How Wounds Heal

Wounds can be observed to heal in stages. The following are the stages a wound undergoes healing:

**The Inflammatory Phase**

The horse’s body begins reacting as soon as an injury occurs with the inflammatory phase. The skin around the wound begins retracting due to tension; immobilizing the wound can help reduce this effect. Skin retraction can continue for up to 15 days post-injury.

Within five to 10 minutes after the horse sustains a wound, a vessel response occurs. During this response, "intense vasoconstriction" (narrowing of the blood vessels) occurs at the wound site, followed by vasodilation. It’s during this response that fibrin—an insoluble protein that forms the nucleus of a blood clot—arrives at the wound site.

Within 30 minutes of injury, the body’s cellular response kicks in. Blood platelets and leukocytes (white blood cells) "line up" at the wound site to begin cleaning it. These cells are required for healing, and their presence activates the fibrin, allowing clotting to begin.

And finally, within an hour of injury, the localization response takes place. At this point, a fibrin clot has localized damage to just the affected area; the clot also prevents contaminants from getting into the horse’s bloodstream or surrounding undamaged tissues, and forms the framework needed to repair the defect.

Unfortunately, the localization response comes with a downside. Because the contaminants have been localized to one central area, inflammation (including swelling, redness, heat, and pain) develops. Excessive inflammation delays healing, and can lead to pressure necrosis, pain, scarring, and bacteria development.

**The Debridement Phase**

The next phase is debridement, which is critical for all wounds and injury healing.

The debridement phase takes place when neutrophils (a type of white blood cell capable of engulfing and destroying bacteria and other disease agents, immune complexes, and cell debris) enter the wound defect and kill bacteria, break down debris, and enhance the inflammatory response; unfortunately, when too many neutrophils enter the wound, the healing process slows. At that point, pus develops, which further slows the healing process by breaking down fibrin working to fill the defect. To prevent excessive neutrophils from inhibiting healing, keep the wound clean and administer antibiotics.

Some inflammation is good, but excessive inflammation slows healing.

Epithelialization—as the first sign of defect repair—begins between eight and 10 hours after a wound occurs. During this stage epithelial cells "migrate" under the scab at a rate of 0.2 millimeters per day on the horse’s upper body and 0.09 millimeters per day on the animal’s limbs or lower body. Factors that inhibit or delay epithelialization, include infection, excessive granulation tissue (commonly known as proud flesh), repeated bandage changes, extreme hypothermia, and dessication (the wound drying out).

**The Repair Phase**

By the fourth or fifth day after a wound occur, fibroblasts (cells responsible for forming connective tissues) move into the area and begin tying the wound edges together to fill the defect. The fibroblasts will continue moving over the defect until they contact other fibroblasts. Fibroblasts produce a substance that enhances the fibrin matrix before producing collagen, which essentially serves as a glue holding the layers of skin (or in this case, new epithelial tissue) together.

In the third to sixth day post-injury, granulation tissue begins to form and subsequently allows wound contraction to occur (more on that in a moment). Granulation tissue is an important part of wound healing: It provides a surface for the epithelial cells to migrate over, it’s resistant to infection, wound contraction centers around it, and it carries the fibroblasts responsible for collagen formation. But granulation tissue can cause problems in some cases.

"Horses are overachievers and can keep producing excessive granulation tissue." "This is when it becomes a problem."

Wound contraction, the process by which open skin wounds reduce in size due to the movement of surrounding full-thickness skin. Special cells on the surface of the granulation tissue bed–modified fibroblasts called myofibroblasts–draw the full-thickness skin toward the center of the wound.

Wound contraction works best in areas where the skin is relatively loose (upper body), but where skin is relatively tight (lower limb) contraction is much less efficient and will result in wider scars.

**The Maturation Stage**

The final stage in wound healing is maturation, and it can last for months to a year or more, depending on wound severity. In this phase, the number of fibroblasts in the area decreases while collagen production and lysis (decomposition) continue. Also, in this phase, the wound’s tensile strength increases. Once a wound heals fully, the defect’s tensile strength will always be 15-20% weaker than the surrounding areas.