

Wounds and Wound Management

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Wounds are common in equine patients. Many times, a great degree of trauma occurs when horses are wounded due to the horse's nature and their living environment. Legs caught in fences, panels, or gates are a frequent occurrence, as are lacerations from steel siding, trailer accidents, and riding accidents. Enormous variation exists in treatments, medications, bandages, and bandaging techniques applied to wounds in horses. In addition, products marketed to owners for wound care at home are ubiquitous and numerous. In some cases, owners have tried to treat the wound at home before consulting a veterinarian or they acquired a horse that had a wound previously. Thus the equine veterinarian may have to treat many chronic and complicated wounds as well. In order to know how best to care for wounds and what to expect when caring for them, an equine ambulatory practitioner should be well versed in the wound healing process. In addition, triage, evaluation, and treatment necessitate a good working knowledge of anatomy. Not all wound types and tissues are covered comprehensively; my focus will be on full-thickness skin wounds.

Wound assessment

Initial assessment of a wound should include careful attention to its severity and anatomical location. Are structures involved that need further attention than routine wound management? Is there involvement of a structure that if damaged or contaminated could be life threatening: thoracic or abdominal cavities, large vessels, synovial structures, fractures, flexor tendon or suspensory damage? Visual examination, careful digital exploration with a gloved hand, palpation and manipulation, ultrasound, and radiographs should all be employed as needed to help determine what structures are involved and what the extent of damage to them is. If the wound communicates with the thoracic or abdominal cavity, it should be evaluated, first aid applied, and then referred for further care if possible. While managing an open abdomen or thorax can be accomplished in the field, complications like pneumothorax and peritonitis will likely be more easily prevented or solved in a hospital setting. If the wound has damaged a large vessel(s) and severe bleeding is occurring, the vessel should be located and ligated or clamped if possible. If it cannot be located, it may be necessary to apply a pressure bandage to help control the bleeding and consider anesthesia in the field or at a referral center, as appropriate, if bleeding does not cease. Most bleeding from smaller vessels can be stopped with the pressure from a good bandage.

If the wound is anywhere near a synovial structure, communication of the wound with the synovial structure should be ruled out. In more chronic wounds (5-7 days or more) that communicate with a synovial structure – severe lameness is usually present. However, in

some of these cases, if an open tract is providing drainage and relief of pressure, the horse may not be very lame, even if a joint or tendon sheath is infected. Even some wounds that do not appear to be located so that they involve a synovial structure may do so because of the position of the skin and underlying tissue at the time of injury. For example, a limb that sustains an injury while it is flexed is often then evaluated once the horse is standing with the limb in extension. In that case, the skin wound may not be directly over the synovial structure. Checking for communication of wounds with synovial structures requires familiarity with their locations and where to approach them for synoviocentesis and distension of the joint. An excellent field reference is available for joint injection techniques. Typically, the joint or tendon sheath is prepared routinely as for injection or synoviocentesis at a site remote from the wound, then a needle is inserted. A synovial fluid sample can be saved at this time for cytology and culture if fluid is obtained, and then a sterile solution such as saline or LRS is used to distend the joint. Fluid should exit the wound if it communicates with the synovial structure. A relative idea of the capacity of each joint is useful, as some require a larger volume to distend, while the veterinarian also does not want to administer so much fluid in smaller joints that they are damaged. Often, leaving the needle in place and disconnecting the syringe after the joint feels pressurized is useful in determining if the joint is intact – the injected solution and synovial fluid will normally come back out of the needle if the joint capsule is intact. A dilute solution (approximately 1:5) of procaine penicillin G to saline is frequently used in our practice to aid in visualization of the fluid exiting the wound. A contrast study may be indicated in some cases to determine if a wound communicates with underlying structures. Radiographs are also often helpful in assessing the synovial structures and the surrounding area for fractures, metallic foreign bodies, and air in tissues.

The possibility of fractures associated with a wound should be suspected if the horse is acutely toe touching to non-weight bearing lame, or if there is crepitus or instability on palpation. While most long bone fractures of the limbs are quite obvious due to the degree of swelling, inability to bear weight, and palpation findings, smaller or nondisplaced fractures may not be so obvious. Wounds on the head or face may have depression fractures that are not immediately apparent, especially if there is concurrent swelling and the wound is small. Again, radiographs of the area are often quite helpful in determining if fractures are present, and are rarely contraindicated when evaluating a wound. If the wound is on the palmar/plantar surface of a limb and the flexor tendons or suspensory ligament are lacerated or damaged, the wound should be cleaned and a heavy bandage applied. A splint maybe warranted in some cases if a tendon or ligament is severed. Referral to a clinic that can proceed with repair and/or external coaptation is appropriate for these cases as these structures are vital to function and injuries to them can be career-ending or life-threatening. This is in stark contrast to the extensor tendons that reside on the dorsal aspect of the limb. These tendons are often damaged during a traumatic equine limb wound that involves the dorsal cannon bone area. The extensor tendons can be damaged or even completely severed and prognosis for return to full function is still excellent in most cases. In the early period after damage to extensor tendons, a splint or very heavy padded bandage may be necessary to prevent the horse from knuckling over, but most cases are able to use the limb normally within days.

Once the wound has been evaluated and career-ending or life-threatening injuries have been ruled out, treated, or first aid and referral pursued, wound care can begin. My recommendations for care of full thickness skin wounds in the field are summarized below.

Wound healing process

Horses frequently suffer traumatic wounds and if they are full thickness, they heal via a process that is typically divided into three stages. These phases - inflammation, proliferation, and maturation/remodeling - overlap temporally and the entire process is a complex occurrence that includes participation of cells, extracellular matrix, and many mediators. This process is described in detail in many resources; as such, I will review the physiology in brief with an eye toward the clinical findings and practical implications during this process.

Inflammation

This phase starts at the time of wounding and the magnitude of inflammation is correlated to the severity of the trauma. White blood cells migrate to the site of injury - neutrophils help clean up bacteria and debris in the acute inflammatory period, but macrophages will take over as the major inflammatory cell. Macrophages kill bacteria and help debride as well, but they also recruit other cells and thus follows angiogenesis, fibroplasia, and epithelialization in the proliferation phase. Inflammation that continues for a protracted period can contribute to exuberant granulation tissue. Clinical signs seen during this period include the classic signs of swelling, heat, redness, and pain. In addition, some wounds become larger before getting smaller as tissues swell, retract, are debrided and even slough. In some cases where the injury that caused the wound involved blunt trauma, surrounding tissue that initially appears viable may slough, and skin flaps may not survive. Many times, it is not clinically apparent that the tissue isn't viable until 7-10 days after wounding.

Proliferation

During the proliferative phase of wound healing, granulation tissue starts to fill the wound gap. Granulation tissue is visible in a wound at about 3-5 days. Fibroblasts, endothelial cells, and epithelial cells are entering the wound during this phase, and so, along with continued debridement by macrophages, fibroplasia and angiogenesis are rapidly occurring. The abundance of new blood vessels along with the fibroblastic stroma gives granulation tissue the classic pink-red "cobblestone" appearance. Not only does granulation tissue provide a surface for epithelial cell migration to occur on, it provides a physical barrier to prevent infection. A bed of granulation tissue must be present for epithelialization to occur; if the granulation tissue has defects, or is unhealthy, this migration can be impaired. Epithelialization can be seen starting to occur around the wound edges at about 4-6 days. During this time, wound strength is still relatively poor, and even as new skin covers the wound, it is easily traumatized, especially as it starts to reach the center of larger wounds where it is frequently thinner.

Maturation and Remodeling

The last stage of the normal healing process includes contraction and scar tissue formation. During the period starting about the second week after the wound occurs, contraction usually starts to occur. Generally, in horses contraction is advantageous as it lessens what the new epithelium has to cover, so it speeds closure of the wound and improves aesthetic appearance and strength. In a few locations, contraction can cause problems with cosmetics or function – notably the eyelid, lips, and ears – as it distorts the tissue or its function. If the tension in the surrounding skin is too great, then contraction will stop. In addition, contraction will stop in very chronic wounds as the myofibroblast (which are responsible for contraction) numbers drop. More contraction occurs in areas with loose skin - such as the pectoral region versus areas with skin under tension - such as the distal limbs. Finally, granulation tissue is converted to scar tissue. This proceeds by collagen synthesis, degradation, and eventually cross-linking and rearrangement. Over time, the tissue becomes more organized and the normal ratio of type I collagen to type III collagen (1:4) is restored, but even when it reaches its greatest strength, the wound will be 15-20% weaker than the original tissue. Remodeling can continue for up to 2 years.

Treatment of the wound

After initial triage of the wound, it should be cleaned. I sedate the horse if they have not been sedated already for the initial exam. A dose of a non-steroidal anti-inflammatory is also appropriate if one has not been given yet. Clipping the hair around the wound is helpful in getting and keeping the wound clean. Applying a water-soluble lubricant in the wound can help keep hair out of the wound while clipping. If the area is covered in dried blood or mud/dirt, preliminary cleansing can begin with a hose. I recommend using the hose without a sprayer nozzle, and water shouldn't be forced or sprayed into tissue planes – rather the surface cleansed. After clipping the hair and cleansing any large volume of organic debris or blood, the wound can be further cleansed with mild soap or dilute betadine, and rinsed with saline or another isotonic fluid. Large amounts of isotonic fluids are useful for lavage of wounds – they dilute and remove foreign material and blood. Judicious sharp debridement can be used in addition to remove a very thin layer of tissue if foreign material is embedded in the tissues. A regional or local block should be performed before debridement. Skin flaps should, in general, not be removed during sharp debridement. Although many skin flaps may have ischemic damage to part or of all of them, they can be used to close and protect the skin after debridement. Additionally, it is surprising in some cases, especially on the head and eyes, how thin a skin flap can be and survive. Similarly, skin flaps should not be removed from distal limb wounds unless it is clearly non-viable (which is usually clear in 7-10 days) as the distal limb has greater skin tension, epithelialization is slower than on the body, and excessive granulation tissue is more likely to occur.

Once the wound is cleaned and debrided, an effort should be made to close the wound, or bring the edges as close as possible. Suture patterns such as near-far-far-near and vertical mattress patterns – with or without stents – can be used to pull the skin edges together in cases where there is skin missing or there is enough swelling to create a lot of tension. Many suture patterns have been described for closing specific wounds, and those can be

employed as the wound configuration dictates. Even if the clinician suspects that a skin flap will later slough or the sutures dehisce due to motion, I still recommend attempting closure of the wound, even if it is only partially closed. The closure can help hold tissues in place, cover underlying structures, and reduce dead space. If the wound is highly contaminated, or a large amount of dead space is present, a drain can be placed and removed a couple of days later. A simple penrose drain exiting the most ventral aspect of the wound or area of dead space is often sufficient. Areas that cannot be closed or that later dehisce will heal by second intention wound healing and owners should be prepared for that occurrence and counseled on what to expect. After debridement and repair, a good bandage should be placed and maintained during healing (see Bandaging section below). High motion areas and areas that are difficult to bandage such as the pectoral area or upper hindquarters may be more prone to dehisce and owners should be aware of this possibility.

What the practitioner and the owner should expect

When assessing and treating wounds, ambulatory practitioners can prepare themselves and owners for likely outcomes at the time of the initial exam. General expectations for wounds healing by second intention sometimes come as a surprise to owners. Informing owners of the duration of healing is often overlooked, but owners should be fully aware that most wounds healing by this process (unless small) will take months to heal. Care and bandaging of a wound can become tedious for owners over time, and they may discontinue treatments in frustration. The presence of wound fluid and the odor of a wound during bandage changes can disturb some owners and lead them to assume the wound is infected or healing poorly, even in cases where healing is ideal. On the other hand, some owners ignore or fail to recognize when healing is impaired or delayed. Description of acceptable and non-acceptable developments can be given to the owner to better their ability to monitor healing and assist in care of the wound. The appearance of a healthy granulating wound versus one that is incomplete because of a sequestrum or foreign body, has developed exuberant granulation, or exhibits impaired/delayed healing are some of the points that we discuss often with clients in our practice.

If bone is exposed, as often happens in lower limb wounds, a sequestrum should be expected. Good debridement of the wound and the surface of the bone (with a curette or bone rasp) and closure of the skin if possible may help reduce the incidence or degree of sequestrum formation, but owners should be aware of a possible additional procedure to remove a sequestrum in the future. Sequestrum formation is usually evident radiographically at about 3 weeks, and should be suspected if the granulation tissue has a cleft or defect when it has otherwise filled the wound. Most sequestrae can also be seen using ultrasound as well. Some horses exhibit lameness during the time the sequestrum is maturing and practitioners and owners need to be aware of this possibility. The lameness is usually transient and can be alleviated with NSAID therapy. Sequestrum removal can often be done in a standing, sedated horse. If the horse's nature or the location or extent of the wound makes standing removal difficult, a brief anesthetic episode can facilitate removal. Radiography and/or ultrasound can be helpful in determining if removal is complete.

Wounds that cause loss of a large area of skin, especially on the limbs, at the time of initial injury or after sloughing/debridement should be considered candidates for skin grafting. Preparing owners for this possibility should involve explaining that some wounds cannot heal, or heal poorly, with contraction and epithelialization alone. Grafting can remedy this as well as decrease healing time for many wounds. There are several techniques for free skin grafting frequently used in horses, and the type chosen may depend on equipment available, cost, and expected cosmetic outcome. Pinch or punch skin grafts are relatively inexpensive, graft harvest and implantation can be performed in a standing horse, and they are relatively durable. Success of each graft is independent of the others, so failure of one or more grafts does not affect the rest. Sheet grafting can cover larger areas, and have a more cosmetic outcome, but are often relatively expensive. Also, harvest of a split-thickness sheet graft must be performed under general anesthesia. Tunnel grafts can be used for large wounds as well, and utilize longer strips of donor skin compared to pinch or punch grafting, but not as large as sheet grafts.

Bandaging

The importance of a good bandage to equine wound care can't be overstated. This element of care – especially for distal limb wounds is, in my opinion, often the most important part. However, I think that the qualifier *good* is significant. A poor bandage can, at best, be little or no benefit to the patient and at worst, be detrimental. A good bandage can help stop bleeding, prevent further contamination and trauma, and reduce swelling in acute wounds. As care of the wound continues, a good bandage limits motion, keeps swelling at bay, and provides a moist wound healing environment. Bandaged wounds heal faster than those that are not bandaged. Unfortunately, bandaging is often discontinued early in the process of wound care or is done improperly because application and maintenance of a good bandage can be time consuming and requires a good deal of work on the part of the veterinarian and owner. Use of an inadequate amount of padding is a very common pitfall. A number of cotton roll products exist, and any can be used to provide this padding. A compressive layer or two over the cotton, such as wide brown gauze followed by a self-adherent elastic bandage will help secure the bandage and provide compression. I prefer to also seal the top and bottom of the bandage with an elastic adhesive tape to help keep the bandage in place and keep shavings and other debris out of the bandage.

Bandage changes can occur every few days in most cases. Early on, bandage changes may need to be more frequent if bleeding is still occurring or if treatments such as debridement, suturing, or regional limb perfusions are necessary. After that, I usually change or have owners change the bandage every 3-5 days or sooner if it slips down or gets torn, worn through, or very wet. In some instances, owners don't feel comfortable changing the bandage, or the horse requires sedation for bandage changes. In those cases, I put on a heavily padded, very snug bandage fully covered with elastic adhesive tape and change the bandage about every 7-10 days. This seems a long period, but a good bandage should last that long and there should be no worry about leaving a bandage on for that duration if it stays intact – when casts are employed to cover a wound, they

are often left in place for 14 days or more. This method can be very helpful for horses that are fractious or otherwise hard to manage and if the owner's farm set up, schedule, or comfort with bandaging are such that the veterinarian must change the bandage every time. Stall confinement will usually prolong the life of a bandage, but unless the injury necessitates it, is not essential in every case. Again, farm set up and management are sometimes such that stall rest is not an easy option.

When the wound is healed and bandaging is to be discontinued, I try to warn owners that the area being bandaged often becomes edematous with the cessation of bandaging. To remedy this, owners can increase exercise if possible, and try "weaning" the horse from bandaging. This is done by applying a bandage for 12-24 hours, then removing the bandage for 12-24 hours, then bandage for 8-12 hours, then remove, and so on.

Treatments, products, and continued management of the wound

Some treatments, products, and procedures have shown modest benefit to healing wounds, but the degree to which each helps is contingent on the wound properties, location on the body, and stage of healing. For the practitioner to search for one product that will heal every wound or heal wounds extremely fast or without complications during healing is, futile. Certainly, partial thickness wounds and wounds that are able to be closed by delayed primary closure will heal quite quickly and often with excellent cosmetic results. However, full thickness wounds that heal by second intention must all go through the same healing process outlined above. Some differences in healing time and quality can be obtained, but no one product or treatment is right to treat every case with, and none other than skin grafting have been shown to make a very dramatic difference in healing time.

Hypertonic saline can be used as a dressing to help debride wounds. This should be discontinued as the wound becomes more dry and appears no longer infected. Calcium alginate dressings are helpful to encourage an inflammatory response and the formation of granulation tissue – for instance over exposed bone or a defect in the granulation tissue. Semioclusive foam dressings can help encourage epithelialization.

Wound healing can be impaired or delayed with some practices and with application of some products. Some examples are: nitrofurazone ointment has been shown to delay wound healing and should not be used in open wounds, formalin has been used to try to prevent or treat the formation of proud flesh, pickling lime and calcium hydroxide have been used for the same reason. There are an astounding number of wound treatment products on the market; too many to list individually here. Careful scrutiny of the ingredients should precede use – many contain agents such as phenols and alcohols, or other chemicals that are known irritants, caustics or drying agents. In addition, some products can damage tissue surrounding the wound or other normal tissue that comes into contact with it. We have even seen cases in our clinic in which the product applied was irritating enough to cause self-mutilation. If a wound has granulation tissue that is discolored or otherwise unhealthy then the application of a caustic treatment should be

considered as a cause. Sometimes wounds treated in this fashion become discolored and have a granulation bed that is below the level of the skin, rather than level with it.

Complicated and chronic wounds

On occasion, chronic, non-healing wounds, are presented to the practitioner. These can be difficult cases, but should be approached with the wound healing process in mind. There are many reasons why a wound may not be healing, and a systematic approach can help narrow down the possibilities. First – is the granulation bed appropriate and intact? If the granulation tissue bed is not intact, if a cleft is present or if the wound itself is a draining tract, then something is causing continued drainage. Causes of this could be sequestrum, foreign body, motion/trauma, or infection of an underlying structure. If the granulation tissue is intact across the entire bed of the wound – is it appropriate? Bulging of the granulation tissue out beyond the wound in cases of proud flesh or granulation tissue with an unhealthy color or consistency are signs that the bed is not healthy. In addition, sarcoids or squamous cell carcinomas might be suspected if the normal skin edge ends abruptly and a mass begins, rather than a healing epithelial edge being present.

Exuberant granulation tissue, or proud flesh, is one cause for a wound to have delayed or impaired healing. Prevention of this occurrence with good wound management, including bandaging, is best but sometimes it is an inevitable outcome. Small to moderate amounts of excessive granulation tissue can be treated with application of corticosteroid cream, but if there is a large amount of proud flesh, it should be sharply excised. The excess granulation tissue should be trimmed flush with the healing epithelial edge, taking care not to remove or damage healthy surrounding skin or new epithelial tissue. Most horses are tractable to this being performed while standing under sedation. A tourniquet above the area that is to be trimmed can help reduce the amount of bleeding, but because of the composition of granulation tissue, bleeding will still occur. The owner should be prepared for the bleeding if they are present for the procedure, as it can appear to be a dramatic amount. The bleeding will cease with a heavily padded bandage placed over the wound after trimming. In some cases, repeated trimming of the granulation tissue is necessary. However, if the wound needs repeated trimming of granulation tissue and does not appear to be making progress healing, skin grafting should be considered.

Habronemiasis can occur in open wounds and will sometimes have an appearance similar to proud flesh or sarcoids. It can be difficult to tell the difference between these three problems and a few other conditions, such as squamous cell carcinoma. Summer sores often contain calcified granules and are usually quite pruritic. Histopathology is recommended for any proliferative non-healing wound as these different conditions may be treated differently. Debulking the portion that protrudes beyond the skin edge and bandaging is almost always an excellent start to getting any of these conditions under control, and a biopsy can be submitted from the portion that is removed.

At times, even if the wound is healing appropriate, a large amount of motion can disrupt the granulation bed. Areas where this may occur are typically near joints, such as the

point of the hock or the dorsal fetlock. Measures to reduce motion including stall confinement, a heavily padded bandage with a splint, or a cast can help limit motion and thus disruption of the healing wound.

Wounds that are chronic and have been left without treatment for a long period of time may have associated limb swelling that could be permanent. Even if the wound is amenable to treatment, the limb may have permanent enlargement if the duration of swelling has been prolonged, and owners should be advised of this possibility. Nevertheless, there are many chronic cases in which treating the wound and bandaging the limb may result in surprising improvement.

CONCLUSION

Care of equine wounds in the field can be a challenging endeavor. Many times, wound care is complicated by chronicity or by prior inappropriate care in addition to the great degree of tissue trauma that occurred when the horse was wounded. Recognizing involvement of synovial structures, loss of skin, and damage to bone are critical in the initial examination of wounds and will guide future care. Education of clients is also important in that preparing them for possible outcomes during healing may help improve compliance and proper treatment of wound. Owners and trainers often perform much of the daily care and monitoring of equine wounds and thus can greatly assist or impede the progress. The practitioner that improves and utilizes his or her understanding of the wound-healing process in concert with his or her knowledge of local anatomy will be the one who is best equipped to care for wounds in ambulatory practice.

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