Plastic Surgery Emergencies

Principles and Techniques

Second Edition

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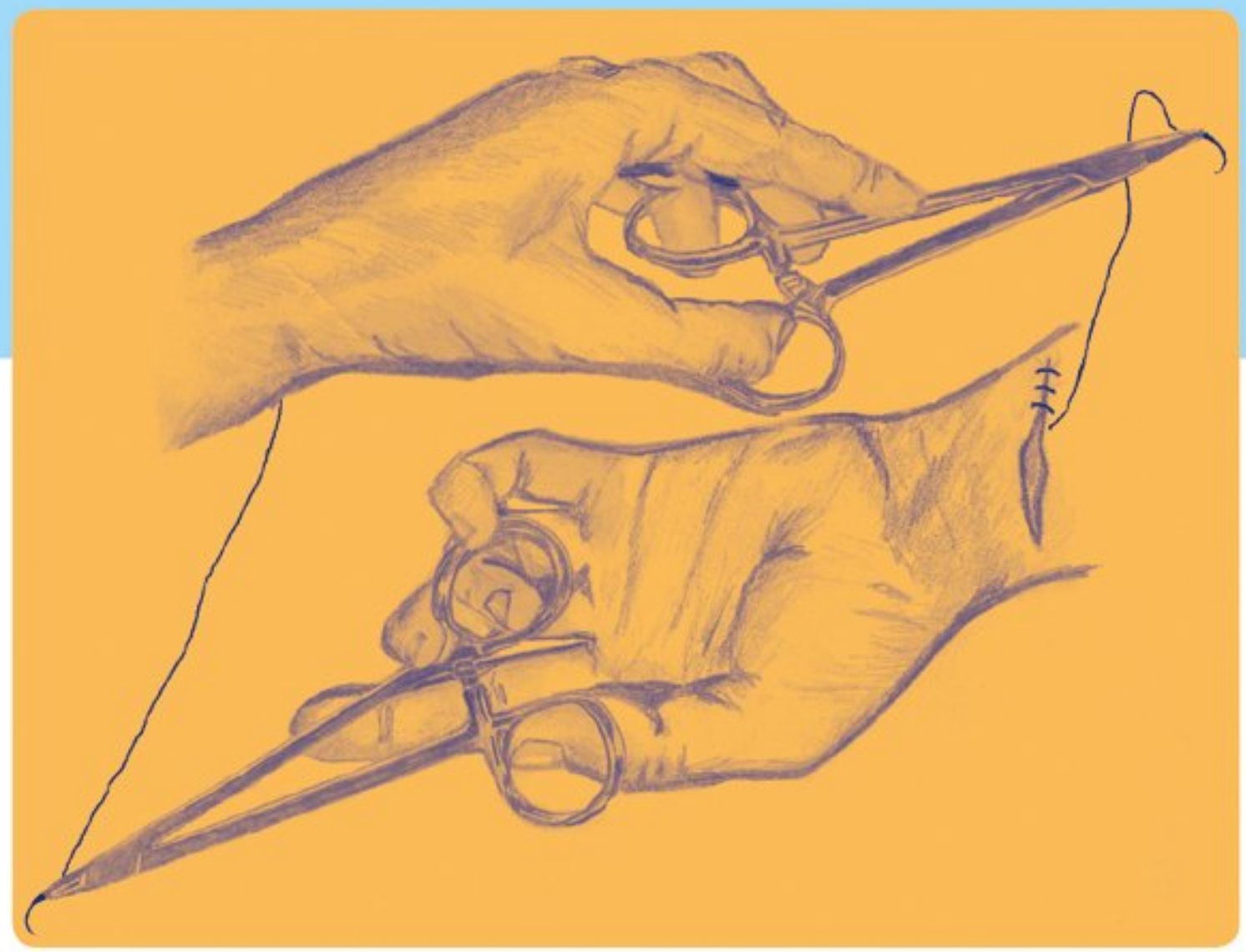

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It is with great pleasure that I dedicate the newest edition of our text to our senior author, Dr. Samuel Stal. Sam died several years ago after a lengthy illness. He would have been most pleased to see that this work has stood the test of time. Sam was a surgeon who dedicated his life to the treatment of children. He was passionate about teaching and passing on all that he had learned through the years. He was a mentor to all of us who worked with him on this book and he was instrumental in seeing the first edition through to publication. I know that I can speak for all of my coauthors, and thank Sam for being the person that he was—an excellent teacher, but first and foremost, a kindhearted and caring man.

—Larry H. Hollier, MD

Contents

Foreword from the First Edition

"The man who graduates today and stops learning tomorrow is uneducated the day after."

—*Newton D. Baker Jr.*

When I was asked to write a foreword for this book *Plastic Surgery Emergencies*, I must confess, my first thought was, "Is another book truly necessary?" But after reading it, I am both honored and flattered by the request. The browser might first question if this relatively small book fulfills a need, and second ask if it fulfills the need well. The answer to both questions is a resounding "Yes."

With the body of medical knowledge doubling every 5 years or so, the information that must either have been learned or be readily available and understandable to both the young as well as the experienced plastic surgeon continues to increase exponentially. This book distills present knowledge into an easily readable guide to almost any emergency a plastic surgeon might face who is on call in the emergency room, or responding to a late-night/early-morning call from the hospital relating to a postoperative patient.

The authors, who are general plastic surgeons and specialists from the Division of Plastic Surgery here at the Baylor College of Medicine, have culled information from their own surgical experiences, as well as a wide variety of outside sources. They have condensed this knowledge into a small, handy volume, which could easily be read either at one's leisure or immediately prior to assuming the care of a patient. It would be difficult to find an injury or complication from a plastic surgery operation whose emergency treatment is not covered in this book. The authors have detailed the specifics in terms of differential diagnosis and the corrective steps necessary to fulfill the responsibilities of a plastic surgeon answering emergency room call. There are many references to the general principles of treatments—those learned in residency training and in the early years of practice that have stood the test of time. The ability of the surgeon to present an organized treatment plan and then carry it out expeditiously will instill confidence in the patient and the health care personnel involved in the treatment of these patients. The format of the book is conducive to allowing readers to add both personal and technical notes, which will serve them well in the treatment of future patients with similar injuries.

I would be remiss if I didn't call special attention to the lead author, Dr. Jamal M. Bullocks, whose ability and youthful enthusiasm has amalgamated the thoughts and experience of the other authors into a volume that will find great value for all plastic surgeons as well as general surgeons and emergency room physicians.

To those older plastic surgeons who may believe that they have already learned the answers to most of the problems presenting to the plastic surgeon on call, I respectfully suggest that although the problems that presented a decade or two ago may be the same, the answers (i.e., treatment) today may be different. It is to that difference that we are indebted to the authors of this book for their effort and time in providing us with concise and practical answers.

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Preface

The goal in creating *Plastic Surgery Emergencies* is to provide a quick reference guide for health care providers to rapidly assess, triage, and treat patients with problems that are commonly referred to the plastic surgeon. The first version targeted acute care scenarios commonly seen in the emergency department of acutely injured facial and hand trauma patients, as well as patients sustaining a variety of soft-tissue injuries from varying mechanisms of trauma, including burns. This new edition provides the reader with additional content, including added chapters, photos, and sections which will expand the book's audience to outpatient and hospital-based physicians caring for chronically ill patients with wounds. The information presented will prove significantly beneficial to plastic surgeons, otolaryngologists, dermatologists, pediatricians, family practice, and hospitalist and emergency room physicians for treating and triaging patients in the acute and chronic disease setting. Ultimately, the aim is to demystify simple problems that present to these providers and elucidate scenarios that require a higher level of care or follow-up with a plastic surgeon. Our intended audience additionally extends to residents and students training in these fields who experience these encounters as consultations and during on-call activity.

The outline format was preserved with truncated introductory vernacular to confer direct mechanisms for instructions on how to work up, categorize, and initiate the first level of treatment. We hope that this focused and simplified presentation with instructive illustrations, charts, and diagrams will provide a single-source reference in a convenient pocket-sized format.

Acknowledgments

Plastic Surgery Emergencies is a collection of the collaborative knowledge and experience of all the affiliated and full-time faculty of the Division of Plastic Surgery in the Michael E. Debakey Department of Surgery at Baylor College of Medicine. The authors would also like to express their gratitude to the residents, staff, and institutions of the Texas Medical Center for their support in the completion of this work.

Illustrator: Mike de la Flor

Cover Illustrator: Cara Ryan Downey, MD

List of Abbreviations

3D	three-dimensional
ABCs	airway, breathing, and circulation
ABGs	arterial blood gases
ACON	acute compressive optic neuropathy
ACS	abdominal compartment syndrome
AFib	atrial fibrillation
AP	anteroposterior
APB	abductor pollicis brevis
APD	afferent pupillary defect
APL	abductor pollicis longus
APTT	activated PTT
ASA	aspirin
BP	blood pressure
BSA	body surface area
BSAB	body surface area burned
CBC	complete blood count
Chem-7	a basic metabolic panel
CK	creatine kinase
CMC	carpometacarpal
CML	carpometacarpal ligament
CN	cranial nerve
COPD	chronic obstructive pulmonary disease
CRP	C-reactive protein
CSF	cerebrospinal fluid
C-spine	cervical spine
CT	computed tomography
CVP	central venous pressure
CXR	chest X-ray
D5 1/2NS	5%dextrose in 0.45%normal saline
DIC	disseminated intravascular coagulation
DIEAP	deep inferior epigastric artery perforator flap
DIP	distal interphalangeal
DISI	dorsal intercalated segment instability
DJD	degenerative joint disease
DRU	distal radioulnar
DVT	deep venous thrombosis
EBL	estimated blood loss
ECRB	extensor carpi radialis brevis
ECRL	extensor carpi radialis longus
ECU	extensor carpi ulnaris
EDC	extensor digitorum communis
EDM	extensor digiti minimi
EIP	extensor indicis proprius
EMG	electromyogram
EMLA	eutectic mixture of local anesthetics
ENoG	electroneuronography
ENT	ear, nose, and throat
EPB	extensor pollicis brevis
EPL	extensor pollicis longus
ER	emergency room
ESR	erythrocyte sedimentation rate (or sed rate)
FCR	flexor carpi radialis
FCU	flexor carpi ulnaris
FDA	Food and Drug Administration
FDM	flexor digiti minimi
FDP	flexor digitorum profundus
FDS	flexor digitorum superficialis
FFP	fresh frozen plasma
FPB	flexor pollicis brevis
FPL	flexor pollicis longus

GCS	Glasgow Coma Scale
Hct	hematocrit
HDCV	human diploid cell rabies vaccine
Hgb	hemoglobin
I&D	incision and drainage
ICU	intensive care unit
IM	intramuscular or intramuscularly
INR	international normalized ratio
I/Os	intakes/outputs
IP	interphalangeal
IRV	inverse ratio ventilation
IV	intravenous or intravenously
IVF	intravenous fluid
JP	Jackson-Pratt
JVD	jugular venous distention
LDH	L-lactate dehydrogenase
LET	lidocaine-epinephrine-tetracaine
LFT	liver function test
LR	lactated Ringer's
MAP	mean arterial pressure
MCP	metacarpophalangeal
MMF	maxillomandibular fixation
MRI	magnetic resonance imaging
MRSA	methicillin-resistant *Staphylococcus aureus*
MVA	motor vehicle accident
NCS	nerve conduction studies
NOE	naso-orbital-ethmoid
NPO	nothing by mouth
NS	normal saline
NSAID	nonsteroidal anti-inflammatory drug
OOB	out of bed
OR	operating room
ORIF	open reduction and internal fixation
OTC	over-the-counter
PA	posteroanterior
PDS	polydioxanone suture
PEEP	positive end-expiratory pressure
PIP	proximal interphalangeal
PL	palmaris longus
PNM	polynuclear monocyte
POD	postoperative day
PRBCs	packed red blood cells
PT	prothrombin time
PTT	partial thromboplastin time
RBBB	right bundle branch block
RBC	red blood cell
RIG	rabies immunoglobulin
ROM	range of motion
RR	respiratory rate
SBP	systolic blood pressure
SC	subcutaneous or subcutaneously
SCM	sternocleidomastoid
SSEP	somatosensory evoked potential
SMAS	superficial musculoaponeurotic system
SOF	superior orbital fissure
STAT	at once, immediately
TBSA	total body surface area
Tc 99m MDP	technetium 99m methylene disphosphonate
Td	tetanus toxoid
TFCC	triangular fibrocartilage complex
TIG	tetanus immunoglobulin
TMJ	temporomandibular joint
TON	traumatic optic neuropathy
TPA	tissue plasminogen activator

TPN	total parenteral nutrition
TRAM	transverse rectus abdominis myocutaneous flap
TSST-1	toxic shock syndrome toxin-1
UC	ulcerative colitis
VDR	volume diffusive respirator
VISI	volar intercalated segment instability
WBC	white blood cell
ZMC	zygomaticomaxillary complex

1 Wound Management

Evaluation

Accurate assessment of the characteristics of and circumstances surrounding the presentation of wounds is critical to guiding treatment strategies. Therefore, before wound management is planned, a full evaluation of the wound must be undertaken with the following considerations.

Acute Wounds

- Assess size, shape, and location.
- Determine the timing of the wound—acute (time elapsed since injury) versus chronic (persistent > 3 months).
- Establish laceration, avulsion, or chronic open wound.
- Evaluate the wound for odor, exudate, purulent drainage, bleeding, and debris.
- Determine if there is exposure of vessels, tendons, nerves, joint, muscle, or bone.
- Evaluate for foreign bodies in the wound; consider X-ray evaluation—if the history is inconsistent with clinical evaluation.

Chronic Wounds

Chronic wounds require investigation into reasons why proper wound healing is not accomplished (**Table 1.1**).

Therefore, chronic wounds warrant serologic evaluation to include

- White blood count.
- Hct/Hgb.
- Albumin.
- Prealbumin.
- ESR, or sed rate.
- C-reactive protein.
- LFTs, hepatitis panel.
- Blood glucose.
- Biopsy of wound.
- Culture of wound.

Table 1.1 Contributors to poor wound healing

Local factors that contribute to poor wound healing	Patient comorbid conditions that contribute to poor wound healing
Tissue ischemia	Anemia
Venous hypertension	Hypoxia
Edema	Advanced age
Infection	Malignancy
Microbial contamination	Poor nutrition
Bacterial > 10^5 or 10^4 group B Streptococcus species	Vitamin deficiencies
Fungus	History of radiation
Atypical mycobacteria	Severe systemic disease (e.g., diabetes, hepatic disease)
	Collagen vascular diseases
Wound tension or pressure > 30 mm Hg	Immunosuppression
	Smoking
Presence of foreign bodies	Obesity

Treatment

Irrigation

Acute Wounds

Irrigation in the acute wound setting is designed to remove blood, foreign bodies, debris, and bacteria from a wound. This can easily be accomplished with a 1-L bottle of normal saline with two or three holes punched into the cap with an 18-gauge needle. When squeezed forcefully, it serves as an effective pressurized irrigator. The wound should be irrigated until all visible debris is washed away. Anesthetizing the wound prior to irrigation and débridement provides for greater patient comfort and allows for aggressive decontamination of the wound.

Chronic Wounds

Simple surface irrigation of a chronic wound is usually only marginal and minimally effective. It can be useful at the bedside if there is debris grossly evident in the wound. Studies have shown that pressure irrigation at approximately 70 psi is needed to reduce bacteria count and particulate

matter. This is best done in the operating room with a pulse lavage or a jet lavage system. If needed, a thorough débridement of devitalized tissue can also be done in the operating room. Tangential hydrotherapy via the Versajet (Smith & Nephew) device is often useful for irrigation and mechanical débridement. A chronic wound may benefit from biopsy and tissue culture as clinically indicated.

Débridement and Hemostasis

Adequate débridement of devitalized tissue and skin edges is important in preparing the contaminated wound for closure. The skin is highly vascular and excessive skin removal is usually not necessary. Jagged skin edges should be trimmed to facilitate an easier closure. Hemostasis can be achieved with pressure, silver nitrate, topical fibrin, Surgicel (Johnson & Johnson), topical thrombin or epinephrine (1:100,000), suture ligature (absorbable for small vessels and nonabsorbable for larger vessels), or cautery (**Fig. 1.1**).

If there is any question as to the viability of the tissue, it is better to allow the tissue to demarcate rather than to débride it initially. Tissue of questionable viability can often undergo necrosis after débridement due to retrograde thrombosis. Once demarcated, the tissue can be débrided to healthy bleeding tissue. This approach allows conservative preservation of the tissues without causing additional tissue loss and disfiguration.

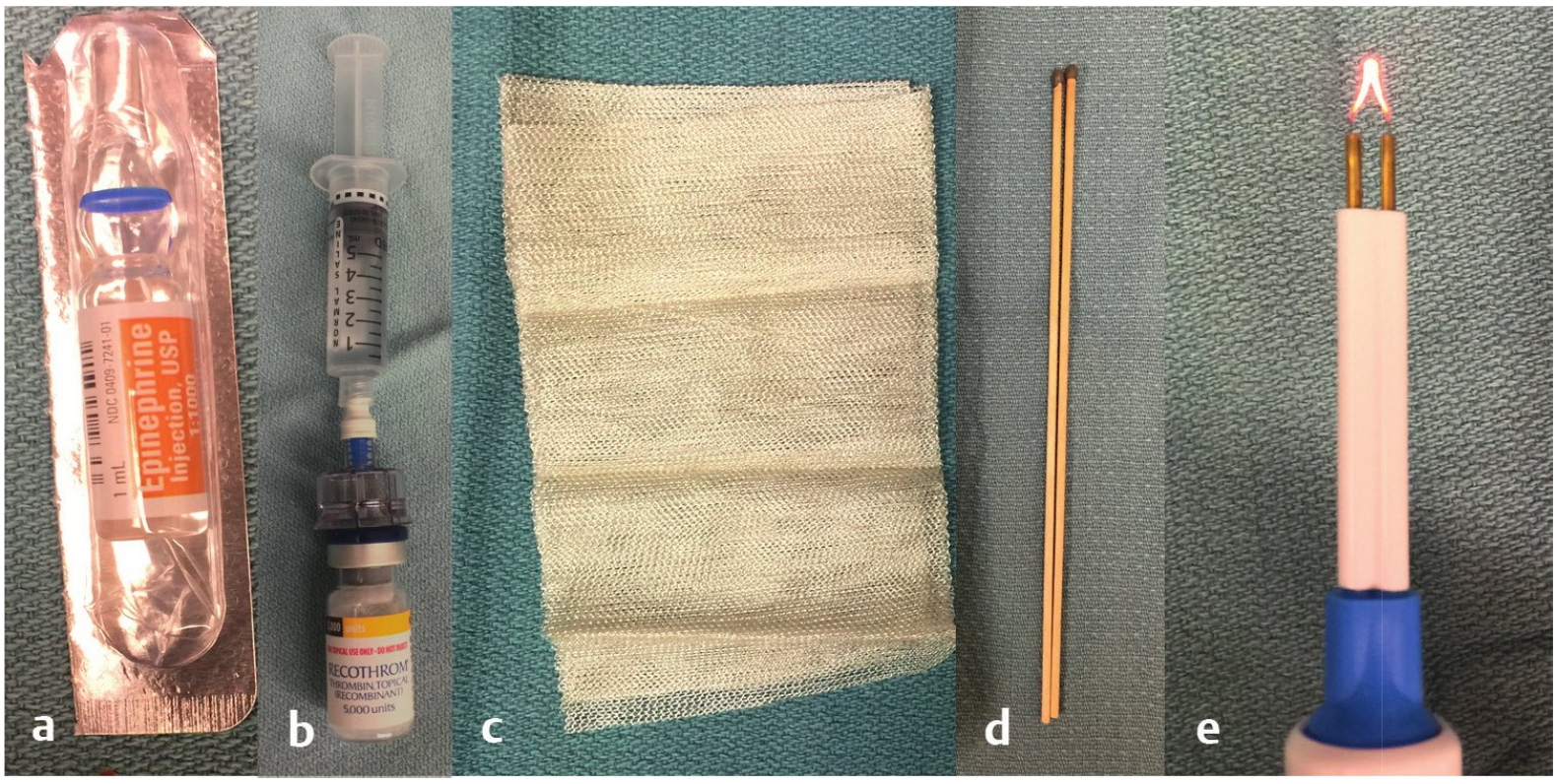


Fig. 1.1 Useful tools for establishing hemostasis in acute wound management: **(a)** topical epinephrine diluted to 1:100,000, applied with gauze, **(b)** topical thrombin spray, **(c)** oxidized methylcellulose (Surgicel), **(d)** coagulation with silver nitrate, or **(e)** disposable portable cautery device.

Closure and Antibiotics

Prior to closure, irrigation, débridement, hemostasis, and trimming of the skin's jagged edges should be performed. A tension-free closure will help to ensure healing with an optimal scar.

Most clean lacerations, if addressed in < 8 hours, have minimal contamination and can be closed primarily without the need for antibiotics. Clean wounds presenting after 8 hours can be closed after débridement of the entire wound and sharp débridement of edges. This would include stab wounds, lacerations by window or glass, and clean avulsions. In effect, sharp débridement and decontamination of these late presenting wounds converts them into fresh wounds that are more appropriate for closure. On the other hand, contaminated wounds, such as wounds with dirt and debris, should be treated with systemic antibiotics with additional consideration for tetanus prophylaxis.

Choice of antibiotics should usually cover gram-positive organisms (cefazolin 1 g IV). Due to the increase in methicillin-resistant *Staphylococcus aureus* (MRSA), certain wounds may require other antibiotics for coverage (clindamycin 600 mg IV or vancomycin 1 g IV). The astute caregiver should take advantage of administration of a single IV dose of antibiotics to wounds at risk for contamination while the patient is in a health care setting undergoing evaluation.

If the wound is grossly contaminated with debris or if the patient is diabetic, broader-spectrum antibiotics should be considered, for example, Avelox (Bristol-Myers Squibb) 400 mg IV or by mouth daily, Zosyn (Wyeth Pharmaceuticals) 3.375 g IV every 6 hours, imipenem 1 g IV every 8 hours, or combination therapy.

Contaminated wounds should be left open except for those on the face. Wet to dry dressing changes should be done at least twice a day. In addition, the patient should shower frequently and wash the wound with soap and water.

A 5- to 7-day course of outpatient antibiotics may also be warranted. Coverage should include gram-positive and MRSA coverage (oral clindamycin 450 mg by mouth four times a day, or oral trimethoprim/sulfamethoxazole twice a day). Cephalexin is not effective in treating a contaminated wound. Rarely, acute wounds will require inpatient treatment with IV antibiotics. Usually débridement and prophylactic oral antibiotics should suffice. In the case of more subacute or chronic wounds with gross contamination or purulence, consideration should be given to admission, IV antibiotics, and formal débridement.

Skin-Flap Wound Closure

If the patient has an avulsed skin flap, the flap should be tacked down where it lies (**Fig. 1.2**). **Do not put tension on the skin flap for complete closure**. Tension will lead to total flap loss. First, débride all devitalized tissue and then inset the flap so that no tension is present. Distal margins of the flap will usually undergo necrosis. Plan on additional débridement as the flap demarcates.

Tetanus Prophylaxis

Tetanus-prone wounds are those that are old (> 6 hours), deep (> 1 cm), and/or contaminated, especially those that involve rusty metal, feces, or soil. Depending on the degree of contamination, tetanus toxoid, tetanus immunoglobulin, or complete immunization may be required. Specific recommendations for tetanus prophylaxis are included in **Table 1.2** through **Table 1.4**.

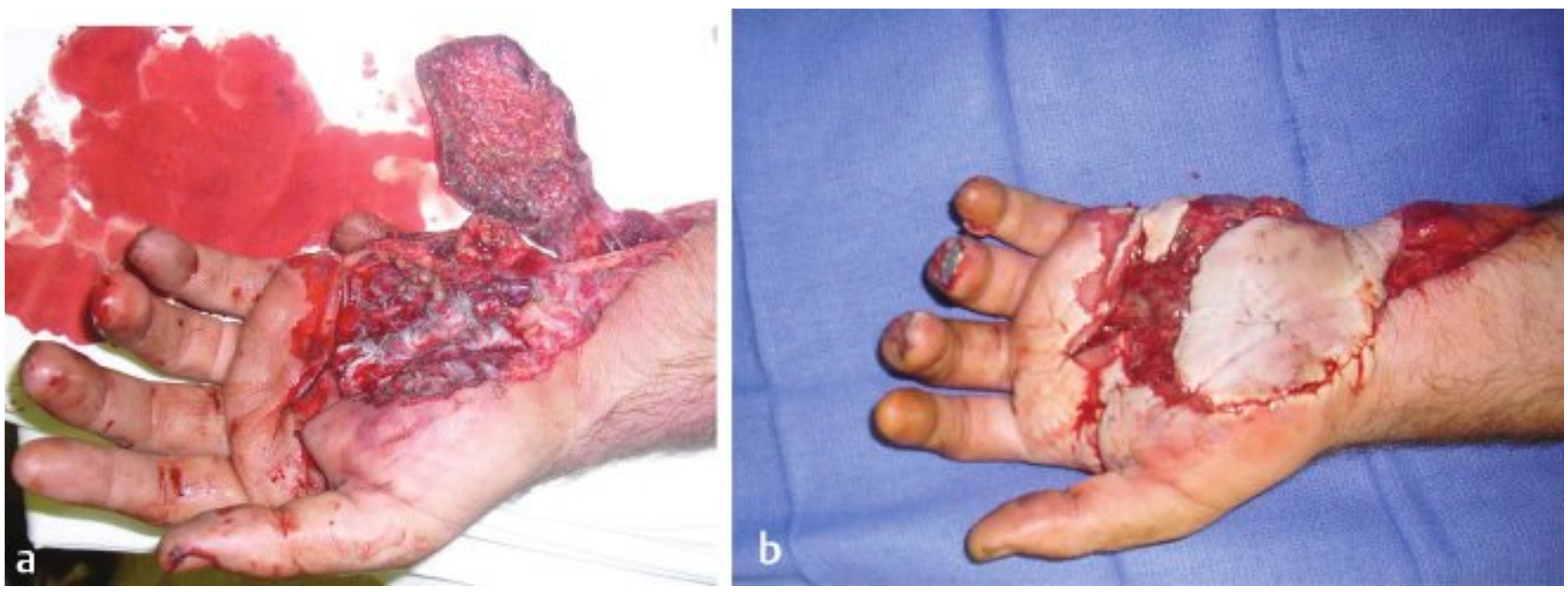


Fig. 1.2 **(a)** Avulsed skin flap. **(b)** Avulsed skin flap tacked down without tension.

Table 1.2 Tetanus-prone wounds

Clean (low risk)	Tetanus prone (high risk)
Clean incised wound	Any wound or burn > 6 h old
Superficial graze	Contact with soil, feces, compost, or saliva
Scalded skin	Puncture-type wound Avulsion wounds Crush open wounds
	Infected wound
	Compound fracture
	Large amount of devitalized tissue
	Animal or human bite Burns and frostbite

Table 1.3 Immunization status and tetanus risk

Immunization status	Low risk	Moderate risk	High risk
Fully immunized, < 5 y since booster	None	None	None
Fully immunized, 5–10 y since booster	None	Td	Td
Fully immunized, > 10 y since booster	Td	Td	Td + TIG
Incompletely immunized or uncertain	Full tetanus vaccine	Full tetanus vaccine + TIG	Full tetanus vaccine + TIG

Abbreviations: Td, tetanus toxoid; TIG, tetanus immunoglobulin.

Table 1.4 Recommendations for vaccination with tetanus immunoglobulin

Patient	Dosage	Treatment
Adult	250–500 U	For both patient groups, the vaccine should be given IM in the opposite upper extremity (arm) to the tetanus toxoid
Pediatric	250 U	

Follow-up

Careful and frequent follow-up is imperative for all wounds. Patients should be asked to return to the clinic or general practitioner within 3 days if possible and educated on all the signs and symptoms of an infection. Specific instructions on wound care and antibiotic therapy are crucial to guaranteeing patient compliance and ultimately a favorable prognosis.

2 Anesthesia and Wound Closure

All wounds should be clean of foreign bodies and adequately irrigated (see Chapter 1). Hemostasis is achieved with pressure, silver nitrate, fibrin, Surgicel, thrombin, or suture ligature (absorbable for small vessels and nonabsorbable for larger vessels) to prevent hematoma formation. Any devitalized tissue, as well as jagged edges, should be trimmed for optimal cosmesis.

Wounds can be closed with sutures, staples, skin tapes, or wound adhesives. Generally, wounds should be closed in layers using appropriate sutures and the epidermis reapproximated so that it is relatively tension free and everted if possible. Everted skin edges eventually flatten out and produce a level wound surface, whereas inverted skin edges have a tendency to produce a depressed scar.

To guarantee a successful wound closure, a comfortable environment should be created for both the practitioner and the patient. The use of analgesics, local anesthesia, and even sedation are helpful adjuncts in reducing patient anxiety. This will ultimately increase the likelihood of more precise closure.

Anesthesia

Local Anesthetics

Local anesthetics work by affecting the sodium (Na^+) channels on afferent sensory nerves. Local anesthetic enters the cell membranes and reversibly binds to Na^+ channels. This reversible binding incapacitates the cells so that they are then unable to depolarize. Lidocaine is the most commonly used and easily accessible local anesthetic agent in the emergency room (ER). Epinephrine should routinely be used with any local anesthetic to assist in hemostasis and to prolong duration. The vasoconstrictive properties lead to decreased absorption so that larger doses of anesthetic can also be used without systemic toxicities.

The maximum safe dose for lidocaine is 4 mg/kg. With the addition of epinephrine (usually at 1:100,000 concentration), the maximum dose increases to 7 mg/kg. A 1% solution of lidocaine is defined as

1 g/100 mL = 10 g/1,000 mL = 10,000 mg/1,000 mL = 10 mg/1 mL

Example Maximum dose of lidocaine with epinephrine in a 70-kg (154-lb) man

70 kg × max dose (7 mg/kg) = 490 mg of lidocaine
490 mg × 1 mL/10 mg (concentration of 1% lidocaine) = 49 mL of 1% lidocaine with epinephrine

Although many textbooks have cited the contraindication for using epinephrine in end arteries such as those in digits and the nose, recent studies have exonerated epinephrine as the culprit in causing tissue necrosis. Therefore, it is safe to use lidocaine with epinephrine virtually anywhere on the body. For the maximum effects of epinephrine to take place, the practitioner should wait 10 to 15 minutes. **Table 2.1** provides other local anesthetics that may be used, with their maximum dosages and duration of action.

Once you have chosen your local anesthetic, it is useful to add bicarbonate to the solution, particularly when the patient is awake. The pH of local anesthetic solutions is generally buffered to between 4 and 5 to prolong shelf life. This acidity routinely leads to a burning pain upon injection. Adding a base such as bicarbonate to the local anesthetic not only alleviates the pain but also accelerates the action because the higher pH favors the nonionized form of the anesthetic, which crosses the cell membrane more easily. The addition of 1 mL of a 1-mEq/mL solution of bicarbonate for every 9 mL of local anesthetic can alleviate the burning and improve patient comfort. Warming the anesthetic, using a smaller-caliber needle (25 gauge or higher), and injecting by inserting the needle within the wound (instead of through the skin) all help in reducing pain felt by the patient.

Table 2.1 Local anesthetics for wound closure

Drug	Onset	Maximum dose mg/kg (with epinephrine mg/kg)	Duration (with epinephrine)
Lidocaine	Rapid	4.5 (7)	120 min (240 min)
Mepivacaine	Rapid	5 (7)	180 min (360 min)
Bupivacaine	Slow	2.5 (3)	4 h (8 h)
Procaine	Slow	8 (10)	45 min (90 min)
Chloroprocaine	Rapid	10 (15)	30 min (90 min)
Etidocaine	Rapid	2.5 (4)	4 h (8 h)
Prilocaine	Medium	5 (7.5)	90 min (360 min)
Tetracaine	Slow	1.5 (2.5)	3 h (10 h)

Topical Anesthetics

- *Eutectic mixture of local anesthetics (EMLA):* 2.5%prilocaine and 2.5% lidocaine cream.
- *Lidocaine-epinephrine-tetracaine (LET) gel:* 4%lidocaine, 1:2,000 epinephrine, 1%tetracaine.

Topical anesthetics are more commonly used in the pediatric patient to alleviate the pain associated with local injections. Although effective, they are not nearly as effective as local anesthetic infiltration in providing anesthesia. The duration and depth of the blockade is dependent on the amount of time the cream is in contact with the skin. Apply to the wound and then cover with a Tegaderm (3M) or other occlusive dressing. The cream or gel will usually need to be in place for at least 45 minutes before *any* anesthetic effect is achieved.

Digital and Facial Nerve Blocks

Please see respective chapters: Upper Extremity Injuries (Chapter 18) and Facial Trauma (Chapter 8).

Conscious Sedation

Most simple and even moderately complex lacerations can be repaired with relative ease with local anesthetics alone in the adult patient. However, fear and anxiety are common in the pediatric patient. Therefore, it may be difficult to repair a laceration in the understandably uncooperative pediatric patient. Conscious sedation may be used if conditions are appropriate and the necessary precautions followed. A well-trained pediatrician or anesthesiologist should be consulted for administration of conscious sedation, especially if the surgeon's experience is limited in this field. Full monitoring by a nurse is required throughout the procedure.

Prior to administering conscious sedation, a complete history and physical examination should be obtained, including

- Age.
- Weight (measured, not estimated, whenever possible).
- Vital signs.
- Oxygen saturation.
- Absence of head injury (document).
- Heart, lung, neurologic, and mental status.
- Complexity and location of injury.

Prior to sedation, there should be

- No oral liquids for 2 hours prior to procedure in children < 2 years of age—3 hours if > 3 years.
- No milk or solid food for 8 hours prior to the procedure.

During the procedure,

- Maintain continuous oxygen saturation and heart rate monitoring.
- Record vital signs and blood pressure every 15 minutes for conscious sedation and every 5 minutes for deep sedation.
- Record drug dose and time administered.
- Record state of consciousness and response to stimulation.

As precautionary measures, ensure that

- Nasal cannula and intubation tray are available during the procedure.
- Reversal agents are ready, prepared in syringe (Narcan [DuPont Pharma] 0.4 mg IV push every 2 to 3 minutes as needed, flumazenil 0.2 mg IV push given over 30 seconds, then 0.3 mg IV push given over 30 seconds as needed, maximum total dose 3 mg).
- Suctioning apparatus and canister are available.
- Nursing staff is in the room during the procedure to assist.
- Drug combinations that include amnestic and analgesic effects are used.

The drugs commonly used are as follows (Table 2.2):

- For adults.
  - Short procedure: Versed (Hoffman LaRoche) + fentanyl.
  - Moderate interval procedure: Morphine + Ativan (Biovail Pharmaceuticals, Inc.).
- For pediatric patients.
  - Ketamine + Versed.

For all patients, start with a subtherapeutic dose, then rebolus in small intervals to titrate sedative effect.

Sutures

A variety of suture materials are available, and, in general, they can be differentiated based on the following categories (**Table 2.3**):

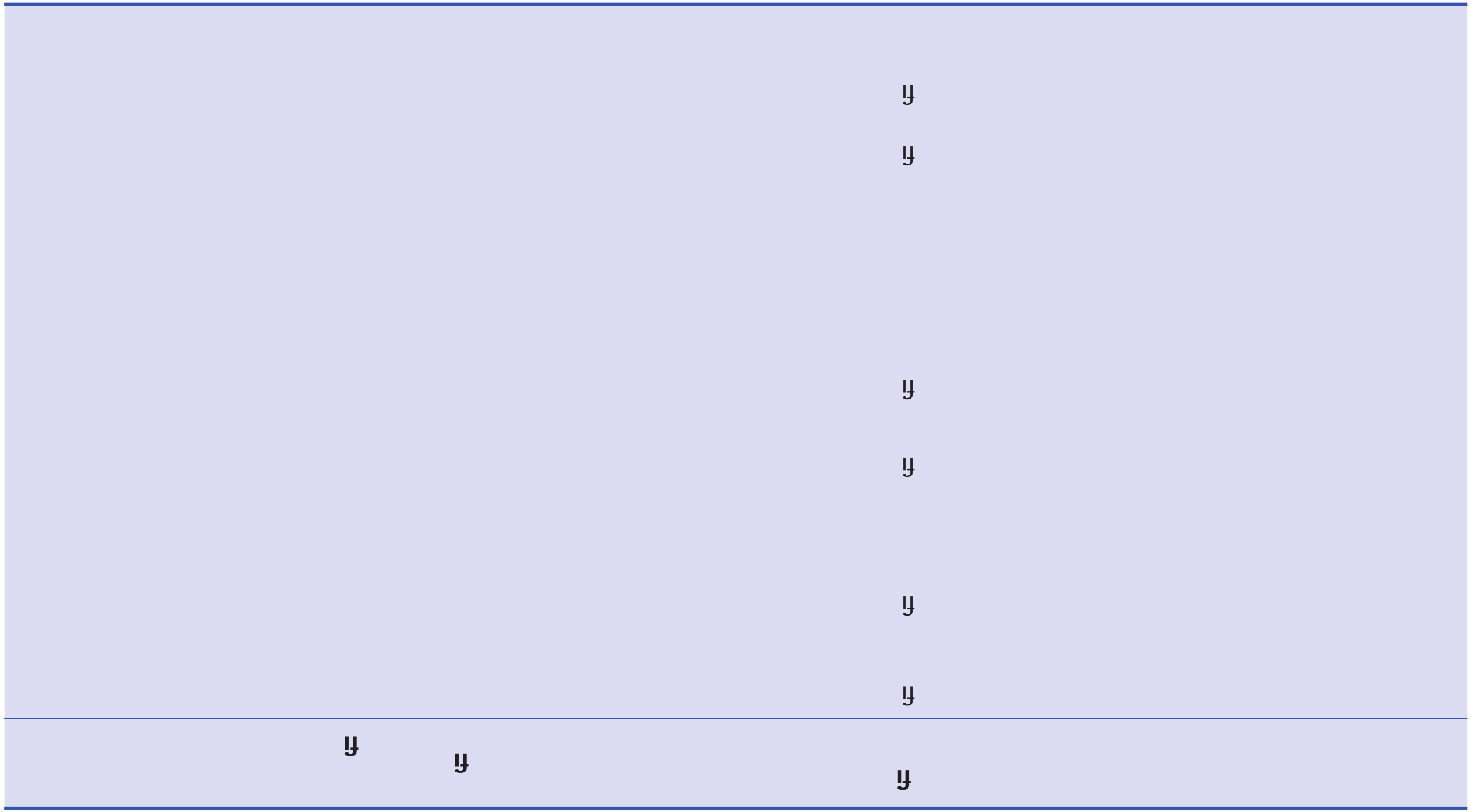
- Absorbable versus nonabsorbable.
- Braided versus nonbraided.
- Tensile strength.
- Half-life.

A variety of needles are also available and can generally be classified as taper or cutting.

- Taper/round needle: Use in muscle, cartilage, and mucosa.
- Cutting needle: For skin.
  - Use a half-circle cutting needle for subcutaneous tissue.
  - Use a 3/8-circle cutting needle for skin.

Suture Techniques (Fig. 2.1)

- **Simple interrupted:** General tissue approximation.
- **Continuous running or running baseball:** An effective and fast continuous suture for long lacerations.
- **Vertical mattress:** Most effective stitch for everting skin edges. Be careful to not set tension too tight to prevent tissue necrosis.
- **Horizontal mattress:** Effective in everting skin edges. Be careful to not set tension too tight to prevent tissue necrosis.
- **Running subcuticular:** A buried dermal suture for closing skin in clean wounds without jagged edges.
- **Staples:** Simple and fast closure commonly used in the scalp or dirty wounds to be closed loosely to allow drainage. Staples should be removed in 5 days to avoid epithelialization and a poor cosmetic result.
- **Adhesive skin tape:** Used to reapproximate small lacerations with very little tension.
- **Dermabond (Ethicon):** Skin adhesive that can be used for clean lacerations without jagged edges. After the wound is adequately prepared, reapproximate skin edges with a finger and apply the first coat, let it dry for 20 seconds, and then apply a second coat.
- In conclusion, the astute practitioner will repair lacerations and wounds in the following order:



1. Anesthetize the patient's wound.
2. Débride it meticulously with removal of jagged edges, devitalized tissue, and any foreign bodies.
3. Properly irrigate the wound in preparation for closure.
4. Obtain hemostasis.
5. Repair the wound in layers with care to reapproximate the dermal and epidermal layers of the skin to provide the patient with the best cosmetic result.

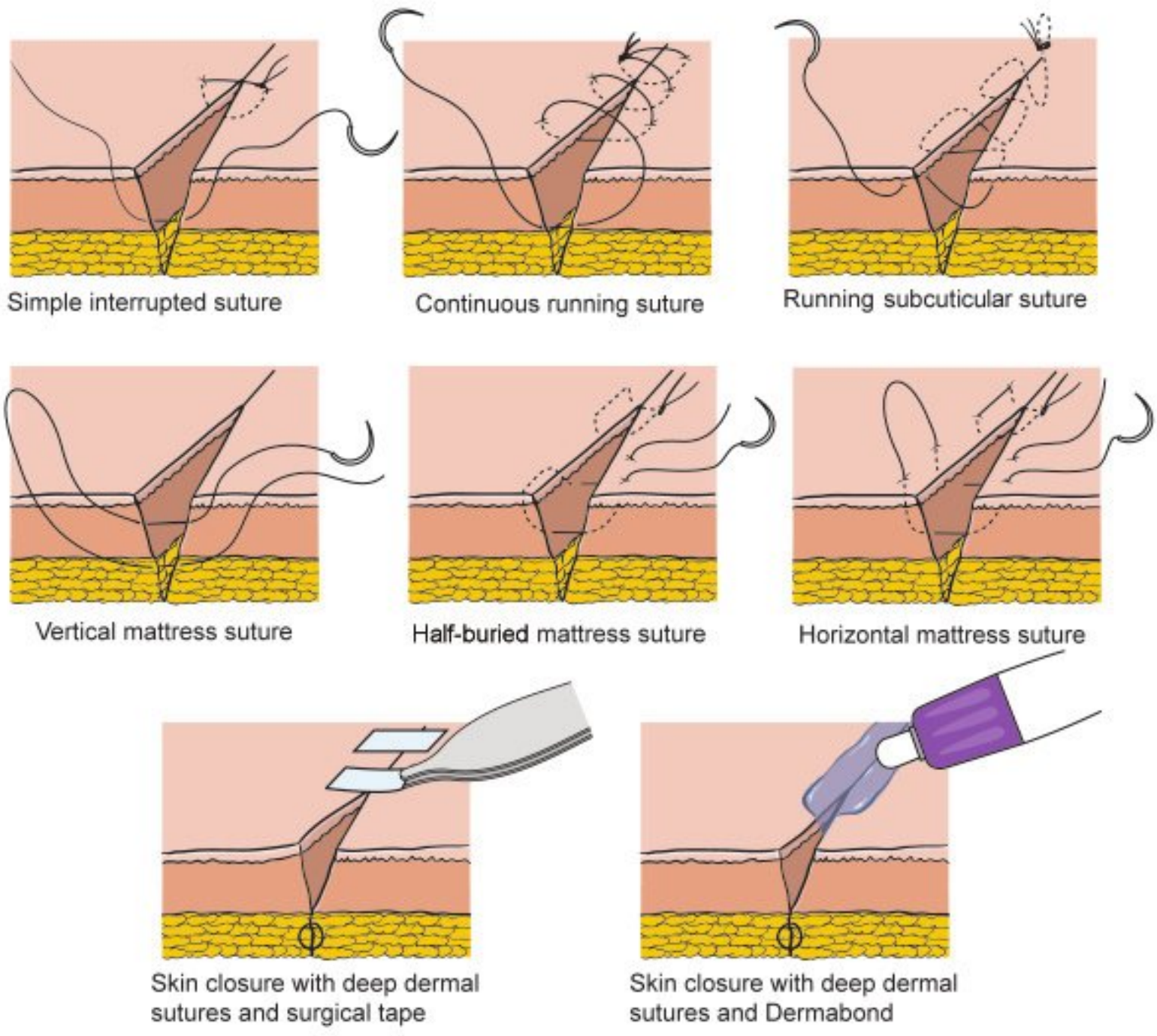


Fig. 2.1 Suture techniques.

3 Pressure Sores

The treatment of pressure sores can be a long and difficult challenge. Pressure sores are frequently a secondary sequela to the sedentary patient with a more complicated primary issue. Commonly, patients with pressure sores present with multiple comorbidities. It is essential to keep in mind that the likely source of fever and infection is oftentimes not the sore itself, since most sores are open to drain. Each case warrants a complete evaluation by the examiner to rule out the pressure sore as the likely cause of an infection.

Pressure Sore Staging System (Fig. 3.1)

- **Stage 1:** Intact skin with nonblanchable erythema.
- **Stage 2:** Superficial ulcer involving partial thickness of the epidermis and dermis; usually presents as an abrasion, blister, or very shallow ulcer.

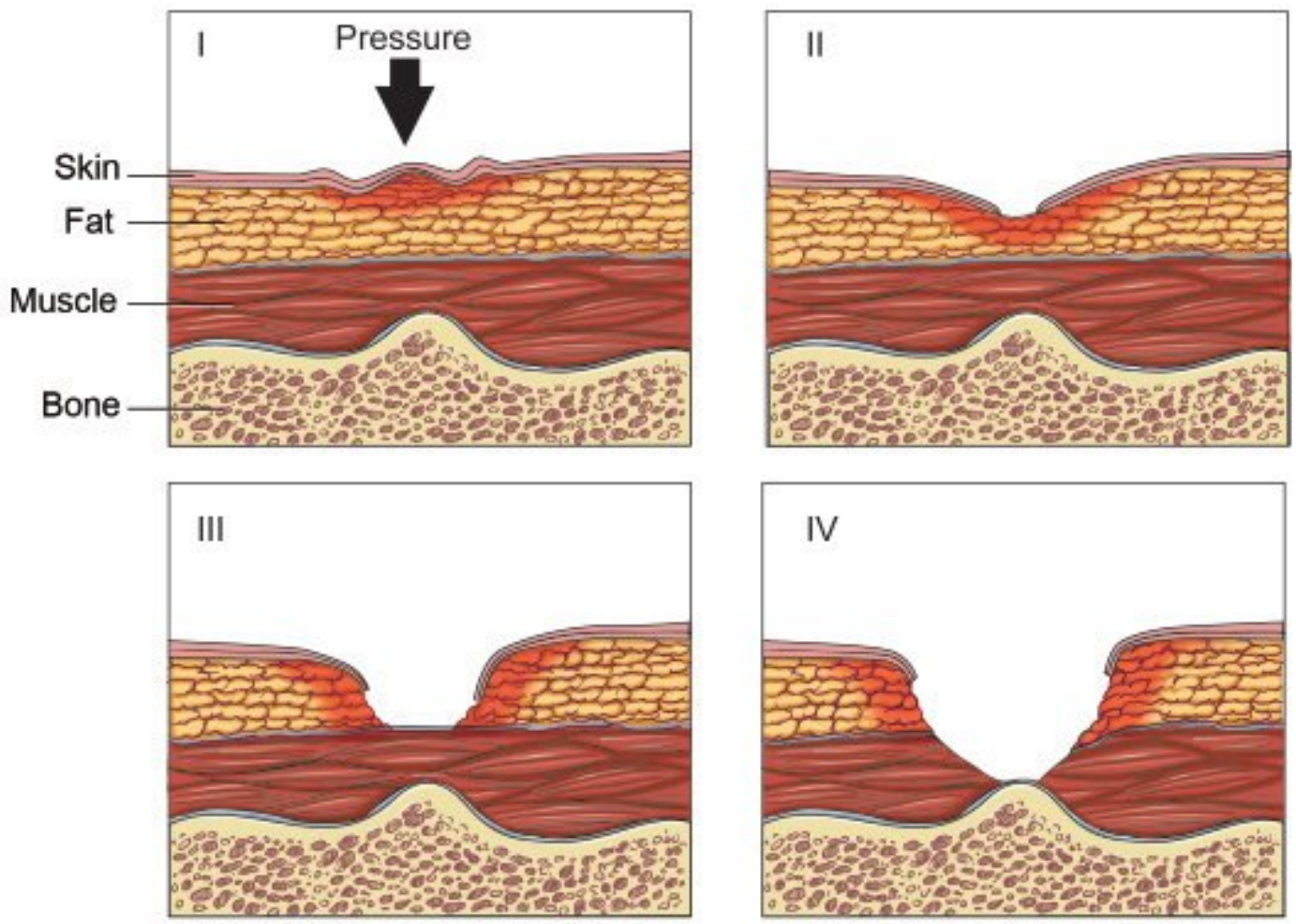


Fig. 3.1 Pressure sore staging system.

- **Stage 3:** Full-thickness skin loss down to the subcutaneous tissue, which does not extend beyond underlying fascia.
- **Stage 4:** Full-thickness skin loss down through subcutaneous tissue with involvement of muscle, bone, tendon, ligament, or joint capsule.

Evaluation

Position the patient in a well-lit area to facilitate visualization of the ulcer. Gently probe the wound and assess for fluid collection or purulent drainage. If pus is present, incision and drainage (I&D) should be performed and the wound irrigated copiously and packed wet to dry (see below). Obtain a culture and samples of the purulent material. Necrotic soft tissue is common. If it is devoid of purulent drainage, it is unlikely to be the source of sepsis. Copious drainage may be indicative of a much larger wound beneath the skin.

Subcutaneous fat and muscle are more prone to ischemia than skin. Therefore, intact skin (possibly with small eschar) may harbor a large area of necrotic tissue below, making the wound unstageable. Often, an eschar at or above the adjacent skin layer is indicative of partial skin thickness loss. An eschar that is depressed may represent full-thickness skin loss.

Larger sores may warrant radiographic evaluation to assess the extent of soft tissue involvement and possible bony involvement. CT scan or MRI will provide more information versus traditional X-ray. An MRI should be performed to rule out osteomyelitis if bone cultures are not available. Check routine studies—CBC, blood cultures, CXR, blood sugar, albumin and prealbumin, ESR, CRP, and urinalysis. Rule out other possible systemic causes of fever—pneumonia, central lines, and urinary tract infections. Check for incontinence.

Treatment

General Treatment for All Ulcers

- Alleviation of pressure—place patient on an air-fluid mattress; use pillows, egg cartons, donuts.
- Avoidance of shearing forces.
- Frequent turning of the patient, hourly if possible.
- Cleaning or diverting away incontinence—use of Foley and suprapubic catheter, rectal tube, or colostomy.
- Maximizing nutrition (albumin > 3.0, prealbumin > 18).

For Staged Ulcers

- *Stage 1:* Use moisturizers to prevent dryness.
- *Stage 2:* No débridement is necessary; use occlusive dressings such as polyurethane film (Duoderm [Convatec Inc.]) or hydrocolloids.
- *Stages 3 and 4:* Sharp débridement is often necessary with the addition of pulse lavage irrigation. Wounds are packed wet to dry with Kerlix (Kendall Co.). Consider bone biopsy to assess for osteomyelitis and to obtain bone cultures to guide antibiotic therapy.

The initial treatment and management of a pressure sore should include trying to alleviate the pressure that initially caused the wound. Even a clean wound will have trouble healing if the inciting event is still present. Proper débridement and washout is paramount. A minimal to moderate amount of necrotic tissue can often be débrided at bedside with local anesthesia, scissors, and a scalpel. Larger areas should be done in the operating room because of pain and the potential for uncontrolled bleeding. Sharp débridement should be performed down to healthy vitalized tissue that bleeds. Properly anesthetizing the patient will help with pain control and hemostasis. Refer to Chapter 2 for a list of local anesthetics to use.

Wet to dry dressings can be done with normal saline, 0.25%Dakin's solution, 0.25%acetic acid, and gauze. Kerlix gauze is commonly used because of the large surface area it can cover. Kerlix gauze is soaked in one of the preferred solutions and then squeezed dry. The moist gauze is then inserted and packed directly into the wound to cover the entire surface of the wound. Do not place moist Kerlix directly on the skin, since this can lead to skin maceration. The dressing should be changed two to three times per day depending on how dirty the wound is. Wet to dry dressings keep the wound moist and allow for mechanical débridement of devitalized tissue once the gauze dries, hence the name "wet to dry." Dakin's 0.25%or acetic acid 0.25%solution should be used in the infected purulent wound; however, it should be discontinued once the wound is clean, since both solutions can inhibit tissue growth and healing. Most hospitals have a wound care team that can assist with bedside pulse lavage and a small amount of sharp débridement by the wound ostomy nurse. Consult the wound care team for assistance with dressing changes, bedside pulse lavage, and minor débridements. Duoderm may be placed on either side of the wound, thereby avoiding frequent tape contact directly with the skin.

Enzymatic débridement is a common adjunct to the management of pressure ulcers. Agents such as Santyl (Smith and Nephew) are frequently applied to the wound to provide constant proteolytic débridement.

Although frequently used, they are by no means a substitute for sharp mechanical débridement of necrotic tissue. These agents have low morbidity and assist in cleaning up the small amounts of necrotic tissue that are often hard to completely remove during bedside débridements.

If the patient is seen in the emergency room and there is no cellulitis, no elevation in white blood cell count, and no purulent drainage, then the wound can be débrided as necessary and the patient can be seen as an outpatient. In these cases, instruct the family on (1) dressing changes every 8 hours, (2) the importance of keeping the wound clean, and (3) the need for frequent turning of the patient. If the patient presents with cellulitis and purulent drainage of the wound, then admission to the hospital should be considered, especially if the patient has other comorbidities.

Silvadene (Sanofi-Aventis Pharmaceuticals), Mafenide Acetate Cream, or Betadine (Purdue Products LP) can be used in selected cases of wounds with superficial eschars. These are usually small sores that involve only the dermis. These antimicrobial agents can help decrease the chance of an infection while the wound heals by secondary intention. Culture swabs are of little use because all wounds are colonized, even in the clean granulating wound. A quantitative tissue biopsy can be obtained to evaluate tissue bacterial counts ($> 10^5$ per gram of tissue), and bone biopsy to rule out related osteomyelitis.

4 Bite Wounds

Bite wounds from animals, insects, and humans are commonly present in the emergency setting. More severe and violent bites can be associated with complex composite tissue defects with devitalized tissue.
General management includes:

1. Infiltrate local anesthesia to anesthetize the wound to allow thorough evaluation and débridement.
2. Removal of foreign bodies (teeth) and débridement of devitalized tissue.
3. Copious irrigation with NS.
4. Determine if tetanus or rabies prophylaxis is indicated.
5. Repair of wound/laceration—consider loose closure or leaving open if infected or contaminated.
6. Postclosure antibiotics and monitoring.

Human Bites

Human mouths contain some of the most concentrated and varied bacteria. Organisms include *Eikenella, Staphylococcus,* viridans streptococci, and *Bacteroides*. The general principles of contaminated wound management, as mentioned above, apply to all human bite wounds. In the acute bite, the wound must be assessed fully and irrigated copiously. The patient should be placed on appropriate prophylactic antibiotics and followed closely for any signs of infection.

The initial injury often appears minor to the patient; thus no care is sought until an infection develops. It is important to fully assess the patient in the urgent care setting and triage for possible hospital admission, IV antibiotics, and operative management. Bite injuries require careful evaluation for a deep infection because of the relatively benign presentation of their appearance. At times, due to the close proximity of the skin and underlying structures, nerve and tendon injuries may also be present. Also, due to the inherent depth of penetration by the teeth, microorganisms easily seed the depth of wounds, allowing rapid dissemination along the deep planes of the fascia and subcutaneous tissue. Therefore, rule out a deep injury even when the presentation is a minor wound such as an abrasion.

Assessment and Treatment

1. Evaluate wound for depth, foreign body, drainage, and cellulitis.
2. Assess for crepitus (subcutaneous emphysema), which would indicate gas-forming organisms along the deep planes.
3. Débride devitalized tissue and copiously irrigate.
4. Loose closure versus pack wound—facial bites should be closed for the best cosmetic results.
5. Treat with antibiotics.

Closed-Fist Injury (Fight Bite)

With closed-fist injuries, the force of the blow to the mouth will often penetrate the skin over the metacarpophalangeal joint to lacerate or infect the extensor tendon and contaminate the underlying joint, such as the metacarpophalangeal joint, with bacteria from the mouth. When the hand is placed back into a neutral position, the bacteria can be displaced, resulting in more proximal contamination. Fight bite wounds not only involve soft tissues but also can infect joints and tendons. Aggressive incision and drainage, irrigation, and débridement in the operating room should be considered for grossly contaminated wounds and those that present late.

1. Evaluate wound for depth, foreign body, drainage, and cellulitis.
2. Assess for crepitus (subcutaneous emphysema), which would indicate gas-forming organisms along the deep planes.
3. Evaluate the integrity of the extensor and flexor tendons (flexor tenosynovitis).
4. Assess for loss of joint height, which would indicate metacarpal head fracture.
5. Obtain hand series (rule out metacarpal head fracture, osteomyelitis, and dental foreign body).
6. Débride devitalized tissue and copiously irrigate.
7. Close the wound loosely or leave the wound open and perform daily dressing changes with gauze.
8. Treat with antibiotics.

See Chapters 14 and 16 for management of fractures of the metacarpal head and extensor tendon injuries, respectively, associated with fight bites.

Antibiotics

All patients seen in the emergency setting should receive a single dose of IV antibiotics. IV antibiotics should be continued in those who require admission for more complicated infections. Those who can be discharged home are released on the appropriate oral regimen with close follow-up within 1 week.

- *First-line IV:* Unasyn (Pfizer Pharmaceuticals) 1.5 g IV every 6 hours or clindamycin 600 mg IV every 6 hours + Levofloxacin 500 mg IV daily.
- *First-line oral:* Augmentin (GlaxoSmithKline).
  - *Adult:* 875/125 mg twice a day × 10 days.
  - *Pediatric:* 45 kg/day twice a day × 10 days.
  - *Alternatives:* Moxifloxacin 400 mg daily × 10 days or clindamycin 450 mg four times a day + Bactrim DS twice a day × 10 days.

Cat

Cat bites are deeply penetrating wounds that are heavily contaminated, and approximately 80% of these wounds become infected. Organisms include *Pasteurella multocida* and *Staphylococcus* species. Irrigate heavily, wash daily, treat with antibiotics, and see below for rabies vaccination criteria. Evaluate for tetanus prophylaxis. Do not close the wound.

Antibiotics

- *First-line oral:* Augmentin.
  - *Adult:* 875/125 mg twice a day × 10 days.
  - *Pediatric:* 45 kg/day twice a day × 10 days.
  - *Alternatives:* Doxycycline 100 mg twice a day × 10 days or cefuroxime 0.5 g twice a day × 10 days.

Dog

Dog bites constitute 80 to 90% of all animal bites. Organisms *include P. multocida, Bacteroides,* viridans streptococci, *Fusobacterium,* and *Capnocytophaga*. Massive force can often cause significant avulsion injuries; however, due to the lower bacterial count, infection is not seen as frequently as in cat bites. Large avulsion injuries can be reapproximated loosely as long as the wound can be packed and allowed to drain should an infection ensue. Elevate and treat with antibiotics. See below for rabies vaccination criteria. Evaluate for tetanus prophylaxis.

Antibiotics

- *First-line oral:* Augmentin.
  - *Adult:* 875/125 mg twice a day × 10 days.
  - *Pediatric:* 45 kg/day twice a day × 10 days.
  - *Alternatives:* Unasyn 1.5 g IV every 6 hours or clindamycin 450 mg four times a day + Bactrim DS twice a day × 10 days.

Rabies

Rabies is a viral infection of the central and peripheral nervous system that causes encephalitis with or without paralysis. If left untreated, it has close to 100% mortality. In the United States, rabies is most common in bats, raccoons, skunks, foxes, coyotes, ferrets, cats, and dogs. Bats are the most common wild animals to carry rabies. Cats are the most common domestic animals to carry rabies because of the high number of unvaccinated strays and their contact with raccoons, bats, and other wild animals.

Transmission is through the mucous membranes and saliva through breaks in the skin. The virus then replicates locally in the muscle and eventually travels through peripheral nerves to the spinal cord, then to the brain. Incubation times have ranged from as short as 5 days to as long as 7 years; however, the average incubation time is approximately 1 to 3 months. Common signs and symptoms of rabies are detailed in the box below.

The most common signs and symptoms of rabies infection

Paresthesias at the site of the bite
Hypersalivation
Hydrophobia
Altered mental status
Anxiety
Hyperactivity
Bizarre behaviors
Hypertension
Hyperthermia
Hyperventilation
Spasms and contractions of the neck muscles
Pharyngeal and respiratory muscle paralysis
Seizures

Treatment

The wound should be copiously irrigated with normal saline. Devitalized tissue should be adequately débrided, with all wounds left open to heal by secondary intention. Tetanus status should be determined and vaccine administered if indicated (see Chapter 1). A broad-spectrum antibiotic may be administered for 10 days (Augmentin 875/125 mg by mouth twice a day).

Domestic Animals

If the rabies status of the domestic animal (e.g., cat, dog, ferret) is unknown, the animal should be quarantined and observed for 10 days; prophylaxis can be postponed if suspicion is relatively low. If the animal is rabid or if the presence of rabies is highly suspected, human rabies immunoglobulin (RIG) and human diploid cell rabies vaccine (HDCV) should be administered.

- RIG: 20 IU/kg, 50%into the wound and 50%given IM.
- HDCV: Given on days 0, 3, 7, 14, and 28.

Wild Animals

Regard all wild animals (e.g., bats, foxes, coyotes, raccoons, skunks) as rabid. Test the animal if captured and administer RIG and HDCV to all patients as indicated above.

Snake

The majority of snakes are nonvenomous; therefore, snakebite wounds will likely heal without extensive intervention. Venomous snakebites, however, can pose a severe threat to the local soft tissues or cause life-threatening systemic reactions. The family Viperidae is the largest family of venomous snakes worldwide. The subfamily Crotalinae (pit vipers) includes rattlesnakes, cottonmouths, and copperheads; pit vipers are the most common type of venomous snake in the United States. The family Elapidae is the next largest family of venomous snakes. Coral snakes are commonly found in the southern and southwestern regions of the United States, while cobras, mambas, and kraits are not indigenous to the United States, but are exotic snakes that can be found in zoos or are kept by private collectors.

The identification of the snake's species is important in determining if envenomation is expected. Commonly patients will present with knowledge of the type of snake that was involved (see **Table 4.1** for some types of venomous snakes). Alternatively, the differentiation between a venomous and a nonvenomous snakebite can be made using the pattern of the bite or physical features of the snake if brought for presentation (**Fig. 4.1**).

Evaluation

Obtain thorough history that includes
- Time of the bite.
- Description of the snake.

Assess the timing of events and onset of symptoms. (Early and intense pain implies significant envenomation.)

Determine history of prior exposure to antivenin or snakebite.

Table 4.1 Venomous snake species

Family	Geographic range	Common names	
Viperidae	Africa, Europe, Asia, North and South America	Subfamily Crotalinae (pit vipers) includes rattlesnakes (diamondback, timber), cottonmouths, copperheads	Pit vipers are the most common type of venomous snake found in the U.S.
Elapidae	North America, Europe, Africa, Asia, Australia	Coral snakes, cobras, mambas, kraits	Coral snakes are commonly found in the U.S. in the southern and southwestern states

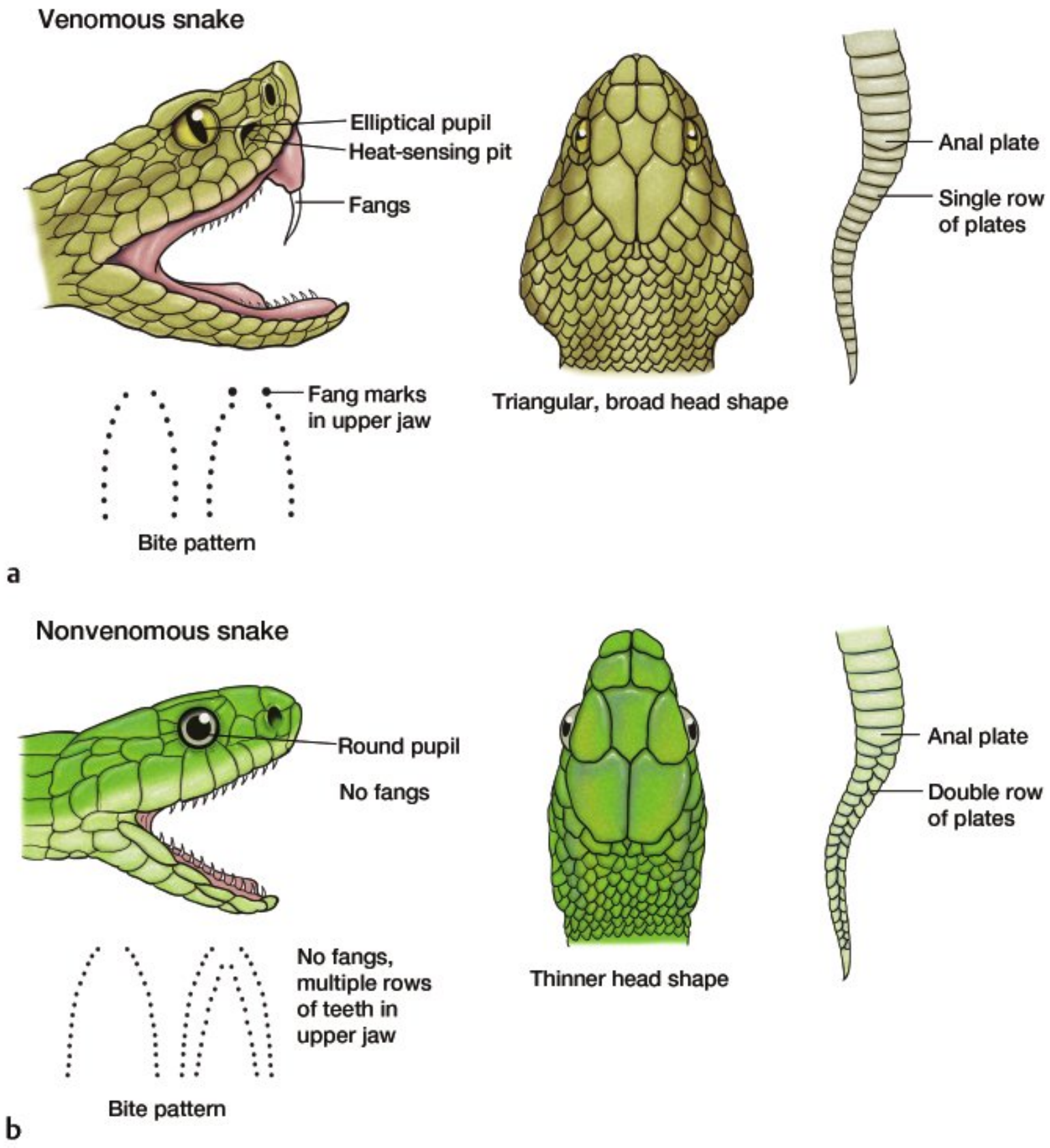


Fig. 4.1 Characteristics of **(a)** venomous versus **(b)** nonvenomous snakes and their bite patterns.

Assessment and physical examination should detail the following:

1. Fang marks.
2. Edema.
3. Bullae.
4. Erythema.
5. Necrosis.
6. Crepitus.
7. Petechiae.
8. Paresthesia.
9. Hemoptysis.
10. Presence of compartment syndrome if the bite occurs on an extremity (**Fig. 4.2**).

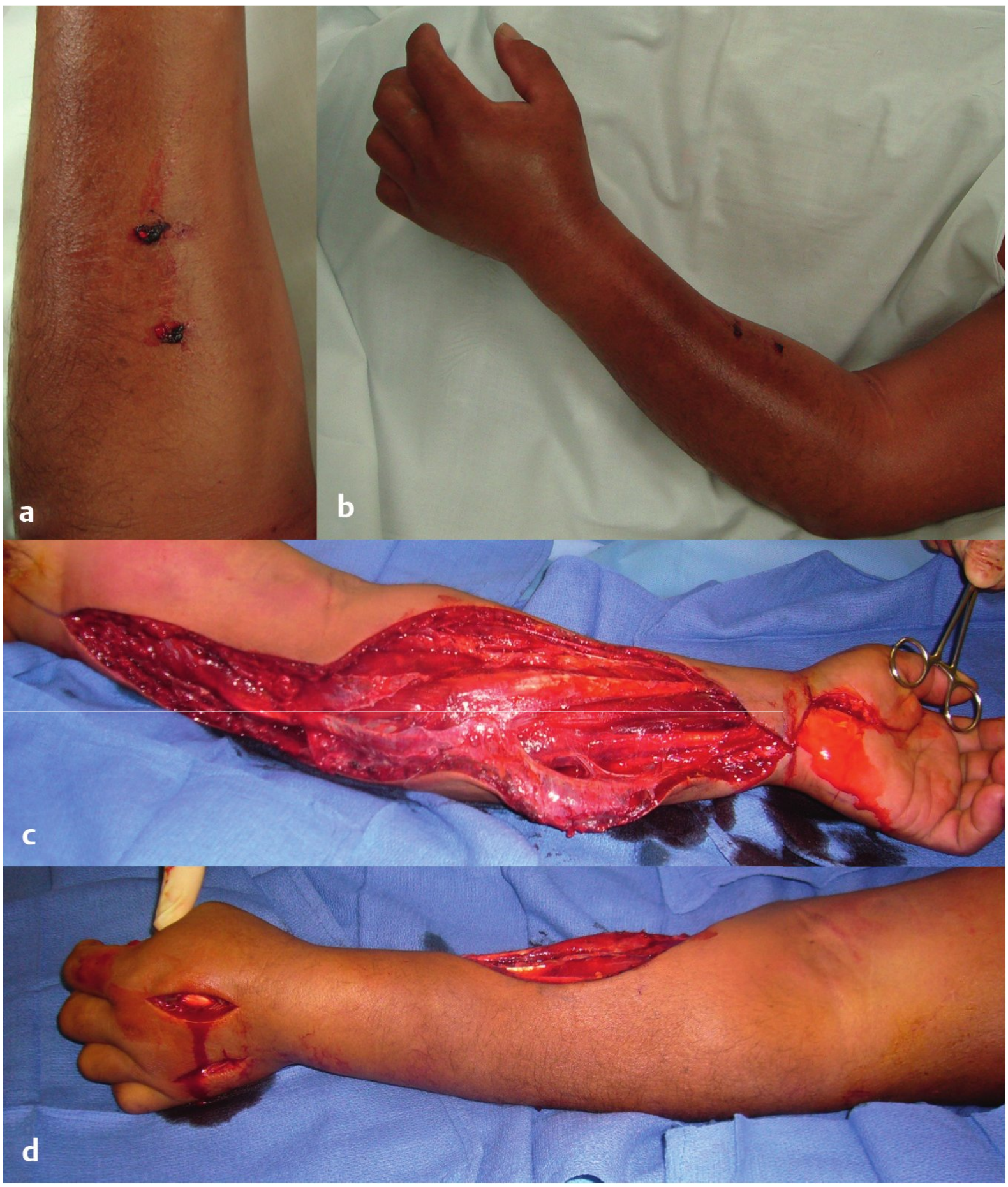


Fig. 4.2 **(a)** Fang marks characteristic of a venomous snakebite. **(b)** Signs of severe local reaction and compartment syndrome. **(c,d)** Forearm and hand fasciotomy required for the treatment of compartment syndrome secondary to the reaction from a venomous snakebite.

Treatment

1. Review the ABCs and evaluate the patient for signs of shock (e.g., tachypnea, tachycardia, dry pale skin, mental status changes, hypotension).
2. Obtain baseline laboratories (including PT, PTT, and INR) and CXR; type and crossmatch patient for FFP and PRBCs.
3. Rule out compartment syndrome and assess every 4 hours for signs of compartment syndrome (see Chapter 19).
4. Tetanus prophylaxis.
5. Prophylactic antibiotic use is controversial; however, some recommendations include the following: Rocephin (Roche Pharmaceuticals) 1 g IV every 12 hours or Timentin (GlaxoSmithKline) 3.1 g IV every 6 hours.
6. Immobilization, neutral positioning (splint) of extremity, and supportive care. Suction devices on the bite can be effective in the first 15 to 30 minutes. Do not attempt incision over the bite, mouth suctioning, tourniquets, or ice packs.
7. **Elevate the involved extremity.** This may require the aid of an IV pole, with which the extremity is hung using a stockinette.

Grading of Envenomation

1. Mild envenomation.
   a. Local pain and edema.
   b. Signs of systemic toxicity are absent.
   c. Laboratory values are normal.
2. Moderate envenomation.
   a. Local reaction—severe pain, edema greater than 12 inches surrounding the wound.
   b. Mild systemic toxicity present, including nausea, vomiting.
   c. Abnormal laboratory values—decreased hematocrit or platelet values.
3. Severe envenomation.
   a. Severe local reaction and generalized petechiae, ecchymosis.
   b. Severe systemic reaction—respiratory distress, airway edema, blood-tinged sputum, hypotension, renal dysfunction.
   c. Changes in coagulation profile—PT, APTT, and DIC.

Antivenin is given for moderate and severe cases of snake envenomation. Serum sickness is possible with antivenins, which are made with horse or sheep serum venom. A test dose is recommended; watch for an anaphylactic reaction. CroFab (BTG International Inc.) is a purified pit viper antivenin

that has fewer hypersensitivity reactions, so that serum sickness is less of an issue. CroFab is the preferred antivenin for pit viper envenomation.

Antivenin is given in ampules. One should start with 5 to 10 vials and continue therapy for up to 24 hours from the initial bite. If the patient responds (a decrease in both local and systemic reaction), then a dosing regimen of antivenin can be weaned. If the patient responds partially, plan to redose the antivenin. Patients should be monitored in an ICU setting during administration of antivenin for signs of allergic reaction. **Bites from coral snakes** ("red on yellow kills a fellow") are not treated with antivenin in the United States due to lack of production of specific coral snake antivenin and a halt by the FDA on the production of Wyeth's North American coral snake antivenin. Because a specific antivenin for coral snakes is not available, patients are currently treated with monitored supportive care.

Spider

There are over 20,000 species of spiders on Earth. Dangerous species often encountered in North America include the brown recluse, the black widow, the hobo or aggressive house spider, and the yellow sac spider. Of these, only the brown recluse and the black widow have ever been associated with significant disease (**Fig. 4.3**).

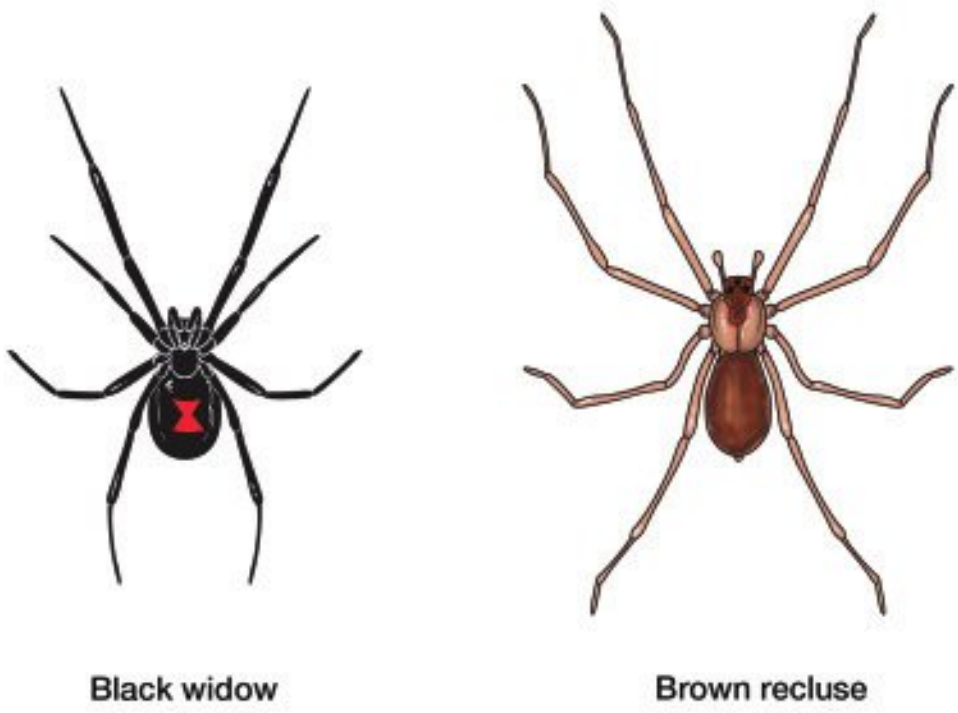


Fig. 4.3 The black widow and brown recluse spiders.

The Brown Recluse Spider

The brown recluse spider has six eyes and a violin-shaped pattern on its thorax and is found almost exclusively in the Midwestern and southeastern states. Although the venom is more toxic than that of the rattlesnake, morbidity is usually not as severe because of the small amount of venom that can actually be injected by the creature. One of the specific enzymes in the venom causes destruction of skin, fat, and blood vessels. This process eventually leads to soft tissue necrosis at the site of the bite.

The venom also has a profound effect on the immune response, triggering the release of various inflammatory cytokines, histamines, and interleukins that can themselves cause further injuries and systemic responses. Although rare, these include hemolysis, thrombocytopenia, coagulopathy, acute renal failure, coma, or death.

One should carefully assess the patient for any of the above symptoms, and admission is warranted for anyone exhibiting systemic toxicity. Apply ice to decrease pain and swelling, and elevate the site of injury above the heart. Wash the area thoroughly with soap and water, and instruct the patient to avoid any strenuous activity, which can facilitate the spread of the venom. Do not place heat on the area; this can accelerate tissue destruction. Do not attempt to suction the venom out, and the use of steroid creams is not advised.

Brown recluse spider bites are usually painless at first, and symptoms are slow to develop. Pain will usually present around 4 hours after the initial bite, with the bite wound presenting with a bull's-eye appearance. Blistering is then commonly seen 12 to 24 hours later, with soft tissue necrosis to follow. Early débridement is not indicated, and necrotic lesions should be kept clean and carefully dressed until spreading stops and the area of necrosis is well defined. A wide area of tissue around the necrotic skin can then be removed, with subsequent skin grafting as needed.

1. Baseline laboratories should include CBC, Chem-7, PT, PTT, and INR.
2. There is no antivenin available; however, dapsone 100 mg by mouth daily can be reserved for people with severe systemic disease (anemia, DIC, acute renal failure).
3. Acetaminophen or opiates for pain. Avoid aspirin, ibuprofen (Motrin [Pfizer Pharmaceuticals], Advil [Wyeth Pharmaceuticals]), and naproxen (Aleve [Bayer Consumer Care]).
4. Diphenhydramine 25 to 50 mg by mouth every 6 hours as needed.
5. Antibiotics should be administered if significant soft tissue necrosis ensues. Patients should be watched very closely, with follow-up the next day if possible.

The Black Widow Spider

Black widow spiders are nocturnal and are found in the southern states. This spider has a distinctive red-colored hourglass figure on its underbelly. Its initial bite is usually associated with local pain followed by systemic reactions that can carry mortality as high as 5%(usually in children or the elderly). Generalized symptoms usually include

- Nausea, vomiting.
- Faintness, dizziness.
- Chest pain.
- Hypotension.
- Tachycardia.
- Respiratory difficulties.
- Abdominal pain mimicking gallbladder disease or appendicitis.

There is minimal tissue toxicity, and the wound should be irrigated and cared for in the usual manner. Treatment for systemic symptoms is supportive, and an antivenin is available for severe cases. It should only be used if the patient is unstable.

Cold compresses have been used to ease the pain at the site, as well as over-the-counter pain medications. Over-the-counter pain medications (e.g., acetaminophen, naproxen, ibuprofen, Advil) can be used, as well as Benadryl 25 to 50 mg by mouth every 6 hours for itching. In general, antibiotic prophylaxis and extensive medical follow-up is not needed.

5 Burns and Frostbite

Evaluation and management of the acutely burned patient is a common requirement of the plastic surgeon on call. Rapid assessment, stabilization, and triage are essential for decreasing morbidity and mortality associated with burn injury. Commonly, the initial encounter will be as a consultant subsequent to the evaluation performed by the emergency room personnel. It is imperative, however, to remember to initiate measures to stop the burning process and practice universal safety precautions to confer increased safety for both the patient and the caregiver. Burn injury is often associated with trauma; therefore, a complete assessment of other injuries should be performed. If a child is burned and the mechanism of injury does not fit the burn pattern or if the patient was burned under unlikely circumstances or conditions, consider abuse.

Thermal Burns

Initial Assessment—Starting with the ABCs

Airway

- Establish a patent airway and begin oxygenation.
  - Employ manual techniques—chin lift, jaw thrust.
    - Utilize nasal trumpets and oral airways.
    - Consider creating a surgical airway when there is upper airway obstruction (cricoidectomy, tracheostomy).
- Assess for inhalation injury (**Fig. 5.1**).
  - Determine whether the burns occurred while the patient was in an enclosed space.
  - Signs and symptoms of inhalation injury.
    - Soot deposits in the oropharynx.
    - Carbonaceous sputum.
    - Singed nasal hair.
    - Facial edema, tongue edema, hoarseness.
  - Measure carboxyhemoglobin level.
    - > 10% requires oxygen therapy and is highly suggestive of an inhalation injury that requires intubation.