Wound management is a common aspect of veterinary medicine. Wounds vary from clean, post-operative incisions to those that may be chronic, infected and/or have substantial tissue loss. Basic wound cleaning and debridement are essential prior to the application of any topical or therapeutic agent. This discussion will cover recent advances in wound management techniques including negative pressure wound therapy and therapeutic modalities used to stimulate healing.

**Negative Pressure Wound Therapy/ Vacuum Assisted Wound Closure (VAC)**

Negative pressure wound therapy (NPWT) is a wound management modality that utilizes local negative pressure applied to a wound in order to promote wound healing. Benefits of this therapy include:

- removal of fluid from the extravascular space
- increased local circulation
- improved formation of granulation tissue
- increased bacterial clearance
- more rapid wound closure

Negative pressure wound therapy was first introduced in human medicine as a method of managing open fractures and chronic diabetic ulcers. Subsequently, NPWT has become an invaluable tool for treating a wide variety of traumatic wounds, including appendicular degloving injuries in human and veterinary patients. Reports of appendicular degloving injuries treated with surgical reattachment of the skin and an overlying NPWT bandage has resulted in skin survival rates between 60 and 100% in human patients. While limited clinical veterinary studies have been published on the use of NPWT, there have been reports of the successful management of 15 dogs with distal extremity wounds using NPWT therapy prior to definitive treatment and the use of NPWT in treatment of a large wound on the dorsum of a cat.

A NPWT bandage consists of either sterile polyurethane foam or gauze placed within the wound, suction tubing, adherent film, and a regulated negative pressure drainage device. There are several commercially available products, which are recommended including VAC (Vacuum Assisted Closure, KCI, San Antonio, TX) and Venturi (Talley Medical, Hampshire, UK).

The negative pressure is typically set at -125 mmHg and bandages should be changed every 48-72 hours. When initially managing traumatic or highly contaminated wounds the bandage may need to be changed every 24 hours to allow for sufficient debridement since NPWT therapy must not be used in place of proper surgical
debridement. Additionally, NPWT should not be used in wounds that may contain neoplastic cells, since this therapy will likely increase blood flow and stimulate cellular proliferation within the wound bed.

**Therapeutic LASER**

Laser is an acronym for “light amplification by stimulated emission of radiation”. In this process, electromagnetic energy is harnessed into an intense, coherent, monochromatic beam of light. The properties of monochromaticity (all waves are same length/ color) and coherence (all waves in phase) are characteristics of all lasers. A laser is made using a material (gas, liquid, solid) that when stimulated by an external energy source such, such as electricity, will release photons of a single color or wavelength.

Therapeutic lasers are commonly referred to as “low level lasers” or “cold lasers”, in contrast to high-powered lasers that are used to cut tissue. Therapeutic or low level lasers have a power output less than 500 miliwatts (mW) and cannot cut tissue. Power output is significant, because a laser with a higher wattage will reach the desired dose more quickly. Amongst low level lasers, power output (watts, W) varies greatly, anywhere from 3.5mW to 500 mW. Recently, lasers with power output greater than 500 mW (typically around 10 W) have been marketed as therapeutic lasers. While these lasers do provide therapeutic properties, they have the capacity cause considerable tissue heating and risk to skin tissue and therefore should only be used by trained medical professionals.

Lasers are divided into four classes with additional subclasses (I, II, IIIA, IIIB and IV). A common misconception is that these classes distinguish the efficacy or quality of the laser. Rather, laser class is determined by the ability to cause eye injury and is based on power output. Class I-IIIA lasers, including supermarket scanners, laser pointers and remote controls, are considered safe. Class IIIB lasers pose a risk of eye injury, and eye protection is recommended. Any laser with greater than 500 mW of power falls into class IV, which is considered to be an acute hazard to the skin and eyes from direct and scattered radiation.

Dosage (also known as energy density or fluence) appears to be the most important laser parameter in clinical application. Dosage is measured in J/cm², and can be calculated using the following formula:

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\text{Dose} = \frac{P \times t}{A}
\]

- \(P\) = laser’s output power (W)
- \(t\) = treatment time (seconds)
- \(A\) = area treated (cm²)
- 1 J = 1 W/s

Lasers that are available commercially and marketed for medical or veterinary use will likely come with recommended doses for various conditions pre-programmed into the unit or listed in the instruction manual. While the optimal treatment dose has not been established for any condition, generally recommended doses fall between 2-10 J/cm².
One last consideration is the depth of laser penetration. This depends on the wavelength of the laser, with longer wavelength resulting in deeper penetration. A GaAs laser (904 nm) can reach tissue depths of 3-5 cm, while a HeNe (633 nm) will have more superficial penetration, near 1cm.

The effects of therapeutic lasers in wound healing include:

- vasodilatation
- angiogenesis
- increased collagen synthesis by fibroblast
- differentiation of fibroblast into myofibroblasts
- stimulation of leukocytes
- enhanced antioxidant activity

The end results of these processes are improved tissue healing and regeneration, increased wound contraction, increased strength of repaired tissue, improved immune function, and defense against ischemia/reperfusion injury. Furthermore, laser therapy can reduce pain through several mechanisms, including increased secretion of serotonin, increased release of endogenous opiates, and blockage of afferent C fiber depolarization.

Based on the aforementioned properties of laser, the indications for use in veterinary medicine are numerous, but primarily include enhancement of cutaneous wound and tissue healing and amelioration of acute and chronic pain. Because laser is recognized to enhance neovascularization, irradiation of tumors or wounds that may contain cancer cells is contraindicated. Furthermore, lasers pose a known risk to the eye, so irradiation of or near the eye should not be performed. Additional contraindications include irradiation over a pregnant uterus and open growth plates.

Finally, it is important to note that a therapeutic window exists for laser therapy. At sub-therapeutic doses, cells will not be stimulated and no reactions will occur; at extremely high doses, detrimental effects can be seen. Interestingly, it is believed that low-level lasers, at any dose, have minimal effect on normal, uninjured tissue.

**Extracorporeal shock wave therapy**

Extracorporeal shock wave therapy (ESWT) was first introduced in the early 1980s as a non-invasive method for treating kidney stones. Over the past two decades, this modality has been increasingly used to treat a variety of musculoskeletal conditions in humans and veterinary patients.

Benefits of ESWT include:

- increased bone, tendon, and ligament healing
- accelerated wound healing
- anti-bacterial properties
- pain relief

These properties have led to ESWT use in the treatment of chronic tendonopathies, delayed and non-union fractures, chronic wounds such as diabetic ulcers, and in the management of pain associated with osteoarthritis.
Extracorporeal shock wave therapy is an acoustic energy modality, similar to but much more intense than ultrasound waves. Shock waves are highly focused (2-8 mm) and have a predictable depth of penetration. Extracorporeal shock wave therapy is applied superficially, and waves enter tissue and are absorbed or reflected. Energy is released when a wave meets an area of high acoustic impedance such as a bone-tendon interface. Compressive and tensile forces result in cavitation and mechanical microstress to cells and tissue.

The exact mechanism of action of ESWT has yet to be fully elucidated; however, the mechanical stimulation of cells is hypothesized to result in increased expression of cytokines and growth factors. Extracorporeal shock wave therapy applied to an area of chronic inflammation may enable acute inflammatory mediators to be released, facilitating appropriate progression of healing. The mechanism behind the pain-relieving function of ESWT is thought to be due to increased serotonin activity in the dorsal horn and descending inhibition of pain signals. For these reasons, ESWT has been used clinically in humans for the treatment of painful, chronic musculoskeletal conditions such as Achilles tendinosis, lateral epicondylitis, supraspinatous tendonopathy, plantar fascitis, and patellar tendonitis.

In addition to its use in musculoskeletal conditions, ESWT has recently been shown to affect the rate of cutaneous wound healing through the expression of growth factors such as VEGF, TGF-B1, and ILG-1. These factors are associated with increased neovascularization of tissue. Studies in pigs have demonstrated hastened epithelialization of partial thickness wounds and improved survival of skin flaps. This modality has also been shown to improve healing of burn wounds in humans and distal extremity wounds in horses.

Adverse effects of ESWT have been reported in humans and animals and tend to be mild, including erythema, bruising of the treated area, and transiently increased pain and lameness following treatment. Contraindications include neoplasia, open physis, and over the chest or abdomen.

References:


