



## Continuing Education Article #1

## FOCAL POINT

★ The primary goal in dealing with pressure wounds is preventing them through padding, skin inspection, appropriate skin hygiene, changes in position, adequate nutrition, and special bandages and splints.

## KEY FACTS

- Animal care personnel are often unaware of developing decubital ulcers because an animal's haircoat conceals the signs of this pressure wound, p. 206.
- Decubital ulcers begin from pressure-induced tissue ischemia, which leads to necrosis and biochemical changes in the skin that contribute to pathologic changes (i.e., oxygen free radicals and thromboxane  $A_2$ ), p. 205.
- Pressure wounds are treated by surgery, topical medications, bandages, and most importantly, by prevention of further pressure, p. 209.
- Horses that have been recumbent for long periods (such as occurs with postanesthetic myopathies, neurologic disease, limb fractures, and laminitis) are prone to decubital lesions, p. 212.

# Pressure Wounds in Animals

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Pressure wounds occur in dogs, cats, and horses. In small animals, pressure wounds are more common in dogs; however, a particularly severe form of pressure wound in cats occurs following onychectomy when paw bandages are placed too tightly. Various terms will be used in this article to describe the types of dermal pressure wounds. In general, however, a pressure wound is a wound induced by any form of pressure on the skin. Pressure wounds encompass decubital ulcers, which are caused by prolonged recumbency and the resultant pressure on skin that is trapped between the surface on which the animal is resting and a bony prominence.

## PRESSURE WOUNDS IN SMALL ANIMALS

### Causes

Decubital ulcers are a problem in dogs.<sup>1-6</sup> Prevention plays a major role in dealing with decubital ulcers; however, once they develop, treatment becomes necessary. Certain breeds of dogs are predisposed to decubital ulcers because of a neurologic condition associated with the breed. Two common examples of such neurologic conditions are presented, but it should be noted that any neurologic condition resulting in paraplegia or tetraplegia can predispose to decubital ulcers. Following surgical procedures to treat these conditions, decubital ulcers are common if preventive measures are not taken.<sup>7</sup>

Breeds of dogs that are predisposed to intervertebral disk herniation (e.g., dachshunds) are more prone than other breeds to paraplegia and tetraplegia, which can result in decubital ulcers. Large- and giant-breed dogs (e.g., Doberman pinschers and Great Danes) are predisposed to the cervical vertebral instability/malformation syndrome. The syndrome may require surgery, which may be associated with the development of decubital ulcers secondary to temporary tetraplegia.

Pressure wounds may result from damage to peripheral nerves. An example is trauma to a forelimb with damage to the ulnar nerve and a resulting motor nerve deficit in the flexor muscles of the forelimb. The abnormal weight distribution on the paw as a result of this deficit may lead to an ulcer at the proximal aspect of the metacarpal paw pad.<sup>8,9</sup>

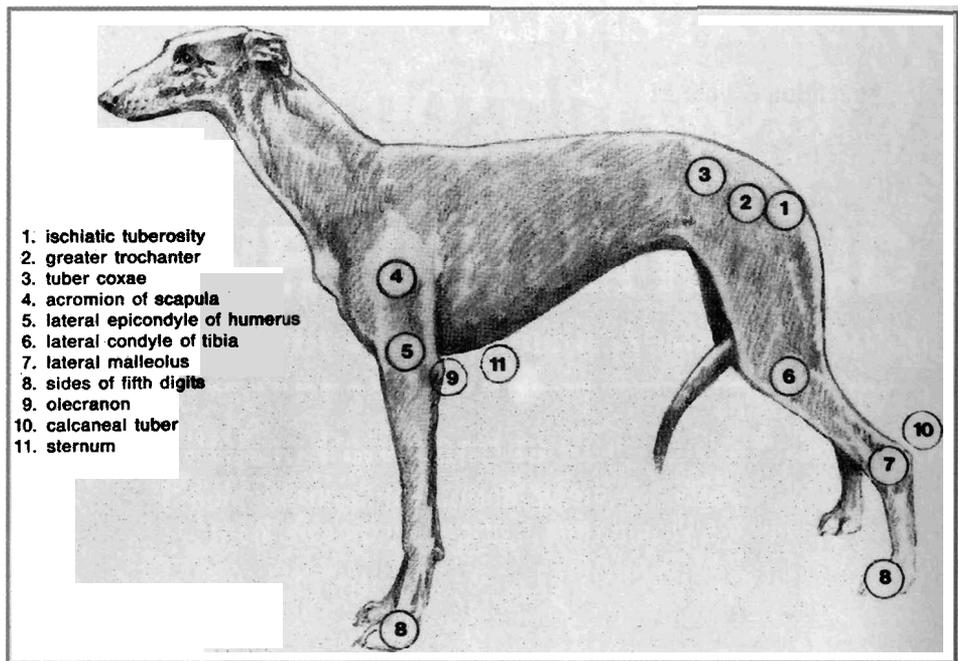
Decubital ulcers are also associated with orthopedic abnormalities in dogs.<sup>4,6</sup> Decubital ulcers may occur secondary to the paraplegia or tetraplegia associated with spinal trauma. Animals that are immobile because of multiple long bone and/or pelvic fractures are also subject to decubital ulcers. Related to orthopedic conditions that cause decubital ulcers are the pressure wounds that develop over bony prominences as a result of an improperly applied or padded coaptation cast or splint.<sup>1,5,10,11</sup> These wounds are usually the result of light pressure over a prolonged period.<sup>1</sup> Another

more severe form of bandage- or cast-induced pressure wound occurs when bandages or casts are applied too tightly. The result is circulatory insufficiency of the paw and sloughing.<sup>5</sup> This is an unfortunate occurrence with tight bandaging after onychectomy in cats.

When a debilitated dog or one that is convalescing from severe injury or illness is unable or unwilling to change body position, decubital ulcers are likely to develop. Predisposing factors to these decubital ulcers include the decrease in padding between skin and bone that results from disease, atrophy, or loss of adipose tissue; loss of tissue elasticity; malnutrition (associated with hypoproteinemia, anemia, or vitamin deficiencies); skin maceration; soft tissue contusion; skin chafing; skin friction and stretching; skin irritation from urine and feces; skin burns and scalds; and improper nursing care.<sup>3-6</sup>

Greyhounds have a very angular conformation, short hair, and thin skin. These characteristics predispose to the development of decubital ulcers.<sup>4,12,13</sup>

Elbow hygroma is another condition that can result from dermal pressure and can lead to another form of pressure wound—an elbow ulcer. Elbow hygromas usually develop secondary to repeated pressure or trauma over the olecranon in young large- or giant-breed dogs (e.g., German shepherds, Great Danes, bull mastiffs, and Irish wolfhounds).<sup>14,15</sup> The condition is often associated with lying in sternal recumbency on unpadded surfaces, which places pressure on skin over the olecranons. After surgical excision of an elbow hygroma,



**Figure 1**—Areas over bony prominences are prone to decubital ulcers. (From Swaim SF, Henderson RA: *Small Animal Wound Management*. Philadelphia, Lea & Febiger, 1990, p 78. Reproduced with permission.)

wound dehiscence may lead to a chronic, nonhealing ulcer if proper preventive measures are not taken and the animal continues to lie in sternal recumbency and place pressure over the surgical site.<sup>14</sup> Hygromas may form abscesses that rupture, which results in a chronic open wound or ulcer over the olecranon.

Hip dysplasia may predispose large dogs to elbow hygroma. Because of the pain associated with the condition, the dog may be less able to protect the elbow from trauma when lying down.<sup>5</sup> Specifically, the pain, which is in the coxofemoral joint, becomes so great that the dog drops on the olecranons rather than easing onto them when lying down in sternal recumbency. Thus, skin over the elbow is traumatized and an elbow hygroma may start to develop, which could lead to ulceration problems.

### Location and Pathogenesis

Decubital ulcers in dogs develop over bony prominences<sup>5</sup> (Figure 1). Most of the decubital ulcer sites are on the lateral aspect of the dog because recumbent dogs usually lie in lateral recumbency. Because of their greater weight, large dogs are more prone to develop decubital ulcers, especially over the greater trochanter (Figure 2). Small, paraplegic dogs that tend to sit up on the perineal region for prolonged periods tend to develop decubital ulcers over the ischiatic tuberosities<sup>3</sup> (Figure 3).

The primary pathologic change of decubital ulcers is tissue ischemia and the resultant necrosis as soft tissues are compressed between a bony prominence and the surface on which the animal is resting. With improperly applied casts or bandages, the cast or splint material causes the compression. Pressure on the soft tissues associated with a developing decubital ulcer causes focal intravascular changes, which result in vascular occlusion and tissue ischemia. The degree and severity of ulceration vary with the extent of vascular occlusion.<sup>16</sup> Biochemical changes occur within the ischemic skin and contribute to necrosis. It has been theorized that damage to the compressed skin also occurs during reperfusion with reoxygenation of ischemic tissue after pressure is released. The endothelium of vessels is damaged by oxygen free radicals.<sup>17</sup>

Thromboxane B<sub>2</sub>, a measurable stable metabolite of thromboxane A<sub>2</sub>, has been identified in tissue of naturally occurring decubital ulcers and impending decubital ulcers in greyhounds.<sup>12</sup> In addition, in greyhounds, this pathobiochemical has also been identified in developing dermal pressure lesions. These lesions were induced over bony prominences by application of coaptation casts with only stockinette lining and no padding.<sup>13,18</sup> Thromboxane A<sub>2</sub> contributes to the existing dermal ischemia by causing vasoconstriction and inducing intravascular platelet aggregation. The platelet aggregation leads to vascular thrombosis, which restricts vascular flow to the tissues and causes progressive dermal ischemia.<sup>18</sup> Research indicates this chemically induced process is a factor in the pathogenesis of dermal pressure lesions. Systemic administration of a thromboxane antagonist in a greyhound model for dermal pressure lesions resulted in reduced thromboxane tissue levels, fewer physical dermal abnormalities, and less severe histopathologic changes in the pressure-exposed skin of treated dogs than the pressure-exposed skin of untreated dogs.<sup>18,19</sup>



Figure 2—Decubital ulcer over the greater trochanter of an Irish setter.



Figure 3—Decubital ulcer over the ischial tuberosity of a toy poodle.

## Preventive Measures

The primary goal with decubital ulcers is prevention. Numerous measures are available to accomplish this goal.

**Padding.** Padded bedding is a primary means of preventing decubital ulcers. Blankets, coated or closed-cell foam pads, air mattresses, water mattresses, thick straw bedding, sheepskin pads, and artificial fleece pads have been described as means for providing a padded surface.<sup>1-7</sup> Sheepskin pads and foam rubber mattresses help provide some air circulation under the animal and help conduct moisture (i.e., urine) away from the skin. Placing these pads and mattresses on grates or racks also helps separate the animal from urine.<sup>1,3,7</sup> Foam rubber with a convoluted, egg-crate design provides a good bedding surface.

In an evaluation of dogs with severe paraparesis or paraplegia resulting from thoracolumbar spinal trauma, it was found that these dogs assumed the posture associated with the Schiff-Sherrington syndrome with pelvic limb spasticity. The result of this neurologic status was that some dogs maintained a posture in which weight was distributed on the ischiatic tuberosities, thus predisposing the area to decubital ulcer development. Vinyl-covered, convoluted foam rubber pads (Comfy<sup>®</sup> Dog Bed, J & M Stuart Co, Inc, St. Louis, MO) have been found to be very effective in helping to prevent decubital ulcers over the ischiatic tuberosities.<sup>20</sup> An artificial fleece (Unreal Lamb Skin<sup>®</sup>, Alpha Protech, North Salt Lake, UT) placed over vinyl-covered foam rubber pads has also been found to be effective in helping prevent decubital ulcers in dogs. The fleece provides an additional dry and soft surface to the bedding.

Proper padding of coaptation casts is important for the prevention of pressure lesions over bony prominences. Evaluation of the dermal effects of different configurations of cast padding in coaptation casts on dogs indicated that absence of cast padding can cause

dermal pressure injury over sharp prominences. In some areas, localized cast padding may settle around larger prominences and increase pressure to potentiate dermal pressure injury. Although pressure over bony prominences may be significant immediately after applying full-length cast padding and a coaptation cast, some compacting of the padding takes place. This provides the best form of cast padding to prevent dermal pressure injury.<sup>11</sup>

**Inspection.** Veterinarians and veterinary technicians have a challenge in dealing with decubital ulcers because their patients are hirsute. Thus, the haircoat will conceal skin with an impending decubital ulcer. It is important for animal care personnel to part the hair over bony prominences and observe the underlying skin to identify hyperemia, moisture, and easily epilated hair.<sup>1,3-6</sup>

Some animals naturally tend to lick or chew at a bandage or cast. In other animals, however, the licking or chewing may indicate an underlying pressure wound as the result of an ill-fitting cast or bandage. In such instances, it is wise to remove the cast or bandage and check for pressure wounds. In addition, a cast that has an offensive odor or an internally derived stain over a bony prominence should be removed and the tissues checked for pressure wounds.

**Positioning.** The body position of an animal that is unable or unwilling to change its own position should be changed frequently to help prevent decubital ulcers.<sup>1-6</sup> Ideally, position should be changed every 2 hours<sup>1,3</sup>; however, a range of 1 to 5 hours has been described.<sup>6</sup> Positions should alternate between left lateral, sternal, and right lateral.<sup>1,3</sup> When placed in sternal recumbency, positioning the pelvic limbs caudally in extension behind the dog helps prevent joint contraction problems.<sup>1</sup> Some dogs that are able to move have a preferred position; this posi-



**Figure 4**—A donut-shaped bandage made from a taped and rolled hand towel. The bandage is taped over the lateral malleolus area. (From Swaim SF, Henderson RA: *Small Animal Wound Management*. Philadelphia, Lea & Febiger, 1990, p 78. Reproduced with permission.)

tion, however, may predispose to the development of decubital ulcers. In dogs that do not cooperate with periodic attempts to change their position, barriers (e.g., cardboard boxes and pads) can be used to restrict movement.<sup>3</sup>

Slings are used occasionally to support dogs in a standing position for 2 to 4 hours daily.<sup>7</sup> The limbs of the dog are placed through holes in the sling material, which is suspended from a frame. This technique is probably the most effective way of keeping pressure off the skin overlying the acro-

mion of the scapula, tuber coxae, and greater trochanter in large dogs. For paraplegic or paraparetic dogs, wheeled carts that support the pelvic area are often used as part of the rehabilitation of the dogs. These carts provide mobility for the dog and help keep pressure off the bony prominences on the hindquarters.

**Skin Hygiene.** Keeping the skin clean and dry (i.e., free of urine and feces) is an important factor in preventing decubital ulcers in dogs.<sup>1-6</sup> Clipping the hair of the perineal area, especially in dogs with long hair, fa-

## Predisposing Factors to Pressure Wounds

- Breed-associated neurologic conditions that result in paraplegia or tetraplegia, such as intervertebral disk herniation in dachshunds and the cervical vertebral instability/malformation syndrome in Doberman pinschers, Great Danes, and other large- or giant-breed dogs
- Any neurologic condition that results in paraplegia or tetraplegia, including the orthopedic and neurologic abnormalities associated with spinal fractures
- Damage to peripheral nerves that results in abnormal limb or paw position and weight-bearing
- Immobility resulting from multiple long-bone and/or pelvic fractures
- Improperly applied or padded coaptation casts or splints
- The inability or unwillingness of a debilitated or convalescing animal to change body position
- Breed-associated characteristics, such as the angular conformation, short hair, and thin skin of greyhounds
- The presence of hygromas, which can lead to elbow ulcers

facilitates cleaning in the presence of fecal incontinence.<sup>3</sup> Proper maintenance of a closed collection system can help prevent urine scalding and skin maceration in animals with urinary incontinence.<sup>3</sup> Whirlpool or warm-water baths, two to three times daily, help keep the skin clean and promote circulation.<sup>6</sup> When a decubital ulcer is developing or has developed on the skin over the ischiatic tuberosities, fecal contamination can enhance wound development or slow healing. A piece of rubber sheeting (cut from a surgery glove) sutured across the perineal area under the anus can help prevent fecal contamination of the area.

**Nutrition.** Animals require proper nutrition as part of the preventive routine for decubital ulcers.<sup>3-6</sup> A high-protein, high-carbohydrate diet with vitamin supplements has been advocated.<sup>4,6</sup>

**Innovative Bandaging.** The nature of the individual patient often requires innovative bandaging and splinting to successfully keep pressure off skin over a bony prominence. Such pressure can be the result of a particular posture that an animal has assumed.

A donut-shaped bandage can be placed over a bony prominence on the lateral aspect of a limb (i.e., lateral malleolus) to keep pressure off the skin. Such a bandage is constructed from a rolled and tightly taped hand towel that is cut to an appropriate length and taped to form the shape of a donut. The bandage is taped to the limb, with the donut hole over the lesion<sup>5</sup> (Figure 4). This type of bandage, although not advocated in treating decubital ulcers in humans, has been used to keep pressure off decubital ulcers and decubital ulcer repair sites on the lower limbs of dogs.

Donut-shaped bandages are difficult to hold in place around decubital ulcers over bony prominences higher



Figure 5A



Figure 5B

**Figure 5—(A)** Foam rubber pipe insulation split lengthwise with a hole cut in the center to fit over an impending decubital ulcer, an existing ulcer, or a repair site. **(B)** Two pieces of pipe insulation stacked and taped together with the hole placed over the olecranon area after the cranial surface of the elbow has been well padded. (From Swaim SF, Henderson RA: *Small Animal Wound Management*. Philadelphia, Lea & Febiger, 1990, p 78. Reproduced with permission.)

on the limbs (e.g., over the acromion of the scapula or greater trochanter). As they slip out of position, donut-shaped bandages can place pressure over the wound. When the bandages do stay in place on these higher and heavier areas, they place pressure on vasculature in tissue near the periphery of the ulcer and thus may impair healing.

Another pressure relief bandage to keep pressure off the olecranon area is a pipe insulation bandage. Two or three pieces of foam rubber pipe insulation of the proper length and diameter are split lengthwise, and a hole large enough to accommodate the olecranon is cut in the center of each piece of split foam rubber (Figure 5A). The pieces are stacked and taped together. With the radiohumeral joint in extension, the cranial surface of the joint is well padded with cast padding material and the foam rubber pad is placed on the caudal aspect of the limb with the hole over the olecranon. The padding and foam rubber pad are taped in place (Figure 5B), which prevents joint flexion. Thus, the dog cannot assume a position of sternal recumbency, which in turn, prevents the dog from putting pressure on the olecranon area. In obese dogs with a short humeral area, a spica-type bandage is sometimes needed to keep the bandage from slipping distally.<sup>5</sup> An aluminum rod loop splint that is incorporated in the front of the elbow bandage bridges the radiohumeral joint, thereby preventing the dog from bending the elbow, lying in sternal recumbency, and putting pressure on the elbow (Figure 6).

In small, paraplegic dogs that tend to sit on the perineal area, decubital ulcers over the ischiatic tuberosity can be prevented by placing side splints along each of the dog such that the splints extend beyond the per-

ineal area (Figure 7). These extended side splints prevent the dog from attaining a posture that allows contact between the ischiatic area and the surface on which the dog is resting.<sup>21</sup>

### General Wound Management

Decubital ulcers in animals are classified in severity from grade I to IV (Table I) and treatment is based on these grades. The appearance of the various grades of ulcers is shown in Figure 8. A major part of treating decubital ulcers is relieving the pressure over the ulcer. Therefore, many of the factors presented as preventive measures also apply in the therapy of decubital ulcers. Wound debridement, stimulation of healthy granulation tissue and wound contraction, and surgical wound closure are the wound management principles used in treating decubital ulcers. The following discussion presents a general treatment regimen for managing decubital ulcers in dogs.<sup>5</sup>

Grade I ulcers are treated by periodic wound cleansing and removal of sloughing surface tissue. The wound is allowed to heal by second intention.

With grade II ulcers, surgical and/or bandage debridement is done to cleanse the wound and free it of necrotic tissue. Wet-to-dry bandages are used. Once a healthy bed of granulation tissue has formed, the wound is allowed to heal by second intention or is closed by secondary closure. If secondary closure is used, efforts are

made to keep suture lines away from bony prominences.



Figure 6—An aluminum rod loop splint that is incorporated in the front of an elbow bandage prevents elbow flexion, thereby keeping pressure off the olecranon area.



Figure 7—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.

Grade III ulcers with undermining of surrounding tissue are debrided of nonviable tissue and treated as open wounds until a healthy bed of granulation tissue is present. Either wet-to-dry or dry-to-dry bandages are used. When pockets are present in the undermined skin, a Penrose drain that is 1/4 inch in diameter is placed at the most dependent area. Secondary closure is performed after a healthy bed of granulation tissue has formed.

With grade IV ulcers, infected tissue (including any infected bone) is removed. Sinus tracts and pockets are excised or opened and debrided. Guidelines for grade III ulcer bandaging, drain placement, and secondary closure are then followed.

Because of the size and/or location of some ulcers, a local skin flap may be necessary for closure (Figure 9). An axial pattern skin flap based on the thoracodorsal vessels has been used to correct an elbow pressure ulcer in an Irish wolfhound.<sup>14</sup> A similar potential flap that could add bulk over the olecranon area is a myocutaneous flap containing the latissimus dorsi muscle transposed off the side of the dog.<sup>22</sup> Muscle flaps from the cranial sartorius and rectus femoris muscles have been used successfully to treat decubital ulcers over the greater trochanter in dogs.<sup>23</sup> A neurovascular island pedicle flap from the dorsal metacarpus has been described for repair of ulcers

at the proximolateral aspect of the metacarpal pad resulting from ulnar nerve damage.<sup>8,9</sup>

Veterinary

(continues on page 212)

Numerous topical medications can be used in the treatment of decubital ulcers. The following are medications primarily used at the Auburn University, College of Veterinary Medicine, Department of Small Animal Surgery and Medicine. After surgical and/or bandage debridement of a wound, the goal is to control infection and stimulate the development of a healthy bed of granulation tissue in the ulcer. Topical antibiotics help control local infection, and after a healthy bed of granulation tissue is present, antibiotics may help control surface bacteria. The granulation tissue, however, serves as a barrier to control against deeper infection. If deeper tissue infection is a factor, systemic antibiotics should be administered. The choice of antibiotic is based on culture and sensitivity test results.

Topical medications are used to help stimulate the formation of granulation tissue in wounds. One veterinary compound (Granulex®, Pfizer Animal Health, West Chester, PA) contains trypsin as an enzymatic debriding agent and balsam of Peru as an angiogenesis stimulant. A hydrogel topical dressing that contains aloe vera gel extract with acemannan (Carravet® [CVMD], Carrington Laboratories, Inc., Irving, TX) has also been used to stimulate granulation tissue formation. Acemannan is a macrophage stimulant, which enhances the production of the cytokines interleukin-1 and tumor necrosis factor.<sup>24</sup> These two cytokines, in turn, stimulate angiogenesis in wounds.<sup>25</sup>

Hydrophilic agents pull body fluids through the wound tissues to bathe them from the inside and enhance healing. A dry starch copolymer flake dressing (Avalon Copolymer Flakes®, Summit Hill Laboratories, Navesink, NJ) and a hydrophilic dextran polymer (DEBRISAN®, Johnson & Johnson Products, Inc., New Brunswick, NJ) have been used in the past for this purpose.<sup>26</sup> The copolymer flake dressing is still available; however, the dextran polymer is no longer available. A hydrophilic powder containing D-glucose polysaccharide, maltodextrin N.F. (Intracell™, Techni-Vet, Inc., Amarillo, TX), has been used to cleanse and promote healing. It has been proposed that the compo-

**TABLE I**  
**Classification of Decubital Ulcers<sup>a</sup>**

Ulcer Type	Characteristics
Grade I	Dark reddened area that does not blanch on pressure; epidermis and upper dermis may slough
Grade II	Full-thickness skin loss down to the subcutaneous tissue
Grade III	Ulcer extends through the subcutaneous tissue down to the deeper fascia; wound edges may be undermined
Grade IV	Ulcer extends through the deep fascia down to the bone; osteomyelitis or septic arthritis may be present

<sup>a</sup>From Swaim SF, Henderson RA: *Small Animal Wound Management*. Philadelphia, Lea & Febiger, 1990, p 76. Reproduced with permission.

nents of such a preparation may provide nutrients for wound tissue to promote healing.<sup>27</sup> Maltodextrin has potential for treating other types of special wounds; however, research on such applications is indicated.

Contact (primary) bandage materials used with wet-to-dry and dry-to-dry bandages in early decubital ulcer therapy are adherent gauze sponges. Once debrided, wounds are covered with a nonadherent bandage, such as a Telfa Pad (KenVet, Ashland, OH), RELEASE Non-Adhering Dressing (Johnson & Johnson Products, Inc., New Brunswick, NJ), or Hydrasorb sponge (KenVet, Ashland, OH). These bandages

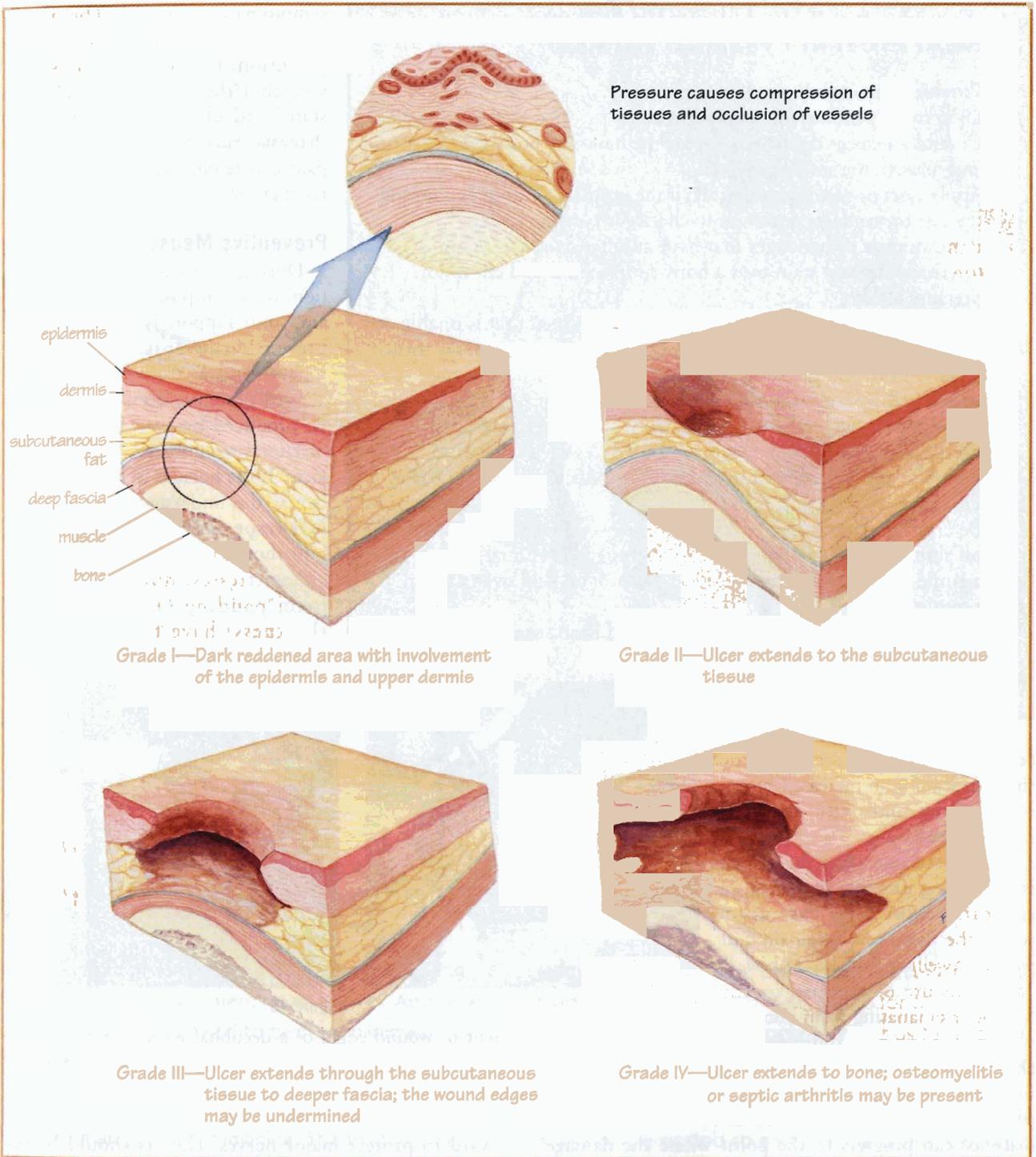
are used in combination with the previously described medications.

## PRESSURE WOUNDS IN LARGE ANIMALS

### Causes and Pathogenesis

Horses that are recumbent for long periods, particularly those with postanesthetic myopathies, neurologic disease, limb fractures, or laminitis, are most prone to develop decubital ulcers (Figure 10). In horses, as in other species, decubital lesions usually occur as a result of prolonged application of pressure in a relatively small area of the body; tissue ischemia and necrosis then occur.<sup>28,29</sup> Decubital ulcers are particularly serious near a joint, because infection of the synovial spaces can result.<sup>30</sup> Preexisting conditions that accelerate the onset of decubital ulcers in horses include some of the same conditions associated with decubital ulcers in dogs—loss of subcutaneous padding as a result of disease, malnutrition, skin friction, urinary and fecal incontinence, inadequate nursing care, or poor skin hygiene.<sup>29</sup>

Although no detailed pathologic or pathobiochemical studies have been reported for pressure lesion pathogenesis in large animals, it is reasonable to assume that the pathologic changes in large animals would be similar to those occurring in tissues of other species. The lesions initially have an erythematous to reddish-purple discoloration. This progresses to oozing, necrosis, and ulceration. The resultant ulcers tend to be deep, under-



**Figure 8**—Grades of decubital ulcers.

mined at the edges, secondarily infected, and very slow to heal.<sup>31</sup>

Casting of limbs in large animals coupled with a significant amount of movement by the animal may result in friction sores underneath the casting material. Al-

though not classified as true pressure wounds, the sores create full-thickness skin lesions that can have devastating results if not properly treated. To reduce the possibility of friction sores, the fiberglass casting material must conform to the limb as perfectly as possible. Ex-

## How to Prevent Pressure Wounds

- Provide clean and dry padded bedding
  - Use proper padding for coaptation casts
  - Carefully inspect the haircoat; part the hair over bony prominences and observe the underlying skin
  - Apply casts or bandages carefully; if the animal is licking or chewing the cast or bandage, remove it to check for pressure lesions
  - Remove casts or bandages that have an offensive odor or an internally derived stain over a bony prominence and check for pressure lesions
- Frequently change the body position of an animal that is unable or unwilling to change its position as well as the position of an animal that is not totally immobile but that has a preferred position, which predisposes to decubital ulcers
- Use slings, if necessary, to support dogs and horses in a standing position for several hours daily
- Keep the animal's skin clean and dry (i.e., free of urine and feces)
  - Provide proper nutrition
  - Be creative about bandages and splinting so that pressure is kept off skin over bony prominences and so that the animal cannot assume a posture that would place pressure on skin over a bony prominence
  - Provide proper positioning, padding, and limb support for large animals during anesthesia

cessive padding compresses inside the cast, leading to increased movement of the limb with resultant friction sores.

One of the first signs that a cast is not fitting properly is reluctance to bear weight on a cast upon which the horse had originally put weight. Swelling of a limb above a cast, moisture of the cast, or any foul odor emanating from above or within the cast area indicates that the cast should be removed, the limb evaluated, and a new cast applied. Skin necrosis or wound dehiscence can progress to the point where the damage created by the cast is worse than the original lesion that led to the application of the cast.<sup>32,33</sup>

Postanesthetic myopathies occur in horses in which there is hypoperfusion during anesthetic recumbency. The hypoperfusion, which results from inappropriate positioning and inadequate padding, is particularly a problem in heavy-muscled breeds. When they are local, myopathies and neuropathies usually resolve with

symptomatic treatment. The generalized myositis associated with hypotension, however, may be so severe that the horse is not able to stand and ultimately requires euthanasia. Such horses are in extreme pain and require aggressive supportive therapy.<sup>34</sup>

### Preventive Measures

During anesthesia, careful attention to patient positioning, padding, and limb support is critical for the prevention of postoperative neuropathy and myositis.<sup>35</sup> Facial, radial, and peroneal nerve paresis may be produced by even short periods of lateral recumbency on hard surfaces. If the horse is in lateral recumbency, the undersurface of the animal (especially the shoulder and hip) should be padded. Inner tubes, air mattresses, dunnage bags, or foam padding (15 to 20 cm in thickness) have been used. The down limbs should be pulled for-



Figure 9A



Figure 9B

Figure 9—(A) Debridement of wound edges of a decubital ulcer over the lateral humeral epicondyle area and skin for creating a transposition flap (F) for surgical repair. (B) Transposition flap (F) covering the ulcer.

ward to protect major nerves. Halters should be removed to prevent facial nerve paralysis. The up limbs should be supported to prevent undue compression of and impaired blood flow to the large chest and thigh muscle masses. Unpadded ropes or tape should not be used for positioning. In dorsal recumbency, the horse's back and neck should be padded and the legs should be loosely extended to prevent compression and impaired blood flow due to limb flexion. Postoperative myositis

has been linked to hypotension; therefore, the anesthesiologist should monitor blood pressure closely to prevent hypotension.<sup>35</sup>

Preventive measures should be instituted in any horse that remains recumbent for more than 3 hours. These measures include bandaging the lower extremities to prevent self-inflicted trauma and having clean, dry bedding free from excreta.<sup>36,37</sup> The position of a horse that is lying in lateral recumbency should be changed every 6 hours. It is preferable to maintain the horse in a sternal position to minimize pulmonary congestion and prolonged weight-bearing on skin surfaces over bony prominences. A body sling is useful to assist the horse to stand, thus decreasing muscle damage and the likelihood of decubital ulcer development. Slings may also improve a horse's attitude as well as increase limb use and circulation<sup>36</sup> (Figure 11). The decision to use a sling should be made on an individual basis because some horses do not tolerate slings well.

Dr. Hanson has found that a bedding constructed with a 40-cm thickness of peat moss above a clay-based flooring works well in minimizing the incidence of decubital lesions. The peat moss reduces the shear forces and friction to the skin. It also acts as a drying agent by allowing excessive moisture to be conducted away from the skin. It is imperative that the top level of the peat moss be changed frequently to prevent the buildup of urine and feces. Plastic-covered pillows can also be used to minimize decubital ulcers (Figure 12). If approximately 40 pillows are placed on one side of a



Figure 10—Extensive decubital ulceration in a horse recumbent for a long period because of chronic laminitis.



Figure 11—A body sling assisting a horse to stand.



Figure 12—Plastic-lined pillows used under a recumbent horse to minimize decubital ulcer development. The pillows are placed on top of a straw bed.

12- × 12-foot stall above a straw base, the horse will learn to lie on the side of the stall with the pillows. Although more expensive than peat moss, the use of pillows is a cleaner and equally effective method.

## Treatment

Severe myositis develops rapidly in horses that are totally recumbent for more than 24 hours and that have not received proper care. To minimize the complications of recumbency and self-induced trauma, the previously described precautions should be employed as soon as possible to minimize further pressure to major muscles and other susceptible areas. Slinging should be attempted if feasible.<sup>36</sup> Skin sores or abrasions should be cleaned and lavaged twice daily with saline and antiseptic solutions to avoid secondary infections.<sup>32,36,37</sup> Topical antibiotic ointments, aluminum and magnesium hydroxide solutions (e.g., Maalox® [Rhône-Poulenc Rorer Pharmaceuticals Inc., Collegeville, PA]), emollient creams (e.g., Silvadene® cream [Hoechst Marion Roussel Inc., Kansas City, MO]), otc cleaning solutions (e.g., Oti-Clens®, [Pfizer Animal Health, West Chester, PA]), and granulated sugar have all been advocated to aid in healing of decubital ulcers.<sup>30,37</sup>

If spontaneous urination is not observed, the bladder should be manually expressed per rectum or catheterized aseptically. An indwelling urinary catheter may be advisable if prolonged recumbency is anticipated. Urine scald should be prevented by application of petrolatum or other water-repellent ointments to areas likely to become wet with urine.<sup>36</sup> Prolonged use of oil-based ointments, how-

ever, may lead to maceration of the tissues.

Adequate nutrition is necessary to promote healing of decubital ulcers. A protein deficiency can cause general debilitation and increased susceptibility to tissue breakdown. Severe anemia can result in low oxygenation of tissue and lead to the death of tissues subjected to pressure. Anorexia and inadequate food intake result in nutritional and caloric deficiencies that depress the healing process.<sup>36,37</sup> Affected horses should be fed a high-roughage, high-protein, and vitamin-supplemented diet.<sup>30,36,37</sup>

The most important aspect of therapy is to identify and correct the cause of the prolonged recumbency so the patient can stand. Surgical treatment of decubital ulcers is not as frequently performed in horses as it is in humans and small animals.<sup>30</sup> Surgical debridement of infected granulation tissue, undermined and traumatized skin, and infected muscle and bone coupled with primary closure of the remaining skin defect has been used successfully. The use of skin flaps and grafts as well as myocutaneous flaps has not been specifically described for correcting equine decubital ulcers. If such procedures were used, it would first be necessary to correct the condition that caused the recumbency and resultant ulcer.<sup>29</sup> Skin grafts have been used to correct limb lesions resulting from improper casting.

Veterinarians, animal care personnel, and owners often face the time- and money-consuming task of treating pressure wounds. The primary objective for large animals, as for small animals, remains prevention.

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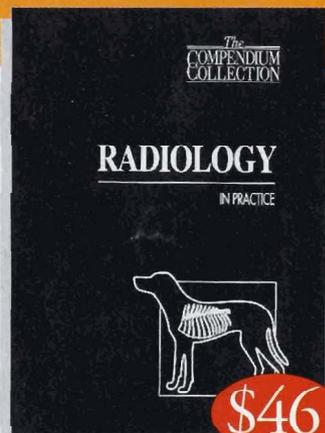
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