Bovine Surgery of the Skin

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KEYWORDS

• Bovine • Skin • Dermis • Repair • Cosmetic • Healing

Within just the past decade, scientific evidence regarding bovine pain and distress responses to surgical stimuli has grown immensely. Although most of the work to date is subjective in nature, objective measures of painful responses are being applied more commonly to address animal welfare concerns. It is important to be cognizant of these findings. Efforts should be made to incorporate animal comfort and welfare in surgical decision-making processes to enhance productivity as a whole.

GENERAL SKIN WOUND HEALING

The skin provides a vital protective barrier to the body. Mechanisms to repair breeches of that barrier during wounding follow a predictable and efficient pattern in mammalian species. The process is often simplified to grasp the concept of the repair process, but in actuality it involves a complex interaction of cells, fluid and protein constituents, and chemical mediators. The first general concept of wound healing is the phases of repair that include inflammation, followed by proliferation, and finally, remodeling. One must first recognize that these phases involve significant time frame overlap during transition. In addition, each primary phase can be divided into subsets with unique mechanisms of repair. Primary surgical closure rapidly concentrates the healing process with more overlap between phases. Second intension healing results in an exaggerated length of time to closure, depending on the size of the wound and the complications arising during the healing process. The reader is referred to other sources for detailed information on wound healing.[1] For a summary of the stages of wound healing relevant to this text, refer to **Fig. 1** and **Table 1**.

Managing Skin Wounds

Complications leading to delays in the healing process often occur. A basic understanding of wound healing can aid in successful wound management. Nonhealing cutaneous wounds may be due to foreign material (metal, organic debris, and so forth) within the wound, periosteitis, or bone sequestrum deep to the wound. Periosteitis should be considered in the presence of chronic draining tracks even when severing

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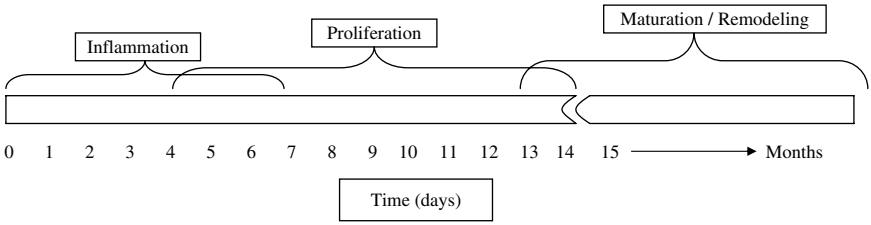

Fig. 1. Phases of wound healing and general time frame of each phase. Epithelialization, a division of proliferation, can be seen histologically at wound edges within the first days of injury.

the skin was not in the history. Blunt trauma in bony areas with little soft tissue protection and crush injury, as might be the case with calving chain trauma, can present in this manner. Nearly all traumatic wounds in bovine practice will be plagued with gross contamination by the time of recognition. It is not uncommon to begin with a wound that is caked with mud, manure, straw, or gravel. A significant delay between the time the wound occurred and injury is recognized is also a common woe, which would therefore suggest that the wound will either have to heal by second intention or delayed primary closure. A third option commonly involves initial primary skin closure to draw the wound periphery "closer" together, providing initial protection over a wound ultimately destined to heal by second intention. The latter option is reasonable, provided drainage from the deep portions of the wound is adequate.

The first order of business is to focus on controlling the inflammatory process, reducing edema, assisting with wound debridement, and treating infection. Regarding inflammation, the goal should be to modulate the inflammatory process and not block it entirely. The aim should be to control an exaggerated systemic inflammatory response while not suppressing neutrophil migration and function within the wound as a normal part of the healing process. Glucocorticoids have been shown to downregulate L-selectin binding, necessary for migration of neutrophils from capillary endothelium, and to delay necessary neutrophil apoptosis for macrophage phagocytosis and sequential functions in the healing process.[2,3] Nonsteroidal anti-inflammatory drugs (NSAIDS) may modulate inflammation more effectively without deleterious effects on cellular function.[4] The clinical debate about the use of steroidal versus nonsteroidal drugs or combinations in the face of infection is ongoing. Edema within a wound can be treated with compression wraps when possible, and hydrotherapy, increasing perfusion and debriding the wound.

Physical debridement of the wound should be undertaken with initial assessment, noting clinical characteristics, severity, structures involved, and estimating the duration. Gentle scrubbing of the wound initially with antiseptics will remove large debris. If povidone iodine is used for scrub/lavage, it should be a dilute solution (~ %), because "free" iodine in solution is the basis for antimicrobial activity. The amount of free iodine in a solution increases as the concentration decreases. Wound lavage with dilute antiseptic solution can then be used. The author prefers lavage with an 18-gauge needle and syringe to provide targeted focal hydro pressure and debridement.

Infection should initially be treated empirically using broad-spectrum systemic antibiotics and topical antiseptic therapy. The wound should be reassessed frequently and culture and sensitivity should guide antibiotic therapy when unresolved infection appears to be complicating the healing process. Intravenous regional antibiotic infusion could be argued in cases of distal limb wounds, with the thought that higher concentrations of drug in the area of interest could be achieved. The counterargument

Table 1
Basic summary of phase designations, approximate timing, and general physiology during healing of an uncomplicated wound

Healing Phase (Clinical Characteristics)	Time	Intraphase Designations	Description
Inflammation (edema, exudate, blood clot, scab)	At time of injury	Capillary permeability changes	Initial serotonin-mediated vasoconstriction in the first 5 to 10 minutes after injury Histamine-mediated vasodilatation follows with increased vascular permeability, flooding wound with blood constituents for hemostasis and cell recruitment signals for later phases of repair.
		Exudation: fibrin and glycoprotein deposition	Forms bridgework for cellular migration in later phases Initial weak cell matrix to be replaced by granulation tissue during proliferative phase
	1 to 6 days post injury	Destruction	Leukocyte (neutrophil) chemotaxis Lysosomal enzyme digestion of debris and wound contaminants and signal monocyte migration to wound Collagenase degradation of matrix
		Debridement	Macrophages further debride wound of debris and signal for cell recruitment of cells and constituents for proliferative phase.
Proliferation (granulation tissue)	3 to 14 days post injury	Epithelialization	Begins within the first couple of days after injury at the periphery of wound (microscopically), and is set to migrate across bridge formed by cellular counterparts during proliferative phase Grossly evident at periphery of wound at about 2 weeks
		Fibroplasia	Fibroblast proliferation for collagen, proteoglycans, and extracellular matrix formation for delivery of necessary constituents of cell growth
		Angiogenesis	Intricate series of steps to form new blood vessels traversing the wound
Maturation/ remodeling (scar tissue)	~14 days onward	Contraction	Tightening of healed wound through myofibroblast tensioning on microfilaments in the extracellular matrix Fibroblast degradation of matrix, thus pulling edges of wound closer together
		Remodeling	Balancing collagen synthesis and catabolism within wound

would be that the antibiotics that are safe and legal to use in this manner, namely B-lactams, have time above minimum inhibitory concentration-dependent mechanisms of action, not concentration dependent.[5] On the other hand, intravenous regional antibiotic perfusion should provide more rapid distribution of the dose within the area of concern.[6]

Primary Closure of Contaminated Wounds

Primary skin closure over a contaminated wound is a reasonable decision provided adequate drainage from the deep portions of the wound is provided. Primary partial closure of gaping wounds will benefit the healing process later on by concentrating the time frame and distance during the proliferative stages and by decreasing the degree of wound contraction during remodeling. Portions of the wound should remain open to provide a portal for wound lavage and discharge of the products of inflammation. Consideration should be given to the orientation of the blood supply to the affected area in regard to the placement and type of tension-relieving suture patterns (**Fig. 2**). Vertical mattress sutures (with and without stents) and near-far-far-near suture

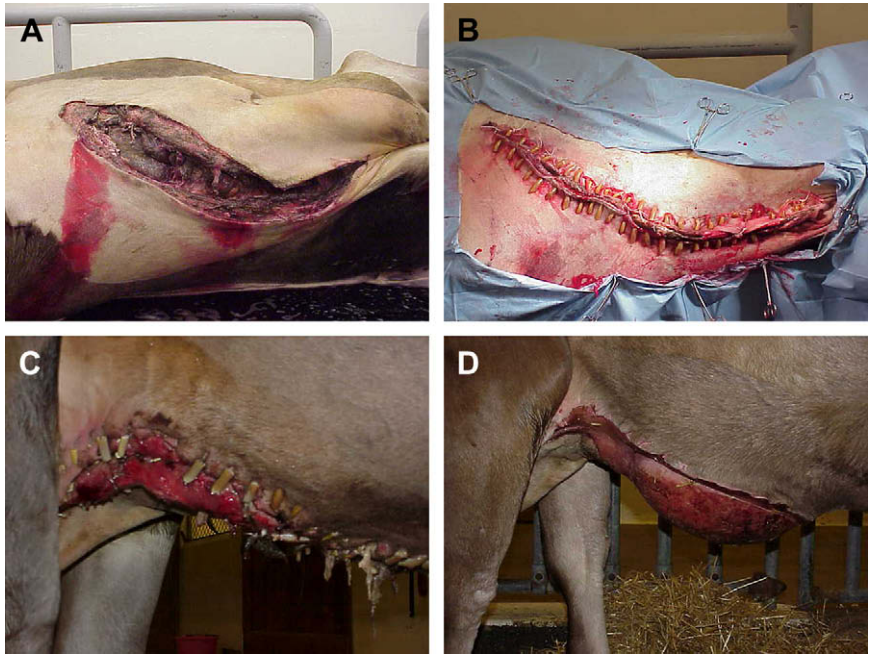

Fig. 2. (*A*) Large contaminated ventral abdominal wound in a pregnant Brown Swiss heifer. The laceration begins adjacent to the brisket cranially and ends caudally, just shy of the subcutaneous abdominal (milk) vein near the udder. Only peritoneum prevents entry into the abdominal cavity. (*B*) The wound was cleaned and superficially debrided before closure with # 3 Braunamid (double strands) with multiple vertical mattress sutures using simplex tubing as stents. (*C*) Approximately 2.5 weeks post–wound closure. Note wound proliferation and expelled exudate, and tension on stents in skin. (*D*) Approximately 6 weeks post–wound closure. Healthy granulation bed traversing wound, with skin proliferation at periphery. Bulge in granulation due to progressing, late, third trimester pregnancy. A flank cesarean section was performed to remove the calf, followed by debridement and closure of the wound 1 week later. Complete healing noted 2 months after delayed primary closure of wound.

patterns are favored whenever possible to relieve tension, preserve collateral blood supply and, in cases of contaminated wounds, provide intermittent gaps for escaping exudate.

SURGICAL DEHORNING OF CATTLE

Surgical Dehorning Considerations

Surgical dehorning of cattle, often referred to as cosmetic dehorning, is discussed in this article. For a lengthier description regarding surgical dehorning, the reader is directed to the March 1995 issue of this text.[7] Many methods of dehorning cattle exist, from basic cautery in young cattle, to straightforward removal in older cattle using various techniques. Closure of the resulting wound would constitute surgical dehorning regardless of the desired cosmetic outcome. Ethical decisions need to be made on an individual basis when goals are purely cosmetic or when removing scurs in designated polled animals. One should recognize that a desirable cosmetic appearance can be achieved with many of the more simplistic methods of dehorning; however, surgical dehorning has some added advantages (see later discussion). Dehorning or disbudding young calves should be undertaken whenever possible to reduce animal stress and chances of complications. The author supports local anesthesia regardless of the age of the animal or the dehorning method used.

Dehorning cattle is advocated for improving cattle and worker safety, facilitating handling, feeding efficiently at allotted bunk spaces, and improving carcass quality and animal health with less muscle bruising. Surgical dehorning reduces healing time, provides accurate hemostasis, and eliminates an open wound that may communicate with the frontal sinus. Veterinary intervention for the surgical procedure and presence on the farm, ranch, or feed yard has its own advantages from a herd health standpoint. Eliminating an open wound prevents fly strike and greatly reduces the chance of soft tissue infection with good surgical technique. Theoretically, the risk for sinusitis should also be reduced because an open sinus will not be continually exposed to environmental contaminants and precautions are taken to facilitate drainage (see later discussion).

Surgical Procedure

The animal should be adequately restrained in a squeeze chute and head catch that allows access to both horns. Additional head restraint is necessary and can be accomplished with the use of halters and lead ropes, tying the lead closely to one side and then the other. Squeeze chutes with a mechanical head restraint apparatus are an added benefit when available and prevent the need to reposition the patient between sides. Sedation with low doses of intravenous xylazine (0.01 mg/kg to 0.04 mg/kg) may be adequate for standing anesthesia and a cooperative patient. The clinician should start with the lower end of the dosing spectrum and titrate as needed. Alternatively, a combination of butorphanol (0.01 mg/kg), xylazine (0.02 mg/kg), and ketamine (0.04 mg/kg) intramuscular or subcutaneous has been used effectively with good results for standing sedation by the author and it provides additional analgesia.

A wide surgical field should be clipped around each horn, across the forehead, and behind the pole. A surgical prep with povidone iodine or chlorhexidine and isopropyl alcohol should be performed. Local anesthesia with 2% lidocaine can then be performed, beginning at the location of the cornual nerve at the frontal crest of the skull (**Fig. 3**), then extending the block subcutaneously around each horn as a ring block. The initial focal block of the cornual nerve provides most of the analgesia;

Fig. 3. Anesthetizing the cornual nerve at the facial crest. The block is then continued as a ring block around the horn. Note the clipped surgical field and clean towels covering the ears.

however, branches of the cranial cervical nerves may provide some sensory input to the caudal horn, hence the reasoning behind the ring block. A second surgical prep after local anesthesia is advisable. The ears should be retracted away from the surgical field, or alternatively, wrapped with clean towels or drape material. The head should not be draped because evaluation of symmetry will need to be monitored during surgery.

A full-thickness skin incision, beginning near the pole and extending in an elliptic fashion around the base and ending ventral to the horn, should be made. An attempt should be made to make a clean incision with two full-thickness passes on the anterior and posterior sides of the horn. The scalpel blade should be maintained at a perpendicular angle to the skin. To prevent partial horn regrowth (scurs), the corium of the horn should be avoided by approximately 0.75 to 1 cm at the widest part of the ellipse. The author initially avoids incising much subcutaneous tissue at

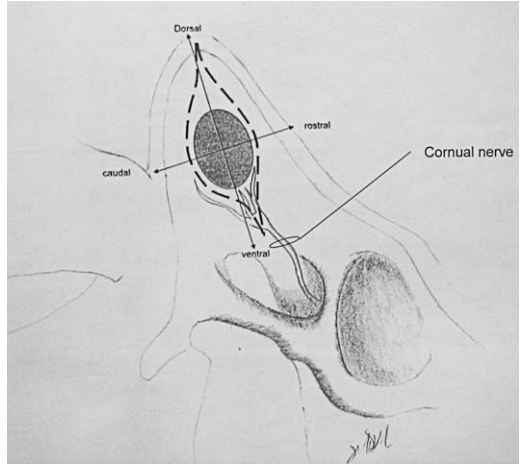

Fig. 4. Orientation of the elliptic incision (*dashed line*) around the horn for removal. (*Courtesy of* Matt Miesner, DVM, MS, Manhattan, KS.)

Fig. 5. Orientation of the anterior incision when viewed from the front.

the ventral apex of the ellipse to prevent cutting the cornual artery. Care should be taken to orient the incision parallel to the long axis of the horn (**Figs. 4–6**). Using a scalpel, the skin to be removed should be undermined up to the base of the horn and the skin to be preserved should be undermined 1 to 2 cm from the cut edges, which allows easy horn access while preventing trauma to the skin to be sutured during horn removal. One should not spend a great deal of time searching for hemorrhaging vessels at this point.

Removing the horn and bone followed by hemostasis are the next steps. Barnes dehorners are effective for removing horn and bone and avoiding skin trauma when oriented parallel to the incision (**Fig. 7**). Obstetric wire can be used for removal of larger horns, being careful not to damage the preserved skin as the wire heats up during use (**Fig. 8**). Once the horn is removed, hemostasis should be commenced by isolating the cornual artery at the ventral base of the horn, then either ligating, twisting, or extracting the vessel. A method used by the author for hemostasis when using obstetric wire is to stop sawing at the ventral margin of the incision after the bone of the horn is cut. One should grasp the horn, pulling down and twisting in one direction until the cornual artery is extracted. After horn removal and hemostasis, the Barnes dehorner, or bone chisel and mallet, can aid in controlled bone removal to shape the skull and remove bone to facilitate skin closure. One should

Fig. 6. It is important to reduce the skin folds when incising the posterior skin, to prevent inadvertently removing excessive skin.

Fig. 7. The Barnes dehorner oriented parallel to the long axis of the incision while removing horn and excess bone.

observe closely for bone fragments and fractures that could serve as a nidus for infection or sequestra after closure. Any loose fragments should be removed before closure. If the frontal sinus was opened during surgery, as is usually the case, debris should be prevented from entering the sinus cavity. Occasionally, a thin periosteal membrane lining the sinus can be seen after horn removal. If the membrane remains once the desired amount of bone is removed, the author prefers to perforate the membrane to facilitate drainage through the sinus and prevent accumulation of inflammatory debris during healing.

Attempt to oppose the skin edges for closure, continuing to undermine anterior and posterior sharply until the skin edges can be opposed under little tension. More skin mobility and tension relief will arise from the posterior margin, but one must be cognizant and avoid traumatizing the auricular tissues. Once the skin edges can be opposed, the suture pattern is left to the discretion of the surgeon. Typically, a #2 or #3 nonabsorbable suture is selected for the single layer closure. A simple continuous suture pattern can be used when little tension exists and is rapid and cosmetic. A forward interlocking pattern is also quick to place and provides more tension relief. The author prefers an inverted cruciate pattern (**Fig. 9**) that is cosmetic, relieves tension,

Fig. 8. Obstetric wire used to remove the horn. Caution must be used so as not to traumatize the skin to be preserved with the wire.

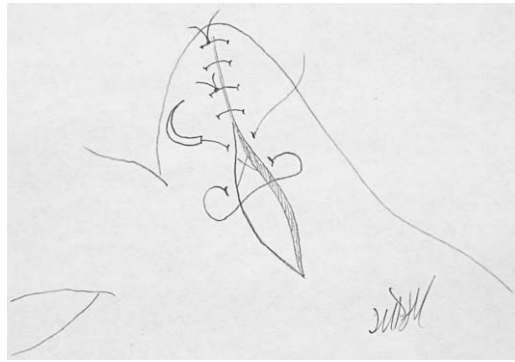

Fig. 9. Inverted cruciate pattern during skin closure. (*Courtesy of* Matt Miesner, DVM, MS, Manhattan, KS.)

preserves the ability to open part of the incision for drainage should infection arise, and prevents loss of the entire line should the animal break part of the suture during healing. Intradermal closure with #0 or #1 absorbable monofilament suture has been performed, but extra precaution and monitoring should be undertaken by the client during recovery to address the complications listed earlier (**Fig. 10**).

Once the opposite horn has been removed symmetric to the first side, the patient should be cleaned off thoroughly. A small amount of hemorrhage originating from the frontal sinus and draining from the nares is common and may be present for the first day after surgery. Applying topical wound ointments or sprays to the surgical site should be avoided if possible; nitrofurazone is now strictly forbidden for use in animals intended for food in the United States. When drugs, including those for sedation, antibiotics, and anti-inflammatory drugs, are used, meat- and milk-withholding times should be clearly stated. Sutures can be removed as early as 10 days postoperatively, but often, 2 weeks is recommended. The client should avoid placing the animal in situations where self-inflicted trauma and wound contamination may occur. In the author's experience, the first few hours after surgery, coinciding with the waning effects of the lidocaine, appear to be the most common time for the animal to rub on the incision. An itemized patient discharge form, describing postoperative care and potential complications of the procedure, facilitates client recognition and follow-up care, if needed.

Fig. 10. Closure of a surgical dehorn using an intradermal suture pattern with #1 absorbable monofilament suture.

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