°C). Rapid and significant tissue cooling occurs, but is difficult to apply because of poor patient compliance.

Ice massage
Water can be frozen in a Styrofoam or plastic cup and then applied to the affected area directly. To perform the massage, the therapist exposes a portion of the ice surface, holds the cup, and applies the ice surface directly to the patient’s skin (Fig. 2). The ice surface is moved in a continuous, circular fashion across the treatment area for 5 to 10 minutes.

Cold application over casts or bandages
Superficial skin temperatures can be reduced with cold application over a cast or bandages. A greater decrease in skin temperature is observed with cold application over plaster and synthetic casts than over a bulky Robert-Jones dressing.16,17

HEAT
Heating agents are classified as superficial or deep heating. Superficial heating agents penetrate up to approximately 2 cm tissue depth, whereas deep heating agents
elevate tissue temperatures at depths of 3 cm or more (Table 1). Heat sources are classified as radiant, conductive, or convective. An infrared lamp is an example of a radiant, superficial heating device. A hot pack is an example of a conductive, superficial heating device, and a whirlpool is an example of moist heat delivered by conduction and convection.

**Basic Properties and Treatment Variables**

Both heat and cold may be used for pain relief and reduction in muscle spasm, although the mechanism of action differs. Heat application causes increased:

- Vasodilation
- Tissue elasticity
- Muscle relaxation
- Pain relief

Locally applied superficial heating agents such as hot packs, electrical heating pads, and infrared lamps stimulate vasodilation through activation of bradykinin and nitrous oxide in the smooth muscle of blood vessels and through a reactive inhibition of sympathetic output. NCV increases, resulting in a decrease in pain and muscle spasm.18

Locally heated tissue increases in extensibility, thus reducing joint stiffness and leading to increased ROM. When soft tissue is heated before stretching, gains in tissue length are greater per unit force in achieving the length gain, and are maintained for longer periods of time than without prior heating.18,19

Therapeutic US has been used in small animal practice for a variety of purposes. Though primarily thought of as a deep heating agent,20,21 it is also used for tissue

<table>
<thead>
<tr>
<th>Physical Agent</th>
<th>Depth of Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot packs</td>
<td>Skin and down to 1.5 cm</td>
</tr>
<tr>
<td>Therapeutic ultrasound (3.3 MHz)</td>
<td>1.0–3.0 cm</td>
</tr>
<tr>
<td>Therapeutic ultrasound (1.0 MHz)</td>
<td>2.0–5.0 cm</td>
</tr>
</tbody>
</table>

Fig. 2. During ice massage, the ice surface should be moved across the skin surface in a continuous, circular motion for 5 to 10 minutes.
healing and repair\textsuperscript{22} and to enhance the transdermal administration of drugs (phonophoresis). The efficacy of phonophoresis has been reported in rats,\textsuperscript{23-25} but studies in dogs are warranted.

US refers to high-frequency acoustic waves above the human hearing range (approximately 20 kHz). Sound waves are produced within a transducer head (also termed the sound head). The advantages of US are that it produces localized heating in deeper tissues and the duration of therapy is short, approximately 10 minutes. A disadvantage is that the heat is difficult to monitor exactly.

### Indications

US is primarily used for the therapeutic effect of tissue temperature increase that leads to increased blood flow, decreasing pain and muscle spasm, improving collagen extensibility, and increasing ROM.

### Contraindications and Precautions

There are certain conditions under which US should not be utilized or should be used with caution:

- Directly over the heart or in animals with pacemakers
- Over areas where thrombophlebitis is present (or any risk of embolus)
- Over infected areas or neoplasms
- Over areas with decreased or absent sensation
- Over the carotid sinus
- Over a pregnant uterus
- Plastic and metal implants
- Over the epiphyseal area of growing bones
- Over the spinal cord after laminectomy

### Frequency

The typical therapeutic US unit has 2 frequencies, 1.0 and 3.3 MHz. The frequency is chosen based on the depth of tissue the clinician is trying to affect. The 1.0-MHz unit penetrates to a depth of 2.0 to 5.0 cm and the 3.3-MHz unit penetrates to 1.0 to 3.0 cm (see Table 1). Knowledge of the anatomy of the tissues that are being treated, in addition to the depth of the particular aspect of the tissues, is important in choosing the frequency.

### Intensity

Intensity on most US devices can range from 0 to 2.5 W/cm\textsuperscript{2}. In general, the higher the intensity, the greater the temperature increases (Table 2).\textsuperscript{20} Intensities required to increase tissue temperature 2.0°C or more generally vary from 1.0 to 2.0 W/cm\textsuperscript{2}

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Tissue temperature change in dog caudal thigh muscles with ultrasound after 10 minutes of treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 W/cm\textsuperscript{2}</td>
</tr>
<tr>
<td>Tissue temperature at 1 cm depth (°C)</td>
<td>3</td>
</tr>
<tr>
<td>Tissue temperature at 2 cm depth (°C)</td>
<td>2.3</td>
</tr>
<tr>
<td>Tissue temperature at 3 cm depth (°C)</td>
<td>1.6</td>
</tr>
</tbody>
</table>

continuous-mode US for 5 to 10 minutes. To heat an area with substantial soft tissue, intensities as high as 2.0 W/cm² may be used. If there is less soft tissue, or if bone is close to the skin surface, lower intensities are appropriate. After selection of an initial intensity, the patient’s tolerance to the heat produced by the US is the final determinant of intensity, although this may be difficult to determine in pets. Most dogs lie quietly during US treatment. However, dogs sometimes begin to move or otherwise seem uncomfortable after commencing US. Although it may appear that the dog just wants to change position and move around, any clear signs of distress such as whining and crying may indicate pain, and the intensity of the US should be reduced or the session interrupted or discontinued. The skin also should never turn red or be hot to the touch.

The hair coat in dogs treated with US presents a problem not encountered with human patients. The hair coat should be clipped and cleaned before treatment. One study examined the effects of hair coat in dogs. Ultrasound delivered through short-hair or long-hair coats produced nontherapeutic, minimal temperature increases in the underlying tissues when compared with US after the hair had been clipped. In addition, there was considerable warming within the hair coat at the skin interface that could cause skin burns.

**Mode**

The mode of US (often called the duty cycle) is typically used at either 100% (continuous) or 20% (pulsed). Other modes are available on some devices, but have not been well researched. The 100% continuous mode is used for heating effect and to increase tissue extensibility. The 20% pulsed mode is used for promotion and acceleration of tissue healing.

**Treatment Time**

Treatment time is based on 2 factors: the size of the area to be treated and the size of the US transducer head. For each transducer head that fits in the area to be treated, approximately 4 minutes of US should be delivered. After determining the precise area to be treated, the number of transducer heads needed to cover the area must be determined. For example, if one is performing US on epaxial muscles and 3 sounds heads completely cover the area, the treatment time is approximately 12 minutes. Transducer heads come in a variety of sizes from 1 to 10 cm². A larger transducer head is much more effective from a time perspective than a small transducer head if large areas are to be treated. When applying US, the sound head should be moved continuously in circular or longitudinal patterns at an approximate speed of 4.0 cm/second.

**Coupling Agents**

A coupling medium, such as commercially available water-soluble gels or a coupling gel pad cushion, must be placed between the sound head and the tissue surface. The US sound beam is transmitted through the coupling medium to the skin. When using a water-soluble gel, the gel is applied to the area to be treated and the sound head is placed in direct contact with the gel. When using a coupling gel pad (Fig. 3), the gel pad is placed over the area to be treated and the sound head is placed in direct contact with the gel pad. This direct coupling method is preferred over other methods such as immersion under water. In the water-immersion method, the part to be treated must be immersed in water, all air bubbles must be removed from the water, and the sound head must be maintained at a distance of 0.5 to 3.0 cm from the skin surface during treatment. Studies indicate less of an increase in tissue temperature with the water-immersion method in comparison with direct application of the sound head.
Research on Ultrasound and Tissue Heating

One prospective randomized trial examined tissue temperature changes that occur at various depths during 3.3-MHz US treatments of the caudal thigh muscles in dogs.20 Dogs received 2 randomly selected US treatments at intensities of 1.0 and 1.5 W/cm². Thermistors were inserted in the muscles at depths of 1.0, 2.0, and 3.0 cm, directly under the US treatment area. Both intensities of US treatment were performed on each dog over a 10-cm² area for 10 minutes using a sound head with an effective radiating area of 5 cm². Tissue temperature was measured before, during, and after US treatment until tissue temperature returned to baseline. At the completion of the 10-minute US treatment, the temperature increase at an intensity of 1.0 W/cm² was 3°C at the 1-cm depth, 2.3°C at 2.0 cm, and 1.6°C at 3.0 cm. At an intensity of 1.5 W/cm², tissue temperatures rose 4.6°C at the 1.0-cm depth, 3.6°C at 2.0 cm, and 2.4°C at 3.0 cm. Tissue temperatures returned to baseline within 10 minutes after treatment in all dogs. This study demonstrated that significant heating occurs in muscle during 3.3-MHz US, but the effect is relatively short-lived.20 Another in vivo trial on dogs found heating with 1.0-MHz US at a depth of 5.0 cm with intensities of 1.5 W/cm² (2.0°C increase) and 2.0 W/cm² (3.5°C increase).21 This same study found no heating at 10.0 cm of depth in any condition, which is consistent with in vivo studies on humans. A depth of 5.0 cm is thought to be the relative maximum depth at which US can have therapeutic benefit.

Research on Ultrasound and Tissue Healing

Most studies performed on US for tissue healing have been on animal models and have involved creating experimentally induced wounds. The animals typically have normal circulation, a condition that should be considered when interpreting effectiveness of treatment. One study using dogs22 reported that pulsed US at 0.5 W/cm² enhanced healing of the common calcaneal tendon. The US treatment was started the third day after surgically severing the tendon, and was performed daily for 10 days. A comprehensive review of the use of US for soft-tissue repair, wound
healing, and fracture healing has recently been published, but is beyond the scope of this article.  

ELECTRICAL STIMULATION

Basic Concepts of Electrical Stimulation

Electrical stimulation (ES) has many documented benefits in humans, including increasing muscle strength, increasing ROM, decreasing acute and chronic pain, reducing muscle spasm, and promotion of soft-tissue and fracture healing. The study of ES in dogs has focused on pain control and muscle strengthening.

Contraindications and Precautions

There are certain conditions under which ES should not be utilized, or should be used with caution:

- High-intensity stimulation directly over the heart or ES in animals with pacemakers
- Animals with seizure disorders (use around the head and neck)
- In areas with impaired sensation
- Over areas of thrombosis or thrombophlebitis
- Over infected areas or neoplasms
- Any time that active motion is contraindicated
- Over the trunk of pregnant females

Preparation and Electrode Placement

To ensure good contact of the electrodes with the skin surface, the animals' hair should be carefully clipped. Most electrodes are self-adherent and stick to the skin. If rubber electrodes are used, a gel medium or water-soaked sponges can be used at the electrode-skin interface. Wetting of the skin with water or alcohol is required if brush-like needle pads are used (Fig. 4). The animal should be placed in a comfortable position before the start of treatment. Initial treatments should be of short duration and low intensity to allow the animal to become accustomed to the sensation of ES. For chronic conditions, electrodes are usually placed directly over or along the edges of the painful area. For example, electrodes can be placed on the medial and lateral side of the joint being treated (eg, elbow; Fig. 5) or directly on the painful area.

Fig. 4. Brush-like needle pads for conduction of electrical stimulation.
area (eg, back; Figs. 6 and 7). The placement of electrodes to the sides of the spine near the nerve origins of the target treatment area is recommended for acute conditions or when direct or more local application of electrodes is not possible. Other possibilities are the placement over acupuncture or trigger points, and along peripheral superficial nerve tracts.

**Electrical Stimulation for Pain Control**

Several theories explain the pain-relieving mechanisms behind ES: the gate control theory,\(^3\) a release of endogenous opiates,\(^3\) an increase in blood flow and reduction in muscle tone,\(^3\) and the counterirritant theory.\(^3\) The term transcutaneous electrical nerve stimulation (TENS) is commonly used to describe a stimulator used for pain control. The conventional TENS (also called sensory-level TENS) uses frequencies ranging from 50 to 150 Hz and a pulse duration of less than 50 microseconds with a low intensity (high-frequency, low-intensity TENS), and is one of the most often used current parameters. This stimulation mode is presumed to stimulate the gate control and counterirritant mechanisms. Low-frequency TENS (also called motor-level TENS) is a low-frequency, high-intensity type of stimulation with frequencies ranging from 1 to 10 Hz and pulse durations ranging from 100 to 600 microseconds,
with a high intensity. Low-frequency TENS is administered at intensities that evoke visible muscle contractions, and is proposed to stimulate the release of endogenous opioids. Regarding this type of stimulation, some investigators differentiate between acupuncture-like TENS with frequencies between 1 and 4 Hz and frequencies between 5 and 10 Hz. These modes may both be applied to acupuncture points or motor points in the segmentally related myotome.\textsuperscript{35,36} Another common application is mixed-frequency TENS whereby both sensory and motor-level TENS are applied in the same treatment. The combination of sensory and motor-like TENS is thought to prevent nervous system adaptation/accommodation to one particular set of parameters. Varying the TENS parameters (termed modulation) has been shown to prevent accommodation in humans.\textsuperscript{37}

**Indications for Transcutaneous Electrical Nerve Stimulation**

TENS for pain control can be used in numerous orthopedic and neurologic disorders. In humans it has been used for the treatment of acute pain,\textsuperscript{36} musculoskeletal pain,\textsuperscript{39} and osteoarthritis.\textsuperscript{40} In the treatment of musculoskeletal pain, a meta-analysis of existing studies was performed, from which the investigators concluded that high-frequency TENS and TENS with frequencies lower than 10 Hz had a significant effect, whereas acupuncture TENS fell just short of significance.\textsuperscript{39} In a meta-analysis study of osteoarthritis of the knee, the combined efficacies of conventional TENS and acupuncture-like TENS were shown to improve pain and stiffness in comparison with placebo treatment. This pain-relieving effect was also found if conventional and acupuncture-like TENS were evaluated separately. Another result of this study was that pain relief by acupuncture-like TENS was approximately 2 times better than that with high frequencies.\textsuperscript{40} Rainov and Heidecke\textsuperscript{41} investigated the impact of TENS on pain in humans who underwent lumbar canal stenosis surgery. One group of patients received only pain medications and the other group received pain medications and TENS. In the TENS-treated group, the total given dose of medications was significantly reduced in comparison with the control group. Nevertheless, despite the positive results of the experimental research, the use of TENS in clinical practice is debated, as other studies have not shown positive results.\textsuperscript{42,43} Unfortunately, few high-quality studies in veterinary medicine are available. In a study of obese dogs suffering from osteoarthritis (OA), a combination of dietary management and intensive physiotherapy including TENS treatments was shown to effectively reduce disability.\textsuperscript{44} In a preliminary study,
positive effects of TENS application for arthritic pain in the stifle joint of 5 dogs was apparent up to 210 minutes after TENS application, but the greatest improvement was found immediately (first 30 minutes) after treatment. Further study of TENS application in dogs is needed to establish effectiveness. Such studies should include larger groups of animals, different parameters, and altered physical activity throughout the study.

**Intensity, Treatment Time, and Frequency of Transcutaneous Electrical Nerve Stimulation**

In general, the intensity must always be adapted to the needs, comfort, and response of the individual patient. The recommended intensity varies with the goal of treatment and tolerance by the patient. Conventional TENS (high frequency, low intensity) is applied with the intensity of the current just below the sensory response threshold. The intensity is increased until the patient feels a tingling sensation. No muscle contraction should occur. In dogs this can be achieved by carefully increasing of the intensity until the animal shows a reaction such as looking at the pads. For low-frequency TENS, the intensity is slowly increased until the motor threshold is reached, as evidenced by a visible twitch contraction.

In the treatment of humans, various recommendations for treatment time and intervals of the TENS can be found in the literature. For example, in the treatment of OA using conventional TENS, recommended treatment times vary between 15, 30, and 60 minutes. The recommended frequency of treatment varies from 3 sessions daily for 3 weeks to twice daily for 6 weeks and up to 2 times per week over 4 weeks. For animals, the following is recommended: lower intensity, short treatment duration, and short intervals between treatment sessions are suitable in acute stages; higher intensities with longer treatment durations and intervals between the treatments are recommended in chronic conditions.

**Electrical Stimulation for Muscle Strengthening**

ES has been used in hundreds of human trials to increase muscle strength. A term commonly associated with ES for muscle strengthening is called neuromuscular electrical stimulation (NMES). NMES has numerous applications for small animals. Examples include patients who have muscle atrophy, in the immediate postoperative period after surgery to manage cranial cruciate ligament injuries, and after femoral head and neck ostectomy. Muscle atrophy seen with nerve injuries, such as radial nerve paralysis, can be attenuated with NMES while waiting for nerve innervation to return. Optimal parameters have not been adequately studied; however, in one trial in dogs with postoperative extracapsular stabilization after cranial cruciate ligament rupture, atrophy was minimized compared with the control group.

**Animal Reaction/Safety for Electrical Stimulation**

As ES can produce pain if used incorrectly, precautions should be taken to avoid injury to the handler and animal. A muzzle may need to be applied and the animal placed in lateral recumbency during the initial treatment. In some cases, tranquilization may be necessary if the animal is anxious. The authors recommend that treatment only be given under the supervision of trained personnel. Most dogs tolerate ES well, but occasionally a dog may find the sensation unpleasant and vocalize and/or try to run. Turning the current up very slowly is one way to allow the dog to get used to the sensation gradually and tolerate the treatment well.
Types of Stimulators

A large variety of electrical stimulators are commercially available, including small portable units and large units. Some multipurpose units generate ES in a variety of modes and waveforms. These units may also incorporate therapeutic US and/or therapeutic laser.

SUMMARY

PAMs can be effective treatments and/or adjuncts to treatments in the overall rehabilitation plan. Understanding the effects, indications, contraindications, and precautions of each modality is critical for proper use. Selection of the appropriate modality depends largely on an understanding of the diagnosis, an accurate assessment of the stage of tissue healing and repair, an accurate clinical assessment of the functional limitations, the established treatment goals, and continued reevaluation of the patient. Cryotherapy is most useful during the acute inflammatory stages of tissue healing to cause vasoconstriction and to decrease edema and pain. Using heat too soon in the inflammatory process may exacerbate the inflammatory process and slow healing. Heating modalities (both superficial and deep) are most commonly used to cause vasodilation and increase tissue extensibility, and to decrease pain and muscle spasm. ES is most commonly used to reduce pain and muscle spasm, in both acute and chronic circumstances, and to increase muscle strength.

REFERENCES


