



# Skin laceration repair with sutures

**AUTHOR:** David M deLemos, MD

**SECTION EDITORS:** Anne M Stack, MD, Allan B Wolfson, MD

**DEPUTY EDITOR:** Michael Ganetsky, MD

---

All topics are updated as new evidence becomes available and our [peer review process](#) is complete.

Literature review current through: **Feb 2024**.

This topic last updated: **Mar 06, 2024**.

---

## INTRODUCTION

Laceration repair with sutures will be discussed here. Information concerning wound preparation and irrigation, topical and infiltrative anesthesia, and laceration closure with tissue adhesive or staples are discussed separately:

- (See "[Minor wound evaluation and preparation for closure](#)".)
  - (See "[Clinical use of topical anesthetics in children](#)" and "[Subcutaneous infiltration of local anesthetics](#)".)
  - (See "[Minor wound repair with tissue adhesives \(cyanoacrylates\)](#)" and "[Closure of minor skin wounds with staples](#)".)
- 

## WOUND ANATOMY

The epidermis, dermis, and subcutaneous layer are the tissue layers of concern during skin laceration repair:

- The epidermis and dermis are tightly adhered and clinically indistinguishable; together, they constitute the skin ( [figure 1](#)). Dermal approximation provides the strength and alignment of skin closure.
- The subcutaneous layer is mainly comprised of adipose tissue. Nerve fibers, blood vessels, and hair follicles are located here ( [figure 2](#)). Although this layer provides little strength

to the repair, sutures placed in the subcutaneous layer may decrease the tension of the wound and improve the cosmetic result.

---

## WOUND HEALING

The healing process of skin occurs in several stages, as summarized here and discussed in detail separately ([figure 3](#)) (see "[Basic principles of wound healing](#)"):

- Hemostasis – Hemostasis and clot formation occur within minutes of superficial skin injury in healthy patients. The fibrin matrix stabilizes the wound and serves as an initial scaffold for wound healing.
- Inflammation – Inflammation promotes vascular permeability, local vasodilation, and cellular migration and, in the absence of infection or other causes of impaired wound healing, is complete by three days. Polymorphonucleocytes engulf and enzymatically digest bacteria, foreign material, and necrotic tissue.
- Proliferation – Endothelial cells arise from basal cells in the epithelium and bridge clean wounds within two days after suturing, providing a barrier that is waterproof. However, this superficial layer is thin and easily disrupted.
- Remodeling – Fibroblasts derived from mesenchymal cells proliferate near the wound site approximately 24 hours after injury. Building upon the fibrin matrix, they produce essential elements for wound contraction and scar formation, including collagen.

Collagen formation is necessary to restore tensile strength to the wound. The process begins within 48 hours of the injury and peaks in the first week. Collagen production and remodeling continue for 6 to 12 months.

---

## WOUND EVALUATION

Important elements of wound evaluation include (see "[Minor wound evaluation and preparation for closure](#)", section on 'Evaluation' and "[Tetanus](#)"):

- Mechanism of injury
- Wound age
- Degree of contamination
- Presence of a foreign body
- Wound size and depth

- Presence of neurovascular compromise
  - Injury to adjacent structures (eg, ligaments, tendons, muscles, bone, or joints)
  - Need for tetanus prophylaxis ( [table 1](#))
  - Potential for impaired wound healing (see "[Minor wound evaluation and preparation for closure](#)", section on 'Risks for poor outcome')
- 

## INDICATIONS

Sutures are appropriate to use for primary closure of skin lacerations when the wound extends through the dermis and is likely to cause excess scarring if the wound edges are not properly opposed. Sutures are preferred when the wound requires careful approximation (eg, lacerations that cross skin tension [Langer's] lines ( [figure 4](#)) or that span important structures such as the eyebrow or vermillion border).

The appropriateness of primary closure with sutures is also determined by the age of the wound, wound location, and patient factors that impact the risk of wound infection as summarized below and discussed separately in detail (see "[Minor wound evaluation and preparation for closure](#)", section on 'Type of closure'):

- Clean, uninfected lacerations on any part of the body in healthy patients may be closed primarily for up to 18 hours following the injury without a significant increase in the risk of wound infection.
- Because of the lower risk of infection or poor wound healing, facial wounds may be closed primarily up to 24 hours following the injury in all patients. In selected patients (no signs of infection, otherwise healthy patient, and easily approximated wound), closure of facial wounds may occur up to 48 to 72 hours after injury.

Some lacerations that meet criteria for closure with sutures may also be amenable to closure with staples, skin adhesives, or wound closure tapes. The table provides guidance for selecting among the wound closure methods ( [table 2](#)).

Closure of lacerations with staples, skin adhesives, or wound closure tapes are discussed separately:

- (See "[Closure of minor skin wounds with staples](#)".)
- (See "[Minor wound repair with tissue adhesives \(cyanoacrylates\)](#)".)
- (See "[Assessment and management of facial lacerations](#)", section on 'Adhesive tapes').

## CONTRAINDICATIONS

Contraindications to primary closure in the ambulatory setting include (see "[Minor wound evaluation and preparation for closure](#)", section on 'Type of closure'):

- Lacerations for which suturing will significantly increase the risk of wound infection:
  - Lacerations through infected skin
  - Deep puncture wounds
  - Lacerations that have been grossly contaminated with foreign debris that cannot be completely removed by irrigation and debridement at the bedside
- Superficial wounds that would be expected to heal without significant scarring, such as lacerations or abrasions that only involve the epidermis. Suturing in these wounds will potentially cause increased scar formation and risk for infection.

Relative contraindications to primary closure of skin lacerations in the ambulatory setting include:

- Dog and cat bites (exception facial and other potentially cosmetic wounds). (See "[Animal bites \(dogs, cats, and other mammals\): Evaluation and management](#)", section on 'Wound management').)
- Most human bites (exception facial and other potentially cosmetic wounds). (See "[Human bites: Evaluation and management](#)", section on 'Wound closure').)
- Wounds, other than facial wounds, that are older than 24 hours in patients with risk factors for infection or poor wound healing (eg, immunocompromise, peripheral arterial disease, or diabetes mellitus), especially when presentation from the time of injury is delayed (eg, >18 hours old) or the wound site is more prone to infection (eg, hands or feet). (See "[Basic principles of wound healing](#)").)
- Lacerations with significant tissue loss in which suturing will cause too much tension across the suture line. In this instance, surgical consultation for consideration of grafting versus healing by secondary intention with later scar revision may be a better approach.

Lacerations not closed primarily may be left for delayed primary closure or healing by secondary intention. (See "[Minor wound evaluation and preparation for closure](#)", section on 'Type of closure').)

## **GUIDELINES FOR SURGICAL CONSULTATION**

Consultation with a plastic surgeon or other surgical specialist is warranted for the following wounds:

- Large or complex laceration that will require prolonged repair or grafting
- Severe contamination that cannot be properly managed at the bedside under local anesthesia
- Neurovascular compromise present
- Fracture, amputation, or joint penetration (eg, laceration through the knee joint capsule) associated with the laceration
- Anatomic sites requiring specialized repair to ensure optimal cosmetic outcomes:
  - The nasal cartilage, ala, or columella (see "[Assessment and management of facial lacerations](#)")
  - Eyelid or orbital lacerations that involve the eyelid margin or tarsal plate, have protruding subcutaneous fat, or involve the tear duct or lacrimal gland ( [figure 5](#)) (see "[Eyelid lacerations](#)")
  - Selected auricle (ear) lacerations (see "[Assessment and management of auricle \(ear\) lacerations](#)", section on '[Indications for subspecialty consultation or referral](#)')

Depending upon the provider's experience and ability to follow the wound until full healing, strong concern about cosmetic outcome by either the patient or family may also be a reason for referring a laceration to a surgeon for closure. However, for experienced providers, the outcome of clean skin lacerations in low-risk patients (eg, healthy children) is similar regardless of who performs the primary closure.

## **PAIN CONTROL**

**Local or regional anesthesia** — For most patients, infiltration of local anesthesia is effective for pain control during laceration repair. The choice of agent depends on several factors, including the duration of the procedure, need for hemostasis, patient sensitivity to catecholamines, and patient allergy to local anesthetics ( [table 3](#)). Subcutaneous infiltration of local anesthetics,

including methods to decrease the pain of injection and techniques for direct infiltration, is discussed separately. (See "[Subcutaneous infiltration of local anesthetics](#)".)

For children with uncomplicated facial or scalp lacerations, we suggest initial pain control with topical lidocaine-epinephrine-tetracaine (LET) rather than infiltrative anesthesia. (See "[Clinical use of topical anesthetics in children](#)", section on '[Agents for laceration repair](#)'.)

Regional anesthesia provides full local anesthesia without distorting tissues adjacent to the wound. This approach permits better approximation for complex lacerations on the face, ear, and lip. In addition, full local anesthesia is difficult to achieve by direct infiltration in some body regions (eg, fingers, toes, tongue, sole of foot). Regional anesthesia in these sites permits greater patient comfort.

Specific nerve blocks by site are listed below and discussed in detail separately:

- Face (see "[Assessment and management of facial lacerations](#)", section on '[Facial nerve blocks](#)'):
  - Mental nerve block ( [figure 6](#))
  - Supraorbital or supratrochlear nerve block ( [figure 7](#))
  - Infraorbital nerve block ( [figure 8](#))
- Lip – Mental ( [figure 6](#)) or infraorbital nerve block ( [figure 8](#))
- Auricle (ear) – Auricular field block ( [figure 9](#))
- Tongue – Inferior alveolar nerve block ( [figure 10](#))
- Fingers and toes – Digital nerve block ( [picture 1](#) and [picture 2A-B](#)) (see "[Digital nerve block](#)")
- Sole of foot – Tibial nerve block (see "[Lower extremity nerve blocks: Techniques](#)", section on '[Ankle block](#)')

**Nonpharmacologic (behavioral) interventions** — In children and older anxious patients, use of nonpharmacologic (behavioral) interventions help alleviate anxiety and may prevent the need for procedural sedation. Child life specialists are experts in applying these techniques when performing laceration repair in children. (See "[Procedural sedation in children: Selection of medications](#)", section on '[Nonpharmacologic interventions](#)'.)

**Procedural sedation** — When local or regional anesthesia and nonpharmacologic interventions are not sufficient, then minimal sedation is usually successful ( [table 4](#)). These

patients should also receive local or regional anesthesia. Moderate sedation may be needed in selected patients (eg, pediatric patients with complex wounds). Procedural sedation in children and adults with suggested agents for laceration repair are discussed in detail separately. (See "Procedural sedation in children: Approach" and "Procedural sedation in children: Selection of medications", section on 'Minimally painful procedures' and "Procedural sedation in adults in the emergency department: General considerations, preparation, monitoring, and mitigating complications".)

---

## WOUND PREPARATION

Methods to ensure adequate hemostasis, debridement, and irrigation prior to laceration repair are discussed in detail separately. (See "Minor wound evaluation and preparation for closure".)

---

## EQUIPMENT

Equipment used for skin laceration repair with sutures includes the following [1-3]:

- Personal protective equipment:
  - Sterile surgical gloves (clean surgical gloves if sterile not available)
  - Surgical mask
  - Goggles or face shield
  - Clean surgical gown
- Analgesia and anesthesia:
  - All wounds – Local anesthetic for local infiltration or regional anesthesia ( [table 3](#)) with 3 cc syringe and narrow-gauge needle (eg, 25- or 27-gauge) (see "[Subcutaneous infiltration of local anesthetics](#)" and '[Local or regional anesthesia](#)' above)
  - Facial and scalp wounds (children): Topical anesthetic (eg, lidocaine-epinephrine-tetracaine [LET] in aqueous or [methylcellulose](#) gel) (see "[Clinical use of topical anesthetics in children](#)")
- Irrigation supplies:

Local anesthesia is necessary in all patients undergoing suturing, including individuals receiving procedural sedation.

- Irrigation solution (irrigation volume determined by wound location, size, and degree of contamination) (see "Minor wound evaluation and preparation for closure", section on 'Irrigation solution')
  - Clean wounds – Sterile isotonic [saline](#) or tap water
  - Contaminated wounds – Sterile isotonic [saline](#) or dilute (1:10 mixture) povidone/iodine in sterile isotonic saline
- 60 cc syringe with 19-gauge needle, intravenous catheter, irrigation attachment with a splash shield, or prepackaged pressurized [saline](#) wound wash product (see "Minor wound evaluation and preparation for closure", section on 'Irrigation pressure')
- Suture tray containing:
  - Sterile field drapes
  - Needle holder (size appropriate to suture being used)
  - Atraumatic tissue forceps or skin hooks
  - Scissors (for cutting suture and wound modification [eg, iris scissors])
  - Hemostats (if ligating bleeding vessels)
  - Sterile cotton swab or surgical probe
  - Sterile gauze

Emergency departments generally are well equipped with minor surgical or suture trays that contain these items.

- Suture. (See '[Suture selection](#)' below.)
- Number 10 or 15 blade scalpel and handle if sharp debridement or wound modification is needed.

The use of clean rather than sterile gloves does not increase the risk of wound infection and is an acceptable practice for uncomplicated skin lacerations undergoing suturing in the ambulatory setting. For example, in a multicenter trial of 816 children and adults undergoing laceration repair, the rate of wound infection was similar between providers using sterile gloves (6.1 percent) or clean gloves (4.4 percent; relative risk 1.4, 95% CI 0.8-2.5) [4].

## SUTURE SELECTION

General guidance for suture material and size by wound location and for closure of skin, dermal, and intraoral lacerations are provided in the tables ([table 5A](#) and [table 5B](#)) [1,2].

Specific suture selection for facial, scalp, and oral lacerations are provided in the table ([table 6](#)) and discussed in detail separately:

- (See "Assessment and management of facial lacerations", section on 'Suture selection'.)
- (See "Assessment and management of lip lacerations", section on 'Techniques'.)
- (See "Evaluation and repair of tongue lacerations", section on 'Procedure'.)

The two major types of suture material are:

- **Absorbable** – An absorbable suture is made from either natural mammalian collagen or synthetic polymers, breaks down in the body, and does not require removal [3,5]. Different types of absorbable suture degrade at different rates. Absorbable suture forms a secure knot after three ties (throws). Some absorbable sutures (eg, polyglactin 910 [Vicryl] and poliglecaprone 25 [Monocryl]) handle well during suturing, while others can break easily (eg, fast-absorbing gut) or are more difficult to handle (eg, polyglycolic acid [Dexon sutures], polydioxanone [PDS], or polyglyconate [Maxon]).
- **Nonabsorbable** – Nonabsorbable sutures are made from synthetic materials such as nylon, polybutester, polypropylene, or natural silk and require removal after placement. Because a synthetic nonabsorbable suture tends to maintain its shape (memory) and not adhere to itself as tightly during knot tying when compared with absorbable suture or natural silk, these sutures require up to five ties (throws) to make a secure knot [3,5]. When compared with absorbable sutures, synthetic nonabsorbable sutures have better handling and will stretch to handle wound swelling. They also come in a variety of colors to make them easier to see during suturing and suture removal.

For all skin lacerations, the goal is to provide a suture that minimizes the risk of excess inflammation or infection and maintains its tensile strength during the initial stages of healing (see '[Wound healing](#)' above); the rate of healing varies by body site and individual patient factors such as age and comorbidities that may slow healing (eg, diabetes mellitus or use of corticosteroids or other immunosuppressive medications). Thus, suture selection for traumatic skin lacerations must take into account wound location, wound characteristics, and patient factors to ensure choice of the correct suture size, material, and needle:

- **Size** – Suture size is commonly indicated by the United States Pharmacopeia (USP) system and is a measure of tensile strength as well. Tensile strength is defined as the amount of weight required to break a suture divided by its cross-sectional area. In the USP system, the number of zeros inversely correlates with size: The higher the number of zeros, the smaller the size and the lower the strength. For example, a 3-0 suture has a diameter that is approximately two to four times larger than a 6-0 suture ([table 5B](#)).

In general, larger suture size is associated with greater inflammation and scarring [1,3,5]. Thus, a smaller suture (eg, USP 5-0 or 6-0) is used for repairs that require close approximation and/or are in regions of cosmetic importance (eg, face, ear, or nailbed) [6]. A larger suture (eg, USP 3-0 or 4-0) is used for:

- Dermal closure of wide gaping wounds
  - Intraoral or tongue lacerations
  - Percutaneous closure of lacerations for which significant tension across the wound is anticipated (wounds near joints or wide gaping wounds in noncosmetic regions) or where cosmetic outcome is of less importance (eg, scalp)
- **Suture material** – The type of suture material (absorbable versus nonabsorbable) is primarily determined by the skin layer being closed and, for percutaneous sutures, the site-specific timing for wound healing:
- **Percutaneous closure** – Options for percutaneous closure include nonabsorbable synthetic sutures, fast-absorbing gut, polyglactin 910 (Vicryl Rapide), and chromic gut:
    - **Synthetic nonabsorbable suture** – Monofilament nonabsorbable sutures (eg, nylon, polypropylene, and polybutester) theoretically promote the least inflammation relative to braided or absorbable sutures and are easy to handle [3]. All three sutures have elasticity, which permits stretching if wound swelling should occur, followed by return to their prior length once swelling resolves. Polypropylene has the greatest elasticity. The major disadvantage of nonabsorbable sutures compared with absorbable sutures is the need for the patient to return for suture removal.
    - **Fast-absorbing gut** – Fast-absorbing gut is heat treated to accelerate tensile strength loss and absorption, which typically occur by six days [7]. It is frequently used for closure of small, low-tension wounds on the face, particularly if suture removal will be difficult (eg, young, uncooperative child or when return for suture removal is not assured) [5]. If fast-absorbing gut is used for wounds with higher tension, placement of dermal sutures with a synthetic absorbable suture (eg, polyglactin 910 [Vicryl] or Monocryl) may decrease wound tension and provide support once the fast-absorbing gut has dissolved.

Fast-absorbing gut is tan and can be difficult to see during suturing. Furthermore, it easily breaks during tying, especially when it becomes dried out [5]. Sterile application of a petroleum coating (eg, antibiotic ointment such as **bacitracin** [Polysporin]) is used by some clinicians to improve handling and to decrease

brittleness. Based on one small randomized trial in 14 patients, coating the suture does not appear to impair its absorption [8]. However, in this study, absorption varied significantly among individuals. Thus, patients should be advised to return for suture removal at five days if the fast-absorbing gut stitches are still present. (See '[Follow-up visits](#)' below.)

- **Polyglactin 910 (Vicryl Rapide)** – Polyglactin 910 (Vicryl Rapide) is a synthetic absorbable suture for approximation of the skin and mucosa. Almost all of its tensile strength is lost by 10 to 14 days, and the suture begins to "fall off" in 7 to 10 days as the wound heals [5]. Thus, it may be appropriate for skin closure in sites where persistence of suture for one week or longer is appropriate (eg, scalp, trunk, extremities, palm, or sole) and when suture removal would be difficult (eg, lacerations located under casts).

Initial evidence found increased inflammation and scarring for Vicryl Rapide relative to fast-absorbing gut or nonabsorbable sutures indicated that it may not be the best choice for percutaneous lacerations, especially for traumatic facial lacerations or other locations of cosmetic importance [9]. More recent evidence from a split-scar trial in 105 adults undergoing Mohs surgery suggests that cosmetic outcomes may be similar to synthetic nylon suture [10]. However, more evidence from large randomized controlled trials is needed before Vicryl Rapide is considered an equivalent suture choice for percutaneous closure compared with nonabsorbable sutures or fast-absorbing gut.

- **Chromic gut** – Similar to Vicryl Rapide, chromic gut retains tensile strength for 10 to 14 days and may be used for repair of fingertip and nailbed lacerations, under a cast or splint, or when follow-up is not assured on scalp lacerations.

Evidence suggests that cosmetic outcomes or frequency of wound complications after repair of traumatic skin lacerations or surgical wounds are similar when lacerations are percutaneously closed with either nonabsorbable or absorbable sutures [10-13]. For example, in a meta-analysis of 19 trials (1748 patients) comparing the efficacy of nonabsorbable sutures with absorbable sutures for skin closure of surgical and traumatic lacerations, absorbable and nonabsorbable sutures had equivalent cosmetic outcomes and no significant difference for wound infection or wound dehiscence, although follow-up was insufficient in several studies [11]. However, evidence from large randomized controlled trials of suture closure of traumatic skin lacerations are lacking. Thus, the clinician should choose suture material for a specific patient based upon other factors such as need and ease of removal, clinician preference based on

handling characteristics, and whether or not follow-up for suture removal can be assured.

- **Dermal closure** – Dermal closure requires the use of absorbable suture that retains tensile strength until the collagen formation stage of wound healing is well established (see '[Wound healing](#)' above). Polyglactin 910 (Vicryl) and poliglecaprone 25 (Monocryl) are most commonly used for this purpose:
  - Polyglactin 910 (Vicryl) is a lubricated, braided synthetic material with excellent handling and smooth tie-down properties [5]. It retains significant tensile strength for three to four weeks. Complete absorption occurs in 60 to 90 days. It has decreased tissue reactivity compared with catgut as well as improved tensile strength and knot strength.
  - Monocryl is a monofilament suture that has superior pliability for easier handling and tying of knots. Its monofilament quality gives it a theoretical advantage over braided sutures for contaminated wounds requiring deep sutures [5]. This suture is often used by plastic surgeons at our institution for facial lacerations closed with subcuticular running sutures. All of its tensile strength is lost by 21 days postimplantation.

Other absorbable sutures such as polyglycolic acid (Dexon), polydioxanone (PDS), or polyglyconate (Maxon) are acceptable alternatives for dermal closure but may be more difficult to handle during suturing and have potential for promoting more inflammation during healing.

Chromic gut and fast-absorbing gut should not be used for dermal sutures, because of their rapid absorption and inadequate wound support.

- **Oral or tongue lacerations** – Because of the difficulty of suture removal, intraoral and tongue lacerations should be closed using absorbable suture. Chromic gut or Vicryl Rapide retain tensile strength for 10 to 14 days in the mouth but are more rapidly absorbed in the oral cavity than other absorbable sutures, making them good choices for this environment. Fast-absorbing gut is broken down too rapidly by enzymes in the saliva to provide adequate time for wound healing and should not be used. Repair of tongue and intraoral lacerations are discussed in greater detail separately. (See "[Evaluation and repair of tongue lacerations](#)" and "[Assessment and management of intra-oral lacerations](#)".)

- **Suture needle** – For most traumatic skin lacerations, the clinician should choose a suture needle with the following characteristics [1-3]:

- Reverse cutting
- Three-eighths curvature
- Labelled for use on the skin (eg, FS, CE, P, PS, PC, or PRE)

The basic components of a suturing needle are ( [figure 11](#)):

- The eye (or swage) is the end of the needle attached to the suture. All sutures used for traumatic skin laceration repair are swaged (ie, the needle and suture are connected as a continuous unit).
- The body of the needle is the portion that is grasped by the needle holder during the procedure. The body determines the shape of the needle and is curved for cutaneous suturing. The curvature may be one-fourth, three-eighths, one-half, or five-eighths circle. For traumatic skin lacerations, the most commonly used curvature is the three-eighths circle, requiring only minimal pronation of the wrist for large and superficial wounds. The one-half and five-eighths circles were devised for suturing in confined spaces, such as the oral cavity.
- The point of the needle extends from the extreme tip to the maximum cross section of body.

Needle points for use on the skin are triangular and include ( [figure 12](#)):

- Reverse cutting – Cutting edge is located on the outer (convex) curvature of the needle and perpendicular to two other opposing cutting edges. This type of needle is preferred for most skin closures.
- Conventional cutting – Cutting edge is located on the inside (concave) curvature of the needle and perpendicular to two other opposing cutting edges. This needle type may be prone to cutout of tissue because the inside cutting edge cuts toward the edges of the incision or wound. Thus, conventional cutting needles should be avoided for closure of skin lacerations.

Needles are further divided by manufacturer designations, which do not necessarily follow a specific convention. Common designations include [14]:

- Standard skin needles such as FS (for skin) or CE (cutting edge) series are suitable for closure of scalp, trunk, and extremity lacerations.

- Plastic needles are smaller and more sharply honed for use during closures requiring precise approximation (eg, facial lacerations) and are indicated by acronyms such as P (plastic), PS (plastic skin), PC (precision cosmetic), or PRE (plastic reconstruction).
- 

## SUTURING TECHNIQUES

**Percutaneous closure** — The simple interrupted suture is the most common method used to close most small, uncomplicated, traumatic skin lacerations [1,14,15]. For proper healing, the edges of the wound must be everted by each stitch. Wound eversion is accomplished using the following technique ( [figure 13](#) and [figure 14](#)):

- The needle should penetrate the skin surface at a 90° angle.
- The suture loop should be at least as wide or wider at the base than at the skin surface.
- The width and depth of the suture loop should be the same on both sides of the wound.
- The width and depth of the suture loop should be similar to the thickness of the dermis and will therefore differ from wound to wound, according to the anatomic location.
- The suture is then tied using a surgeon's knot (nonabsorbable suture) or a square knot (absorbable suture) ( [figure 15](#)). (See '[Instrument knot tying](#)' below.)

The number of ties (throws) is determined by suture type; three to four ties for an absorbable suture or four to five ties for a synthetic nonabsorbable suture. (See '[Suture selection](#)' above.)

- Once tied, the knot is positioned to one side or the other of the wound so that the knot does not interfere with wound healing at the margin.

To ensure proper apposition of the wound without excess tissue on one side (also called a "dog ear"), the clinician places the first stitch at the midline of the wound ( [figure 16](#)). The next two stitches go on each side of the first stitch, midway between the center stitch and the wound corners [15]. Additional bisecting stitches are placed until the wound is properly aligned.

The number of sutures needed to close a wound varies depending upon the length, shape, and location of the laceration. In general, sutures are placed just far enough from each other so that no gap appears in the wound edges.

**Dermal closure** — Dermal closure is typically used in the following circumstances:

- Deep lacerations because closing the cutaneous layer alone will leave significant dead space, with the potential for hematoma or abscess formation
- Wide lacerations because approximation of the dermis permits less tension at the skin level

The dermal or buried suture approximates the dermis just below the dermal-epidermal junction, thereby improving the cosmetic result in both situations. To reduce the amount of inflammation and risk of wound infection, simple interrupted stitches are placed to reduce the amount of suture material placed below the skin.

Absorbable suture material must be used for dermal or buried sutures. The knot should be buried away from the skin surface of the wound so that it will not interfere with epidermal healing. This knot orientation is accomplished by inverting the suture loop using the following technique ( [figure 17](#)):

- The needle should be inserted in the dermis and directed toward the skin surface, exiting near the dermal-epidermal junction on the same side.
- The needle should then be inserted on the opposite side of the wound near the dermal-epidermal junction, directly across from the point of exit.
- The suture loop should be completed in the dermis, directly opposite the origin of the loop, and the knot tied.
- Before tying the knot, pulling the two ends longitudinally along the course of the wound helps to bring the two sides of the wound together more effectively compared with pulling the ends perpendicular to the wound margin [15].
- The suture is then tied using a square knot ( [figure 15](#)) with no more than three ties (throws). (See '[Instrument knot tying](#)' below.)

Dermal sutures do not increase the risk of infection in clean, uncontaminated lacerations [16]. However, animal studies suggest that dermal sutures should be avoided in highly contaminated wounds [17]. Thus, reduced dead space and tension across the wound should be achieved with the fewest number of sutures possible.

**Instrument knot tying** — After the suture is placed, it is tied using the needle holder as follows ( [figure 18](#)):

- Pull the suture through the wound and leave a tail approximately 1 inch (2.5 cm) long at the initial entry site.

- Drop the suture needle on the sterile field and close the empty needle holder.
- Place the closed needle driver along the axis of wound between the two ends of the suture. (Repeat for each throw described below.)
- For the first tie (throw), in the nondominant hand, grasp the suture on the side of the wound where the needle emerged, approximately halfway between the needle and the wound site, and wrap it twice (surgeon's knot) or once around the needle holder (square knot) being held in the dominant hand.
- Open the needle holder and grasp the tail end of the suture.
- Pull the tail end through the two loops and across the wound, while moving the nondominant hand in the opposite direction across the wound. This action forms a surgeon's knot (two wraps) or a one-half knot (one wrap) ([figure 15](#)).
- For percutaneous closure, pull the surgeon's knot flat to the skin, with enough tension to gently evert the skin edges without strangulating the tissue, and then release the tail.
- Wrap the suture around the needle holder once in the opposite direction of the first two loops and pull the one-half knot so that it lies flat on the surgeon's knot.
- Repeat the one-half knot tie to place the suggested number of throws as determined by suture type and layer of closure ([table 5A](#)).
- Cut the suture ends at the appropriate length, as follows:
  - Percutaneous knot – Approximately the distance between sutures to prevent the ends from entangling
  - Dermal knot – Close to the last knot to minimize the amount of suture in the wound
- For percutaneous closure, the completed knot is positioned to one side or the other of the wound so that the knot does not interfere with wound healing at the margin.

## Special situations

**Triangular wound with a flap** — The half-buried horizontal mattress suture combines elements of a horizontal mattress suture with a dermal closure. It can be used to approximate the corner of a flap [2,3]:

- The needle is introduced through the skin in the portion of the wound that does **not** include the flap ([figure 19](#)).

- In the dermal (or buried) portion of the suture, the needle is passed through the corner of the flap horizontally through or just below the dermis.
- The stitch is completed by bringing the needle out through the skin on the opposite side of the non-flap portion. The knot is tied on the non-flap portion of the wound.

**Wounds under tension** — Mattress sutures provide additional eversion to wounds under tension (eg, wounds with tissue loss or requiring extensive debridement):

- **Vertical mattress suture** – The vertical mattress suture is recommended for wounds under tension and for those with edges that tend to invert (fall or fold into the wound) [18,19]. It acts as a deep and superficial closure all in one stitch. Vertical mattress sutures are well suited for body regions with thin or lax skin or reduced subcutaneous tissue (eg, the shin) that do not provide adequate subcutaneous tissue for dermal closure [3].

We prefer the shorthand vertical mattress technique ( [figure 20](#)) [2]:

- The needle is initially inserted at the epidermal/dermal (near-near) edges as if performing a simple interrupted suture. This near-near portion of the suture loop everts the edges of the wound.
- The needle is then rotated 180° in the needle holder, and the direction of the suture loop is reversed (backhanded). The needle entrance is at a distance from the wound edge, crossing through the dermal tissue and exiting through the skin on the opposite side at an equal distance from the wound edge. This is the far-far portion. This stitch approximates the dermal structures.
- The knot is then tied in standard fashion. (See '[Instrument knot tying](#)' above.)

Alternatively, in the traditional vertical mattress technique, the deeper bites are performed first, followed by the smaller wound edge bites. In one trial that compared repair time and wound healing for patients randomized to receive either the traditional or the shorthand technique, wounds were repaired in one-half of the time using the shorthand technique [20]. There was no difference between the two groups with respect to wound healing.

- **Horizontal mattress suture** – A horizontal mattress suture also achieves wound eversion in areas of high skin tension [18,19]. In addition, horizontal mattress sutures distribute tension along the length of the laceration.

The needle is introduced into the skin in the usual manner and brought out on the opposite side of the wound ( [figure 21](#)). A second bite is taken along the opposite side,

approximately 0.5 cm from the first exit site, and is brought back to the original starting side, also 0.5 cm from the initial entry point.

Both vertical and horizontal mattress sutures can cause excess tension at the wound margin, which can lead to skin ischemia with wound breakdown [3]. To decrease the chance of this complication, clinicians may alternate mattress stitches with simple interrupted stitches or only use a mattress suture at the point of maximal tension.

**Long, straight wounds** — A running suture provides a rapid means of percutaneous closure for long, straight wounds at low risk of infection and with edges that align easily ( [figure 22](#)):

- The closure is started with the standard technique of a percutaneous simple interrupted suture, but the suture is not cut after the initial knot is tied.
- The needle is then used to make repeated bites, starting at the original knot, by making each new bite through the skin at an angle of 45° to the wound orientation.
- The cross stays on the surface of the skin will be at an angle of 90° to the wound.
- The final bite is made at an angle of 90° to the wound direction to bring the suture out next to the previous bite. The final bite is left in a loose loop, which acts as a free end for tying the knot.

A disadvantage to this technique is that, if the stitch breaks, then wound dehiscence may occur. Furthermore, good wound eversion is more difficult to achieve with running sutures, which may increase the risk of scarring [2,3]. For these reasons, this technique is avoided on the face or other cosmetically important regions and should only be performed by properly trained and experienced providers.

**Advanced repair of facial wounds** — The subcuticular running suture is often used by plastic surgeons and other experienced providers to close straight lacerations on the face. An absorbable suture, such as Monocryl or Vicryl, is used. The suture is anchored at one end of the laceration, and then a plane is chosen in the dermis or just deep to the dermis in the superficial subcutaneous fascia ( [figure 23](#)). Mirror-image bites are taken horizontally in this plane for the full length of the laceration. The final bite leaves a trailing loop of suture so a final knot can be tied. The wound is then reinforced with adhesive tape [2].

**Specific wound sites** — The evaluation and management of traumatic lacerations at specific locations listed below are discussed in detail separately:

- Lip – (See "Assessment and management of lip lacerations".)

- Tongue and intraoral mucosa – (See "Evaluation and repair of tongue lacerations" and "Assessment and management of intra-oral lacerations".)
  - Eyebrow – (See "Assessment and management of facial lacerations", section on 'Eyebrow'.)
  - Eyelids – (See "Eyelid lacerations".)
  - Cheek (zygoma) – (See "Assessment and management of facial lacerations", section on 'Cheek'.)
  - Ear – (See "Assessment and management of auricle (ear) lacerations".)
  - Scalp – (See "Assessment and management of scalp lacerations".)
- 

## AFTERCARE

**Topical antibiotics and wound dressing** — For traumatic lacerations in patients without sensitivity to **neomycin** or other components, we recommend application of a topical antibiotic ointment such as topical **bacitracin** zinc or combination ointment containing neomycin sulfate, bacitracin zinc, and **polymyxin B** sulfate [21,22]. For patients with sensitivity to neomycin, we suggest dressing the wound without topical antibiotics. To enhance healing, we also suggest that lacerations repaired with sutures be initially covered with an open or semiocclusive dressing, as determined by the amount of anticipated drainage:

- **Wounds with potential drainage or closed with nonabsorbable sutures** – Sterile gauze dressing or adhesive bandage (open dressing).
- **Wounds without drainage or closed with absorbable sutures (fast-absorbing gut or Vicryl Rapide)** – Either an open or semiocclusive dressing such as a polymer film (eg, Tegaderm, Cutifilm, Blisterfilm, or Biocclusive) can keep the sutures dry. Polymer films may permit the patient to shower more easily without getting the wound wet and permit examination of the wound for signs of infection without removing the dressing.

The dressing should be left in place for at least 24 hours, after which time, wounds can be left open to air. An antibiotic ointment can be applied to the wound as well, with instructions to apply the ointment two times per day at home until suture removal.

The use of a topical antibiotic ointment is supported by a randomized blinded trial of 426 adults undergoing traumatic laceration repair with sutures in which topical ointment containing **neomycin** sulfate **bacitracin** zinc and **polymyxin B** sulfate significantly reduced the rates of

wound infection when compared with a petroleum ointment control (5 to 6 versus 18 percent, respectively) [21]. In another randomized and blinded study of 177 children with minor wounds, most of which were grazes, abrasions, and cuts, individuals who treated the wound with topical antibiotics also had significantly lower rates of infection (1.6 percent) compared with placebo (12.5 percent), although the rate of infection in the control group was higher than expected [23].

Topical antibiotics have not been shown to prevent infection or hasten healing after minor skin surgery (eg, punch biopsy or skin excision); petrolatum ointment is suggested instead to avoid potential contact dermatitis. (See "[Skin biopsy techniques](#)", section on '[Wound dressing](#)').

Occlusion of the wound helps to maintain a moist environment, which enhances wound healing (see "[Basic principles of wound management](#)", section on '[Wound dressings](#)'). Small crossover trials evaluating surgical wounds also indicate that occlusion of the wound increases the speed of re-epithelialization, although complete healing appears to occur at approximately the same time when compared with uncovered wounds [24,25].

**Bathing** — For patients with lacerations closed with a nonabsorbable (eg, nylon, polypropylene) suture, we advise gentle cleaning using mild soap and water or one-half-strength peroxide 24 hours after closure to prevent crusting over the suture knots. Furthermore, these patients may be allowed to shower or wash the wound with soap and water without risking increased rates of infection.

Lacerations closed with percutaneous absorbable sutures may also be gently cleaned 24 to 48 hours after placement, although some experts advise keeping the stitches dry until the suture is mostly absorbed (typically, five days for fast-absorbing gut or 7 to 10 days for Vicryl Rapide).

Prolonged soaking of stitches including swimming in chlorinated water should be avoided because of the theoretical risk of premature loss of suture tensile strength with wound dehiscence. Patients with sutures should also not swim in natural bodies of water, because of a potential increased risk of infection.

Limited evidence is available to guide the timing of bathing after suture placement:

- In a trial of 857 patients who underwent minor skin excisions that were repaired with a nonabsorbable suture and were dressed with dry gauze, those who washed the wound site within 12 hours after suture placement and left the wound open had similar infection rates to those who kept their wounds dry and covered for at least 48 hours (8.4 versus 8.9 percent, respectively) [26,27]. Patients were advised to avoid the use of antiseptic solutions

or antibacterial soap on the wound site and were not given topical antibiotics, which likely explains the relatively high rates of infection in these clean surgical wounds.

- An observational study of 100 patients who underwent primary excision of a skin or soft-tissue lesion or local flap closure and began washing their wounds twice daily within 24 hours of surgery found no wounds developed infection or dehiscence [28].

**Tetanus prophylaxis** — Tetanus prophylaxis should be provided for all wounds as indicated ([table 1](#)). Tetanus prophylaxis for pregnant women depends upon their immunization history and is discussed in detail separately. (See "[Immunizations during pregnancy](#)", section on '[Tetanus, diphtheria, and pertussis vaccination](#)').

**Prophylactic antibiotics** — Proper wound preparation is the essential measure for preventing wound infection after suturing simple lacerations. (See "[Minor wound evaluation and preparation for closure](#)".)

For healthy patients with uncomplicated traumatic skin lacerations, we recommend local wound care without prophylactic antibiotics. All patients should receive instructions advising that they return for evaluation if they develop any signs of wound infection (eg, pain, redness, swelling, drainage of pus, or fever).

Evidence does not support the use of prophylactic antibiotics to reduce wound infections in healthy patients with clean traumatic skin lacerations. In a meta-analysis of seven trials (1701 total patients with a total of 110 wound infections), prophylactic antibiotics in healthy patients with wounds other than bite wounds did not decrease the infection rate (odds ratio 1.2, 95% CI 0.8-1.7; mean infection rate among controls 6 percent) [29].

The use of prophylactic antibiotics for selected wounds with higher baseline risks of infection are discussed in detail separately:

- Animal and human bites (see "[Animal bites \(dogs, cats, and other mammals\): Evaluation and management](#)" and "[Human bites: Evaluation and management](#)")
- Intraoral lacerations (see "[Assessment and management of intra-oral lacerations](#)", section on '[Prophylactic antibiotics](#)')
- Nailbed injuries (see "[Evaluation and management of fingertip injuries](#)", section on '[Wound care and patient instructions](#)')
- Patients with excessive wound contamination (eg, soil or water contamination) (see "[Soft tissue infections following water exposure](#)")

**Suture removal** — The timing of nonabsorbable suture removal varies with the anatomic site, according to the expected rate of healing [1,2]:

- Face – 5 days
- Eyelids – 5 days (3 days for low-tension wounds and up to 7 days for high-tension wounds)
- Neck – 5 days
- Scalp – 7 to 10 days
- Trunk and upper extremities – 7 days
- Lower extremities – 8 to 10 days
- Digits, palm, and sole – 10 to 14 days

**Follow-up visits** — Most clean wounds do not need to be seen by a clinician until suture removal (if nonabsorbable sutures were placed) or if absorbable sutures have not dissolved as expected.

Wounds at higher risk for infection (eg, repaired lacerations due to animal or human bites or in patients with risk factors for infection [eg, diabetes mellitus, immunocompromised host, or contaminated wound]) warrant evaluation at a follow-up visit in 48 to 72 hours.

---

## UNIQUE PEDIATRIC CONSIDERATIONS

**Anxious caregiver** — A caregiver is an important advocate for their child, and their concerns need to be addressed with patience and understanding. It is inevitable that the clinician will encounter some caregivers who demand a plastic surgeon for simple laceration repairs or sedation for a laceration that easily could be managed with patient distraction, topical and/or injectable anesthetics, and an assistant to help hold the child still. The best approach is to listen first and to suggest reasonable alternatives later.

In some instances, there is no choice but to call the surgeon. At other times, caregivers will listen to the explanation that for a simple, clean laceration, the cosmetic outcome will be acceptable whether repaired by a surgeon or another clinician. At times, it is also an issue of plastic surgeon availability.

In cases where a caregiver demands sedation for a simple laceration, they must understand that sedation has risks that are unnecessary if a reasonable and safe alternative exists. The use of distraction methods and the use of topical anesthetics should also be explained to the caregiver. Child life specialists, if available, can provide invaluable assistance in this scenario, along with an assistant to hold the child still. The child life specialist can adequately distract many patients by reading books with the patient, playing a video, or providing visual imagery.

(See "[Procedural sedation in children: Selection of medications](#)", section on 'Nonpharmacologic interventions'.)

**Anxious and uncooperative patient** — The anxious and uncooperative patient is a challenge that, at times, can be managed with an assistant to hold the child still and similar methods of distraction and imagery but, at other times, leaves no choice but to sedate the patient to repair the laceration. Sedation choices vary depending upon age, mechanism of injury, and time required for repair and are discussed in detail separately. (See "[Procedural sedation in children: Approach](#)" and "[Procedural sedation in children: Selection of medications](#)", section on 'Minimally painful procedures').

---

## SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "[Society guideline links: Minor wound management](#)".)

---

## INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5<sup>th</sup> to 6<sup>th</sup> grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10<sup>th</sup> to 12<sup>th</sup> grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topic (see "[Patient education: Stitches and staples \(The Basics\)](#)").
- 

## SUMMARY AND RECOMMENDATIONS

- **Wound evaluation** – The management of minor skin lacerations begins with assessment and preparation of the wound, including the need for tetanus prophylaxis ( [table 1](#)). (See "[Minor wound evaluation and preparation for closure](#)".)
- **Indications** – Sutures are appropriate when the depth of the wound will lead to excessive scarring if the wound edges are not properly apposed. Concern about wound infection is the main reason not to close a wound primarily (see '[Indications](#)' above):
  - Clean, uninfected lacerations on any part of the body in healthy patients may be closed primarily for up to 18 hours following the injury without a significant increase in the risk of wound infection.
  - Because of the lower risk of infection or poor wound healing, facial wounds may be closed primarily up to 24 hours following the injury in all patients. In selected patients (no signs of infection, otherwise healthy patient, and easily approximated wound), closure of facial wounds may occur up to 48 to 72 hours after injury.
- **Contraindications** – Contraindications to primary closure in the ambulatory setting include (see '[Contraindications](#)' above):
  - Absolute:
    - Lacerations through infected skin
    - Deep puncture wounds
    - Lacerations that have been grossly contaminated with foreign debris that cannot be completely removed by irrigation and debridement at the bedside
  - Relative:
    - Human, dog, and cat bites (except facial and other potentially cosmetic wounds)
    - Wounds, other than facial wounds, that are older than 24 hours in patients with risk factors for infection or poor wound healing
    - Lacerations with significant tissue loss in which suturing will cause too much tension across the suture line
- **Specialty consultation** – Consultation with a plastic surgeon or other surgical specialist is warranted for (see '[Guidelines for surgical consultation](#)' above):
  - A large or complex laceration that will require prolonged repair or grafting

- Severe contamination that cannot be properly managed at the bedside under local anesthesia
- Neurovascular compromise
- Fracture, amputation, or joint penetration (eg, laceration through the knee joint capsule) associated with the laceration
- Specialized repair necessary to ensure optimal cosmetic outcomes, such as:
  - Lacerations involving the nasal cartilage, ala, or columella (see "[Assessment and management of facial lacerations](#)")
  - Eyelid or orbital lacerations that involve the eyelid margin or tarsal plate, have protruding subcutaneous fat, or involve the tear duct or lacrimal gland ( [figure 5](#)) (see "[Eyelid lacerations](#)")
  - Selected auricle (ear) lacerations (see "[Assessment and management of auricle \(ear\) lacerations](#)", section on '[Indications for subspecialty consultation or referral](#)')

- **Pain control** – For most patients, infiltration of local anesthesia is effective for pain control during laceration repair ( [table 3](#)). Topical lidocaine-epinephrine-tetracaine (LET) rather than infiltrative anesthesia is suggested for pain control in children with uncomplicated facial or scalp lacerations. Regional anesthesia provides full local anesthesia without distorting tissues adjacent to the wound in selected wound sites. Nonpharmacologic (behavioral) interventions also alleviate anxiety and may prevent the need for procedural sedation. (See '[Pain control](#)' above.)

When local or regional anesthesia and nonpharmacologic interventions are not sufficient, minimal sedation is usually successful ( [table 4](#)). These patients should also receive local or regional anesthesia. (See "[Procedural sedation in children: Approach](#)" and "[Procedural sedation in children: Selection of medications](#)", section on '[Minimally painful procedures](#)' and "[Procedural sedation in adults in the emergency department: General considerations, preparation, monitoring, and mitigating complications](#)".)

- **Wound preparation** – Wound irrigation, foreign body removal, and necrotic tissue debridement are the main preventive measures against tissue infection. Suggested solutions and proper performance of these measures are discussed in detail separately. (See "[Minor wound evaluation and preparation for closure](#)", section on '[Preparation for closure](#)').

- **Equipment and suture selection** – Equipment used for skin laceration repair (including general guidance for suture material, needle, and size by wound location and for closure of skin, dermal, and intraoral lacerations) is provided in the tables ([table 5A-B](#)). (See '[Equipment](#)' above and '[Suture selection](#)' above.)
- **Choice of suturing technique** – The simple interrupted suture provides adequate closure for most uncomplicated skin lacerations ([figure 13](#) and [figure 14](#)) (see '[Percutaneous closure](#)' above). For deep or wide lacerations, the clinician should first perform dermal closure ([figure 17](#)) (see '[Dermal closure](#)' above). Wounds requiring other closure techniques include (see '[Special situations](#)' above):
  - Triangular wound with a flap (half-buried mattress) ([figure 19](#))
  - Wounds under tension (vertical) ([figure 20](#)) or horizontal mattress ([figure 21](#))
  - Long, straight wounds (running suture) ([figure 22](#))
- **Aftercare and suture removal** – Aftercare of skin lacerations closed with sutures includes the following:
  - For patients undergoing repair of traumatic skin lacerations and without sensitivity to [neomycin](#) or other components, we recommend application of a topical antibiotic ointment (such as topical [bacitracin](#) zinc or combination ointment containing neomycin sulfate, bacitracin zinc, and [polymyxin B](#) sulfate) to reduce the risk of wound infection (**Grade 1B**). For patients with sensitivity to neomycin, we suggest dressing the wound without topical antibiotics (**Grade 2C**). (See '[Topical antibiotics and wound dressing](#)' above.)
  - To enhance healing, we suggest that lacerations repaired with sutures be initially covered with an open (eg, sterile gauze or adhesive bandage) or semiocclusive (eg, polymer film) dressing (**Grade 2C**). The dressing should be left in place for at least 24 hours, after which time, wounds can be left open to air. (See '[Topical antibiotics and wound dressing](#)' above.)
  - For patients with lacerations closed with a nonabsorbable (eg, nylon or polypropylene) suture, we advise gentle cleaning using mild soap and water or one-half-strength peroxide 24 hours after closure to prevent crusting over the suture knots. Furthermore, these patients may be allowed to shower or wash the wound with soap and water without risking increased rates of infection. Lacerations closed with percutaneous absorbable sutures may also be gently cleaned 24 to 48 hours after placement, although some experts advise keeping the stitches dry until the suture is mostly

absorbed (typically, five days for fast-absorbing gut or 7 to 10 days for Vicryl Rapide). (See '[Bathing](#)' above.)

- For healthy patients with uncomplicated traumatic skin lacerations, we recommend local wound care without prophylactic antibiotics (**Grade 1A**) (see '[Prophylactic antibiotics](#)' above). The use of prophylactic antibiotics for selected wounds with higher baseline risks of infection is discussed in detail separately:
  - Animal and human bites (see "[Animal bites \(dogs, cats, and other mammals\): Evaluation and management](#)" and "[Human bites: Evaluation and management](#)")
  - Intraoral lacerations (see "[Assessment and management of intra-oral lacerations](#)", section on '[Prophylactic antibiotics](#)')
  - Nailbed injuries (see "[Evaluation and management of fingertip injuries](#)", section on '[Wound care and patient instructions](#)')
  - Patients with excessive wound contamination (eg, soil or water contamination) (see "[Soft tissue infections following water exposure](#)")
- The timing of nonabsorbable suture removal varies with the anatomic site, according to the expected rate of healing (see '[Suture removal](#)' above):
  - Eyelids – 5 days (3 days for low-tension wounds and up to 7 days for high-tension wounds)
  - Face – 5 days
  - Neck – 5 days
  - Scalp – 7 to 10 days
  - Trunk and upper extremities – 7 days
  - Lower extremities – 8 to 10 days
  - Digits, palm, and sole – 10 to 14 days

Use of UpToDate is subject to the [Terms of Use](#).

## REFERENCES

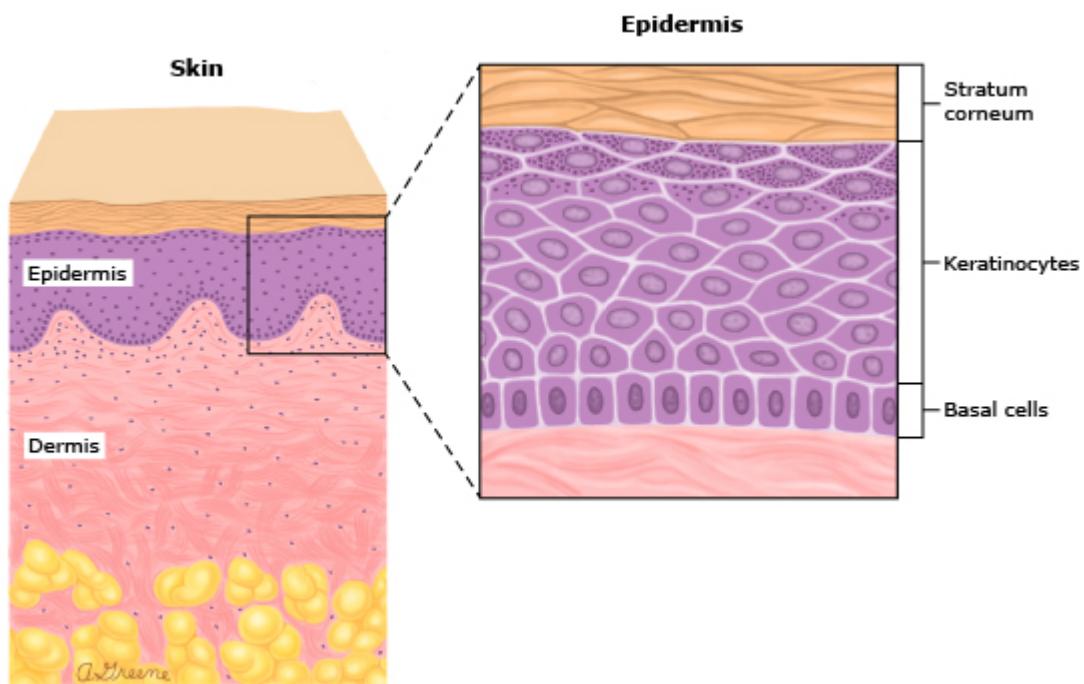
1. McNamara R, DeAngelis M. Laceration repair with sutures, staples, and wound closure tapes. In: Textbook of Pediatric Emergency Procedures, 2nd edition, King C, Henretig FM (Eds), Wolters Kluwer | Lippincott Williams & Wilkins, Philadelphia 2008. p.1005.

2. Lammers RL, Scrimshaw LE. Methods of wound closure. In: Clinical Procedures in Emergency Medicine, 7th ed, Roberts JR, Custalow CB, Thomsen TW (Eds), Elsevier, Philadelphia 2019. p.655.
3. Hollander JE, Singer AJ. Selecting sutures and needles for wound closure. In: Lacerations and acute wounds: An evidence-based guide, Singer AJ, Hollander JE (Eds), F.A Davis Company, Philadelphia 2003. p.98.
4. Perelman VS, Francis GJ, Rutledge T, et al. Sterile versus nonsterile gloves for repair of uncomplicated lacerations in the emergency department: a randomized controlled trial. Ann Emerg Med 2004; 43:362.
5. Byrne M, Aly A. The Surgical Suture. Aesthet Surg J 2019; 39:S67.
6. Pourang A, Crispin MK, Clark AK, et al. Use of 5-0 Fast Absorbing Gut versus 6-0 Fast Absorbing Gut during cutaneous wound closure on the head and neck: A randomized evaluator-blinded split-wound comparative effectiveness trial. J Am Acad Dermatol 2019; 81:213.
7. Webster RC, McCollough EG, Giandello PR, Smith RC. Skin wound approximation with new absorbable suture material. Arch Otolaryngol 1985; 111:517.
8. Susong JR, Neiner JR. Effect of petrolatum coating on fast-absorbing gut suture. J Am Acad Dermatol 2018; 79:952.
9. Tejani C, Sivitz AB, Rosen MD, et al. A comparison of cosmetic outcomes of lacerations on the extremities and trunk using absorbable versus nonabsorbable sutures. Acad Emerg Med 2014; 21:637.
10. Moran B, Humphrey S, Seal A, et al. Photographic assessment of postsurgical facial scars epidermally sutured with rapidly absorbable polyglactin 910 or nylon: A randomized clinical trial. J Am Acad Dermatol 2020; 83:1395.
11. Xu B, Xu B, Wang L, et al. Absorbable Versus Nonabsorbable Sutures for Skin Closure: A Meta-analysis of Randomized Controlled Trials. Ann Plast Surg 2016; 76:598.
12. Al-Abdullah T, Plint AC, Fergusson D. Absorbable versus nonabsorbable sutures in the management of traumatic lacerations and surgical wounds: a meta-analysis. Pediatr Emerg Care 2007; 23:339.
13. Luck R, Tredway T, Gerard J, et al. Comparison of cosmetic outcomes of absorbable versus nonabsorbable sutures in pediatric facial lacerations. Pediatr Emerg Care 2013; 29:691.
14. Kanegaye JT. A rational approach to the outpatient management of lacerations in pediatric patients. Curr Probl Pediatr 1998; 28:205.

15. Singer AJ, Rosenberg L. Basic suturing and handling techniques. In: *Lacerations and Acute Wounds: An Evidence-Based Guide*, Singer AJ, Hollander JE (Eds), F.A. Davis Company, Philadelphia 2003. p.108.
16. Austin PE, Dunn KA, Eily-Cofield K, et al. Subcuticular sutures and the rate of inflammation in noncontaminated wounds. *Ann Emerg Med* 1995; 25:328.
17. Mehta PH, Dunn KA, Bradfield JF, Austin PE. Contaminated wounds: infection rates with subcutaneous sutures. *Ann Emerg Med* 1996; 27:43.
18. Zuber TJ. The mattress sutures: vertical, horizontal, and corner stitch. *Am Fam Physician* 2002; 66:2231.
19. Lloyd JD, Marque MJ 3rd, Kacprowicz RF. Closure techniques. *Emerg Med Clin North Am* 2007; 25:73.
20. Jones JS, Gartner M, Drew G, Pack S. The shorthand vertical mattress stitch: evaluation of a new suture technique. *Am J Emerg Med* 1993; 11:483.
21. Dire DJ, Coppola M, Dwyer DA, et al. Prospective evaluation of topical antibiotics for preventing infections in uncomplicated soft-tissue wounds repaired in the ED. *Acad Emerg Med* 1995; 2:4.
22. Waterbrook AL, Hiller K, Hays DP, Berkman M. Do topical antibiotics help prevent infection in minor traumatic uncomplicated soft tissue wounds? *Ann Emerg Med* 2013; 61:86.
23. Langford JH, Artemi P, Benrimoj SI. Topical antimicrobial prophylaxis in minor wounds. *Ann Pharmacother* 1997; 31:559.
24. HINMAN CD, MAIBACH H. EFFECT OF AIR EXPOSURE AND OCCLUSION ON EXPERIMENTAL HUMAN SKIN WOUNDS. *Nature* 1963; 200:377.
25. Agren MS, Karlsmark T, Hansen JB, Rygaard J. Occlusion versus air exposure on full-thickness biopsy wounds. *J Wound Care* 2001; 10:301.
26. Toon CD, Sinha S, Davidson BR, Gurusamy KS. Early versus delayed post-operative bathing or showering to prevent wound complications. *Cochrane Database Syst Rev* 2015; :CD010075.
27. Heal C, Buettner P, Raasch B, et al. Can sutures get wet? Prospective randomised controlled trial of wound management in general practice. *BMJ* 2006; 332:1053.
28. Noe JM, Keller M. Can stitches get wet? *Plast Reconstr Surg* 1988; 81:82.
29. Cummings P, Del Beccaro MA. Antibiotics to prevent infection of simple wounds: a meta-analysis of randomized studies. *Am J Emerg Med* 1995; 13:396.

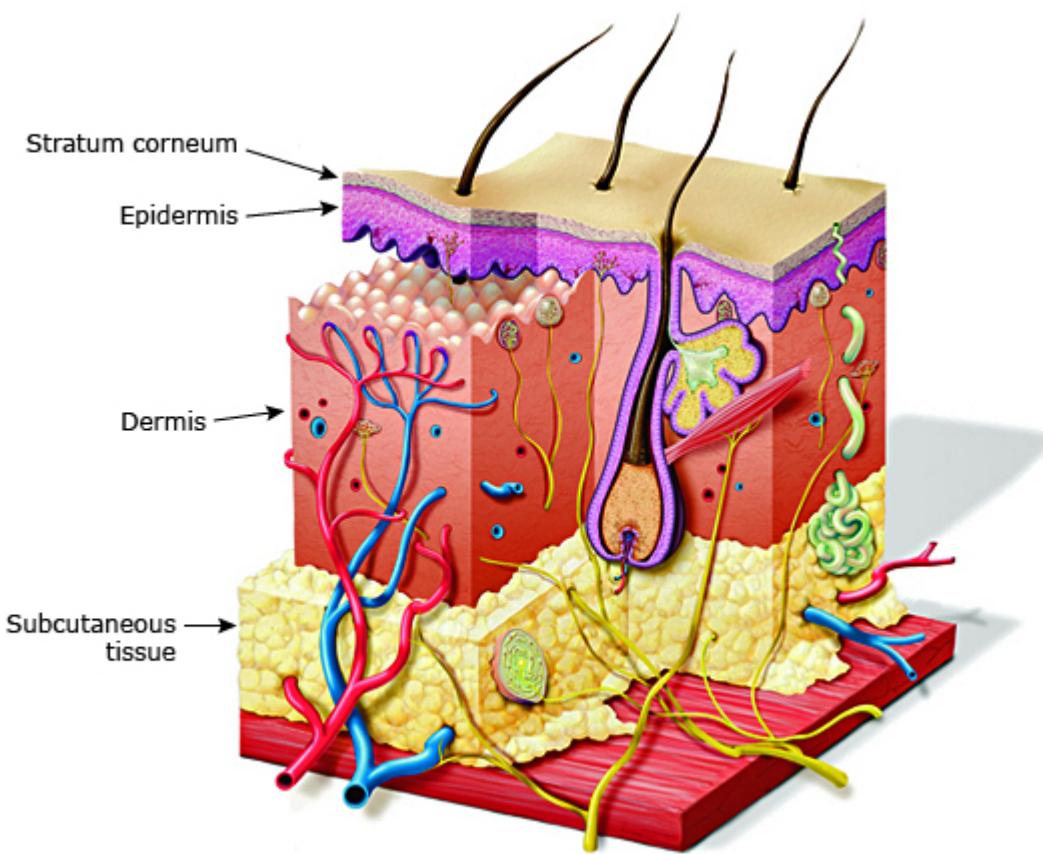
## GRAPHICS

### Normal skin



Graphic 70895 Version 5.0

## Skin anatomy



The skin and common disorders. The skin is the body's largest organ. It covers the entire body and weighs approximately six pounds. The skin includes two primary layers: the epidermis and the dermis. The epidermis has important protective functions. It protects against injury and excessive water loss. It also prevents disease-causing microorganisms from entering the body. The thick dermis contains blood vessels, nerve endings, and glands that respond to heat, pressure, and pain. Beneath the dermis, the subcutaneous layer is made up of loose connective tissue and fat (adipose) tissue. This layer acts as a cushion for the skin, helps maintain body heat, and is a store of energy.

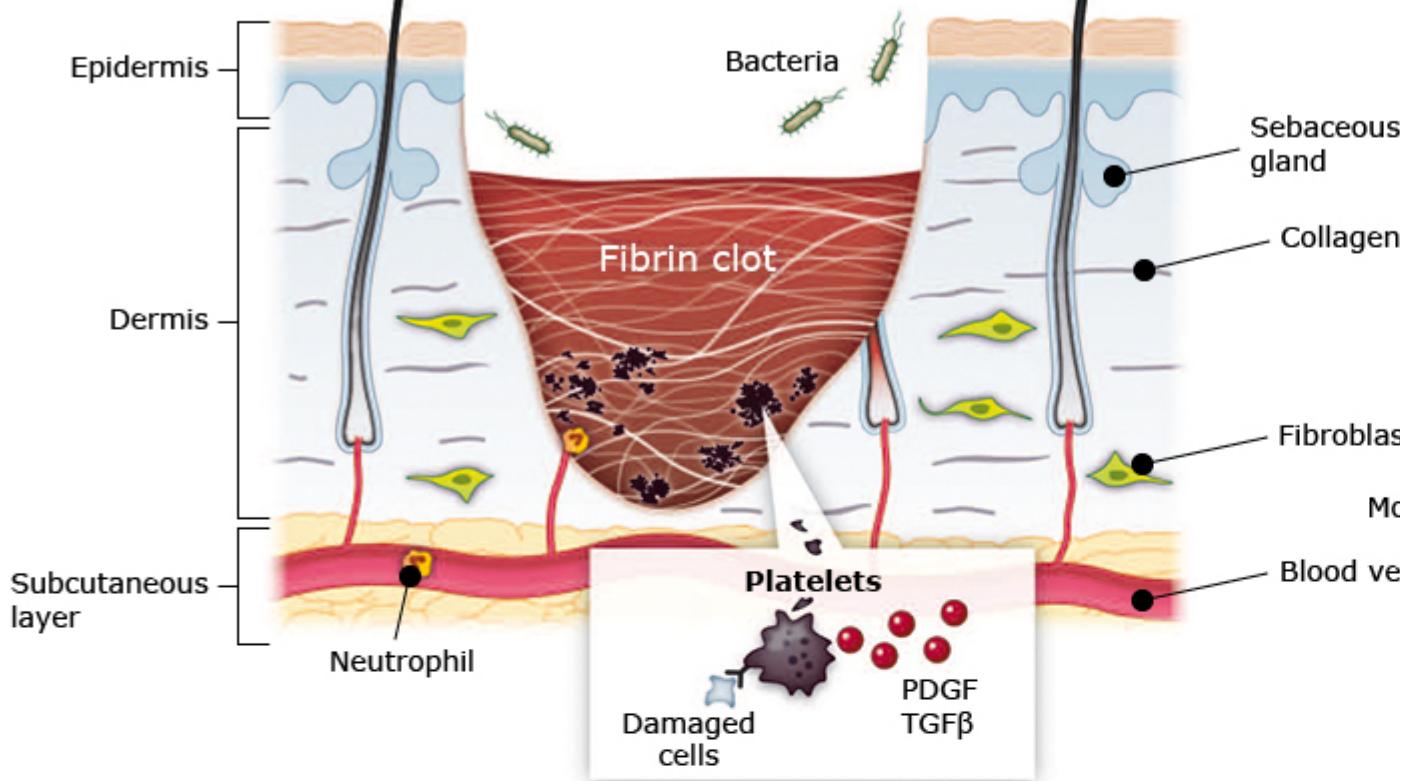
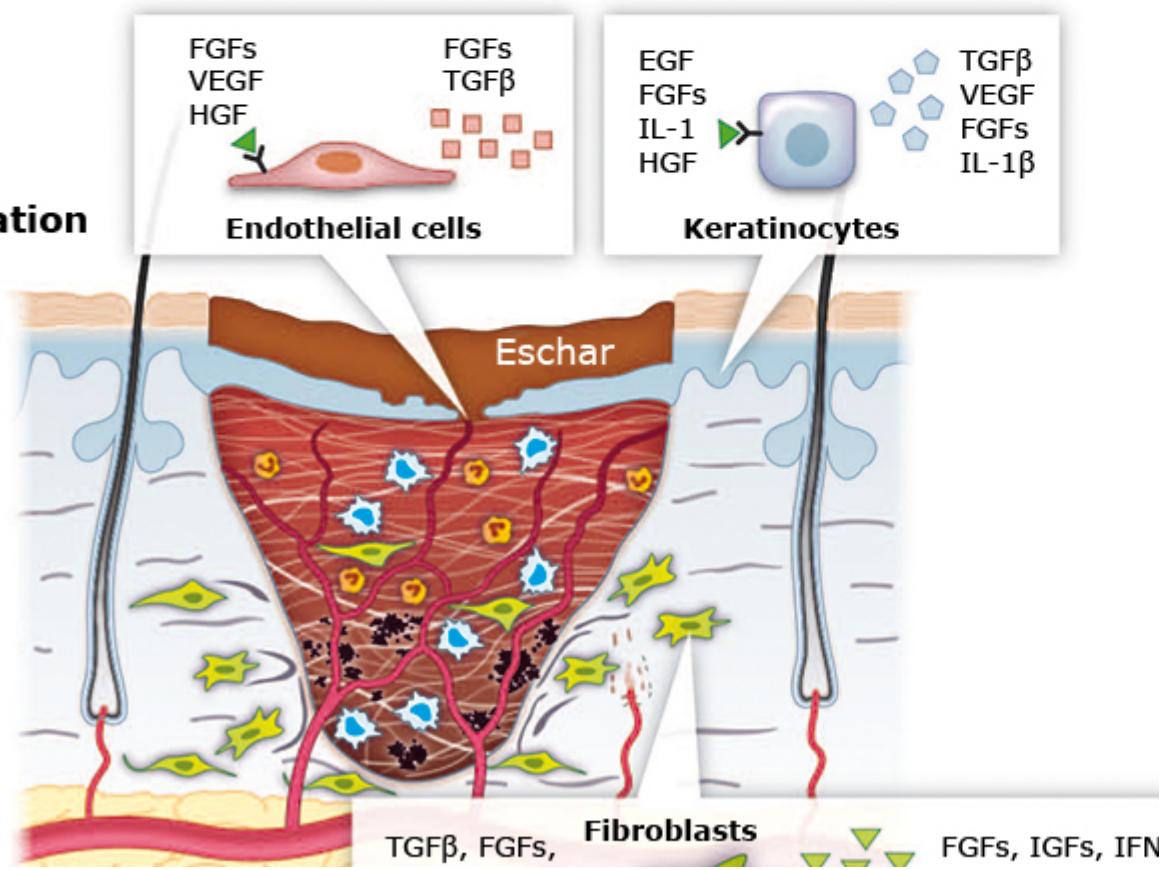
---

*Reproduced with permission. Copyright © 2009 Anatomical Chart Company.*

---

Graphic 54157 Version 5.0

## **Stages of wound healing**

**A****Hemostasis****C****Proliferation**



Wound healing is classically divided into 4 stages: (A) hemostasis, (B) inflammation, (C) proliferation, and (D) remodeling. Each stage is characterized by key molecular and cellular events and is coordinated by a host of secreted factors that are recognized and released by the cells of the wounding response. A representative subset of major factors are depicted.

---

PDGF: platelet-derived growth factor; TGF: transforming growth factor; FGFs: fibroblast growth factors; IL-1: interleukin-1; TNF: tumor necrosis factor; KGF: keratinocyte growth factor; IGF: insulin-like growth factor; IFN: interferon; VEGF: vascular endothelial growth factor; HGF: hepatocyte growth factor; MMP: matrix metalloproteinase; TIMP: tissue inhibitor of metalloproteinase.

---

*Reproduced from: Sun BK, Siprashvili Z, Khavari PA. Advances in skin grafting and treatment of cutaneous wounds. Science 2014; 346:941.*

---

Graphic 128480 Version 1.0

## Wound management and tetanus prophylaxis

Previous doses of tetanus toxoid*	Clean and minor wound		All other wounds¶	
	Tetanus toxoid-containing vaccine△	Human tetanus immune globulin	Tetanus toxoid-containing vaccine△	Human tetanus immune globulin◊
<3 doses or unknown	Yes§	No	Yes§	Yes
≥3 doses	Only if last dose given ≥10 years ago	No	Only if last dose given ≥5 years ago‡	No

Appropriate tetanus prophylaxis should be administered as soon as possible following a wound but should be given even to patients who present late for medical attention. This is because the incubation period is quite variable; most cases occur within 8 days, but the incubation period can be as short as 3 days or as long as 21 days. For patients who have been vaccinated against tetanus previously but who are not up to date, there is likely to be little benefit in administering human tetanus immune globulin more than 1 week or so after the injury. However, for patients thought to be completely unvaccinated, human tetanus immune globulin should be given up to 21 days following the injury; Td or Tdap should be given concurrently to such patients.

DT: diphtheria-tetanus toxoids adsorbed; DTP/DTwP: diphtheria-tetanus whole-cell pertussis; DTaP: diphtheria-tetanus-acellular pertussis; Td: tetanus-diphtheria toxoids adsorbed; Tdap: booster tetanus toxoid-reduced diphtheria toxoid-acellular pertussis; TT: tetanus toxoid.

\* Tetanus toxoid may have been administered as DT, DTP/DTwP (no longer available in the United States), DTaP, Td, Tdap, or TT (no longer available in the United States).

¶ Such as, but not limited to, wounds contaminated with dirt, feces, soil, or saliva; puncture wounds; avulsions; or wounds resulting from missiles, crushing, burns, or frostbite.

△ The preferred vaccine preparation depends upon the age and vaccination history of the patient:

- <7 years: DTaP.
- Underimmunized children ≥7 and <11 years who have not received Tdap previously: Tdap. Children who receive Tdap at age 7 through 9 years should receive another dose of Tdap at age 11 through 12 years.
- ≥11 years: A single dose of Tdap is preferred to Td for all individuals in this age group who have not previously received Tdap; otherwise, Td or Tdap can be administered without preference. Pregnant women should receive Tdap during each pregnancy.

◊ 250 units intramuscularly at a different site than tetanus toxoid; intravenous immune globulin should be administered if human tetanus immune globulin is not available. Persons with HIV infection or severe immunodeficiency who have contaminated wounds should also receive human tetanus immune globulin, regardless of their history of tetanus immunization.

§ The vaccine series should be continued through completion as necessary.

¥ Booster doses given more frequently than every 5 years are not needed and can increase adverse effects.

---

*References:*

1. Liang JL, Tiwari T, Moro P, et al. *Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP)*. MMWR Recomm Rep 2018; 67:1.
  2. Havers FP, Moro PL, Hunter P, et al. *Use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccines: Updated recommendations of the Advisory Committee on Immunization Practices - United States, 2019*. MMWR Morb Mortal Wkly Rep 2020; 69:77.
- 

Graphic 61087 Version 34.0

## Langer's lines of the face



*Reproduced with permission from: Blackbourne LH. Advanced Surgical Recall, 2nd ed, Lippincott Williams & Wilkins, Baltimore 2004. Copyright © 2004 Lippincott Williams & Wilkins.*

---

Graphic 50913 Version 2.0

## Choice of closure method for minor wounds

Method	Wound selection*	Wound with actively oozing blood	Use for wounds in hair or near moist regions of the body (eg, axilla, perineum)	Use if wound under tension (eg, hands, feet, or over joints)	Use in patients with conditions associated with poor healing <sup>¶</sup>	Pain of repair	Speed of closure
Sutures	Any laceration through the dermis, especially wounds that require careful wound approximation (eg, vermillion border)	Yes	Yes	Yes	Yes	+++	Slower
Staples	Scalp wounds, wounds in noncosmetic areas, especially long, linear wounds	Yes	Yes	Yes	Yes	+++	Fast
Tissue adhesives	Linear wounds under low tension, skin tears and flaps in patients with fragile skin (eg, older adults)	No	No <sup>Δ</sup>	No <sup>◊</sup>	Yes	None/+	Fast
Wound-closure tapes	Linear, low-tension lacerations, skin tears and flaps in	No	No	No	Yes	None/+	Fast

patients with  
fragile skin  
(eg, older  
adults)

\* Wounds eligible for closure must be appropriately irrigated, debrided of all devitalized tissue and foreign bodies, and have no signs of infection. Refer to UpToDate topics on minor wound preparation.

¶ For example, diabetes mellitus, peripheral vascular disease, chronic steroid use, or history of keloids. The clinician should use judgment regarding whether wound closure is preferred to healing by secondary intention in such patients. Factors to take into account include the size of the wound, age of the wound, degree of wound contamination, and the severity of the underlying disorder.

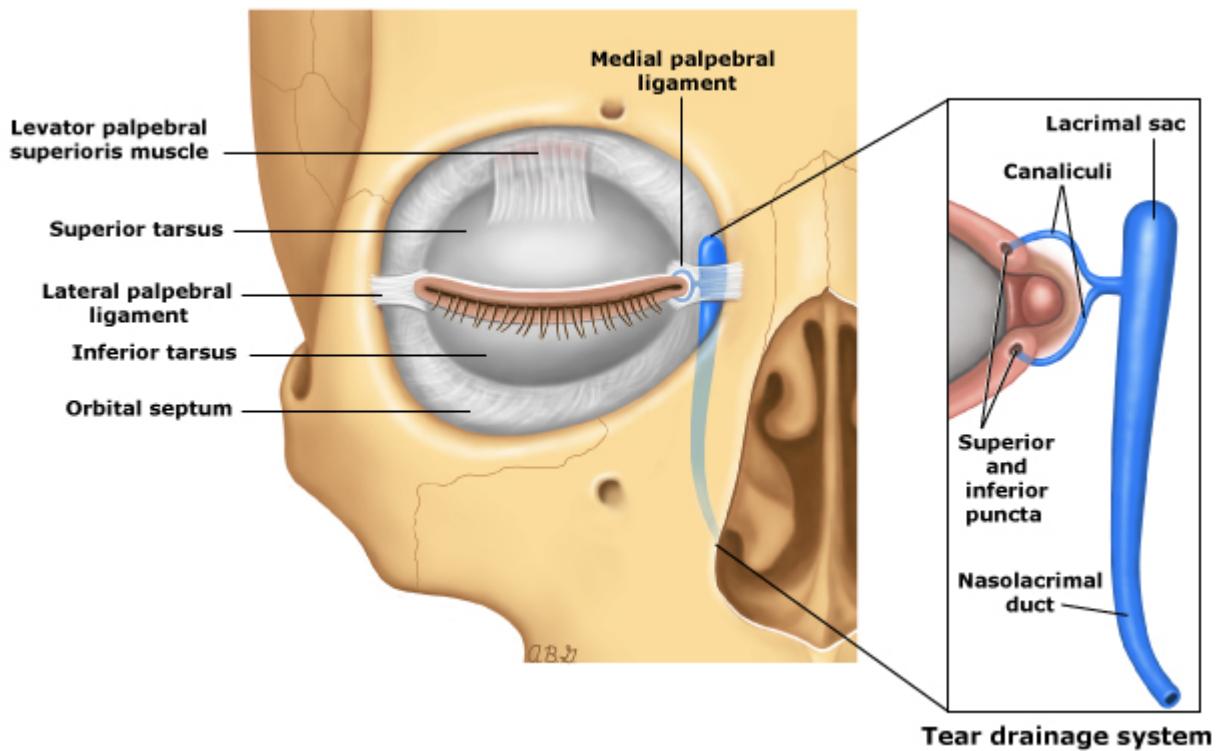
Δ Tissue adhesives may be used on hairy areas such as the scalp, if the hair is first trimmed.

◊ Tissue adhesives can be used on hands, feet, or over joints, if the involved area is immobilized with a splint or cast.

---

Graphic 90472 Version 7.0

## Important anatomic structures that can be injured during eye trauma



Lacerations to the eyelid may involve important underlying structures such as the tear duct apparatus, palpebral ligaments, and muscles. Failure to recognize these injuries can result in significant functional and cosmetic impairment.

---

Graphic 68267 Version 5.0

## Comparison of commonly infiltrated local anesthetics

Infiltration anesthetic	Concentration (percent)	Physiochemical properties				Maximum allowed dose mg/kg
		Lipid:water solubility	Relative potency	Onset of action (minutes)	Duration (minutes)	
<b>Lidocaine 1%</b>						
Without epinephrine	1	2.9	2	2 to 5	50 to 120	4 to 5
With epinephrine (1:200,000)	1	2.9	2	2 to 5	60 to 180	5 to 7
<b>Mepivacaine 1%</b>						
Without epinephrine	1	0.8	2	2 to 5	50 to 120	5
With epinephrine <sup>¶</sup> (1:200,000)	1	0.8	2	2 to 5	60 to 180	5 to 7
<b>Bupivacaine 0.25%</b>						
Without epinephrine	0.25	27.5	8	5 to 10	240 to 480	2 to 2.5
With epinephrine (1:200,000)	0.25	27.5	8	5 to 10	240 to 480	3
<b>Procaine 1%<sup>Δ</sup></b>						
Without epinephrine	1	0.6	1	5 to 10	60 to 90	7 to 10

\* Maximum total dose for intradermal-subcutaneous infiltration anesthesia may vary according to site of administration and concomitant use of vasoconstrictors. The maximum dosing values in this table are at the lower end of what many experts regard as safe. Lower doses and concentrations than what are listed are generally used for children, debilitated patients, or those with cardiac disease. Note that preparations of infiltrated local anesthetics are available in concentrations **other** than those shown in table. Maximum allowable and maximum total volumes shown apply **only** to the specific concentration of the preparation in table. Toxicity may occur with doses within the suggested range, especially with inadvertent vascular injection.

¶ Not commercially available, provider must mix.

Δ Not commercially available in the United States or Canada.

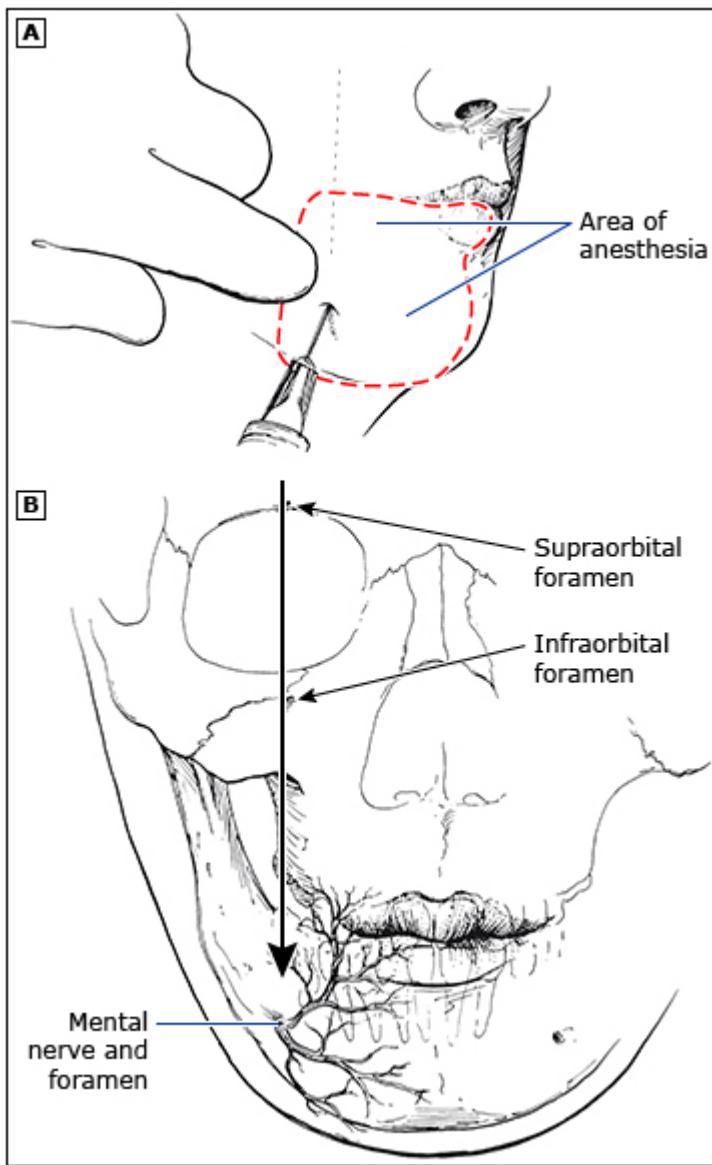
---

Data from:

1. McCreight A, Stephan M. Local and regional anesthesia. In: *Textbook of Pediatric Emergency Procedures*, 2nd edition, King C, Henretig FM (Eds), Lippincott Williams & Wilkins, Philadelphia 2008.
  2. McGee DL. Anesthetic and analgesic technique. In: *Roberts and Hedges Clinical Procedures in Emergency Medicine*, 5th edition, Roberts JR, Hedges JR (Eds), Saunders Elsevier, Philadelphia 2010.
- 

Graphic 56799 Version 19.0

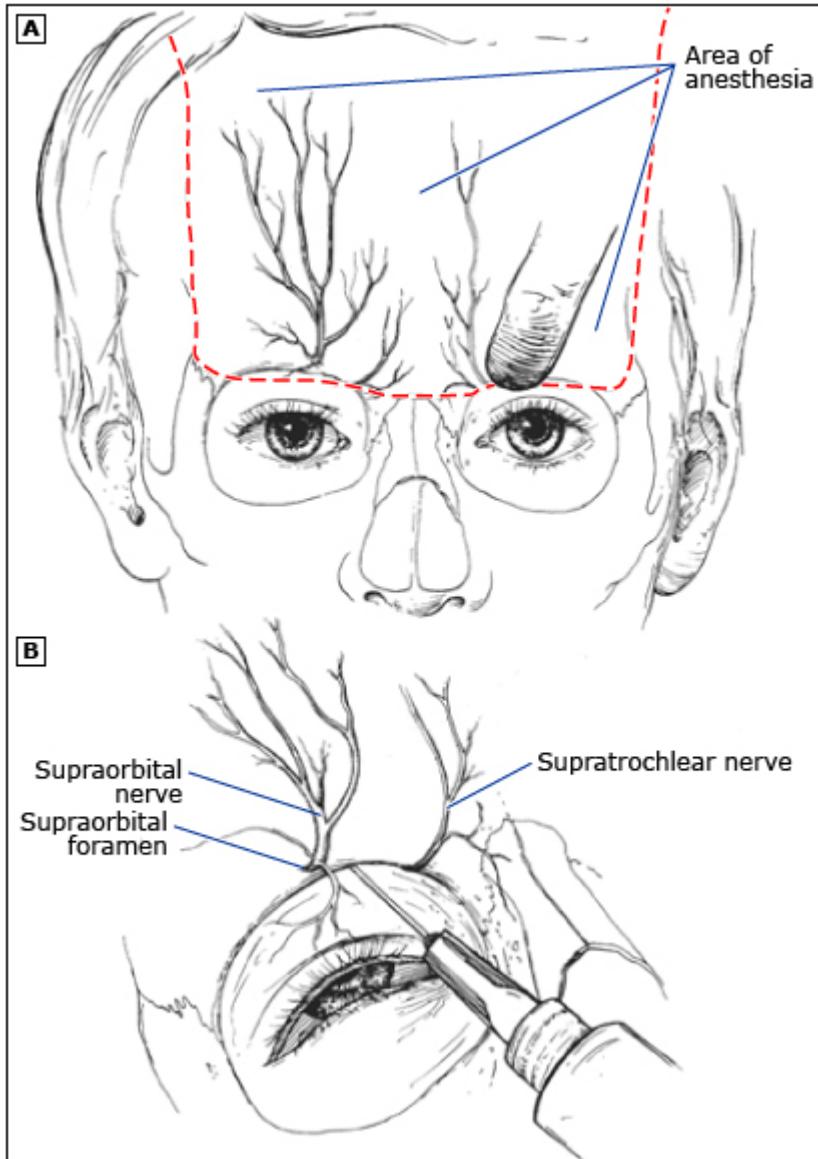
## Mental (infraoral) nerve block



The mental nerve block anesthetizes the lower lip, skin below the lip, and chin as shown in A above. To perform, locate the mental nerve foramen by palpation of the mandible in line with the infraorbital and supraorbital foramen as shown in B above. After cleansing, insert a small needle (eg, 25 or 27 gauge) through the skin just medial and directed towards the foramen (see A above). Insert the needle to a depth of approximately 0.5 cm and inject one to two mL of local anesthetic (eg, buffered lidocaine 1 percent with epinephrine). In older children and adolescents, who report paresthesias, withdraw the needle until paresthesias resolve prior to injection of anesthetic.

*Reproduced with permission from: Cimpello LB, Deutsch RJ, Dixon C, et al. Illustrated techniques of pediatric emergency procedures. In: Textbook of Pediatric Emergency Medicine, 6th edition, Fleisher GR, Ludwig S (Eds), Lippincott Williams & Wilkins, Philadelphia 2010. Copyright © 2010 Lippincott Williams & Wilkins. [www.lww.com](http://www.lww.com).*

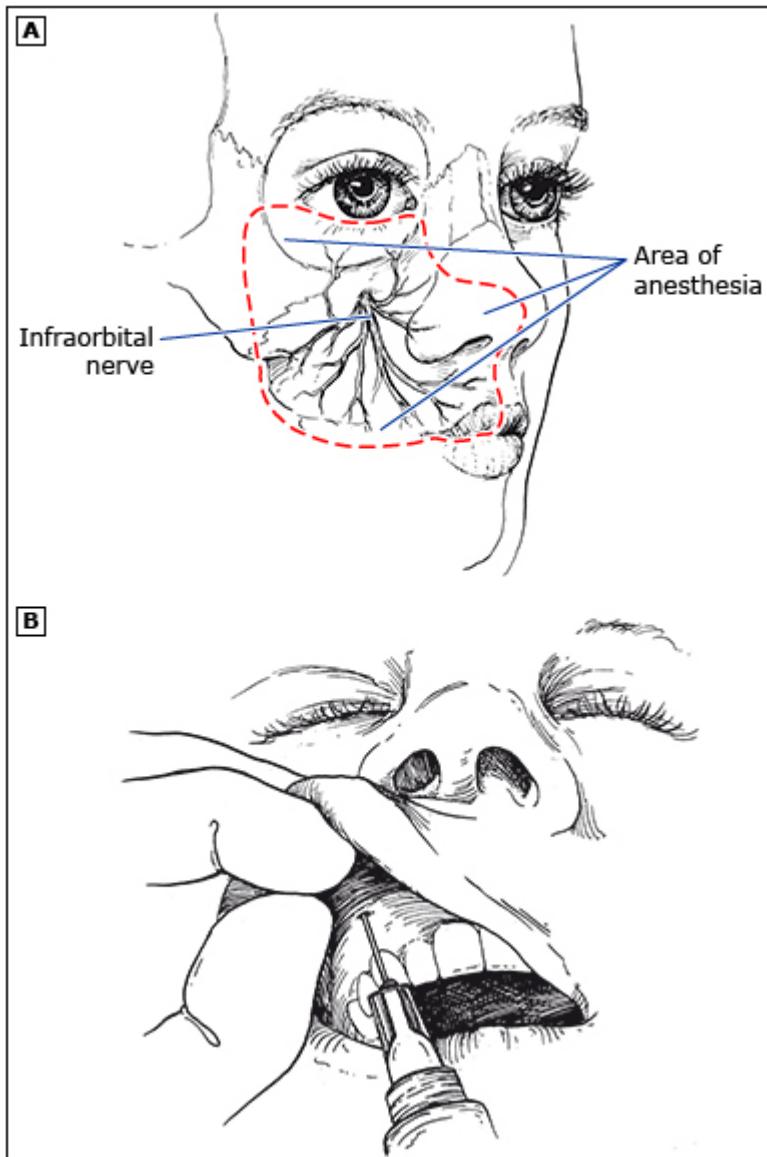
## Supraorbital and supratrochlear nerve block



This block anesthetizes the forehead and anterior third of the scalp. To perform, locate the supraorbital nerve foramen in the medial aspect of the supraorbital ridge as shown in A. After cleansing, insert a small needle (25 or 27 gauge) to a depth of 0.5 to 1 cm just medial and directed towards the foramen as shown in B. Inject 1 to 3 mL of local anesthetic. In older children, adolescents, and adults who report paresthesias, withdraw the needle until paresthesias resolve prior to injection of anesthetic. Allow 5 to 10 minutes for complete anesthesia to occur.

Reproduced with permission from: Cimpello LB, Deutsch RJ, Dixon C, et al. Illustrated techniques of pediatric emergency procedures. In: Textbook of Pediatric Emergency Medicine, 6th edition, Fleisher GR, Ludwig S (Eds), Lippincott Williams & Wilkins, Philadelphia 2010. Copyright © 2010 Lippincott Williams & Wilkins. [www.lww.com](http://www.lww.com).

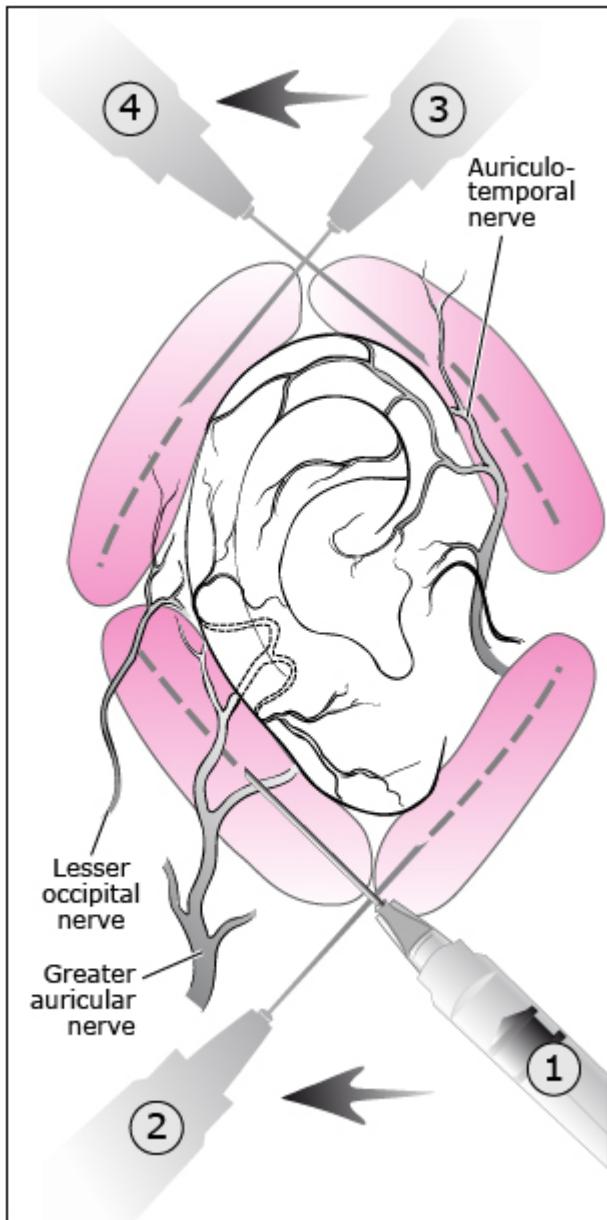
## Infraorbital nerve block (intraoral approach)



The infraorbital nerve block anesthetizes the upper lip, lateral nose, lower eyelid, and medial cheek as shown in A. To perform, locate the infraorbital foramen with the middle finger and lift the upper lip with the index finger and thumb as shown in B. Numb the upper gum line near the second bicuspid using topical anesthetic (eg, 2 percent viscous lidocaine on a Q-tip). Insert a small needle (gauge 25 or 27) through the gum line and at the second bicuspid as shown until the needle is palpated at the infraorbital foramen (approximately 2 cm in the adolescent or adult). If the patient reports paresthesias, withdraw the needle until paresthesias resolve. Inject one to two mL of buffered lidocaine 1 percent with epinephrine. Allow 5-10 minutes for complete anesthesia to occur.

*Reproduced with permission from: Cimpollo LB, Deutsch RJ, Dixon C, et al. Illustrated techniques of pediatric emergency procedures. In: Textbook of Pediatric Emergency Medicine, 6th edition, Fleisher GR, Ludwig S (Eds), Lippincott Williams & Wilkins, Philadelphia 2010. Copyright © 2010 Lippincott Williams & Wilkins. [www.lww.com](http://www.lww.com).*

## Auricular field block

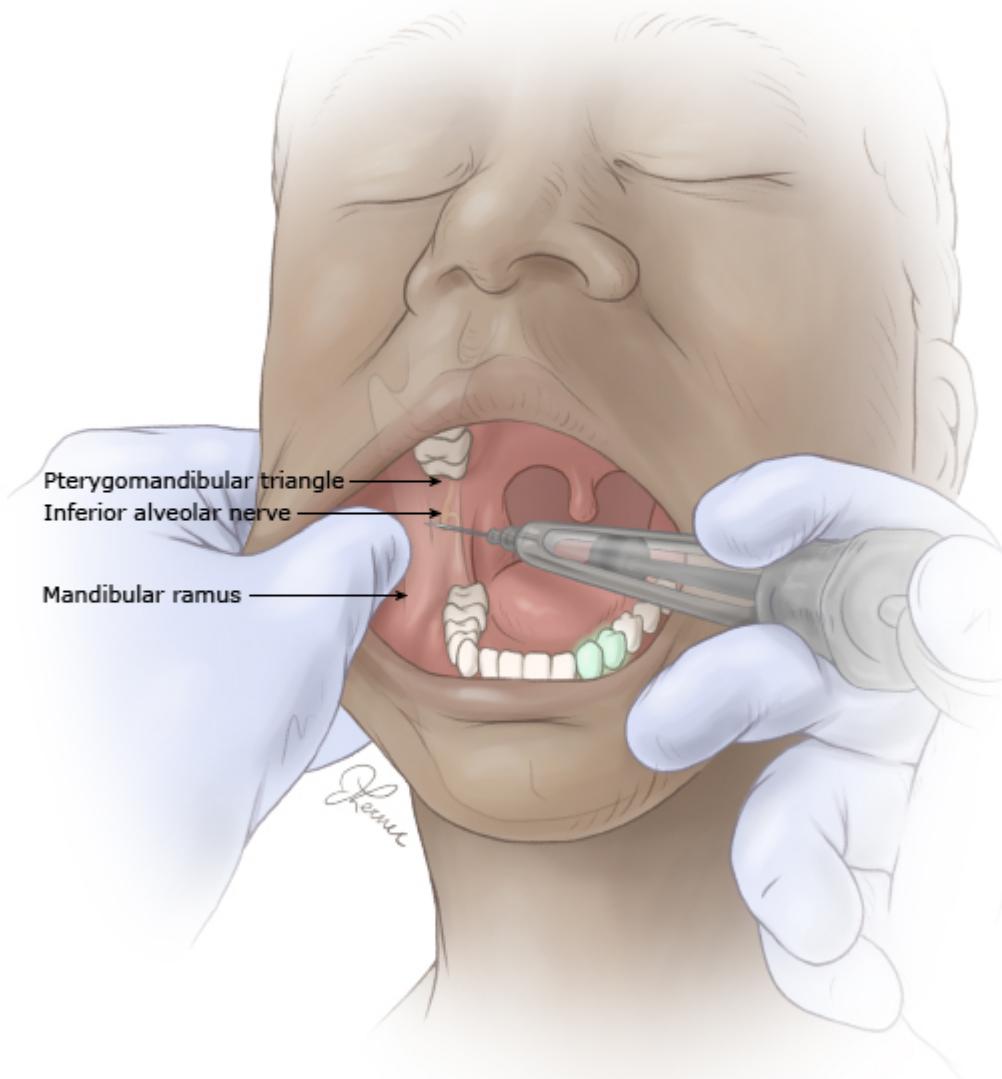


A regional auricular block is indicated for repair of extensive auricular lacerations or to avoid local tissue distortion when cosmetic alignment is important. This technique provides anesthesia to the auricle with the exception of the concha and meatus. After cleansing the ear and surrounding skin with antiseptic solution, anesthetize with buffered lidocaine 1 percent **with** epinephrine using a long (1.5 inch), small gauge (25 or 27 gauge) needle and injecting along a straight track within the skin covering the mastoid and temporal bone anterior and behind the auricle as shown in the figure. The total dose of buffered lidocaine administered should not exceed 7 mg/kg (0.7 mL/kg) of lidocaine 1 percent. Lidocaine **with** epinephrine should be **avoided** when directly infiltrating the ear itself.

Reproduced with permission from: Martinez NR, Friedman MJ. External ear procedures. In: Textbook of Pediatric Emergency Procedures, 2nd Edition. King C, Henretig FM (Eds), Lippincott Williams & Wilkins, Philadelphia, 2008. Copyright © 2008 Lippincott Williams & Wilkins. [www.lww.com](http://www.lww.com).

Graphic 77328 Version 10.0

## Inferior alveolar nerve block



When administering the inferior alveolar block, the target area lies on the medial surface of the mandibular ramus at the inferior tip of the pterygomandibular triangle and adjacent to where the inferior alveolar nerve exits the mandible. The needle is inserted parallel to the mandibular occlusal plane as shown, with the syringe overlying the first and second premolars (colored green) on the opposite side of the mandible; the syringe is rotated approximately 30 degrees (in a horizontal plane) during the injection so that when the injection is complete, the syringe barrel overlies the incisors.

## Finger digital block



To perform a finger web space block, insert the needle into the subcutaneous tissue of the web space at the base of the finger, just distal to the MCP (metacarpal/phalangeal) joint. Slowly advance the needle straight through the web space toward the palmar surface, injecting as the needle is advanced. The black ink line illustrates the likely course of the dorsal digital nerve.

---

*Courtesy of Robert Baldor, MD.*

---

Graphic 50533 Version 3.0

## Great toe digital block



To perform a three-sided toe block or four-sided ring block, insert the needle just distal to the MTP (metatarsal/phalangeal) joint at the lateral edge of the toe. Slowly advance the needle straight from the dorsal to the plantar surface, injecting as the needle is advanced. This picture shows the position of the needle just after it has been inserted.

---

*Courtesy of Robert Baldor, MD.*

---

Graphic 62289 Version 3.0

## Great toe digital block



To perform a three-sided toe block or four-sided ring block, insert the needle just distal to the MTP (metatarsal/phalangeal) joint at the lateral edge of the toe. Slowly advance the needle straight from the dorsal to the plantar surface, injecting as the needle is advanced. This picture shows the position of the needle after it has been advanced.

---

*Courtesy of Robert Baldor, MD.*

---

Graphic 74315 Version 3.0

## Commonly used agents for pediatric procedural sedation in children without IV access

**Sedation with these agents can result in significant respiratory depression and other adverse effects. Children should receive appropriate monitoring by personnel skilled in pediatric resuscitation until full recovery has occurred. Please refer to UpToDate topics on procedural sedation in children for more details.**

Agent	Dose	Onset (minutes)	Duration (minutes)	Comments
Nitrous oxide (N <sub>2</sub> O)	50 to 70% N <sub>2</sub> O administered with oxygen typically delivered through a demand valve system with scavenging capability	<0.5	Recovery typically within 3 to 5 minutes of cessation of N <sub>2</sub> O delivery	<ul style="list-style-type: none"><li>▪ Primarily used in children older than 4 years of age.</li><li>▪ Provides amnesia, mild to moderate anxiolysis, mild to moderate sedation, and mild analgesia.</li><li>▪ Common adverse effects: Vomiting and dysphoria.</li><li>▪ Clinicians must know how to test and use the equipment in use in their facility. In addition, equipment must be carefully maintained and periodically tested to ensure adequate safety.</li><li>▪ Relatively contraindications and precautions: Nausea and vomiting.</li><li>▪ Absolute contraindications: Pregnancy and conditions with trapped gas within body cavities (eg, bowel obstruction, pneumothorax, middle ear infection).</li></ul>
Midazolam	0.25 to 0.5 mg/kg PO or SL (maximum single dose: 20 mg)  0.2 to 0.3 mg/kg IN* (maximum single dose: 10 mg)	20 to 30	30 to 60	<ul style="list-style-type: none"><li>▪ Midazolam has poor oral bioavailability (15 to 35%). IN, SL, and buccal has bioavailability approaching 70 to 80% during gradual administration.</li><li>▪ Provides amnesia, mild anxiolysis and mild sedation for procedures that do not require full immobilization (eg, laceration repair with local topical anesthesia).</li></ul>

	Buccal dosing is as for IN			<ul style="list-style-type: none"> <li>▪ Flumazenil can reverse effects but should be avoided in patients with seizure disorder or who are chronically maintained on benzodiazepines.</li> <li>▪ Common adverse effects: Respiratory depression and apnea, especially if combined with opioids or other sedatives; paradoxical reactions including hyperactivity, aggressive behavior, and inconsolable crying.</li> </ul>
Dexmedetomidine	2.5 to 4 mcg/kg IN (maximum single dose: 200 mcg)	20 to 30	30 to 45	<ul style="list-style-type: none"> <li>▪ Provides mild anxiolysis and mild sedation for nonpainful and minimally invasive procedures.</li> <li>▪ Common adverse events: Bradycardia or hypertension with IV administration, uncommon with IN use.</li> <li>▪ Relative contraindications and precautions: Children with dehydration or reduced cardiac output.</li> <li>▪ Absolute contraindications: Patients receiving digoxin or other medications acting on sinus node or with sinus node dysfunction unless it is provided by clinicians with training and expertise in cardiac anesthesia.</li> </ul>
Ketamine	4 to 5 mg/kg IM	5 to 10	30 to 60	<ul style="list-style-type: none"> <li>▪ Provides sedation AND analgesia for moderately to severely painful procedures.</li> <li>▪ Common adverse events: Vomiting, emergence reaction; frequency of vomiting is reduced by premedication with ondansetron (0.15 mg/kg, typical dose 4 mg) or by co-administration of propofol.</li> <li>▪ Compared with IV administration IM ketamine increases the risk of</li> </ul>

vomiting and the duration of sedation and recovery.

- Laryngospasm and apnea occur rarely, but bag-mask ventilation may be needed in about 1% of sedated patients.
- Relative contraindications and precautions: Age younger than 1 month, active pulmonary infections (including URI), known or suspected cardiac disease, suspected increased intracranial pressure (eg, head trauma with signs or symptoms, intracranial mass, or hydrocephalus), glaucoma or acute eye injury (open globe), porphyria, thyroid disease, or seizures.
- Absolute contraindications: Age younger than 3 months or patients with known or suspected psychosis.

---

PO: oral; SL: sublingual; IN: intranasal; IM: intramuscular; URI: upper respiratory infection.

\* Pretreatment with lidocaine spray (10 mg/puff) one minute prior to intranasal midazolam decreases nasal mucosal irritation. Intranasal preparation is not commercially available in the United States; 5 mg/mL injectable solution may be given IN.

---

Graphic 83889 Version 10.0

## Types of sutures for skin and mucous membrane laceration repair

Suture (brand names)	Site	Type	Tensile strength	Comments
<b>Superficial skin closure</b>				
Nylon (Ethilon, Unilon, Riverlon)	▪ Any	Nonabsorbable	Good	<ul style="list-style-type: none"> <li>▪ Good handling; requires at least 3 to 4 throws to make a secure knot</li> <li>▪ Stretches to handle wound swelling</li> <li>▪ Green color available for suturing in scalp or eyebrows</li> </ul>
Polybutester (Novalfil)	▪ Any	Nonabsorbable	Good	<ul style="list-style-type: none"> <li>▪ Similar to nylon</li> </ul>
Polypropylene (Prolene, Synthalin, Unilene)	▪ Any	Nonabsorbable	Best	<ul style="list-style-type: none"> <li>▪ Slippery; requires at least 4 to 5 throws to make a secure knot</li> <li>▪ Stretches to handle wound swelling</li> <li>▪ Blue color available for suturing in the scalp or eyebrows</li> </ul>
Fast-absorbing gut	▪ Face	Absorbable	Low	<ul style="list-style-type: none"> <li>▪ Typically holds for 4 to 6 days</li> <li>▪ Breaks easily during tying (especially small-diameter [eg, 6-0 or higher] suture)</li> <li>▪ Tan color can be difficult to see</li> <li>▪ Often used in young children</li> <li>▪ Also used for nailbed laceration repair</li> </ul>
Polyglactin (Vicryl Rapide)	<ul style="list-style-type: none"> <li>▪ Scalp</li> <li>▪ Skin laceration under cast or splint</li> </ul>	Absorbable	Fair	<ul style="list-style-type: none"> <li>▪ Typically holds for 7 to 10 days</li> <li>▪ Alternative to nonabsorbable suture when removal may be</li> </ul>

				difficult or patient follow-up is not assured
Chromic gut	<ul style="list-style-type: none"> <li>▪ Scalp</li> <li>▪ Fingertip and nailbed</li> <li>▪ Laceration under cast or splint</li> </ul>	Absorbable	Fair	<ul style="list-style-type: none"> <li>▪ Typically holds for 10 to 14 days</li> <li>▪ Alternative to nonabsorbable suture or staples when removal may be difficult or patient follow-up is not assured</li> </ul>

### Deep (subcutaneous) closure

Polyglactin (Vicryl)	<ul style="list-style-type: none"> <li>▪ Any</li> </ul>	Absorbable	Good	<ul style="list-style-type: none"> <li>▪ Holds for 30 days</li> <li>▪ Braided synthetic; good handling</li> </ul>
Poliglecaprone 25 (Monocryl)	<ul style="list-style-type: none"> <li>▪ Any</li> </ul>	Absorbable	Fair	<ul style="list-style-type: none"> <li>▪ Holds for 7 to 10 days</li> <li>▪ Monofilament suture; easy to handle and tie</li> <li>▪ Also used for subcutaneous closure of facial lacerations</li> </ul>

### Mucous membrane closure

Chromic gut	<ul style="list-style-type: none"> <li>▪ Oral mucosa or tongue</li> </ul>	Absorbable	Fair	<ul style="list-style-type: none"> <li>▪ Typically holds for 10 to 14 days</li> <li>▪ More rapidly absorbed in the oral cavity</li> </ul>
Polyglactin (Vicryl)	<ul style="list-style-type: none"> <li>▪ Oral mucosa or tongue</li> </ul>	Absorbable	Good	<ul style="list-style-type: none"> <li>▪ Typically holds for 30 days</li> </ul>

Graphic 129653 Version 1.0

## Suggested suture sizes for traumatic skin laceration closure by site

Site	USP (skin closure)	USP (dermal closure)
<b>Superficial skin closure</b>		
Face (especially nose, vermillion border, or eyelid)	6-0	5-0 or 6-0
Face (forehead, cheek, or chin) and digits (fingers or toes)	5-0 or 6-0	5-0 or 6-0
Scalp, trunk, extremities, palm, and sole	4-0 or 5-0	3-0 or 4-0
Trunk, extremities (wounds under tension [eg, gaping or located near or across a joint])	3-0 or 4-0	3-0 or 4-0
<b>Mucous membrane closure</b>		
Intraoral mucosa	4-0 or 5-0	N/A
Tongue	3-0 or 4-0	N/A

Suture size is commonly indicated by the USP (United States Pharmacopeia) system. The higher the number of zeros, the smaller the size and the lower the strength. For example, 3-0 suture has a diameter that is about 2 to 4 times larger than 6-0 suture.

---

Graphic 129828 Version 1.0

## Suture selection, anesthetic options, and time to suture removal for facial and scalp lacerations

Location	Suture material*	Size	Anesthetic <sup>¶</sup>	Removal
<b>Scalp</b>				
Galea	Absorbable	3.0 or 4.0	Local	None
Skin	Staple, nonabsorbable <sup>Δ</sup> , hair apposition	Stainless steel (staples), 3.0 or 4.0 (sutures)	Local	7-14 days, none for hair apposition
<b>Forehead</b>				
Frontalis	Absorbable	4.0	Local	None
Skin	Nonabsorbable <sup>Δ</sup>	5.0 or 6.0 (adults), 6.0 (children)	Local/supraorbital	5 days
<b>Cheek/face</b>				
Muscle	Absorbable	4.0	Local/infraorbital	None
Subcutaneous	Absorbable	4.0	Local/infraorbital	None
Skin	Nonabsorbable <sup>Δ</sup>	5.0 or 6.0 (adults), 6.0 (children)	Local/infraorbital	5 days
<b>Eyelids</b>				
Skin	Absorbable	6.0	Supra/infraorbital	3-5 days
<b>Nose</b>				
Mucosa	Absorbable	4.0	Local/intranasal pack	None
Cartilage	Absorbable	5.0	Local/intranasal pack	None
Skin	Absorbable	6.0	Local/intranasal pack	3-5 days
<b>Lip</b>				
Muscle	Absorbable	4.0 or 5.0	Infraorbital/mental	None
Mucosal skin	Absorbable	5.0 or 6.0 (adults), 6.0 (children)	Infraorbital/mental	None
Vermillion border	Nonabsorbable <sup>Δ</sup>	6.0	Infraorbital/mental	5 days

**Intraoral mucosa**

	Absorbable	4.0 or 5.0	Local	None
--	------------	------------	-------	------

**Tongue**

	Absorbable	3.0 or 4.0	Local	None
--	------------	------------	-------	------

**Chin**

Muscle	Absorbable	4.0	Local/mental	None
Subcutaneous	Absorbable	4.0	Local/mental	None
Skin	Nonabsorbable <sup>Δ</sup>	5.0 or 6.0	Local/mental	5 days

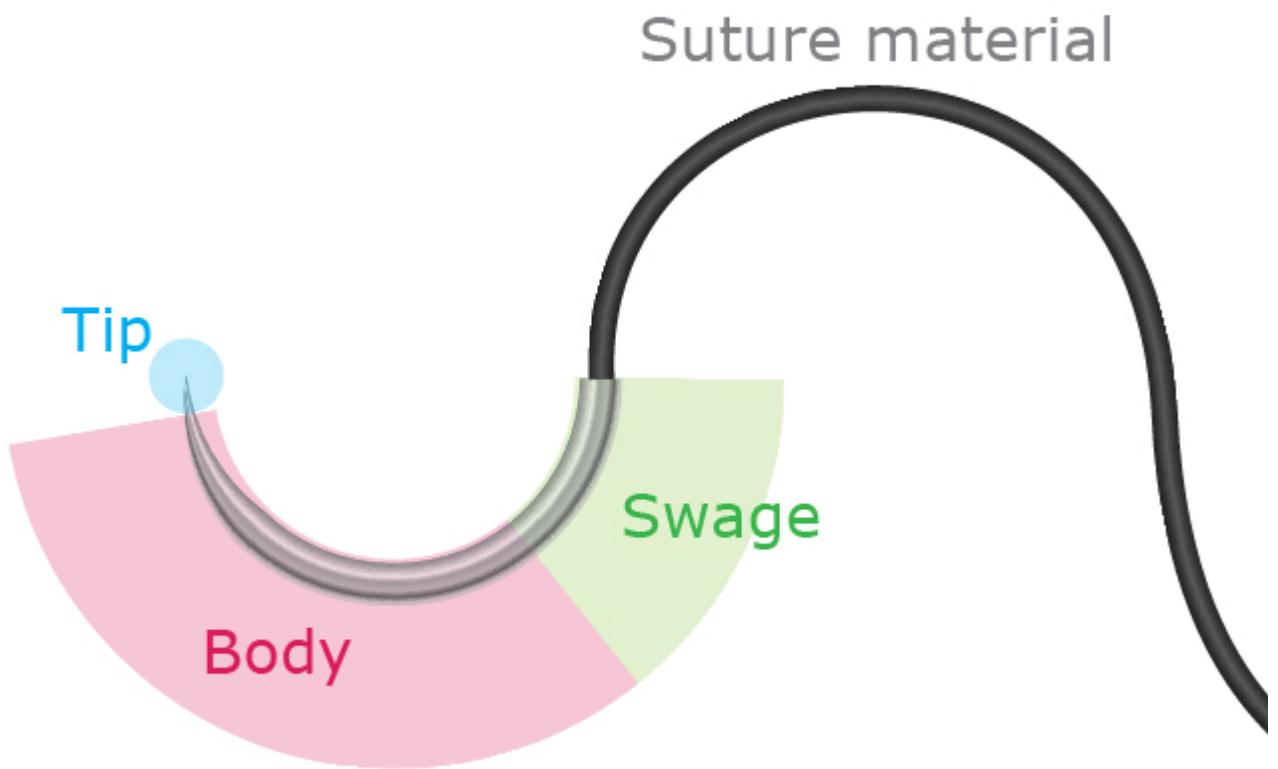
\* Absorbable suture will resorb within 60 days. Subcutaneous absorbable sutures commonly used on facial lacerations include polyglactin 910 (Vicryl®), poliglecaprone 25 (Monocryl®), and polyglycolic acid (Dexon). Chromic gut is appropriate for surface sutures on mucosa. Fast-absorbing gut and, for scalp lacerations, coated polyglactin 910 [Vicryl Rapide®] are appropriate for skin sutures.

Nonabsorbable suture will not resorb within 60 days. Nylon (Dermalon®, Ethilon®), Polybutester (Novafil®), and polypropylene (Surgilene®, Prolene®) are commonly used.

¶ Refer to "Assessment and management of facial lacerations", section on 'Facial nerve blocks' for instructions on how to perform supraorbital, infraorbital, and mental nerve blocks.

Δ Fast-absorbing gut or, for scalp lacerations, coated polyglactin 910 [Vicryl Rapide®] may be used for skin closure without negatively impacting wound outcomes in young children to avoid the anxiety and difficulty of suture removal and in patients for whom followup for suture removal is not assured.

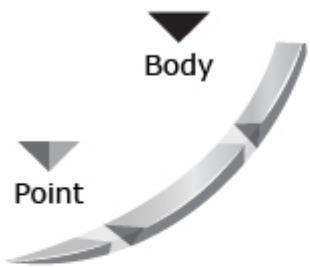
## Surgical needle



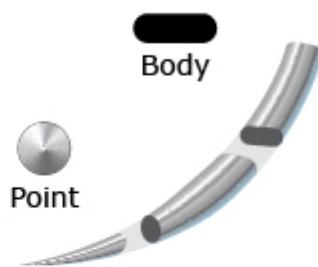
Graphic 129829 Version 1.0

## Common surgical needle tips

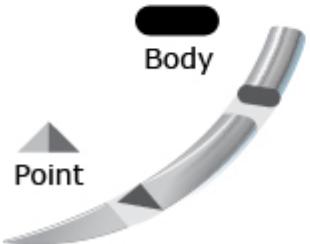
Reverse Cutting\*



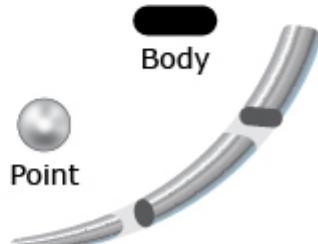
Taper Point



Conventional Cutting



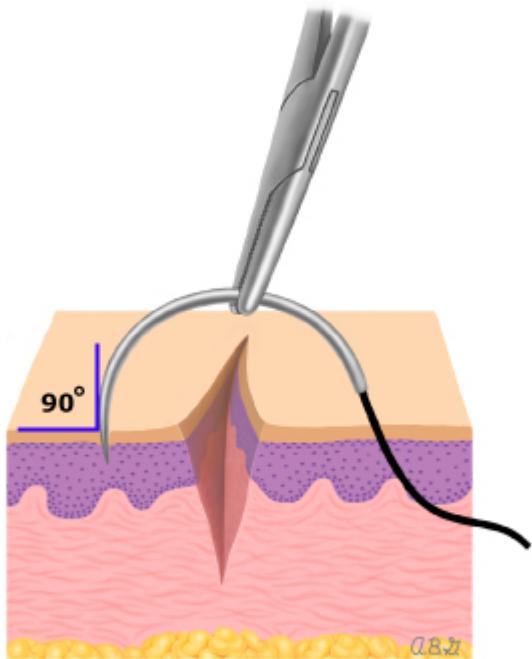
Blunt Point



\*Choose reverse cutting suture needles for percutaneous (skin) closure to prevent cutting out of tissue between the suture entry point and the wound edge.

Graphic 129830 Version 1.0

## Needle insertion for eversion technique

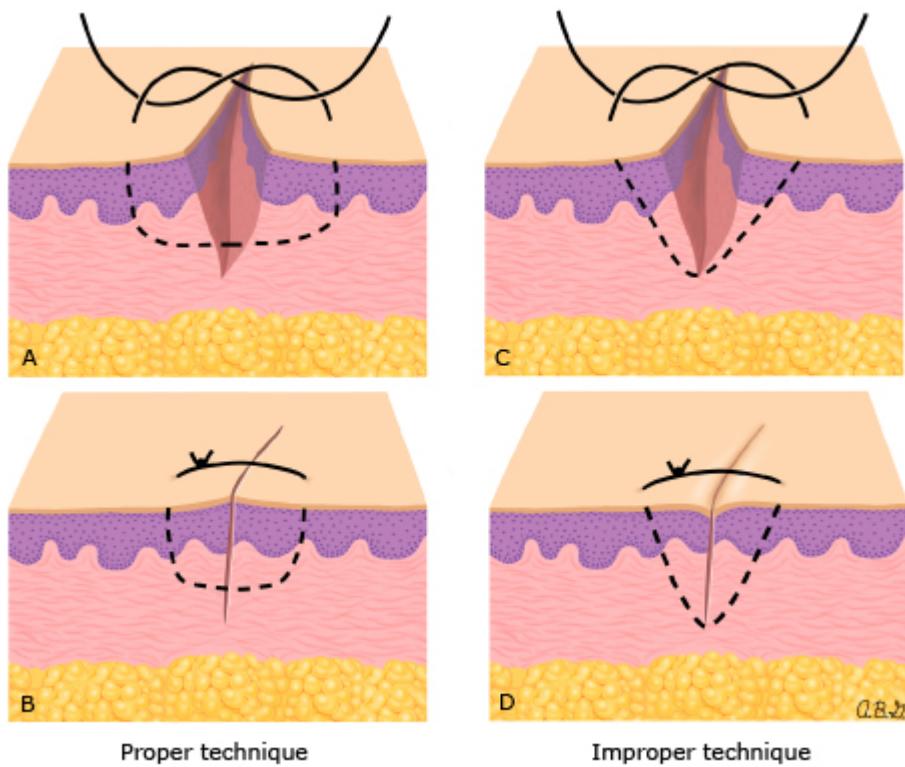


For proper healing, the edges of the wound must be everted. To accomplish this, the needle should penetrate the skin at a 90 degree angle to its surface.

---

Graphic 60681 Version 4.0

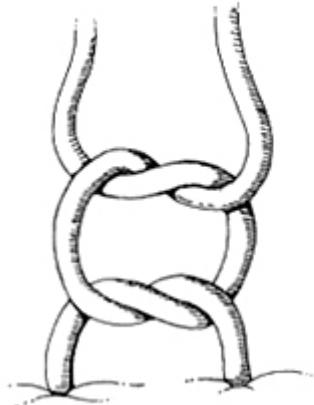
## Proper technique for wound edge eversion



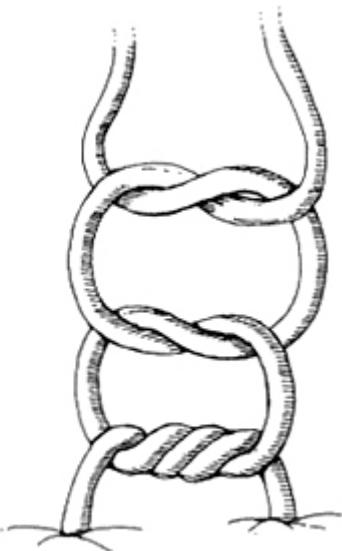
The proper technique for everting the edges of a wound is illustrated in the panels on the left.

- (A) The needle has been inserted at a 90 degree angle.
- (B) The suture loop is as wide at the base as it is at the skin surface. The width and depth of the suture loop are the same on both sides of the wound. In the panels on the right, improper technique has resulted in inversion of the wound edges, which will interfere with wound healing.
- (C) The needle has entered the skin at an angle.
- (D) The base of the wound is narrower than the skin surface.

## Surgical knots



**Square knot**



**Surgeon's knot**

Square knot and surgeon's knot.

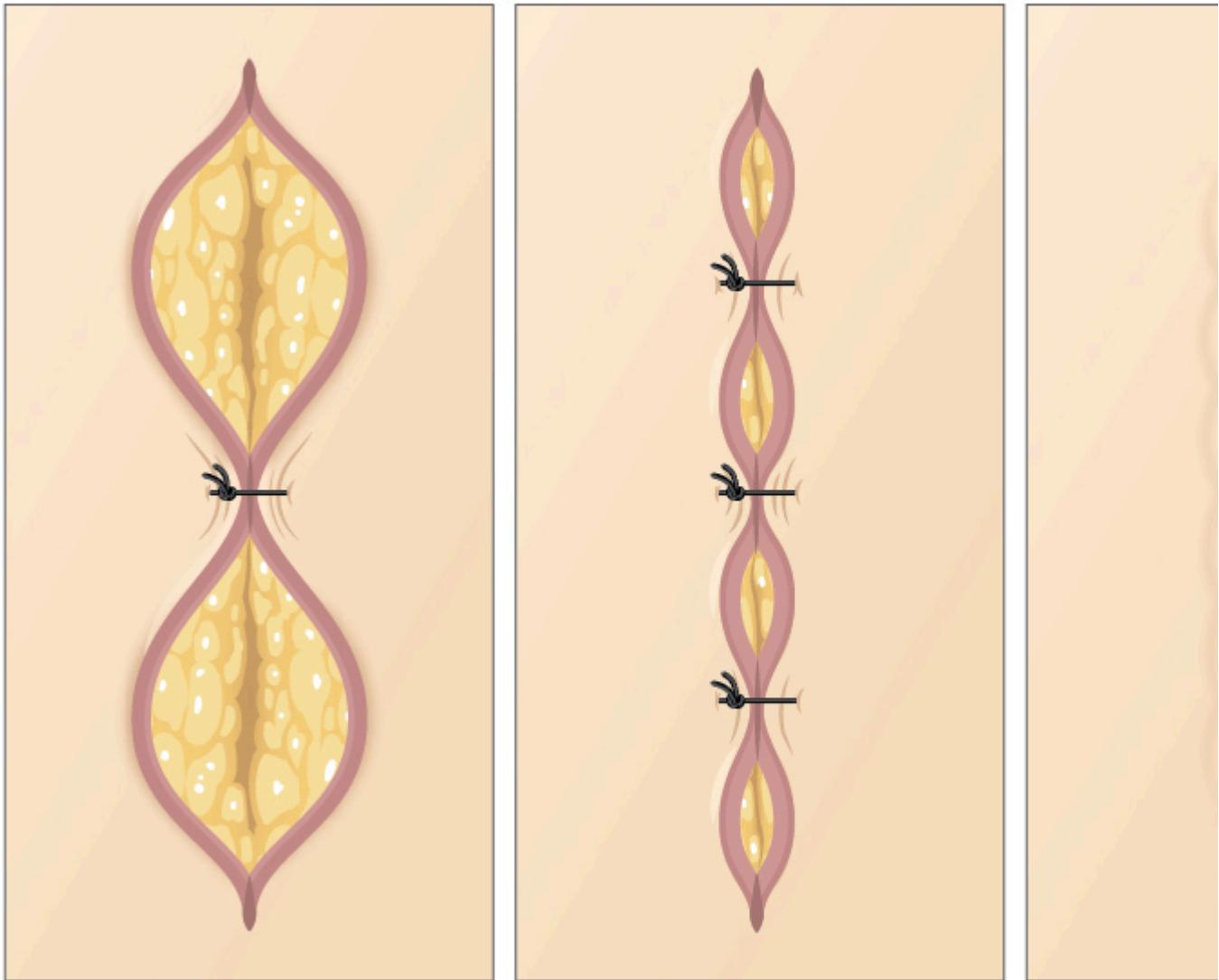
---

*Courtesy of William J Mann, Jr, MD.*

---

Graphic 74576 Version 2.0

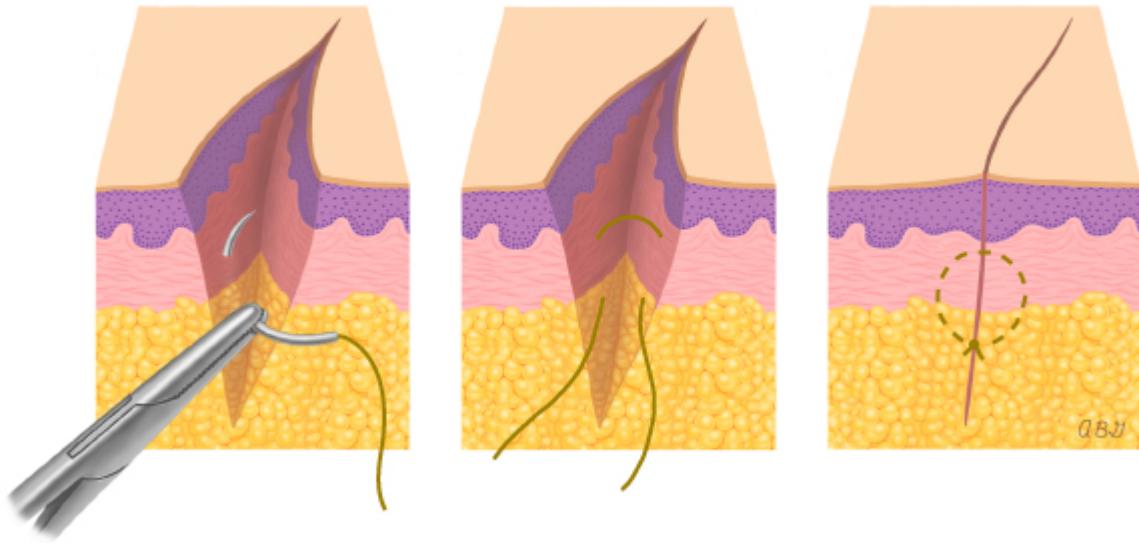
## Suture placement during laceration repair



To ensure proper apposition of the wound without excess tissue on one side (also called a "dog ear"), the clinician places the first stitch at the midline of the wound. The next two stitches go on each side of the first stitch, midway between the center stitch and the wound corners. Additional bisecting stitches are placed until the wound is properly aligned. The number of sutures needed to close a wound varies depending upon the length, shape, and location of the laceration. In general, sutures are placed just far enough from each other so that no gap appears in the wound edges.

Graphic 129832 Version 1.0

## Technique for placing a dermal suture

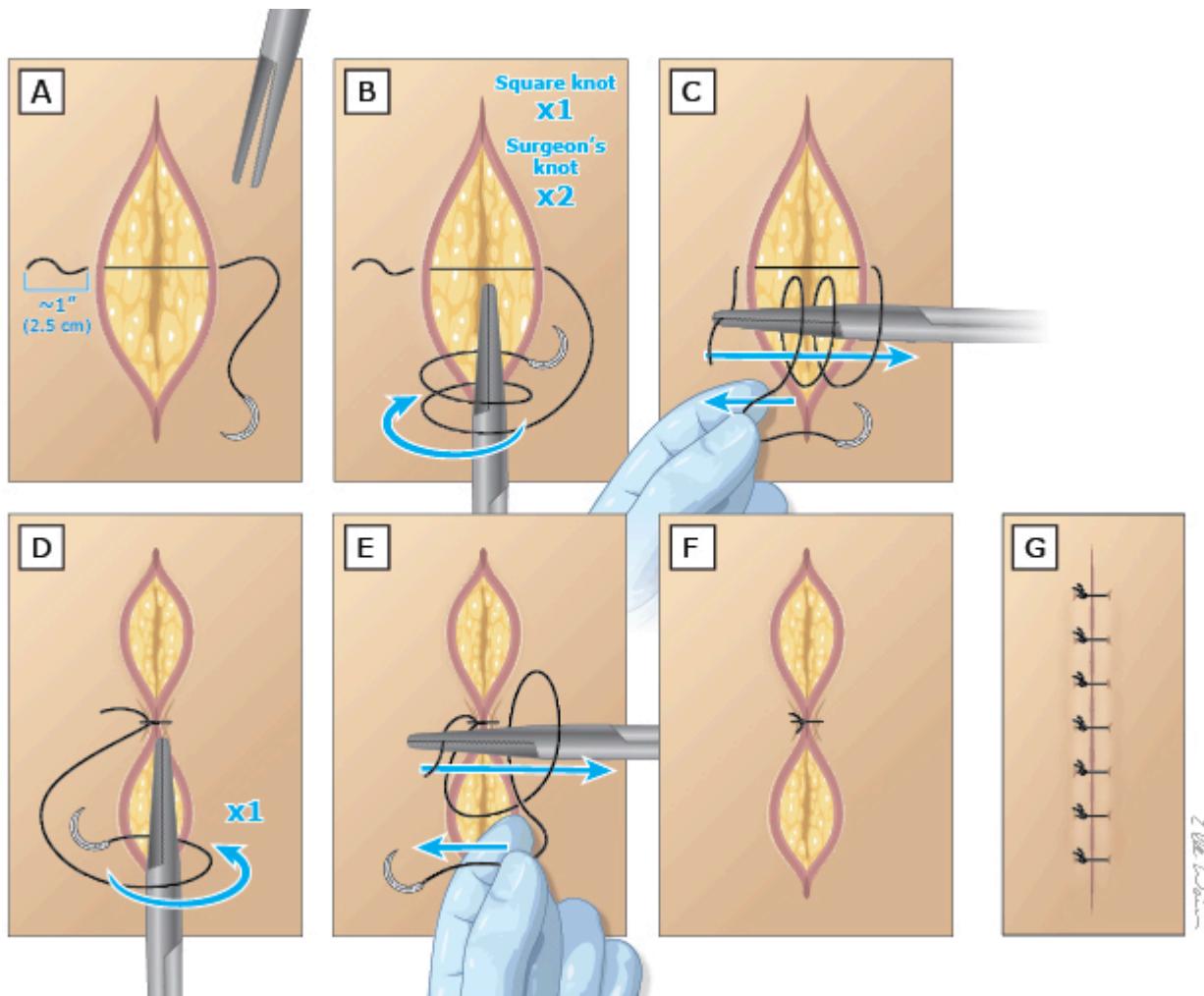


Absorbable suture material should be used for dermal sutures. The knot is buried by placing the suture using an inverted technique in which the suture loop begins in the dermis. The needle is directed toward the skin surface, exiting near the dermal-epidermal junction. It is then inserted into the opposite side of the wound directly across from the point of exit. The loop is completed in the dermis at the level where the needle was initially placed.

---

Graphic 75042 Version 4.0

## Instrument suture tying



After the suture is placed, it is tied using the needle holder as follows:

- (A) Pull the suture through the wound and leave a tail about 1 inch (2.5 cm) long at the initial entry site. Drop the suture needle on the sterile field and close the empty needle holder.
- (B) Place the closed needle driver along the axis of the wound between the 2 ends of the suture (repeat for each throw described below). For the first tie (throw), in the nondominant hand, grasp the suture on the side of the wound where the needle emerged about halfway between the needle and the wound site and wrap it twice (surgeon's knot) or once around the needle holder (square knot) being held in the dominant hand.
- (C) Open the needle holder and grasp the tail end of the suture. Pull the tail end through the 2 loops and across the wound while moving the nondominant hand in the opposite direction across the wound. For a surgeon's knot (percutaneous suture) use 2 wraps and then pull the surgeon's knot flat to the skin with enough tension to gently evert the skin edges without strangulating the tissue. Release the tail. For a half knot (dermal suture), use one wrap (not pictured).
- (D) Wrap the suture around the needle holder once in the opposite direction of the first 2 loops and pull the half knot so that it lies flat on the surgeon's knot.
- (E) Repeat the half knot tie to place the suggested number of throws as determined by suture type and layer of closure.

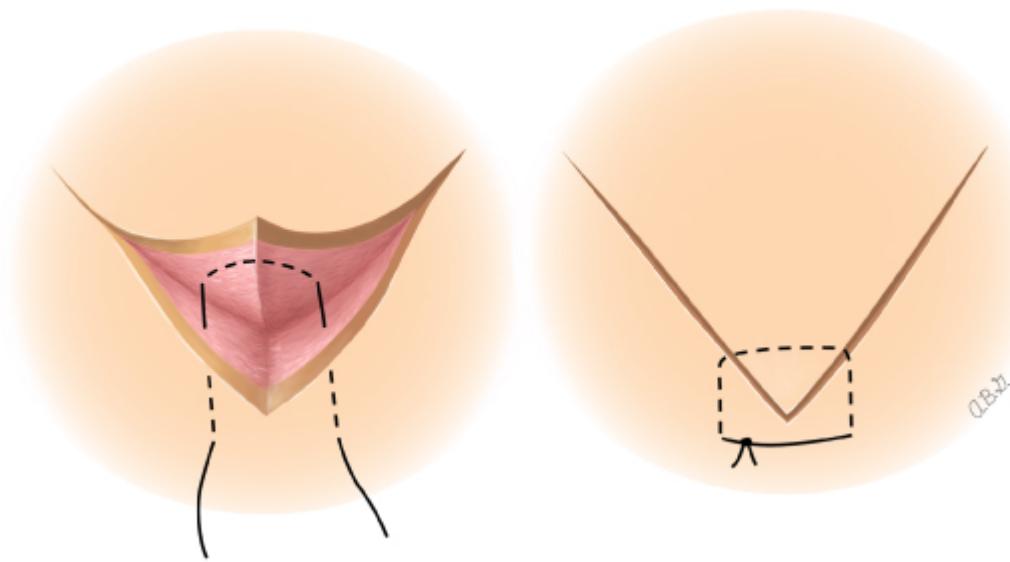
(F) Cut the suture ends at the appropriate length (percutaneous knot: approximately the distance between the sutures; dermal knot: close to the last knot to minimize the amount of suture in the wound).

(G): Ensure even spacing by placing the initial suture in the middle of the wound. The next two stitches go on each side of the first stitch, midway between the center stitch and the wound corners. Additional bisecting stitches are placed until the wound is properly aligned.

---

Graphic 129833 Version 1.0

## Technique for closing the corner of a flap: Half-buried horizontal mattress

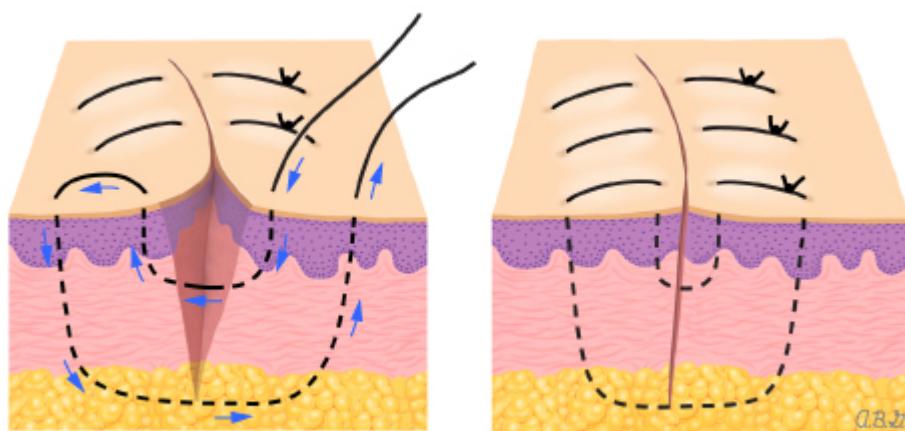


The half-buried horizontal mattress suture combines elements of the horizontal mattress suture with a dermal skin closure and can be used to approximate the corner of a flap. The needle is introduced through the skin in the non-flap portion of the wound. In the dermal (or buried) portion of the suture, the corner of the flap is picked up horizontally through or just below the dermis. The suture loop is completed by bringing the needle out through the skin on the opposite side of the non-flap portion.

---

Graphic 51901 Version 4.0

## Vertical mattress stitch (shorthand method)

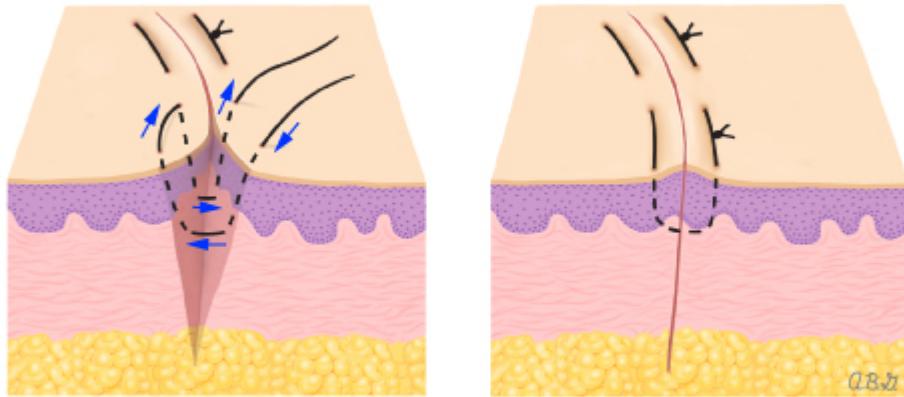


To place a vertical mattress suture using the shorthand method, the needle is initially inserted at the epidermal/dermal (near-near) edges as if performing a simple interrupted suture. This near-near portion of the suture loop everts the edges of the wound. The needle is then rotated 180° in the needle holder, and the direction of the suture loop is reversed (backhanded). The needle entrance is at a distance from the wound edge, crossing through the dermal tissue and exiting through the skin on the opposite side at an equal distance from the wound edge. This is the far-far portion. This stitch approximates the dermal structures.

---

Graphic 69848 Version 4.0

## Technique for placing a horizontal mattress stitch



A horizontal mattress suture can be used to achieve wound eversion in areas of high skin tension. The needle is introduced into the skin in the usual manner and brought out on the opposite side of the wound. A second bite is taken along the opposite side, approximately 0.5 cm from the first exit site, and is brought back to the original starting side, also 0.5 cm from the initial entry point.

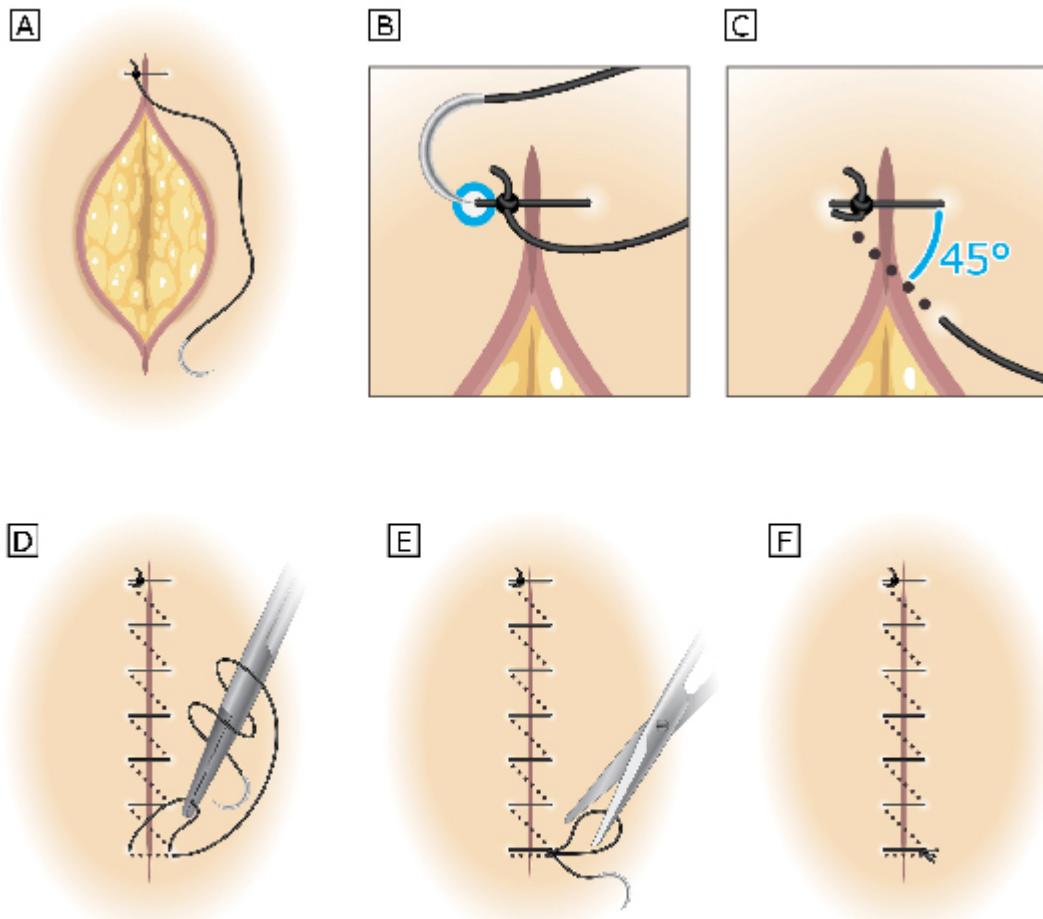
---

*Modified from: McNamara R, DeAngelis M. Laceration repair with sutures, staples, and wound closure tapes. In: Textbook of Pediatric Emergency Procedures, 2nd ed, King C, Henretig FM (Eds), Lippincott Williams & Wilkins, Philadelphia 2008.*

---

Graphic 116784 Version 1.0

## Running suture



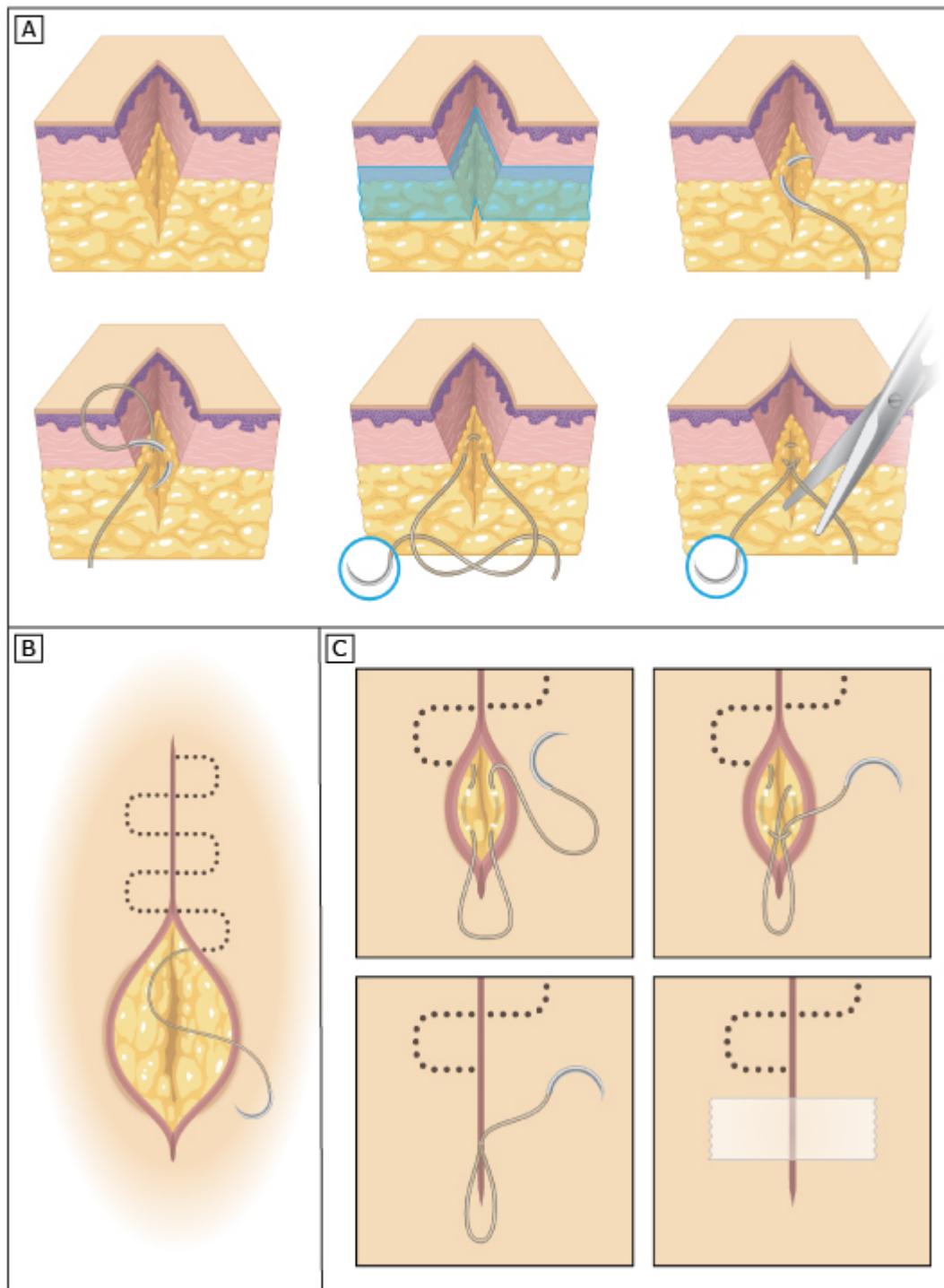
(A) The closure is started with the standard technique of a percutaneous simple interrupted suture, but the suture is not cut after the initial knot is tied.

(B and C) The needle is then used to make repeated bites, starting at the original knot by making each new bite through the skin at an angle of 45 degrees to the wound orientation.

(D) The cross stays on the surface of the skin will be at an angle of 90 degrees to the wound.

(E and F) The final bite is made at an angle of 90 degrees to the wound orientation to bring the suture out next to the previous bite. The final bite is left in a loose loop, which acts as a free end for tying the knot.

## Subcuticular closure with absorbable suture



The suture is anchored at one end of the laceration (A). The plane chosen is either the dermis or just deep to the dermis in the superficial subcutaneous fascia. While maintaining this plane, "mirror image" bites are taken horizontally the full length of the wound (B). The final bite leaves a trailing loop of suture, as shown, so that the knot can be fashioned for final closure (C). This technique is commonly supplemented with wound tapes, particularly if there remains some degree of gapping of the edges.

*Modified from: Trott AT. Wounds and lacerations: emergency care and closure, 2nd ed, Mosby Year Book, St. Louis 1997.*

---

Graphic 71747 Version 2.0

