Soft Tissue Injuries

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Daniel Isacson and Daniel Nowinski

Recommendations

Level I

Wounds should be thoroughly irrigated.

Removal of sutures in the face should be done within 5–7 days to avoid track marks.

Level II

Tap water is as efficient as sterile water with no difference in infection rates.

Antibiotics may have benefits in contaminated wounds.

Level III

Layered closure leads to restoration of muscle and reduces dead space with less scarring.

Timing is of importance in suspected nerve injuries, as after approximately 48–72 h, the distal nerve end can no longer be stimulated.

Tips, Tricks, and Pitfalls

- Meticulous wound irrigation is the most important aspect of treatment of soft tissue injuries.
- There is no evidence for antibiotic prophylaxis except for contaminated wounds.
- Lip repair requires meticulous attention to details, as a misalignment of the vermillion border of only 1 mm is clearly noticeable at conversational distance.
- Staples saves time and reduces alopecia. Pay attention to hair-bearing areas when closing the scalp.
- Always consider wound irrigation in sedation in the pediatric consideration.

32.1 Overview

Soft tissue injuries in the head and neck area are commonly encountered in trauma patients. Their early identification and treatment is important to prevent hemorrhage, infections, and later deformity. Minor lacerations may usually be adequately treated in the emergency room. However, more complex injuries should be managed in an operating room setting with access to surgical assistance and instruments. Soft tissue injury should always alert to the presence of deeper

D. Isacson (✉)
Department of Plastic and Maxillofacial Surgery, Uppsala University Hospital, Uppsala, Sweden
e-mail: daniel.isacson@akademiska.se

D. Nowinski
Department of Plastic and Maxillofacial Surgery, Uppsala University Hospital, Uppsala, Sweden

Department of Surgical Sciences, Plastic Surgery, Uppsala University, Uppsala, Sweden
e-mail: daniel.nowinski@akademiska.se

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injuries to the bone or vital structures, and a thorough understanding of the mechanism of trauma is of paramount importance.

Management of soft tissue injuries should be performed in a systematic way following the sequence of hemorrhage control, wound assessment, irrigation, and repair. Depending on the anatomical region consultation with plastic surgery, ENT or ophthalmology should be considered.

32.2 Hemorrhage Control

Hemorrhage from superficial soft tissues may usually be controlled by local compression. Scalp injuries that disrupt major vessels may result in hypovolemic shock and may need ligation in the emergency setting. Bleeding in the nasal cavity that cannot be controlled by direct pressure requires packing. Packing is usually effective and rarely requires a transnasal balloon catheter. If massive hemorrhage is present, the airway should be managed first by emergent intubation, followed by packing and direct pressure. Control of the source bleed, usually a branch from the external carotid artery, is best done by angiographic embolization. Surgical ligation of the external carotid is not adequate and will not control bleeding (Thorne et al. 2013).

32.3 Wound Assessment

Once hemorrhage control is achieved, a thorough wound assessment should be made. Location, size, and extent of defect all determine the extent of further treatment. The location of the wound may lead to suspicion of nerve damage, muscular injury, or underlying fractures. The size of the wound, large soft tissue avulsion, or areas of necrosis may not allow for primary closure and require consultation with a plastic surgeon.

Fractures to the supporting facial bones should be excluded by clinical exam and computer tomography. A recent large study from the US national trauma database found the incidence of facial fractures to be 13.5% in patients with a cervical spine injury, 21.7% in patients with a head injury, and 24.0% in patients with a combined cervical spine and head trauma. Furthermore, about 5–8% of isolated and 7–11% of multiple facial fracture cases are associated with cervical spine injury, and appropriate care should always be taken to stabilize the neck before ruling out these injuries (Mulligan et al. 2010).

32.4 Irrigation

Thorough irrigation and removal of any foreign bodies is essential before closure. Irrigation reduces the risk of infection, and foreign bodies are a cause of prolonged inflammation which may ultimately lead to infection. Devitalized tissue should be removed with sharp debridement. Debris must be removed from the dermis or may result in permanent tattooing. Freshening the wound margins contributes to rapid healing and improves final outcome (Thorne et al. 2013). Cleansing is best performed with a mild surgical soap and the light use of a scrub brush. Extensive and contaminated wounds should be irrigated with a pulsed lavage system (Thorne et al. 2013). The role of irrigation cannot be overemphasized and should not be delayed. A Cochrane review and several RCTs support the role of tap water to be as efficient as sterile water with no difference in infection rates (Fernandez and Griffiths 2012; Moscati et al. 2007; Weiss et al. 2013). The head and neck's rich vascularity increases resistance to infection (Adalarasan et al. 2010; Hollander et al. 2001); however, the risk increases the longer a wound is open (Waseem et al. 2012).

32.5 Repair

Primary closure is usually the preferred treatment. Wounds may heal by secondary intention but have increased risk of scarring and infection which will generally result in inferior final appearance compared with other reconstructive options. Absolute contraindications to closure are signs of inflammation(Hollander and Singer 1999).

Layered closure of the muscles and skin is preferred to restore muscle function and reduce dead space. Further, by placing the tension of the closure deep to the skin with excellent approximation of the dermal layer, the resulting scar is improved. Layered suturing does unfortunately lead to increased risk of infection. Select monofilament sutures small enough to minimize the risk of tissue damage and suture marks but strong enough to avoid wound dehiscence. Good choices include 5-0 for face and 6-0 in the eyelid. Local flaps should be avoided in the acute setting.

Noninfected wounds in the scalp and face caused by clean objects may undergo primary closure up to 24 h after injury (Berk et al. 1988). Factors that may increase the likelihood of infection include wound contamination, laceration length greater than 5 cm, laceration located on the lower extremities, extensive soft tissue contusion, and diabetes mellitus (Quinn et al. 2014).

Delayed primary closure should be considered for complicated wounds that present after 24 h. It involves cleaning and debridement followed by a 4–5 day of waiting period. This allows the host defense system to decrease bacterial load and initialize wound healing. Antibiotics may be administered. Additional debridement and granulation tissue trimming back to wound margins may be needed at time of closure (Marion 2018). Other indications for healing by secondary intention are deep wounds that cannot be adequately irrigated, contaminated wounds, small non-cosmetic animal bites, abscess cavities, and presentation after significant delay (Berk et al. 1988).

32.5.1 Scalp

The scalp consists of five layers: the skin, subcutaneous tissue, galea aponeurotica, loose areolar tissue, and pericranium. The scalp's blood vessels, lymphatic system, and nerves run superficially to the galea aponeurotica in the subcutaneous tissues. The galea is continuous with the frontalis muscle anteriorly, the occipitalis posteriorly, and temporoparietal fascia laterally. The galea is very inelastic, but where the galeal edges blend into the temporoparietal fascia and scalp musculature fascia, there is better mobility (Desai et al. 2015).

The blood supply to the scalp arises from both the internal and external carotid arteries. The arteries form a collateralization in the subcutaneous tissue. The paired supraorbital and supratrochlear arteries arise anteriorly. The superficial temporal artery supplies the lateral portion. It branches into an anterior-frontal and posterior-parietal division at the superior helix of the ear. The posterior scalp is supplied by the occipital artery superior to the nuchal line, and inferior to this, perforating branches form the trapezius and splenic capitis muscle. This rich blood supply may lead to hemorrhagic shock in scalp injuries. Shock, if present, is usually associated with underlying complex facial fractures or intracranial injury and delayed control of hemorrhage or other injuries such as abdominal trauma or long bone fractures (Fonseca 2013).

The dense galea and underlying loose areolar tissue predispose to large avulsion or degloving of tissue, with maintained blood supply in the avulsion flaps. Scalp lacerations without tissue loss should be closed with 3.0 or 4.0 interrupted nonabsorbable sutures. Alternatively, a layered closure with absorbable sutures in the galea and staples in the skin can be used. The hair does not need removal unless it interferes with wound closure (Howell and Morgan 1988; Tang et al. 2001). Staples are faster and more cost-effective than using sutures (Edlich et al. 1990; Bennett 1988). Staples may cause less alopecia on the scalp than other forms of closure. Cautery should be used with caution for similar reasons (Ritchie and Rocke 1989).

Large shearing injuries, where there is tissue loss that does not allow for primary closure, may need flap reconstruction. This should not be done in the acute phase. When considering reconstruction of the scalp, the unique characteristics of scalp skin and its hair-bearing nature must be considered to provide an aesthetically pleasing reconstruction. Consultation with a plastic surgeon is therefore recommended (Fig. 32.1).

Fig. 32.1 Crush injury of the scalp with underlying fractures

32.5.2 Face

Soft tissue injuries to the face require consideration of several important aspects. Besides the obvious and clearly visible scars that may result, special consideration should also be taken to the examination of the eye and lacrimal apparatus, the external auditory meatus, the facial nerve, and the parotid duct. If the patient is awake, motor and sensory innervation should be evaluated before local anesthetic is administered. Testing should include eyebrow elevation, forced closure of the eyes, voluntary smile, and eversion of the lower lip. Deficits in the presence of a penetrating injury likely represent transection of a facial nerve branch and require operative exploration. Timing is of importance, as after approximately 48–72 h, the distal nerve end can no longer be stimulated, making it difficult to identify and repair it during microscopic surgery. Nerve regeneration typically occurs at a rate of 1 mm/day after a 1-month lag (Thorne et al. 2013).

If open fractures are present, meticulous, early wound treatment is of paramount importance to prevent deep infection and enable subsequent fracture treatment at a later stage.

Forehead lacerations may injure the temporal (frontal) branch of the facial nerve or the frontalis muscle causing brow ptosis. The temporal branch of the facial nerve and the superficial temporal artery lies within the deep temporoparietal fascia. Its course is consistent from 0.5 cm below the tragus to 1.5 cm above the lateral brow (Pitanguy's line). The eyebrow should be preserved. Attention should be paid to alignment, as misalignment is aesthetically obvious. The frontalis is repaired with interrupted absorbable sutures. The skin is closed with nonabsorbable monofilament sutures.

With trauma to the eye or eyelid, the most important aspect is to ensure that there is no globe injury. An ophthalmologist should be consulted. The most important aspect of eyelid repair is placement of an everting suture along the lid margin gray line. This facilitates proper alignment and makes notching of the lid margin less likely. All layers of the eyelid—inner, middle, and outer lamella—should be repaired.

With ear injuries, hematomas should be evacuated as they may cause cartilage resorption and ultimately a reactive chondrogenesis, which will lead to cauliflower ears. Hematomas are usually drained with an incision through the overlying skin. A bolster dressing is then required to avoid re-accumulation of the hematoma. Through-and-through sutures may be used for this. Skin laceration can usually be closed in one layer. It is unnecessary to place sutures in the cartilage as the skin adheres firmly to it and allows for proper alignment.

The nose consists of three lamella: the skin and soft tissue, cartilaginous framework, and mucosa. Intranasal examination is required to rule out septal hematomas and mucosal lacerations. Once hemorrhage control is established, evaluation of the soft tissue injury is important. In contrast to the ear, damage to the underlying nose cartilage requires repair of all layers, after appropriate anatomic reduction. Skin lacerations may be sutured with nonabsorbable 5-0 sutures. Deeper injuries require consultation with a plastic or ENT surgeon.

Lip repair requires meticulous attention to details, as a misalignment of the vermillion border of only 1 mm is clearly noticeable at conversational distance (Thorne et al. 2013). Prior to infiltration of local anesthetic, the location of the vermillion border on either side of the laceration should be marked out. The lip is sutured in all three layers: the skin, orbicularis oris, and mucosa. Failure to reapproximate the orbicularis oris muscle separately will result in bunching of the mus-

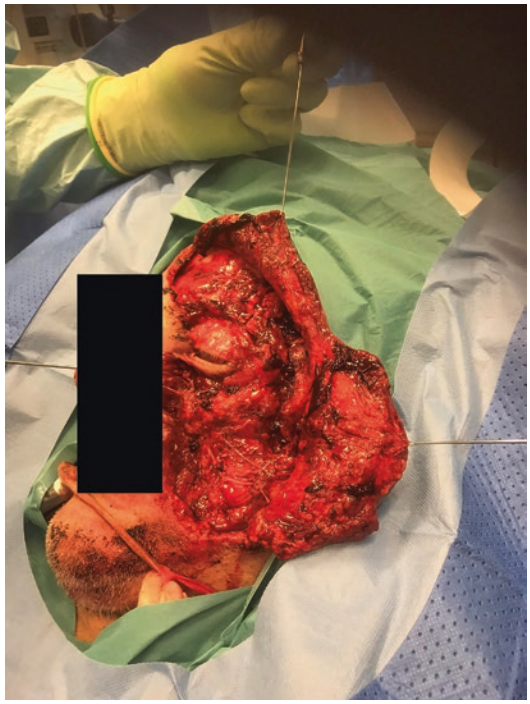

Fig. 32.2 Facial laceration and degloving injury of the left face with the facial nerve exposed

cle with animation and shortened scar, with an exaggerating notching of the lip. Use resorbable 6-0 sutures for the two inner layers and nonabsorbable 5-0 or 6-0 suture for the skin (Fig. 32.2).

32.5.3 Aftercare

Scalp wounds should be left open to air unless they require a pressure dressing. After 24–48 h, they can be let to air and cleansed with soap and water. Staples and nonabsorbable sutures should be removed after 7–10 days, but large and deeper wounds warrant removal at 10–14 days. Highly contaminated wounds should be seen for follow-up within 48–72 h. Removal of sutures in the face should be done within 5–7 days.

32.5.4 Antibiotics

Prophylactic antibiotics have little benefit in healthy patients with clean wounds. A meta-analysis of seven RCTs with simple wounds found that those who received systematic antibiotics did not have a significantly lower incidence of infection compared with untreated patients (Cummings and Del Beccaro 1995). Antibiotics may provide benefit in grossly contaminated wounds, immunocompromised patients, open fractures, wounds contaminated with oral secretion, or delayed closure (Abubaker 2009).

Bites may be associated with polymicrobial infection. These are most common after feline bites because of the deep, puncture-type wounds and virulent bacteria. The most common bacterium is *Pasteurella multocida* (Jaindl et al. 2016).

A tetanus booster dose should be given to patients who have had (1) three vaccine doses and whose last injection is >10 years ago or <10 years ago if the wound is deep or (2) four vaccine doses and their last injection is >20 years ago. Patients who have had less than three vaccine doses should complete a basic scheme with pure tetanus vaccine and diphtheria vaccine (Ljungberg 2019).

32.6 Specific Pediatric Concerns

Soft tissue injuries occur in the pediatric population and are usually caused by accidents related to sports and play. The same fundamental principles of wound care outlined above for adults hold true in the pediatric age group. However, there are also special considerations to be made. In the case of vascular injury, children have less margin for blood loss, and it may also be more difficult to control hemorrhage by compression in the awake child. Vascular access for resuscitation should therefore be promptly ascertained when indicated. Physical examination of nerve injuries may not be as reliable as in adults; that is why proper nerve exploration should be performed if there is reason to suspect injuries to the facial nerve.

Children have less skin laxity and redundancy, and tissue loss through avulsion is usually not manageable by direct wound edge approximation. On the other hand, children heal efficiently with low risk for infection; that is why some minor avulsion injuries may be primarily managed by healing through secondary intention.

Facial fractures are generally rare in the pediatric population. There are also differences in the typical fracture patterns compared to adults due to less developed paranasal sinuses, a more elastic and immature bony framework, and a relatively less prominent facial skeleton compared to the cranium. In general, pediatric facial fractures can be managed more conservatively compared to adults, and the future, expected growth has to be considered in the planning of surgical reduction and fixation.

Depending on the age and maturity of the child, general anesthesia will frequently be indicated to ascertain adequate wound assessment and treatment while preventing psychological trauma. If local anesthetic is used, the physician needs to be familiar with dosing. Topical anesthetic should be used to prepare the area of injection, and sodium bicarbonate should be added in a 1:10 ratio to the local anesthetic to neutralize the solution and reduce pain when injected. Topical local anesthetic (EMLA) can also be applied in advance to reduce sensation to needle injections.

Children often heal quickly, but increased collagen deposition also increases the tendency for hypertrophic scars. Rapidly absorbable sutures are best utilized to avoid general anesthesia for suture removal. Permanent sutures, if used, should be removed within 5 days and wound support dressings applied for 10–14 days to remove tension from the wound bed.

When the wound is well epithelialized, usually within 7–10 days, silicone sheeting or topical gels can be applied for 3 months to minimize scar formation.

It is always important to remember that if the wound or presentation seems suspicious, child health services should be contacted to avoid potential further harm to the child.

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