Soft Tissue Trauma

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KEYWORDS

• Soft tissue trauma • Wound healing • Wound closure • Wound care

KEY POINTS

- Copious irrigation with normal saline is the only debridement and preparation needed for most soft tissue wounds before closure.
- Well-irrigated and debrided facial soft tissue wounds do not require antibiotics.
- Careful resuspension of soft tissue with approximation and eversion of the wound at the dermal level will provide superior esthetic outcomes.
- Explore soft tissue trauma carefully, keeping in mind the pertinent anatomy, so that vital structures are treated along with the closure of the wound.
- Follow the healing wound, and intervene in the first few weeks to modulate the healing process for the best outcome.

Soft tissue trauma is a commonly encountered sequel of head and neck trauma (Figs. 1—3). The injury may be limited to superficial structures or may be the harbinger of injury to deeper anatomic structures. The ability to accurately diagnose soft tissue injuries, manage their repair, and modulate the healing process will provide your patients a superior outcome.

Skin

Soft tissue injuries, by their nature, involve the overlying skin and/or mucosa of the head and neck. The skin is the largest organ of the body and is also the most abused. The skin is, however, remarkably resilient and has a high capacity to heal. It provides protection from the environment, regulates body temperature, prevents fluid loss, and prevents entry of pathogens. It is made up of 3 general layers: the epidermis, dermis, and subcutaneous connective tissue (Fig. 4). The epidermis is stratified squamous epithelium. It contains no blood vessels, minimal extracellular matrix, and few nerves. It does contain Langerhans cells, which are antigen-presenting cells of the immune system. It ranges in thickness from 0.05 mm over the eyelids to 1.5 mm over the soles of the feet. The epidermis is a waterproof, semipermeable membrane that turns over in about 40 days. Epidermal cells migrate through the 5 layers of the epidermis. They start at the basement membrane, which separates the epidermis from the dermis, and ultimately are desquamated at the skin's surface. The 5 cell layers are the basal cells (the only dividing cell layer), stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum.

Dermis

The dermis makes up about 90% of the thickness of skin. It supports the epidermis with its collagen matrix and contains the dermal appendages, such as hair follicles, sweat glands, and sensory organs. The dermis provides nutritional support to the epidermis with a robust vascular plexus. Local and regional flaps owe their viability to this vascular plexus. It is thinnest over the eyelids (0.3 mm) and thickest over the back (3 mm). Closure of soft tissue wounds occurs primarily at the level of the dermis because it has the necessary tensile strength to support suture/staple closure. Accurate reapproximation of the dermis with eversion of the wound edges provides the greatest chance for a cosmetic closure. The dermis is 70% collagen by dry weight and 2% elastin, with glycosaminoglycans taking up the intervening space. A 1-mm collagen strand has a static load capacity of 20 kg. The subcutaneous tissue is a variable layer of adipose and connective tissue that intervenes between the skin and underlying musculature/fascia or skeleton. This subcutaneous fat allows the skin to move somewhat independently of the underlying tissue.

Physical properties

Skin has biphasic deformation properties. There is a rapid initial extension and a slow secondary extension termed *creep*. The initial extensibility is caused by elastin being stretched and collagen aligning. Creep is stress relaxation and is caused by the gradual change in collagen bonding and displacement of water. If skin is put under tension, the force required to maintain a constant length decreases over time. This property of skin can be used to close avulsion defects and is particularly helpful for scalp wounds. Skin also has the property of resting skin tension lines (Fig. 5). Skin's strength and distensibility are directional, which is caused by collagen orientation. Lacerations from blunt trauma tend to follow the resting skin tension lines. These lines are in the direction that the skin is weakest,

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Atlas Oral Maxillofacial Surg Clin N Am 21 (2013) 49—60
1061-3315/13/$ - see front matter Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.cxom.2012.12.011

Fig. 1 A 20-year-old woman status post s/p ejection from motor vehicle through windshield. Patient sustained lacerations, abrasions, and an avulsion injury to the right cheek.

that is, perpendicular to muscle pull and parallel to dermal collagen bundles. Wounds following these lines tend to heal with the best cosmetic outcome.

Healing

Skin and soft tissue heal in a regular pattern: an inflammatory phase, proliferative phase, and remodeling phase. The inflammatory phase is characterized by fibrin deposition and the start of epithelial cell migration under fibrin and over collagen. This phase lasts from 48 to 96 hours. The proliferative phase is characterized by fibroblast migration with production of extracellular matrix. It starts around the third to fourth day. Myofibroblasts contract the wound and macrophages clear

Fig. 2 Same patient seen in Fig. 1 after irrigation, debridement, and closure of lacerations in emergency department.

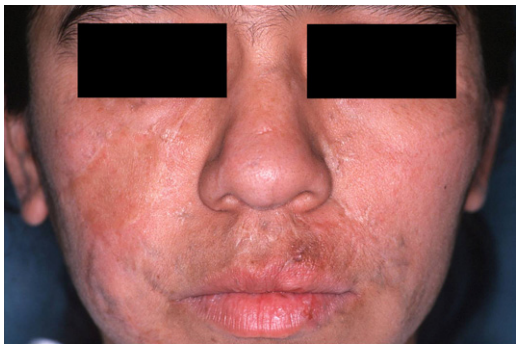

Fig. 3 Same patient seen in Figs. 1 and 2 after full-thickness skin graft from supraclavicular region and fat transfer to right cheek. Patient would likely benefit from dermabrasion to smooth skin contours and even skin tone.

debris. The remodeling phase begins with the decrement in fibroblast and macrophage number at around 3 weeks. At 6 weeks, the collagen synthesis and degradation is equalized. The final strength of the repaired tissue reaches 70% to 80% of the preinjury level (Boxes 1 and 2).

Wound types

Facial wounds can be one of several types but are frequently a combination. A simple laceration is similar to a surgical incision. These lacerations should be irrigated and closed with minimal undermining. Complex lacerations require a more detailed study of their pattern to return tissue to its original position and should be closed in a layered fashion, suspending tissue as required to remove tension from wound edges.

Abrasions are the removal of the epidermis and outer portion of the dermis. Carefully debride and clean abrasions and cover with antibiotic ointment. These wounds should not be allowed to dry out during their re-epithelialization. Re-epithelialization will occur from keratinocytes migrating from the wound edges and from adnexal structures.

Avulsive injuries involve the loss of soft tissue, including complete loss of the epidermis and dermis. These wounds may be treated with the use of wound vacuums to prepare the wound bed for grafting procedures and/or reduce the size of the wound. Wet to dry dressings may also be used to debride the wound and allow the formation of granulation issue. Avulsive injuries may be closed by secondary intention, local flaps, regional flaps, or grafts (Figs. 6—8).

Puncture wounds have a small epidermal defect in comparison with their depth. The greatest challenge with puncture wounds is achieving adequate irrigation, which may require the use of catheters to reach the depth of the wound or may require opening the wound.

Contusions and blast injuries may produce extensive soft tissue damage, which is not readily apparent on initial presentation. These injuries compromise the microvasculature and, thus, the healing capacity of the soft tissue. Minimal manipulation is warranted with monitoring of the tissue to determine vitality and signs of infection (Figs. 9—11). Burns require specialized treatment and should be referred to a burn unit for treatment except for those limited in surface area and depth. Small, superficial burns can be treated like an abrasion with topical antibiotic ointments.