Closure of skin wounds with sutures

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INTRODUCTION — The basic principles of laceration repair have not changed significantly in the last century, but the therapeutic options now available are more innovative and rigorously studied. The development of topical anesthetics, tissue adhesives, and fast-absorbing sutures has made the management of lacerations less traumatic for the patient. In addition, the use of procedural sedation for difficult lacerations or for the extremely anxious child has made the experience more tolerable for the patient, family, and physician.

The goals of wound management are simple: to avoid wound infection, assist in hemostasis, and to provide an esthetically pleasing scar [1]. The majority of studies now are focusing on the esthetic nature of wound healing rather than infection rates, because infection rates remain low, regardless of management.

Laceration repair with sutures will be discussed here. Information concerning wound preparation and irrigation, topical and infiltrative anesthesia, and tissue adhesive and staples is found separately. (See "Closure of minor skin wounds with staples" and "Minor wound preparation and irrigation" and "Tissue adhesives".)

WOUND PHYSIOLOGY AND HEALING — The epidermis, dermis, subcutaneous layer, and deep fascia are the tissue layers of concern in wound closure [2]:

- The epidermis and dermis are tightly adhered and clinically indistinguishable, and together constitute the skin. 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. 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.

- The deep fascial layer is intermixed with muscle and occasionally requires repair in deep lacerations.

The healing process of skin occurs in several stages [3]:

- Coagulation begins immediately following the injury. Vasospasm as well as platelet aggregation and fibrous clot formation occur. During the inflammatory phase, proteolytic enzymes released by neutrophils and macrophages break down damaged tissue.

- Epithelialization occurs in the epidermis, which is the only layer capable of regeneration. Complete bridging of the wound occurs within 48 hours after suturing.

- New blood vessel growth peaks four days after the injury.

- 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 up to 12 months.

- Wound contraction occurs three to four days following the injury, and the process is poorly understood. The full wound thickness moves toward the center of the wound, which may affect the final appearance of the wound.

Systemic disturbances can influence wound healing. These host factors include renal insufficiency, diabetes mellitus, nutritional status, obesity, chemotherapeutic agents, corticosteroids, and anticoagulant or antiplatelet adhering drugs. Disorders of collagen synthesis such as Ehlers-Danlos syndrome and Marfan's syndrome can also affect wound healing [1]. (See "Minor wound preparation and irrigation", section on 'Risks for poor outcome'.)

Local disturbances are more common contributors to abnormal wound healing. These factors include temperature, ischemia, tissue trauma, denervation, and infection.

- Temperature, blood supply, and ischemia are interrelated. The higher the temperature of the anatomic area, the greater the blood supply and resultant oxygen delivery. The skin temperature of the face can be up to nine degrees Fahrenheit warmer than that of the foot, thus allowing for sutures to remain for shorter periods of time and also allowing for lower infection rates. Different suturing techniques can contribute to tissue ischemia, in particular the vertical mattress suture. Vertical mattress sutures have been shown in animal studies to cause more ischemia than continuous or simple interrupted sutures [4]. (See 'Vertical mattress' below.)

- Infection can occur in any traumatic wound, and all acute wounds are contaminated to a certain degree. An infection occurs when there is an imbalance between host resistance (systemic or local) and bacterial inoculum. The mechanism of injury and the time from injury to potential repair are important considerations. Crush injuries may cause extensive cellular necrosis and higher infection rates than shear injuries due to the greater energy distributed over a larger area [4]. An injury heavily contaminated with dirt, gravel, or other debris also has a higher infection risk. The length of time between the injury and the evaluation also affects infection risk. (See "Minor wound preparation and irrigation", section on 'Age of injury'.)

**WOUND ASSESSMENT** — The management of minor lacerations begins with assessment and preparation of the wound. Wound assessment includes:

- Determination of the mechanism of the injury
- Age of the injury
- Identification of possible contamination or foreign body
- Assessment of extent of the wound
- Assessment for neurovascular compromise or tendon injury in the surrounding area
- Need for tetanus prophylaxis (table 1)
- Identification of risk factors that might affect healing.

These issues are discussed in detail separately. (See "Minor wound preparation and irrigation", section on 'Assessment' and "Tetanus").

**WOUND PREPARATION** — Wound irrigation, foreign body removal, and necrotic tissue debridement are the main preventative measures against tissue infection. (See "Minor wound preparation and irrigation", section on 'Irrigation'.)
Surfactant cleaners, such as the nonionic surfactant poloxamer 188 (ShurClens), are also safe and useful for wound decontamination. They possess no antibacterial activity, but decrease the mechanical trauma of scrubbing while reducing bacterial load and incidence of infection. A high-porosity sponge (Optipore) is typically used in conjunction to limit local trauma [1]. This system is ideal for scrubbing large surface areas like "road rash" or burns.

Debridement has been considered by many to be equally or more important than irrigation in the management of the contaminated wound. (See "Minor wound preparation and irrigation", section on 'Debridement'.)

SUTURE MATERIALS

Terminology — A number of terms are used to describe the properties of various types of sutures.

- The physical configuration of a suture describes whether it is monofilamentous (Prolene or Ethilon) or multifilamentous (silk). Multifilamentous sutures come in braided and twisted types. Braided types are usually easier to handle and tie, but can harbor bacteria between strands and cause higher infection rates.

- Tensile strength is defined as the amount of weight required to break a suture divided by its cross sectional area. The designation for suture strength is the number of zeros. The higher the number of zeros (1-0 to 10-0), the smaller the size and the lower the strength.

- Knot strength is the measure of the amount of force required to cause a knot to slip and is directly proportional to the coefficient of friction for a given material.

- Elasticity refers to the suture's intrinsic ability to hold its original form and length after being stretched. This allows the suture to expand with wound edema or to retract and maintain wound edge apposition during wound contraction. Plasticity refers to a material that, when stretched, does not return to original length.

- Memory is closely related to plasticity and elasticity. It refers to the inherent ability of a material to return to its former shape after being manipulated, and is often a reflection of its stiffness. A suture with a high level of memory is stiffer, more difficult to handle, and more susceptible to becoming untied than a suture with low memory. Polypropylene (Prolene) is a good example of a suture with a high level of memory [5].

Absorbable sutures — An absorbable suture is generally defined as one that will lose most of its tensile strength within 60 days after implantation beneath the skin surface [6]. The most commonly used today are the synthetic sutures (polyglactin 910 [Vicryl], polyglycolic acid [Dexon], polydioxanone [PDS], and polytrimethylene carbonate [Maxon]) (table 2). Catgut is used less frequently now, but does have some specific indications.

The ideal absorbable suture has low tissue reactivity, high tensile strength, slow absorption rates, and reliable knot security. Classically, absorbable sutures were only used for deep sutures. However, many have advocated the use of absorbable sutures for percutaneous closure of wounds in adults and children [7-10]:

- Fast-absorbing gut for percutaneous closure of some facial lacerations is reasonable, particularly if suture removal will be traumatic. Subcutaneous sutures with a synthetic absorbable suture may improve wound tension and provide support to the healing wound once the gut has dissolved.

- Vicryl Rapide is ideal for percutaneous closure of lacerations underneath casts or splints, but is limited for facial use due to the smallest available suture size (5-0).

- Chromic gut or Vicryl works well for single or layered closure of tongue or oral mucosa
lacerations.

- Vicryl or Monocryl is ideal for dermal closure of deep facial lacerations.
- Vicryl is often used to repair hand and finger lacerations when suture removal could damage a fragile repair.
- Nailbed closure is best done with chromic gut or Vicryl.

**Catgut** — Catgut is a natural product derived from sheep or cattle intima. Plain catgut retains significant tensile strength for only five to seven days. Chromic gut is treated with chromium salts to resist body enzymes, thus delaying absorption time. Chromic gut retains tensile strength for 10 to 14 days [5].

The main use of chromic gut is to close lacerations in the oral mucosa. Chromic gut is more rapidly absorbed in the oral cavity than most synthetic sutures, making it ideal for this environment.

Fast-absorbing gut is a newer material not treated with chromic salts. It is heat-treated to accelerate tensile strength loss and absorption. It is used primarily for epidermal suturing, where sutures are only required for 5 to 7 days [11]. The use of this fast-absorbing suture was studied in 654 wounds during plastic surgery procedures. The suture was adequately dissolved in the majority of cases during follow-up visits at four to six days [8]. Fast-absorbing gut is ideal for suturing facial lacerations when tissue adhesives cannot be used or suture removal will be difficult. However, care must be taken to be gentle with tying knots when using the smaller (6-0) fast-absorbing gut, due to its low tensile strength. It is reasonable to reinforce this suture with skin tapes.

**Polyglactin 910 (Vicryl)** — Introduced in 1974, Vicryl is a lubricated, braided synthetic material with excellent handling and smooth tie-down properties. 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 [5]. Vicryl is an ideal choice for subcutaneous sutures.

A newer form of Vicryl, Vicryl Rapide, has properties similar to fast-absorbing gut. It is the fastest absorbing synthetic suture and is indicated only for use in superficial soft tissue approximation of the skin and mucosa. 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. It is ideal for skin closure in patients in whom suture removal would be difficult or for closure of lacerations under casts [11]. The smallest size available is 5-0, which may limit its usefulness in some facial closures.

**Poliglecaprone 25 (Monocryl)** — 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. 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 [11].

**Polglycolic acid (Dexon)** — Introduced in 1970, polglycolic acid was the first synthetic absorbable suture to become available. It is a braided polymer, is less reactive than gut sutures, and has excellent knot security. It maintains at least 50 percent of its tensile strength for 25 days [12]. The main drawback is a high friction coefficient causing “binding and snagging” when wet. Newer forms of this suture have been developed, Dexon Plus and Dexon II, which have an added synthetic coating to improve handling properties while maintaining knot security [5].

**Polydioxanone (PDS)** — PDS is a synthetic monofilament polymer marketed as having improved tensile strength compared with Vicryl. It retains the majority of its tensile strength at five to six weeks. Because it is a monofilament, it has the theoretical advantage of creating a lower potential for infection. In addition, it appears to have a lower friction coefficient and
better knot security than Vicryl. A disadvantage of using PDS is that it is more difficult to use than the braided synthetics because of intrinsic stiffness. In addition, it costs about 14 percent more than either Dexon or Vicryl [5].

**Polytimethylene carbonate (Maxon)** — Maxon is a synthetic monofilament. It was developed to combine the excellent tensile strength of PDS with improved handling properties. The majority of its tensile strength is present at five to six weeks. It has minimal tissue reactivity, excellent first-throw holding capacity, and smoother knot tie-down than Vicryl. The only disadvantage is the approximate 7 percent increased cost compared with Vicryl or Dexon [5].

**Nonabsorbable sutures** — (table 3)

**Silk** — Silk is a natural product that is renowned for its ease to handle and tie. It has the lowest tensile strength of any nonabsorbable suture. It is rarely used for suturing of minor wounds because stronger synthetic materials are now available.

**Nylon (Dermalon, Ethilon)** — Nylon was the first synthetic suture introduced; it is popular due to its high tensile strength, excellent elastic properties, minimal tissue reactivity, and low cost. Its main disadvantage is prominent memory that requires an increased number of knot throws (3 to 4) to hold a suture in place [12].

**Polypropylene (Surgilene, Prolene)** — Polypropylene is a plastic, synthetic suture that has low tissue reactivity and high tensile strength similar to nylon. It is slippery and requires extra throws to secure the knot (4 to 5). Prolene is especially noted for its plasticity, allowing the suture to stretch to accommodate wound swelling. When wound swelling recedes, the suture will remain loose. The cost of Prolene is approximately 13 percent more than nylon [5]. Prolene can be purchased in a blue color, which can be advantageous in localizing sutures in the scalp and dark-skinned individuals.

**NEEDLES** — Choosing the proper needle can be confusing because of varying nomenclature. The two most prominent manufacturers of suture, Ethicon and Davis and Geck, use different nomenclature for their needles [5]. The basic anatomy of a needle remains the same, however:

- The eye is the end of the needle attached to the suture. All sutures used for acute wound 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 1/4, 3/8, 1/2, or 5/8 circle. The most commonly used curvature is the 3/8 circle, requiring only minimal pronation of the wrist for large and superficial wounds. The 1/2 and 5/8 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. For soft tissue and fascia, the taper needle, round in cross section, is ideal.

Needle points are also available in cutting, conventional cutting, or reverse cutting form. Cutting needles have at least two opposing cutting edges. Cutting needles are ideal for skin sutures that must pass through dense, irregular, and relatively thick dermal connective tissue. Conventional cutting needles have a third cutting edge on the inside concave curvature of the needle. This needle type may be prone to cutout of tissue because the inside cutting edge cuts toward the edges of the incision or wound. Reverse cutting needles have a third cutting edge located on the outer convex curvature of the needle, which theoretically reduces the danger of tissue cutout [11]. Reverse cutting needles should be used for thick skin like the palm and soles.

Standard skin needles (FS series, CE series) are suitable for the scalp, trunk, and extremities. Finer sutures on the face require a smaller and more sharply honed needle (P, PS, PC, and PRE
SUTURING TECHNIQUES

Percutaneous skin closure — The simple interrupted suture is used to close most uncomplicated wounds. For proper healing, the edges of the wound must be everted. This is best accomplished using the following technique (figure 1 and figure 2):

- The needle should penetrate the skin surface at a 90 degree angle.
- The suture loop should be at least as wide at the base as it is 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 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. A useful guideline is that the distance between sutures is equal to the bite distance from the wound edge [12].

Dermal closure — The dermal or buried suture approximates the dermis just below the dermal-epidermal junction, which minimizes skin tension and closes dead space. Removing tension from a wound allows percutaneous sutures to be tied loosely and removed sooner, thereby improving the cosmetic result.

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 can be accomplished by inverting the suture loop using the following technique (figure 3):

- 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.

Dermal sutures do not increase the risk of infection in clean, noncontaminated lacerations [13]. However, animal studies suggest that deep sutures should be avoided in highly contaminated wounds [14]. There should be no more than three knots per suture and the fewest number of sutures possible should be placed.

Alternative suture techniques

Running suture — A running suture is used for rapid percutaneous closure of longer wounds. It provides even distribution of tension along the length of the wound, preventing excess tightness in any one area. This technique is best reserved for wounds at low risk of infection with edges that align easily.

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 degrees to the wound direction. The cross stays on the surface of the skin will be at an angle of 90 degrees to the wound direction. The final bite is made at an angle of 90 degrees 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 suture is if the stitch...
breaks or if the physician wants to remove only a few sutures at a time [12].

**Subcuticular running suture** — The subcuticular running suture is often used by plastic surgeons 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 4). 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 [12].

**Vertical mattress** — 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). It acts as a deep and superficial closure all in one suture. The first portion of the suture loop (far–far) approximates the dermal structures. The second portion (near–near) closes the wound and everts the edges.

A vertical mattress suture is traditionally placed using the following technique (figure 5) [12]:

- The needle is initially inserted 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.
- The needle is then rotated 180 degrees in the needle holder and the direction of the suture loop is reversed (backhanded).
- On the return, small bites are taken at the epidermal/dermal edges, which become approximated when the knot is tied. This near–near portion of the suture loop closes and everts the edges of the wound.

Alternatively, in the shorthand vertical mattress technique, the small backhand bites at the wound edges are completed first, followed by the deeper, wider forehand 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 the time using the shorthand technique [15]. There was no difference between the two groups with respect to wound healing.

**Horizontal mattress** — A horizontal mattress suture can also 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.

The half-buried horizontal mattress suture combines elements of the horizontal mattress suture with a dermal closure. It can be used to approximate the corner of a flap (figure 6) [12]. The needle is introduced through the skin in the nonflap portion of the wound. In the dermal (or buried) portion of the suture, the corner of the flap is picked up horizontally through the dermis. The suture loop is completed by bringing the needle out through the skin on the opposite side of the nonflap portion. The knot is tied on the nonflap portion of the wound.

**SPECIFIC WOUND TYPES**

**Lip** — The major consideration in lip lacerations is the integrity of the vermilion border. The casual observer can notice a misalignment as small as 1 mm [12]. The first suture should be placed through both edges of the divided vermilion border (figure 7).

An infraorbital nerve block for the upper lip and a mental nerve block for the lower lip are ideal for local anesthesia. Injection of local anesthesia directly into the wound should be avoided since it may distort the anatomic landmarks necessary to approximate the vermilion border.

While the skin and vermilion border virtually always require sutures, the mucosal surface of a
through-and-through lip laceration may not require suturing if there is good hemostasis and the wound edges are well-approximated.

**Tongue** — The decision whether or not to repair a tongue laceration depends upon the extent of the laceration and the risk of compromised function after healing, but evidence suggests that outcomes for most tongue lacerations in young children are not improved by suturing. A more in-depth discussion of the indications and technique for repair of tongue lacerations is found separately. (See "Evaluation and repair of tongue lacerations").

**Scalp** — Careful exploration of scalp wounds for underlying skull fracture or foreign body is important. The consequences of a subsequent subgaleal infection are serious.

Although the scalp can bleed profusely, bleeding is almost always controlled by suturing the skin. Shaving the scalp is not recommended, although trimming the hair can make suturing easier.

Defects in the galea or in the frontalis or occipitalis fascia may require separate closure with absorbable sutures. The galea is a key anchoring structure of the frontalis muscle. If the frontalis loses its anchoring point, contraction of that muscle can become asymmetric and noticeable to any observer. The galea is tightly adherent to the skull and is fragile. It can be challenging to suture. Nevertheless, closure of large galeal lacerations in other areas of the scalp should be performed to prevent excess scar formation because the galeal gap will fill with excess collagen tissue [12].

**Eyebrows** — The eyebrow should never be shaved, because regrowth of the hair is unpredictable. Debridement and excision of the wound should be conservative and parallel to the direction of hair follicle growth. The eyebrow is of major cosmetic significance and the wound edges should be carefully approximated.

**Eyelids** — Assessment and management of eyelid lacerations are discussed in detail separately. (See "Eyelid lacerations").

**Cheek or zygomatic area** — Deep lacerations to the cheek, just anterior to the ear, have the potential to injure the parotid gland or the facial nerve (figure 8). If the parotid gland is injured, bloody fluid can be seen leaking from the parotid duct via the buccal mucosa at the level of the maxillary second molar.

The facial nerve function should be tested in all five branches as follows:

- Temporal- Contract the forehead and elevate the eyebrow
- Zygomatic- Open and shut eyes
- Buccal- Smile
- Mandibular- Frown
- Cervical- Contract the platysma muscle [12]

**Ear** — Wound closure on the ear can proceed in standard fashion when the cartilage is not involved. The cartilage should not be sutured if at all possible because of the risk of infection. If suturing is necessary, the perichondrium must be included in the stitch in order for it to hold. The goal in repairing a wound with exposed cartilage is to cover it with skin as completely as possible.

**GUIDELINES FOR CONSULTATION** — Consultation with a plastic surgeon or other surgical specialist may be required in some circumstances:

- Closure of large defects that might be more practical to close in the operating room or that might require grafting
- Severely contaminated wounds requiring drainage
- Tendon, nerve or vessel damage that requires repair
Open fractures, amputations, and joint penetrations

Laceration over the site of a fracture (even if contiguity seems unlikely, this is still technically considered an open fracture)

Compression between two rollers (eg, washing machine, industrial), which can cause delayed, extensive soft tissue and muscle damage [12]

Paint and grease gun injuries, which can initially appear as benign puncture wounds but later develop widespread tissue injury due to high-pressure injection [12]

Strong concern about cosmetic outcome by either the patient or family

Lacerations in some areas of the face may also require surgical consultation, such as nasal septal hematoma or complex lacerations with fracture displacement or extensive nasal cartilage injury, complex cartilage injuries of the ear, and complex vermilion border involvement of the lip. In addition, eyelid and cheek laceration may require special consideration.

AFTERCARE

**Dressing** — Most wounds should be covered with an antibiotic ointment and a nonocclusive dressing after laceration repair. A nonadherent gauze (eg, Xeroform) from which most of the grease is wrung, followed by cloth gauze, is ideal [16]. A simple Band-Aid will suffice for many small lacerations. Scalp wounds can be left open if small, but large head wounds can be wrapped circumferentially with Kerlix.

The dressing should be left in place for at least 48 hours, after which time most wounds can be opened to air. The wound should be gently cleaned with mild soap and water or half-strength peroxide after 24 hours to prevent crusting over the suture knots. An antibiotic ointment can be applied to the wound as well, with instructions to apply the ointment two to three times per day at home until suture removal.

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

We recommend that healthy patients with sutured nonbite wounds NOT be prescribed prophylactic antibiotics [17]. A metaanalysis of 7 trials (1701 total patients) found that prophylactic antibiotics in healthy patients with nonbite wounds were associated with a 16 percent increase in infection relative to control patients (95% CI 23 percent reduction to 78 percent increase in infection) [17].

Prophylactic antibiotics may decrease the risk of infection in some animal and human bites, intraoral lacerations, open fractures, and wounds that extend into cartilage, joints or tendons [18]. In addition, some experts advocate prophylactic antibiotics in patients with excessive wound contamination (eg, soil contamination), vascular insufficiency (eg, devascularized wound, peripheral artery disease), or immunocompromise [18]. (See "Initial management of animal and human bites", section on 'Antibiotic prophylaxis'.)

**Suture removal** — The timing of suture removal varies with the anatomic site [19]:

- Eyelids – 3 days
- Neck – 3 to 4 days
- Face – 5 days
- Scalp – 7 to 10 days
- Trunk and upper extremities – 7 days
Lower extremities – 8 to 10 days

Follow-up visits — Most clean wounds do not need to be seen by a physician until suture removal, unless signs of infection develop. Highly contaminated wounds should be seen for follow-up in 48 to 72 hours. It is imperative that clear discharge instructions are given to every patient regarding signs of wound infection.

SPECIAL ISSUES SPECIFIC TO THE PEDIATRIC PATIENT

Anxious parent — A parent is an important advocate for his or her child, and his or her concerns need to be addressed with patience and understanding. It is inevitable that we will encounter some parents who demand a plastic surgeon for simple laceration repairs or sedation for a laceration that easily could be managed with patient distraction and topical and/or injectable anesthetics. The best approach is to listen first and to suggest reasonable alternatives later. In some instances, there is no choice but to call a plastic surgeon. At other times, parents will listen to the explanation that the cosmetic outcome will be no different if repaired by a surgeon in the case of a simple, clean laceration. At times, it is also an issue of plastic surgeon availability. Often their viewpoint changes when the parents are truthfully told that it will be two to three hours before a surgeon can see their child.

In cases where a parent demands sedation for a simple laceration, he or she 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 parent. Child life specialists, if available, can provide invaluable assistance in this scenario. The child life specialist can adequately distract many patients by reading books with the patient or providing visual imagery.

Anxious and uncooperative patient — The anxious and uncooperative patient is a challenge that at times can be managed with 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. Ketamine is most commonly used for laceration repair in children. Other reasonable alternatives include propofol, fentanyl, and midazolam, midazolam alone, or nitrous oxide. (See "Procedural sedation and analgesia in children".)

SUMMARY

Wound irrigation, foreign body removal, and necrotic tissue debridement are the main preventative measures against tissue infection. (See 'Wound preparation' above.)

Classically, absorbable sutures were only used for deep sutures. However, absorbable sutures are now advocated in some cases for percutaneous closure of wounds in adults and children. In particular, fast-absorbing gut is ideal for skin closure of facial lacerations in patients in whom suture removal would be difficult or tissue adhesives are not an option. Chromic gut or Vicryl are recommended to close lacerations in the oral mucosa, and Vicryl Rapide is ideal for closure of lacerations under casts or splints. (See 'Suture materials' above.)

Cutting needles are ideal for skin sutures that must pass through dense, irregular, and relatively thick dermal connective tissue. Standard skin needles (FS series, CE series) are suitable for the scalp, trunk, and extremities. (See 'Needles' above.)

The simple interrupted suture is the standard technique used for the closure of most uncomplicated wounds (figure 1 and figure 2). (See 'Percutaneous skin closure' above.)

Deep sutures should be avoided in highly contaminated wounds (figure 3). (See 'Dermal closure' above.)
• A running suture is used for rapid percutaneous closure of longer wounds. It is best reserved for wounds at low risk of infection with edges that align easily. (See 'Running suture' above.)

• The vertical mattress suture is recommended for wounds under tension and for wounds with edges that tend to fall or fold into the wound (figure 5). A horizontal mattress suture can also be used to achieve wound eversion in areas of high skin tension (figure 6). (See 'Vertical mattress' above and 'Horizontal mattress' above.)

• The timing of suture removal varies with the anatomic site. (See 'Suture removal' above.)

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REFERENCES

## Wound management and tetanus prophylaxis

<table>
<thead>
<tr>
<th>Previous doses of adsorbed tetanus toxoid*</th>
<th>Clean and minor wound</th>
<th>All other wounds•</th>
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<tr>
<td></td>
<td>Tetanus toxoidΔ</td>
<td>TIG</td>
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<tr>
<td>&lt;3 doses or unknown</td>
<td>Yes§</td>
<td>No</td>
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<tr>
<td>≥3 doses</td>
<td>Only if last dose given ≥10 years ago</td>
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TIG: human tetanus immune globulin; DT: diphtheria-tetanus toxoids adsorbed (children); DTP, DTwP: diphtheria-tetanus-whole cell pertussis (no longer used in United States); DTaP: diphtheria-tetanusacellular pertussis; Td: tetanus-diphtheria toxoids adsorbed (adult); Tdap: booster tetanus toxoid-reduced diphtheria toxoid-acellular pertussis; TT: tetanus toxoid.

* Tetanus toxoid may have been administered as DT, DTP (DTwP), DTaP, Td, Tdap, or TT.
• Such as, but not limited to, wounds contaminated with dirt, feces, soil, or saliva; puncture wounds; avulsions; wounds resulting from missiles, crushing, burns, or frostbite.
Δ The preferred vaccine preparation depends upon the age of the patient:
- <7 years: DTaP.
- ≥7 and <11 years: Td.
- 11 through 64 years: Tdap is preferred to Td for those who have never received Tdap.
- Td is preferred to TT for those who received Tdap previously, when Tdap is not available, and for persons >64 years of age.
◊ 250 units intramuscularly at a different site than tetanus toxoid; intravenous immune globulin should be administered if TIG is not available.
# Absorbable sutures

<table>
<thead>
<tr>
<th>Suture material</th>
<th>Knot security</th>
<th>Wound tensile strength</th>
<th>Security (days)*</th>
<th>Tissue reactivity</th>
<th>Anatomic site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast-absorbing gut</td>
<td>Poor</td>
<td>Least</td>
<td>4 to 6</td>
<td>Most</td>
<td>Face</td>
</tr>
<tr>
<td>Vicryl Rapide</td>
<td>Good</td>
<td>Fair</td>
<td>5 to 7</td>
<td>Minimal</td>
<td>Face, scalp, under cast/splint</td>
</tr>
<tr>
<td>Surgical gut</td>
<td>Poor</td>
<td>Fair</td>
<td>5 to 7</td>
<td>Most</td>
<td>Face (rarely used)</td>
</tr>
<tr>
<td>Poliglecaprone 25 (Monocryl)</td>
<td>Good</td>
<td>Fair</td>
<td>7 to 10</td>
<td>Minimal</td>
<td>Face, consider in contaminated wounds needing deep closure</td>
</tr>
<tr>
<td>Chromic gut</td>
<td>Fair</td>
<td>Fair</td>
<td>10 to 14</td>
<td>Most</td>
<td>Mouth, tongue, nailbed</td>
</tr>
<tr>
<td>Polyglactin (Vicryl)</td>
<td>Good</td>
<td>Good</td>
<td>30</td>
<td>Minimal</td>
<td>Deep closure, nailbed, mouth</td>
</tr>
<tr>
<td>Polyglycolic acid (Dexon)</td>
<td>Best</td>
<td>Good</td>
<td>30</td>
<td>Minimal</td>
<td>Deep closure</td>
</tr>
<tr>
<td>Polydioxanone (PDS)</td>
<td>Fair</td>
<td>Best</td>
<td>45 to 60</td>
<td>Least</td>
<td>Deep closure</td>
</tr>
<tr>
<td>Polyglyconate (Maxon)</td>
<td>Fair</td>
<td>Best</td>
<td>45 to 60</td>
<td>Least</td>
<td>Deep closure</td>
</tr>
</tbody>
</table>

## Nonabsorbable sutures

<table>
<thead>
<tr>
<th>Suture material</th>
<th>Knot security</th>
<th>Wound tensile strength</th>
<th>Tissue reactivity</th>
<th>Workability</th>
<th>Anatomic site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylon (Ethilon)</td>
<td>Good</td>
<td>Good</td>
<td>Minimal</td>
<td>Good</td>
<td>Skin closure anywhere</td>
</tr>
<tr>
<td>Polypropylene (Prolene)</td>
<td>Least</td>
<td>Best</td>
<td>Least</td>
<td>Fair</td>
<td>Skin closure anywhere. Blue dyed suture useful in dark-skinned individuals.</td>
</tr>
<tr>
<td>Silk</td>
<td>Best</td>
<td>Least</td>
<td>Most</td>
<td>Best</td>
<td>Rarely used</td>
</tr>
</tbody>
</table>

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.
Proper technique for wound edge eversion

The proper technique for evverting 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.
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.
Subcuticular 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. Reproduced with permission from: Trott, AT. Wounds and lacerations: emergency care and closure, 2nd ed, Mosby Year Book, St. Louis 1997. p.160. Copyright ©1997 Elsevier.
Technique for placing a vertical mattress suture

To place a vertical mattress suture, the needle is initially inserted at a distance from the wound edge, exiting through the skin on the opposite side, at an equal distance from the wound edge (far-far). The needle is then rotated 180 degrees in the needle holder and the direction of the suture loop is reversed. On the return, small bites are taken at the epidermal/dermal edges (near-near).
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 the dermis. The suture loop is completed by bringing the needle out through the skin on the opposite side of the non-flap portion.
Technique for closing a lip laceration

The edges of the vermillion border must be precisely aligned to achieve an optimal cosmetic outcome for lacerations that cross the vermillion border. To accomplish this, the first suture placed should bring the edges of the vermillion border together.
The parotid gland and facial nerve underlie the zygomatic and cheek areas.

The parotid gland and facial nerve branches are superficial to the masseter muscle and can be damaged in lacerations to the cheek and zygoma that are anterior to the ear.