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A guide to better wound closures

The techniques described—and pictured—here can help you improve outcomes, whether the wound is a laceration or the result of a surgical procedure.

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PRACTICE RECOMMENDATIONS

› *If the skin edges of a wound require pressure to approximate, consider undermining the edges.* (C)

› *When removing a cutaneous neoplasm, avoid resecting excessive tissue.* (A)

› *For deep lacerations with potential "dead space," use vertical mattress sutures to approximate the wound edges.* (C)

Strength of recommendation (SOR)

(A) Good-quality patient-oriented evidence

(B) Inconsistent or limited-quality patient-oriented evidence

(C) Consensus, usual practice, opinion, disease-oriented evidence, case series

Skin procedures such as closing wounds and removing neoplasms are an integral part of most family medicine practices. While closure of simple lacerations and small surgical procedures are relatively straightforward, some lesions require extra techniques and attention to achieve the best outcomes.

This article describes some steps you can take to achieve the best outcomes for wound healing and cosmesis. Although suturing basics are important for successful wound closure, that information is not covered in this article. Forsch,[1] however, provides an excellent discussion of basic wound skin preparation and suturing techniques.

Before beginning, visualize the ending

Before beginning any skin repair—whether it is a planned surgical procedure or a more urgent wound closure—review the patient's medical record for conditions or medications that may adversely affect wound healing. Key in on patients with poorly controlled diabetes or those taking anticoagulants or antiplatelet drugs. Good diabetes control before surgery improves healing[2] and drugs that promote bleeding sometimes may be temporarily discontinued before a procedure. If a patient's diabetes is poorly controlled, an elective procedure can be postponed. If a patient is taking an anticoagulant and the international normalized ratio is within the therapeutic window, the procedure can be performed, but the physician must be ready to address bleeding by having electrical or chemical cautery available.

During your initial evaluation of the patient, assess and document the condition of the joints, muscles, tendons, and ligaments in the area in question before the procedure. Being aware of the local anatomy will help you avoid inadvertently damaging nerves, tendons, vessels, and other vital structures. Also, any time a procedure is beyond your comfort level, ask for help or refer the patient to a subspecialist. For example, if a lesion is on a patient's neck near the carotid artery, the proce-

dure is better left to an ear, nose, and throat specialist.

On the day of the procedure, plan how you will close the wound before you make the first cut, and include this information in your informed consent. Mentally review the anatomy of the area before starting a procedure to anticipate obstacles or structures that may be inadvertently injured. Visualize how the skin will fit together and how it will heal before making an incision. Reassure the patient that you will use techniques to minimize pain and scarring. Consider taking photos both before and after the procedure for documentation.

The best cosmetic results usually are achieved when the final closure line (and therefore the scar) lies parallel to the lines of least skin tension. When doing an excision, start choosing possible closures by considering layouts that produce this result. Eliminate from consideration any closures that would pull skin tension from areas that are immobile or that would cause cosmetic problems (such as a closure on or near the eyebrows or mouth, since this would change the contours of these structures). For such closures, a skin rearrangement flap may offer a cosmetically better outcome, especially on the face.

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Tips for irrigating the wound and prepping the skin

If you are repairing a wound that is the result of an injury, you will need to clean the laceration gently but thoroughly. Avoid using products on open wounds that can damage regenerative tissue, such as organified iodines or hydrogen peroxide.[3,4] Before irrigating a wound with normal saline, thoroughly examine it for foreign bodies, which may promote infection and impede healing. Consider giving local anesthesia before irrigation. Typically, irrigation pressure of approximately 8 pounds per square inch (psi) is considered ideal.[5] Using irrigation pressures of <4 psi only moistens the wound, and >15 psi can damage the wound and drive bacteria deeper into tissue.[6] Pressures of 8 to 11 psi can be achieved using a 18- to 19-gauge needle or angiocatheter with a 30 cc to 35 cc syringe.

Consider snipping off the tip of the cap and leaving it snugly on the needle. This will help prevent needle sticks and allow for thorough and safer irrigation. If commercial irrigation equipment is available, use it as directed by the manufacturer. Always be aware of potential splashback while irrigating and use appropriate personal protective equipment.

For wounds that result from a surgical procedure, employ appropriate site preparation and sterile technique. Iodophors provide broad-spectrum coverage, are not associated with microbial resistance, and provide a bacteriostatic effect as long as they remain on the skin. They require at least 2 minutes of contact to release free iodine, which exerts antibacterial activity.

Chlorhexidine gluconate offers broad-spectrum coverage against bacteria, yeast, and molds. It appears to provide greater reduction in skin microflora than povidone-iodine, and remains active for hours after application.[7] Use it with caution around the eyes because of the risk for conjunctival irritation, keratitis, or corneal ulceration.[8] Make sure to apply the prep solution to an area larger than the area exposed by the fenestrated drape because the drape may move around during the procedure, inadvertently contaminating the surgical field.

When excising a neoplasm, consider the margin

When performing a surgical procedure such as removing a cutaneous neoplasm, don't resect excessive tissue, but do excise adequate margins. (For adequate margins of various cutaneous neoplasms, see **TABLE 1**.[9-11]) Mark the outlines of the visible tumor and the excision margin and show them to the patient, because some patients mistakenly assume that only the visible tumor will be removed.

Keep in mind when treating basal cell carcinomas (BCC) or squamous cell carcinomas (SCC) that the presence of high-risk characteristics may require larger surgical margins. The cure rates are lower for higher-risk BCCs, such as lesions that have morpheaform morphology or aggressive histologic features, or those that are ≥2 cm, recurrent, or located on the lips or paranasal or periocular regions.[10-12]

TABLE 1

Recommended margins when excising malignant lesions[9-11]

Type of neoplasm	Recommended margin
Small BCC located on lower-risk areas	3-5 mm
Higher-risk BCC*	>5 mm
Well-defined, small (<2 cm) SCCs lacking high-risk features	4 mm
Higher-risk SCC†	>5 mm
Atypical melanocytic lesions	1-3 mm
Melanoma in situ	0.5-1 cm
Melanoma ≤1 mm	1 cm
Melanoma >1 to 2 mm	1-2 cm
Melanoma >2 mm	2 cm

BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

*Higher-risk BCC lesions are those with morpheaform morphology or aggressive histologic features or those that are ≥2 cm, recurrent, or located on the lips, paranasal, or periocular regions.

† Higher-risk SCC lesions are those that are ≥2 cm in diameter, poorly differentiated on histology, in high-risk sites, or invade subcutaneous tissue.

Cure rates for these higher-risk BCCs can be improved substantially by using intraoperative margin evaluation (frozen sections) or Mohs micrographic surgery. (For more on Mohs surgery, see "When to consider Mohs surgery," *J Fam Pract*. 2013;62:558.)

Primary SCCs that are ≥2 cm in diameter, poorly differentiated on histology, in high-risk sites, or invading subcutaneous tissues require larger margins.[13] The approach to a suspicious pigmented cutaneous neoplasm consists of an initial biopsy or excision with 1 to 2 mm margins and pathologic evaluation.[14]

Because hematoma formation inhibits wound healing, pay special attention to hemostasis when excising a neoplasm. Use pressure for minor bleeding. Use mosquito forceps to clamp a bleeder followed by ligation with an absorbable suture for larger bleeders. Other techniques for hemostasis include electrical or chemical cauterization and hemostatic solutions.

Positioning of edges is key to minimize scarring

When suturing a wound—whether it is from an injury or a procedure—take care to evert the skin edges; the underlying dermis from both edges should touch. This is to compensate for future contracture of the wound and thus, to produce a flat scar. It is difficult to evert the edges when they are too far apart or under tension, and excess skin tends to invert the skin edges, which is undesirable. If the pressure generated by the suture is greater than the closing pressure of the skin capillaries, the result will be local necrosis.

Before placing the suture, gently pinch the skin edges together. If the skin edges require pressure to approximate, consider undermining the skin edges, that is, cutting the fibrous septae that connect the skin to the underlying fascia so you can more easily pull the wound edges together. Undermining can be performed with a scalpel blade, scissors, or by bluntly using a hemostat. Use skin hooks or forceps to lift the wound edge. The safest level of undermining is in the fat, just below the dermal-fat junction. It usually takes 2 to 3 cm of undermining to free up 1 cm of tissue. Periodically check to see how much tissue has been released and undermine the minimum amount necessary.

Use the recommended size suture for the area of the body and remove sutures at recommended times (**TABLE 2**).[7] In general, use the thinnest suture for the least amount of time possible. When giving the patient wound care instructions, emphasize the importance of having the sutures removed on time. Delay may cause local irritation and increased

Irrigation pressure of approximately 8 psi is considered ideal.

TABLE 2

When should you remove sutures? It depends on where they are[7]

Location of sutures	Recommended suture size	Recommended removal time (days)
Face	5-0 to 6-0	3-5
Neck	5-0 to 6-0	5-7
Scalp	4-0 to 5-0	7
Trunk	3-0 to 4-0	10-14
Extensor surface of the hands	5-0 to 6-0	10-14
Upper extremity	4-0 to 5-0	14
Lower extremity	4-0 to 5-0	14-28

Buried dermal sutures do not increase the risk of infection in clean, uncontaminated lacerations.

scarring. To prevent suture marks, consider earlier removal of a single suture that causes extra tension (such as a vertical mattress suture, which is described on page 186) within a line of simple sutures. Infection or patient factors such as age, presence of vascular or chronic disease, and nutritional status may influence healing times and suture removal times, so carefully assess wound healing; it may be necessary to remove sutures earlier or later than the recommended time.

Avoid dog ears. Dog ears (bunching of skin at one end of a wound closure) usually are the result of unequal amounts of opposing tissue. Causes range from ragged lacerations and flap procedures to uneven apportion of tissue when suturing.

If the difference in the lengths of the 2 sides of a wound is ≤15%, the halving technique (placing the first suture in the center of the wound, the next suture in the center of each remaining segment, and so on) works well to avoid dog ears. Otherwise, a Burow triangle repair—a procedure that slightly extends the wound but removes the excess tissue and results in a better cosmetic outcome—may be required.

If while in the process of repairing a relatively small wound you notice that dog ears occur as the result of poor technique, consider removing and redoing the sutures.

Deep suturing reduces tension, improves outcomes

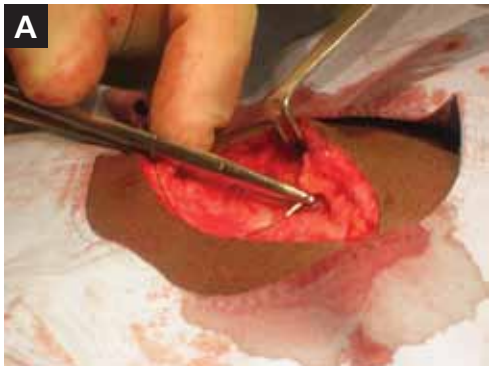
To achieve the best possible cosmetic outcomes when closing a particularly deep wound, consider placing deep sutures. Because scars remodel for about a year post-repair, tension across the wound area may produce a wider and more unsightly scar as time goes by. Deep closure of a wound with dissolvable sutures can:[15]

- reduce or eliminate wound tension when suturing the epidermis
- close potential space below the skin
- stop subcutaneous bleeding
- reduce hematoma and seroma formation.

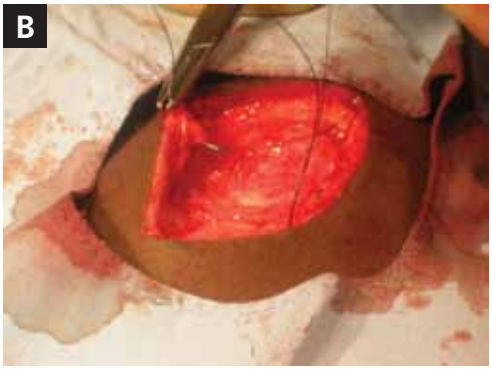
The technique for deep suture placement is shown in **FIGURES 1A TO 1D**. The decreased tension in the healing scar that results from placing deep-buried sutures will reduce the final width of the scar. Buried dermal sutures do not increase the risk of infection in clean, uncontaminated lacerations. However, animal studies suggest that deep sutures should be avoided in highly contaminated wounds.[16]

For deep lacerations with potential space remaining, use vertical mattress sutures to approximate the wound edges.[15] The vertical mattress suture technique is shown in **FIGURES 2A TO 2C**. This technique incorporates a large amount of tissue within the passage of the suture loops and provides good tensile strength in closing wound edges over a distance or under tension. It also is used for wounds in locations where wound edges tend to invert, such as on the posterior neck, behind the ear, in the groin, in the inframammary crease, or on concave body surfaces. Early removal

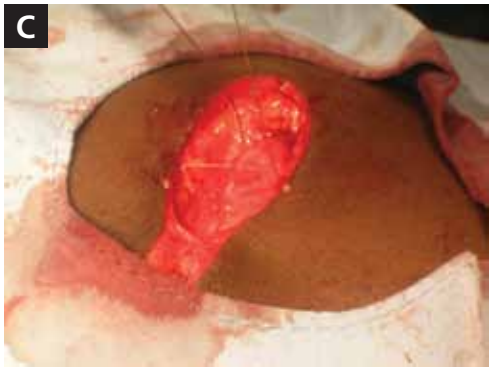
FIGURE 1
Deep suturing technique



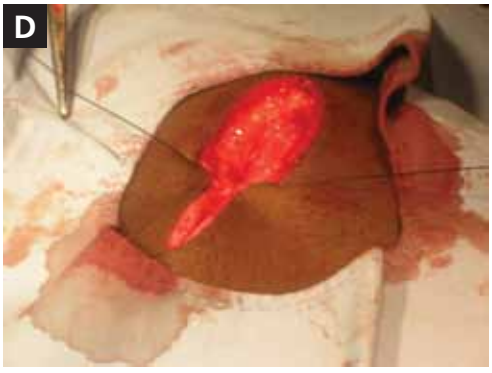
Begin in the center of the wound and pass the needle beneath the edge of one side of the wound and then back into the center of the wound through the dermis.



Place the needle upside-down and backward into the needle holder and pass it through the dermis into the edge on the other side of the wound and down to the base of the wound.



Place the suture ends on the same side of the center part of the suture that passes across the top of the wound. If you place the suture ends on both sides of the center part of the suture and tie them, the knot will rest on top of the center of the suture, and won't be buried in the deep tissue.



Pull the ends of the suture parallel to the wound to tie and deeply bury the knot. (This photo shows the end of this procedure, after the knot has been deeply buried in the wound.)

PHOTOS COURTESY OF: LUKE M. BAUDOIN, MD; EJ MAYEAUX JR, MD, DABFP, FAAFP

(half of the generally recommended days) of vertical mattress sutures can help prevent suture marks, especially if nearby simple interrupted sutures can remain in place for the recommended duration.

When to consider tape, staples, or adhesive

Don't overlook wound closure tapes for superficial wounds. Even if tape is a poor candidate for the primary wound closure, it still may be used during the early stages of wound healing to support other closures by spreading tension over a larger area than just the suture area. Apply one strip at a time on one side of the wound, then pull the tape across, everting the edges of the wound. This can help eliminate the "railroad track" scars sometimes caused by tight sutures.

Often, the tip of a triangular flap will refuse to nudge up to the corner, even with a well-placed corner suture. Tape applied and then pulled over the tip can help approximate the tissue for this type of wound. An alternative use of tape is to strengthen fragile skin to allow for suturing. The tape can be applied to either side of a wound and the suture needle can be driven though the tape and skin so you can close as usual. To improve adhesion, use tincture of benzoin over the areas on which you want to apply tape.

Carefully assess wound healing; it may be necessary to remove sutures earlier or later than the recommended time.

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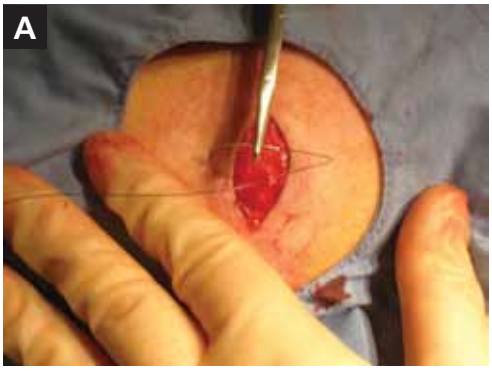
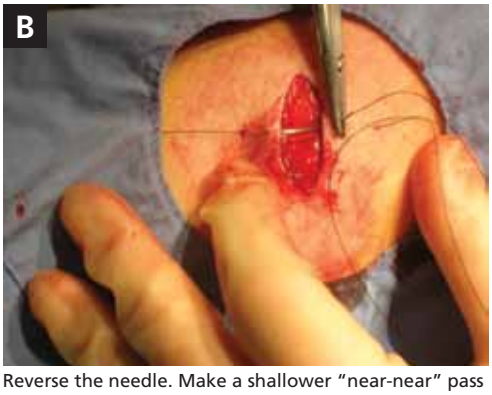
The vertical mattress suture technique provides good tensile strength in closing wound edges over a distance or under tension.

FIGURE 2

The vertical mattress suture technique



Start with a "far-far" pass, with the suture needle entering (and exiting) the skin 1.5 needle widths (typically 5-8 mm) from the wound edge. Pass the suture needle vertically and symmetrically through the tissue.



Reverse the needle. Make a shallower "near-near" pass 0.5 to 1 needle width (usually 3-5 mm) from the wound edge using a backhand pass. This pass should be mostly within the dermis.

Tie the suture gently to produce skin edge eversion. Simple interrupted sutures usually can be used to close the rest of the wound.

PHOTOS COURTESY OF: LUKE M. BAUDOIN, MD; EJ MAYEAUX JR, MD, DABFP, FAAFP

When using staples for closure, be certain to approximate the tissue carefully. When possible, have an assistant approximate the edges. Hold the stapler with the center mark at the middle of the skin edges. Squeeze the handle completely while keeping the stapler still during application. Properly applied staples are much less painful to remove, which your patients will appreciate.

Using tissue adhesives can save time because the procedure is quick and does not require suture or staple removal. Clean, low-tension wounds on the face tend to do well with adhesives. When on the fence about whether to suture or use adhesive, choose suture. Any wound for which you would consider using adhesive should be small enough to suture in just a few minutes. JFP

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