CURRENT MATERIALS, MEDICATIONS, AND TECHNIQUES IN WOUND MANAGEMENT AND BANDAGING

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As with other areas of veterinary medicine and surgery, there have been advances in the field of wound care. This includes new topical medications that stimulate wound healing.

Acemannan is a topical wound healing stimulant available as a hydrogel (Carravet Wound Dressing®, Carrington Laboratories, Inc., Irving, TX). It stimulates macrophages to produce the cytokines interleukin-1 and tumor necrosis factor-alpha. Fibroblast proliferation, neovascularization, epidermal growth and motility and enhanced collagen deposition result from its application. In dogs it has been found to accelerate the healing of paw pad wounds when applied topically and when injected intralesionally in its injectable form. It is indicated to manage superficial and deep partial thickness burns, lacerations, dermal ulcers, and abrasions in dogs, cats and horses.

A wound should be debrided and lavaged before applying the gel. The most effective time to begin application is in the early inflammatory stage of healing, with daily application under a bandage. The medication has its most pronounced effect during the first 7 days of application.

Acemannan is also available in a freeze dried form (CaraSorb, FDG, Carrington Laboratories, Inc., Irving, TX). In addition to its wound healing stimulation properties, this form of the medication is hydrophilic and tends to pull fluid from tissues. If the animal is on systemic antibiotics, these are delivered to wound tissues via the fluid. This can be beneficial in cleansing a wound by drawing the body's homeostatic fluids through wound tissues to bathe them from the inside. The hydrophilic nature of the medication can also help reduce edema of wound tissues.

A D-glucose polysaccharide, Maltodextrin N. F. (Intracell®, Maclead Pharmaceuticals, Ft. Collins, CO) is a hydrophilic powder and gel that can be used to cleanse and promote healing of contaminated and infected wounds. Its hydrophilic nature acts as previously described to bathe the wound from the inside. The medication may supply glucose to provide energy for cell metabolism to promote wound healing. The drug reportedly causes chemotaxis of polymorphonuclear cells, lymphocyctes, and macrophages in wounds, all of which play a role in wound healing. Matlodextrin has also been shown to have antibacterial and bacteriostatic properties.

Following debridement and lavage, the wound is covered with the Maltodextrin. Daily application with bandage change is done. The powder is preferred for exudating wounds, and the gel is preferred for drier wounds. Saline solution should be applied to the bandage if it has become dry at bandage change. The medication can be applied from the early inflammatory healing stage on into the repair healing stage.

A tripeptide-copper complex medication (Iamin-Hydrating Gel®, Procyte Corp.,

Redmond, WA) is a chemoattractant for mast cells and monocytes/macrophages in wounds. Macrophages debride a wound and produce cytokines that stimulate healing, while mast cells enhance angiogenesis in wounds. The medication also stimulates epithelialization and collagen synthesis in wounds. The topical form of the medication has been found to enhance open wound healing in dogs, and the injectable form has resulted in more type I collagen in healing pad wounds of dogs. It has also been found effective in enhancing healing of ischemic wounds in rats.

The topical gel should be applied following debridement and irrigation of a wound. It should be applied daily with bandage change beginning in the late inflammatory and early repair healing stage on into the repair stage of healing. It also has its most pronounced effect on healing during the first 7 days of application.

The acemannan, tripeptide-copper complex, and D-glucose polysaccharide, Maltodextrin medications would have application on chronic wounds as well as acute wounds. Once the wounds have been evaluated for possible etiologic causes these medications could be considered to stimulate wounds into an active state of healing in combination with any other specific therapy needed.

It has been found by the author that if something has an effect on wound healing, be it good or bad, it has its greatest effect during the first 7 days it is used. This can be taken advantage of in using the wound healing stimulants. The medications can be used at 7 day intervals.

Sugar has been described both in history and recently as a topical wound treatment. The basis for its use is its high osmolality. Thus, it is effective in reducing edema due to its hydrophilic action. It has also been reported to attract macrophages, accelerate slough of devitalized tissue, provide cellular energy, and promote granulation tissue. Its use should be discontinued after the wound has a good bed of granulation tissue. It has been reported to be effective against Staph., Strep., Enterobacter, E. coli, Klebsiella, Pseudomonas, and Serratia organisms. It reportedly does not cause hyperglycemia. It should be used with caution on large wounds. Its hydrophilic action can pull more fluids, electrolytes, and proteins from the wound tissues.

Honey has also been described for wound therapy. Its action is similar to sugar, with its antibacterial activity being attributed to peroxides that are effective against a wide variety of organisms. The honey should be unpasteurized or least not heated over 37° C. Like sugar, it should be used with caution on large wounds due to its hydrophilic action.

Collagen is an integral part of the repair stage of healing. It is produced by the fibroblast and provides wound strength. Exogenous collagen (porcine or bovine) is being used to treat wounds. Such collagen is available in powder, gel, and sheet (matrix) form.

A study with a hydrolyzed bovine collagen (HyCure®, Hymed Group, Bethlehem, PA) has shown that it has hydrophilic properties. These work in the manner previously described to help cleanse a wound. In the study, the moist wound environment created by the hydrophilic

nature of the product was beneficial in enhancing early epithelialization of the wounds. In addition, histologic studies of the wound tissues revealed little inflammatory reaction to the hydrolyzed product even though it was bovine collagen placed in dogs. Hydrolyzed bovine collagen is also available as a gel (Collasate®, PRN Pharmacal, Pensacola, FL).

Porcine collagen (Vet BioSISt®, SurgiVet, Waukesha, WI) is available for wound management. This is a swine intestinal submucosa product in the form of a resorbable acellular collagen matrix. It contains types I, III, and V collagen, fibronectin, decorin, hyaluronic acid, chondroitin sulfate, heparan sulfate and two growth factors (transforming growth factor-beta and beta fibroblast growth factor). Because the material contains these factors, it is included with wound medications. The material has a smooth and rough side. Since it may be difficult to distinguish between the sides, the material is packaged to help with this determination. There is a notch in the upper right corner of the sheet. In this position, the rough side is facing the surgeon. This side of the material should be placed against the wound after the sheet has been cut a little larger than the wound and rehydrated with sterile physiologic saline.

The product can be used on degloving and other large skin wounds following debridement and saline lavage of the wound. With badly traumatized tissue, staged debridement for a few days may be necessary to assure all devitalized tissue is removed before applying Vet BioSISt. When placing the sheet, the edges of the Vet BioSISt should be placed under the skin at the wound edges, if possible, and sutured or stapled to the skin edge. If there is the possibility of exudate accumulation under the sheet, slits can be cut in it to allow drainage. The author prefers to cut small round holes in the sheet using a 1.5 mm diameter skin biopsy punch. The author places a nonadherent semiocclusive bandage pad over the Vet BioSISt followed by an absorbent secondary bandage wrap and tape as the tertiary outer bandage wrap.

After the original sheet degenerates over the wound after 3-4 days, another sheet can be laid over the wound without removing the remnants of the first sheet. This is repeated 2-3 times. Then the VetBioSISt is discontinued but the other bandage layers are continued. Use of strong antiseptics and antibiotics should be avoided, esp. aminoglycosides and sulfas. It has been reported that there is rapid incorporation of the Vet BioSISt into full-thickness wounds. Preclinical studies have shown that there is an earlier appearance of granulation tissue over exposed bone in wounds treated with Vet BioSISt as compared to control wounds treated with only a bandage. The material is also available in a sponge/powder form, a multilaminate sheet, and an ocular disc form.

Vet BioSISt enhances angiogenesis. It also recruits progenitor cells (stem cells from the animal's bone marrow) into the wound. These stem cells differentiate, organize, and develop into tissue like the surrounding tissue, i.e. skin.

Bandaging can play in important role in providing good wound healing. Not only are the materials important in bandaging, but the technique is also important. As with wound medications, there have been advances in the materials used to bandage wounds. In veterinary surgery, it is often necessary to be innovative in the techniques used to bandage wounds to prevent pressure on a wound and/or to immobilize a wound in providing an adequate healing environment.

BANDAGE MATERIALS

Calcium alginate dressings (Curasorb®, Tyco Healthcare Kendall, Mansfield, MA) and is a felt-like dressing derived from certain seaweeds. They enhance granulation tissue formation and provide some mechanical hemostasis. The dressing is placed on heavy to moderately exudating wounds and covered with outer bandage materials to include a nonadherent pad over the dressing. The ion exchange of calcium in the dressing and sodium in the wound fluid results in a sodium alginate gel over the wound which entraps bacteria that can be lavaged away at bandage change. Lavage of the gel is less painful than removing an adherent gauze during the debridement healing stage. The hydrophilic nature of the dressing keeps the wound moist to enhance healing. The disadvantage of this dressing is that if there is insufficient wound fluid, a calcium alginate eschar forms which is difficult to remove.

Moisture retentive dressings (MRD's) are being used to a greater extent in wound management. The basis for the use of such dressings is that they provide a warm moist environment which enhances cell proliferation and function. The presence of wound fluid provides proteases, protease inhibitors, cytokines, and growth factors. In addition, the WBC's in the fluid result in autolytic debridement. Such dressings also furnish a barrier against exogenous bacteria, urine, and feces. If the animal is on systemic antibiotics, the retained fluid will contain a concentration of the antibiotic. The low oxygen tension under such bandages results in a low pH. This, in turn, deters bacteria, favors collagen synthesis, inhances angiogenesis, and attracts WBCs. In addition such bandages are comfortable. As healing progresses, these bandages can be left in place longer between changes. Disadvantages of MRD's are that the retained moisture can cause tissue maceration and excoriation.

An example of a MRD is a polyethylene oxide gel (CarraDres, Carrington Laboratories, Inc., Irving, TX). The gel is sandwiched between 2 layers of polyethylene film. One layer is peeled off and the gel is placed against the wound. The gel is hydrophilic and will absorb 3 times its weight in exudate (hydrophilic). It provides a moist wound environment and allows visualization of the wound.

A semiocclusive polyurethrane foam sponge (Hydrasorb®, Tyco Healthcare Kendall, Mansfield, MA) can be used in the debridement stage of healing when there is considerable exudate on the wound, or it can be used in the later repair stage since it does not adhere to wound tissues. An alternate use of the sponge is to deliver liquid medications or wetting agents to wounds by saturating the sponge prior to application. As a wound heals and has less fluid production, these dressings are changed less often. These sponges can quickly transform smooth quiescent granulation tissue to a healthy appearing granulation tissue.

A polymeric solution of hexamethyldisiloxane acrylate copolymer (Cavilon™ No Sting Barrier Film, 3M Health Care, St. Paul, MN) provides a uniform transparent, colorless, noncytotoxic film on the skin. It is applied every third day to the very irritated intact skin associated with urine and fecal incontinence, and it provides a surface beneath which inflammation is quickly resolved.

The barrier film can also be applied to the skin to help ensure that adhesive tape will stick to the skin. This use also helps prevent the tape from stripping the epidermal layer at bandage change.

An antimicrobial primary and secondary dressing sponge and gauze roll, respectively, are available. They are impregnated with 0.2% polyhexamethylene biguanide (Kerlix, A.M.D., Tyco Healthcare Kendall, Mansfield, MA). Dressings have been found effective against wound invasion by Pseudomonas aeruginosa and Staphylococcus epidermidis. The dressings could be effective in veterinary medicine in preventing external wound contamination when urine or feces get on a bandage. They are also effective in treating wounds that already have microorganisms.

Silver dressings are available (Acticoat Artimicrobial Barrier, Westaim Biomedical Corp., and Silverlon, Argentum). Silver dressings are antibacterial and antifungal. Silverlon is available in pad or rope form. They are moistened with water (not saline), and are changed every 1 to 3 days. At bandage changes, the outer bandage layers are removed. The Silverlon is removed, cleansed and reapplied to the wound. The same dressing can be reapplied 3 times before discarding. The secondary and tertiary layers are changed at each bandage change.

BANDAGE TECHNIQUES

It is often necessary to prevent pressure on paw pads as wounds heal. For major wounds and wounds on the paws of large dogs, a "clam shell" bandage can be used to prevent such pressure. With this bandage, a regular bandage is placed on the paw. The bandage should extend to near the elbow on the forelimb and to near or over the hock on the pelvic limb. The bandage may need to be a little bulky to allow the splints to fit properly. Two metal splints (Metal Splints, Surecraft, Upton, MA) with paw cups are then applied to the bandage with one on the cranial surface of the limb and one of the caudal surface of the limb. The splints are applied so that the concave portion of the paw cups are facing each other and they extend beyond the distal and of the bandage about 1 inch. These are taped in place and serve as a local "crutch" for the paw to keep pressure off of the pads.

Another form of special bandage to keep pressure off of areas is a modified donut bandage. Adding padding over a bony prominence in a bandage can increase pressure, but a modified donut bandage relieves the pressure. To make a modified donut bandage, some soft cast padding material (Specialist Cast Padding, Johnson and Johnson Professional, Inc., Raynham, MA) is folded on itself several times to make a pad. The pad is then folded on itself and a slit is cut in its center. Fingers are then used to enlarge the slit into a hole. The pad is then incorporated in a bandage with the hole over the bony prominence to relieve pressure and help prevent a pressure wound.

Another form of donut bandage is used in paw bandages to help keep pressure off of injured pads. This can be used when the damage is not severe or is on a smaller dog. A piece of foam rubber padding (Comforfoam, HiTech Foam, Lincoln, NE) of medium compressibility is cut to the shape of the plantar/palmar surface of the paw and a section is cut out of the pad that conforms to the size and location of the pad lesion. This is incorporated into the paw bandage with the hole over the lesion.

In small dogs with spinal pathology, they may tend to take a sitting position with the pelvic limbs extended forward. This puts pressure on the skin over the ischial tuberosities making them subject to pressure wounds. To help keep pressure off of these areas, a body bandage is placed on the dog which extends from the axillary region to the flank folds. Bilateral padded aluminum splints can be incorporated in each side of the bandage. Each splint extends beyond the perineal area to prevent the dog from getting in a sitting position to put pressure on the skin over the ischial tuberosities.

To treat wounds over the point of the elbow (olecranon), immobilization of the area in extension is necessary. This immobilizes the tissues to allow them to heal together. The extension keeps the dog from bending the elbow to get in sternal recumbency and placing pressure on the skin to impair healing. A prepackaged fiber glass immobilizer (C-splint, Johnson and Johnson Orthopaedics, Raynham, MA) can be incorporated into the front or side of a forelimb bandage to help immobilize the radial-humeral area. After placing a forelimb bandage on the dog, the splint material is removed from its package and placed in warm water for a few minutes. It is then removed, squeezed out and molded to the radial-humeral area over the bandage until it hardens. After it is dry, it is incorporated into the bandage.

The splint can be molded to the cranial or lateral aspect of the area. Placing it over the lateral aspect of the area may be most effective. When used this way, the forelimb bandage is made continuous, with a body bandage and the splint is incorporated into the lateral aspect of the bandage in a spica splint fashion, often extending over the dorsal midline. For large dogs where the C-splint is not large/long enough, fiber glass casting tape can be used to create a lateral immobilizing splint that extends from the paw, up the leg, and over the shoulder area. When taped to the lateral side of the forelimb-body spica bandage, it provides extension and immobilization.

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