

# COMPLICATIONS

## Pressure-Related Wounds: Prevention and Treatment

Steven F. Swaim, DVM, MS, Auburn University

### Wound Healing—an Overview

Wound healing is a continuum of overlapping stages comprising inflammation, debridement, repair, and maturation. During the **inflammatory stage**, hemorrhage occurs immediately, followed by small vessel constriction and clot formation to attenuate hemorrhage. Plasma leaks from dilated permeable vessels, and leukocytes escape the vessels by diapedesis. The fibrinous clot in the wound aids in hemostasis and maintains homeostasis as the surface dries to a scab, serving as a biologic bandage. During this stage, the wound area is hyperemic, edematous, and painful.

Early in the healing process, neutrophils and macrophages in the wound begin the **debridement process**. In addition, macrophages produce cytokines and growth factors essential for healing progression. They work in concert with lymphocytes to activate the local immune response in the wound. The wound fluid, degenerating leukocytes, and dead tissue comprise the purulent inflammatory exudate associated with this stage of healing. At this time, the appearance of the wound will generally deteriorate before it begins to improve.

The **repair stage** is manifested by proliferation of fibroblasts, capillary infiltration, and epithelial proliferation and migration. Proliferation of fibroblasts and capillary infiltration manifest as granulation tissue. This tissue is a barrier to infection, causes wound contraction, incorporates collagen production by fibroblasts, and provides a surface over which epithelium can migrate. In open wounds, the tissue has a bright reddish-pink appearance and is associated with decreased fluid production. The granulation bed of healthy wounds progressively decreases in size.

During **maturation**, the wound gains strength. Early in this stage, strength results from collagen production by fibroblasts. Later, strength comes from inter- and intramolecular cross-linking of collagen fibers.

Wound healing can be complicated by many factors—one of the most notable is pressure applied to the tissues. Pressure both causes wounds and prevents healing.



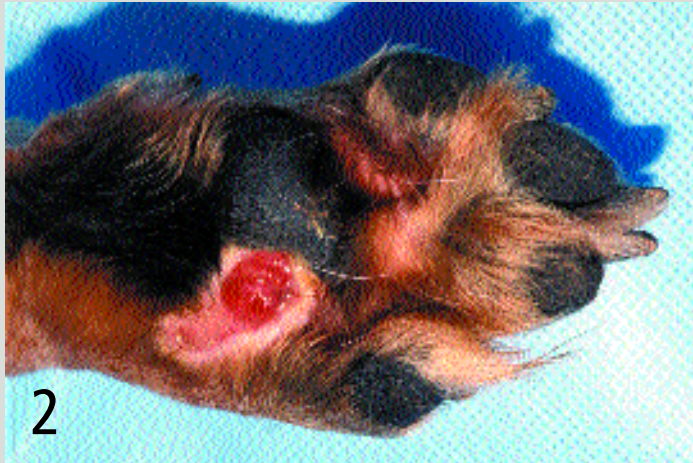
Decubital ulcer over the ischial tuberosity of a toy poodle.

### Types of Pressure Complications

Decubital ulcer is a wound caused by compression of tissues between a bony prominence and the surface on which the patient is resting (**Figure 1**). The pressure causes dermal capillary collapse and subsequent avascular necrosis. Neutrophilic predominance and biochemical changes are also associated with decubital ulcers. Elevated tissue thromboxane levels result in vasoconstriction, platelet aggregation, and ischemia to exacerbate already-compromised tissue circulation. In addition, a persistent neutrophilia causes an ongoing inflammatory state, leading to a chronic wound.<sup>1,2</sup> Casts, splints, and bandages also can cause wounds by exerting pressure over bony prominences, and peripheral neuropathy or other musculoskeletal abnormalities cause anatomical malalignment and abnormalities, which result in pressure wounds on the palmar/plantar surface of a paw (**Figure 2**).

The best bandage for one side of a wound is the other side of the wound. Pressure complicates healing by pushing the wound edges apart; it can also cause biochemical and cellular changes in wound tissue that prevent progression of the healing process, as stated above

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Pressure ulcer at the proximalateral aspect of the metacarpal pad resulting from abnormal weight-bearing following ulnar nerve paralysis.

with decubital ulcers. This complication applies to pressure wounds (see above) and wounds of other causes on which pressure is being exerted (e.g., lacerations on paw pads that are bandaged improperly).

## Prevention

Prevention and relief of pressure are key to precluding pressure wounds and in providing an environment for normal progression of healing. Although what is best to put on a pressure-related wound to enhance healing is a common question, remember: It is not necessarily what you put on the wound that enhances healing, it is what you do not put on the wound. There is an adage about decubital ulcers: "You can put anything on a decubital ulcer but the patient."

## Decubital Ulcers

Dogs in recumbency for prolonged periods are subject to decubital ulcers. Various methods can be used to prevent them. One of the best types of padded bedding for recumbent dogs is a thick, egg-crate-type foam-rubber pad with a vinyl covering.<sup>1,3</sup> An artificial sheepskin mat placed over this cushion provides more padding, allows some air circulation under the animal, and conducts moisture (urine) away from the skin. Changing the dog's position every 1 to 5 hours from left lateral to sternal and right lateral also helps prevent prolonged pressure on areas predisposed to ulcers.<sup>1,3,4</sup> Placing a dog in a sling for 2 to 4 hours a day can help keep pressure off the acromion of the scapula, tuber coxae, and greater trochanter, especially in large dogs.<sup>1,3</sup> Wheeled carts support the pelvic area in paraparetic or paraplegic dogs, thereby keeping pressure off the bony prominences of the hindquarters and providing mobility.



Pieces of aluminum splint incorporated in a body bandage to extend beyond the perineal area. The splints keep the ischial tuberosities from contacting the surface on which the animal is resting, thereby preventing a decubital ulcer.

Splints incorporated in bandages can be helpful in preventing decubital ulcers. A splint over an elbow can immobilize it in extension to help prevent pressure, movement, and a subsequent elbow ulcer. Side splints that extend beyond the perineal area can be incorporated in a body bandage to help prevent pressure wounds over the ischiatic tuberosities that may occur during attempts to sit (Figure 3).

Skin inspection, good hygiene, and good nutrition are important in preventing decubital ulcers. Skin inspection can be done by parting the hair over bony prominences to look for hyperemia. Reducing local skin moisture is important to help prevent the bacterial proliferation and skin maceration that contribute to decubital ulcer development. The previously mentioned artificial sheepskin pads are quite effective for this purpose. In addition, warm whirlpool baths and clipping the perineal and caudal abdominal area help keep the areas clean, especially in incontinent dogs. A high-protein, high-carbohydrate diet with vitamin supplements is advocated to provide adequate nutrition.<sup>1</sup>

## Pressure Wounds on Limbs and Paws

When a cast, bandage, or splint is being placed over a convex area, such as the elbow, hock, or carpal pad, the tendency is to place extra padding over these areas to prevent pressure. However, this actually increases pressure when the outer bandage layers are applied. A donut-type pad made of soft cast padding (Specialist Cast Padding—Johnson & Johnson Orthopaedics, Raynham, MA) is best for preventing pressure over the area. The padding is made by folding several layers together and cutting an opening in the center of the pad ("donut"

continues



4A



4B



4C



4D



"Donut"-type pad. A. Several layers of cast material are folded together to make a pad. B. The pad is folded on itself, and a slit is cut in the center. C. Digital tension is used to form the slit to a round hole. D. The pad is placed with the hole over a bony prominence.

hole). The hole is placed over the convex area. This keeps pressure off by distributing pressure around the area (Figure 4).

Wounds on the paw pads need pressure relief to keep the stress of weight-bearing from pushing wound edges apart. A Velpeau bandage or Robinson sling can be used to prevent any weight-bearing on the forelimb and pelvic limb, respectively. However, the pressure on pads can be relieved while allowing limb use through application of special bandages.

**Digital pads.** To relieve pressure on digital pads, a triangle of medium-density, foam sponge-rubber (ComforFoam—HiTech Foam, Lincoln, NE) in the shape of the metacarpal/metatarsal pad is placed under that pad (Figure 5). Then the cup portion of a metasplint is placed under the foam sponge-rubber pad during paw bandaging. The resultant elevation offloads the digits.<sup>5</sup>

**Metacarpal/metatarsal pads.** For pressure relief on metacarpal/metatarsal pads, the foam is cut to the shape of the palmar/plantar paw surface. Then a donut hole in the sponge area to be placed over the wound is cut (Figure 6), and again the cup portion of a metasplint is placed underneath the paw during bandaging.

Maximum pressure relief on both digital and metacarpal/metatarsal pads can be attained by "clam shell" splints, where two metasplints are incorporated in the paw bandage. The concave cup portions of the splints face each other and extend about 1 inch beyond the end of the bandage. This puts the paw in a "toe-dancing" posture to offload all the pads<sup>5,6</sup> (Figure 7).

**Anatomical malalignment/abnormal weight-bearing.** When pressure-wounds on the paw are caused by peripheral neuropathy or other musculoskeletal abnormalities that cause anatomical malalignment and abnormal weight-bearing, the bandages and splints described above will aid in pressure relief during healing. However, other means of more permanent pressure relief or tissue toughening are needed to prevent wound recurrence.

**Pad toughening agents.** When weight-bearing is occurring on tissue other than pad skin and has caused an ulcer, a commercial or compounded pad-toughening agent (Pad Toughening Compound—Island Pharmacy Services, Woodruff, WI) can be applied to the skin once it heals. This, with progressively reduced thickness of the bandage, may result in metaplasia of the skin adequate to withstand the stress placed on it. In the author's experience, this method is more effective in smaller dogs.

**Surgery.** Surgical procedures may be indicated to eliminate pressure resulting from nerve or musculoskeletal abnormalities. Amputation of a badly ulcerated digit can be considered. Orthopedic procedures, such as wedge osteotomy and/or joint arthrodesis, can be used to realign and immobilize a distal limb to redistribute weight. With the abnormal paw position caused by ulnar nerve paralysis, a "phalangeal fillet" or "phalangeal/partial metacarpal fillet"



technique may be considered to prevent pressure ulcers caused by the metacarpal–phalangeal articulation on the skin during weight-bearing. **If surgery is being considered, remember that correcting pressure in one area may cause abnormal weight-bearing in an adjacent area, resulting in another ulcer.**

## Treatment

The techniques discussed above for preventing pressure-related complications can also play a major role in treatment of ulcers that have already developed. However, the author also uses the newer topical agents to stimulate wound healing. An acemannan-containing topical gel (CarraVet Wound Dressing—Veterinary Products Laboratories, Phoenix, AZ) or freeze-dried gel (CarraSorb-M-FDG—Veterinary Products Laboratories, Phoenix, AZ) stimulates macrophages to produce cytokines and growth factors that enhance the early stage of healing.<sup>7</sup> A D-glucose polysaccharide (Maltodextrin N.F., Intracell—Mcleod Pharmaceuticals, Ft. Collins, CO) is reportedly antibacterial and bacteriostatic and provides glucose for cell metabolism to stimulate healing.<sup>7</sup> A tripeptide-copper complex medication (lamin—Procyte Corp., Redmond, WA) has been found to stimulate healing as it attracts mast cells and macrophages into the wound.<sup>7</sup> Mast cells enhance angiogenesis, and macrophages have associated cytokines and growth factors to stimulate healing.

In some instances, surgical correction is indicated for pressure wound treatment. For decubital ulcers, this may entail moving local tissue or use of skin flaps for wound closure. For paw pad wounds that do not heal as open wounds, digital pad flaps in the form of “phalangeal fillet” or pad grafts may be indicated for treatment.

## Conclusion

Prevention and treatment of pressure-related wounds center around prevention of pressure, which may require some creative bandaging, splinting, or padding. Good nutrition, hygiene, and topical medications also play an important role in prevention and treatment of these wounds. ■

See Aids & Resources, back page, for references, contacts, and appendices.

### PHOTO CREDITS

Figures 1 & 3. From Pressure wounds in animals. Swaim SF, Hanson RR, Coates JR. *Compent Contin Educ Pract Vet* 18:203-219, 1996.

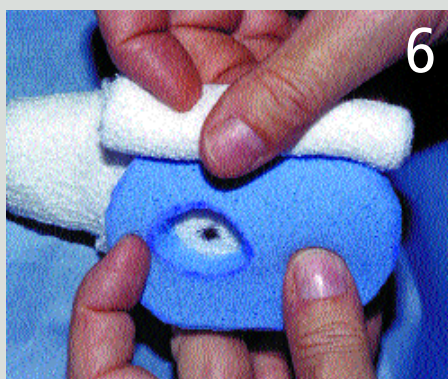
Figure 4. From *Small Animal Wound Management, 2nd ed.* Swaim SF, Henderson RA. Baltimore: Williams & Wilkins, 1997, pp 87-141.

Figures 5 & 6. From Effects of bandage configuration on paw pad pressure: A preliminary study. Swaim SF, Marghitu DB, Rumph PF, et al. *JAAHA* 39:209-216, 2003.

Figure 7. From Construction of a weight-bearing surface on a dog’s distal pelvic limb. Bradley DM, Scardino MS, Swaim SF. *JAAHA* 34:387-393, 1998.



A triangle of foam sponge-rubber cut to the shape of the metacarpal/metatarsal pad is placed under it in a paw bandage to relieve pressure on the digital pads. The cup portion of a metasplint is placed underneath.



A foam sponge-rubber pad is cut to the shape of the palmar/plantar paw surface to relieve pressure on the metacarpal/metatarsal pad. A hole is cut in the sponge in the area of the pad that goes over the wound. The cup portion of a metasplint is placed underneath.



A “clam-shell” splint.

A. Metal splints are placed on the dorsal and palmar/plantar surfaces of a paw bandage, with the concave cup portions facing each other and extending beyond the bandage about 1 inch.



B. Splints on which the dog stands are taped in place.