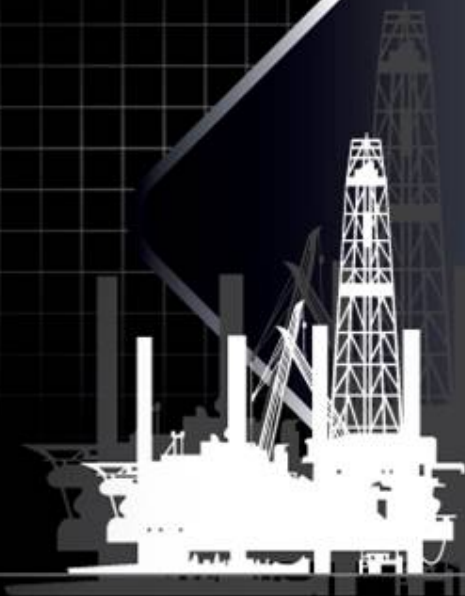




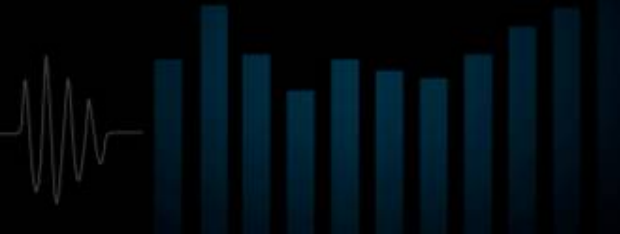
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# WOUND CLOSURE



## Why do we suture wounds?

- ❖ **When your patient asks you why you want to suture his wound, tell him the repair of lacerations will help prevent infection, prevent wound contracture, foster return to normal function, and heal more quickly**



- ❖ **Understand why repair of wound is needed.**
- ❖ **Understand the mechanisms of injury**
- ❖ **Know that patients may also have concomitant medical problems**



- ❖ **Bandages**
- ❖ **Butterfly Bandages**
- ❖ **Steri-strips**
- ❖ **Sutures**



- ❖ **Distal Exam - Check distal pulses and capillary refill**
- ❖ **Test pinprick and light touch to extremity**
- ❖ **Assure that movement of joints and digits distal to a wound are full, without pain, and with good strength**



- ❖ **Local Exam - The physical exam of the wound should be done under anesthesia just prior to closure**
- ❖ **Look for foreign bodies and remove them**
- ❖ **Check for any unrecognized arterial lacerations**
- ❖ **Inspect for partial tendon lacerations that might not show up as a distal motor effect**



- ❖ **Diabetes Mellitus - Presence of an infection poses more threat to diabetic patients**
- ❖ **Diabetics also are known to develop premature peripheral vascular disease, and run higher risk of ischemia induced wound infection**



- ❖ **Anti-Inflammatory Agents - Some medications to decrease or prevent the normal inflammatory response to trauma**
- ❖ **Patients taking these medications are at higher risk of infection or abnormal wound healing**
- ❖ **Asprin or ibuprofen do not appear to hinder wound healing or increase the risk of infection**

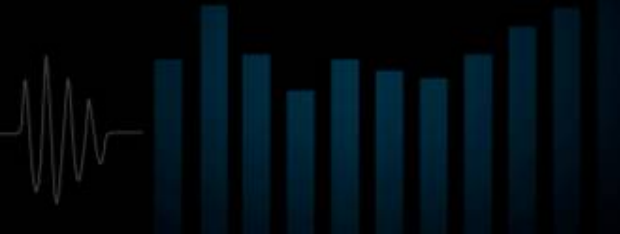




- ❖ **Vitamin C Deficiency (Scurvy) - Vitamin C is required for the rapid synthesis of collagen**
- ❖ **Significant deficiency in Vitamin C will prohibit adequate wound healing**



- ❖ **Peripheral Vascular Disease - Poor peripheral circulation creates poor environment for wound healing**
- ❖ **These patients are prone to wound infection and chronic ulceration**



❖ **Wounds are caused by one of two mechanisms:**

❖ **Blunt Trauma**

❖ **Penetrating Trauma**



- ❖ **Frequently contaminated**
- ❖ **More tissue destruction due to the blunt forces applied**
- ❖ **Local swelling and the necessity for debridement of tissues leads to difficulty in approximating wound edge**



- ❖ **Wound edges are frequently jagged and torn making approximation difficult**
- ❖ **As a result of swelling and tissue loss from debridement or the trauma itself, there will be more tension across the sutures which leads to less available blood supply**
- ❖ **Lack of oxygen, white cells and nutrients lead to wound infection**



- ❖ **It is important to establish the environment in which the wound occurred**
- ❖ **It is also important to establish the type of object causing the injury may provide clues to the degree of contamination**
- ❖ **Time lapse since the injury is significant in determining if a wound should even be repaired primarily**



- ❖ **Usually caused by a sharp object**
- ❖ **Minimal local tissue destruction**
- ❖ **Less local Edema**



## Wound Types

- ❖ **Linear**
- ❖ **Curved**
- ❖ **Beveled**
- ❖ **Stellate**
- ❖ **Triangular**
- ❖ **Flaps**

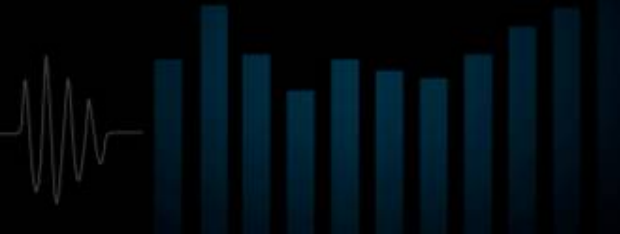




- ❖ **Irrigation - Irrigate the wound with a high velocity “jet” by taking a 30 ml syringe and a 18 gauge catheter and squirting the wound with at least 200 milliliters of Normal Saline**



- ❖ **Do NOT flush the wound with Hydrogen Peroxide**
  - ❖ **Hydrogen Peroxide can interfere with the tissue viability**
- ❖ **It may be used to cleanse the wound edges of dried blood**



- ❖ **Abrasions require vigorous scrubbing under local anesthesia if necessary, with soap or diluted betadine and a brush**
- ❖ **A wound must be explored for deep tissue injuries such as tendons and nerves**



## Wounds NOT to be closed

- ❖ **Wounds over 6 hours old**
- ❖ **Wounds contaminated with saliva, especially human saliva which easily causes infection**
- ❖ **Wounds over fractures**
- ❖ **When there is a foreign body that cannot be removed**

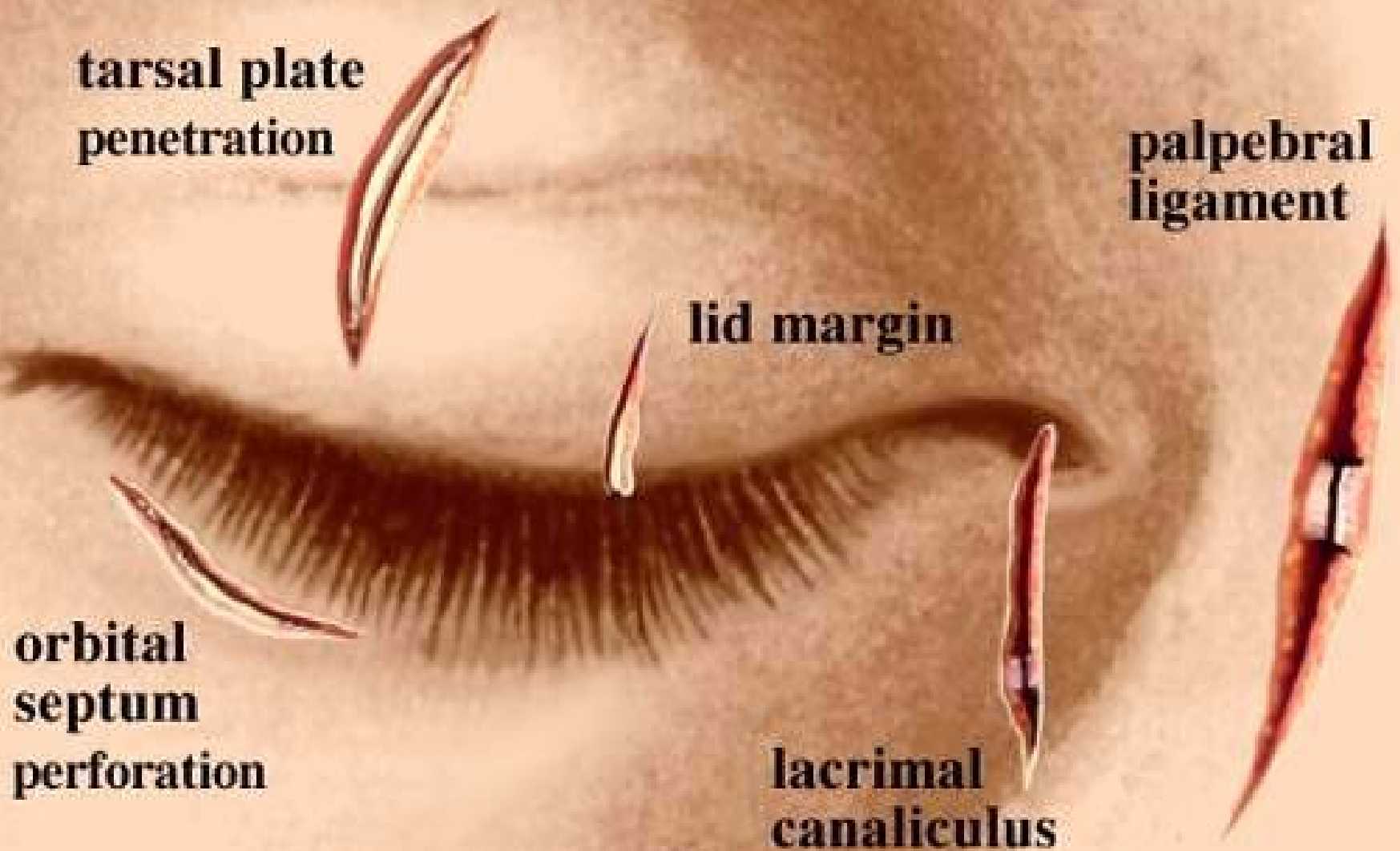


## Wounds NOT to be closed

- ❖ **If any underlying tissue damage is evident**
- ❖ **If joint involvement is present**
- ❖ **Wounds on the face**



# Lacerations Requiring a Specialist

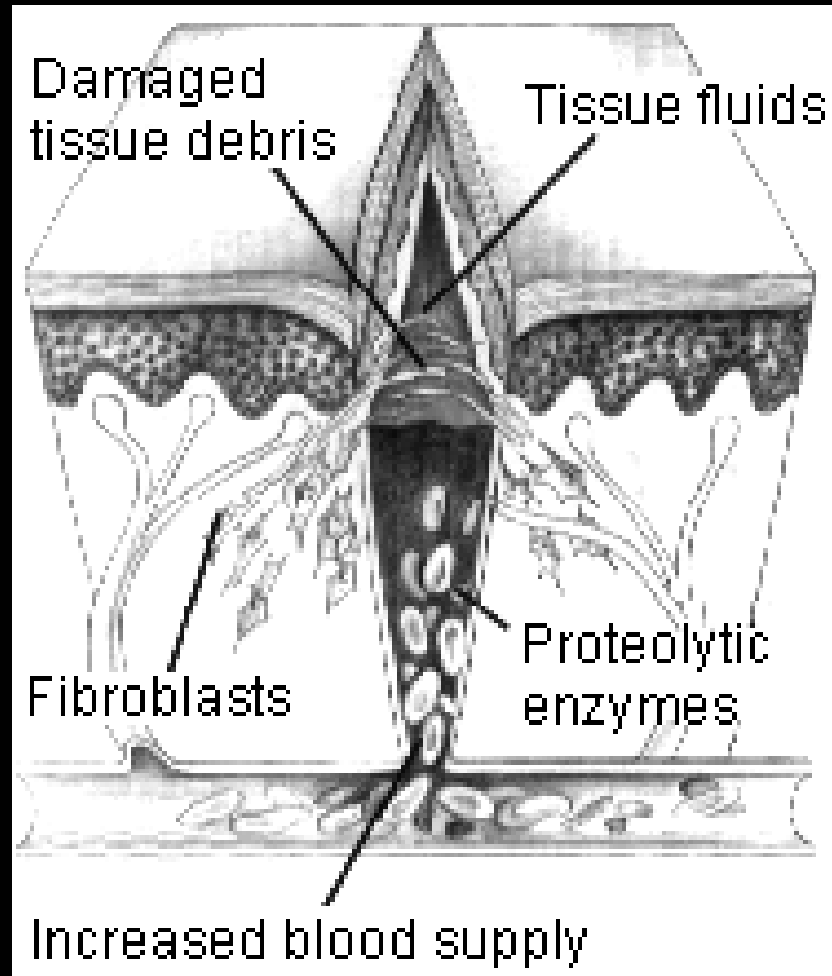


### ❖ Phase – 1:

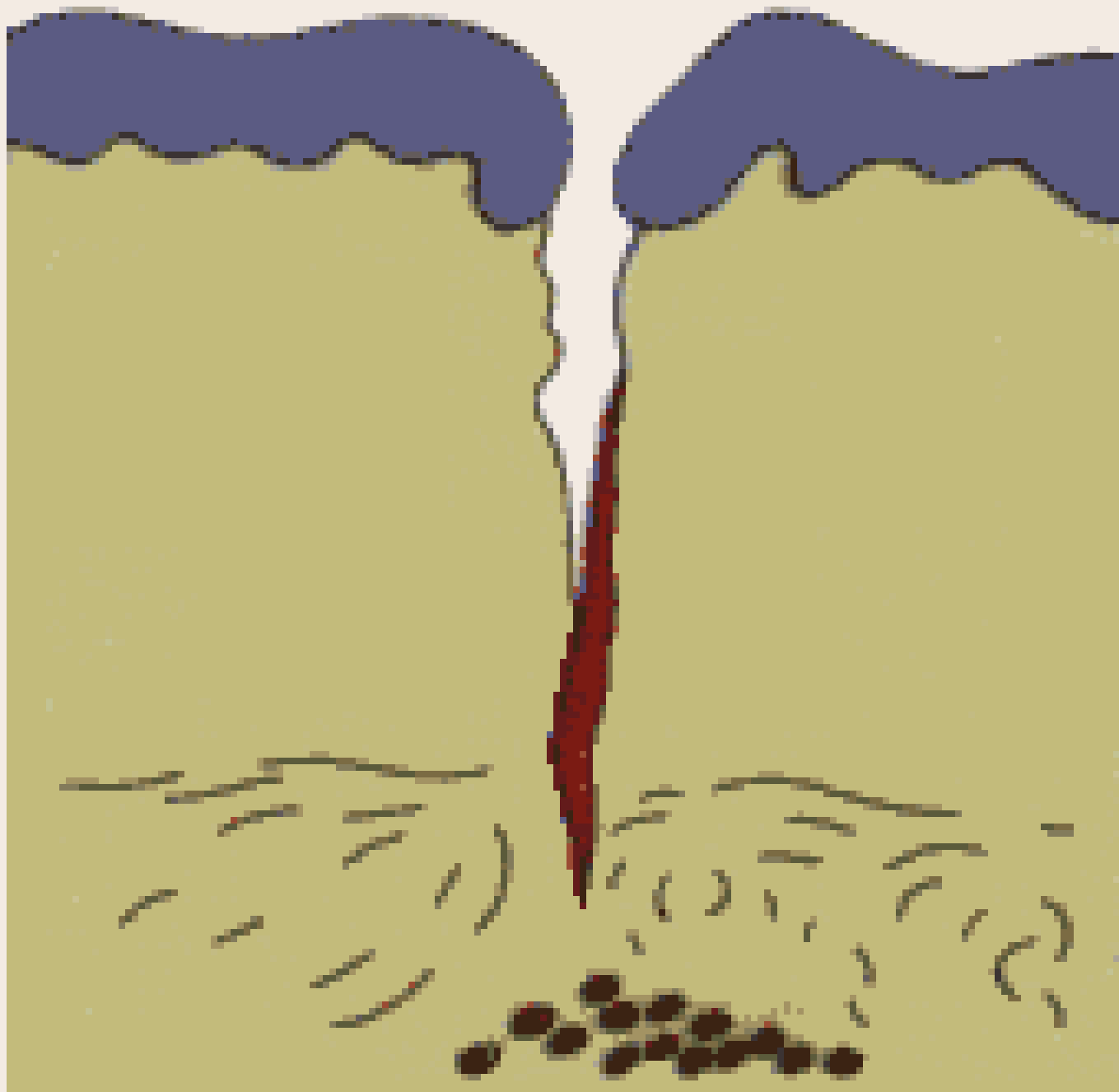
- ❖ During the first few days, an inflammatory response causes an outpouring of tissue fluids, an accumulation of cells and fibroblasts, and an increased blood supply to the wound
- ❖ Leukocytes and the other cells produce enzymes which dissolve and remove damaged tissue debris



## Inflammatory Response to a Wound





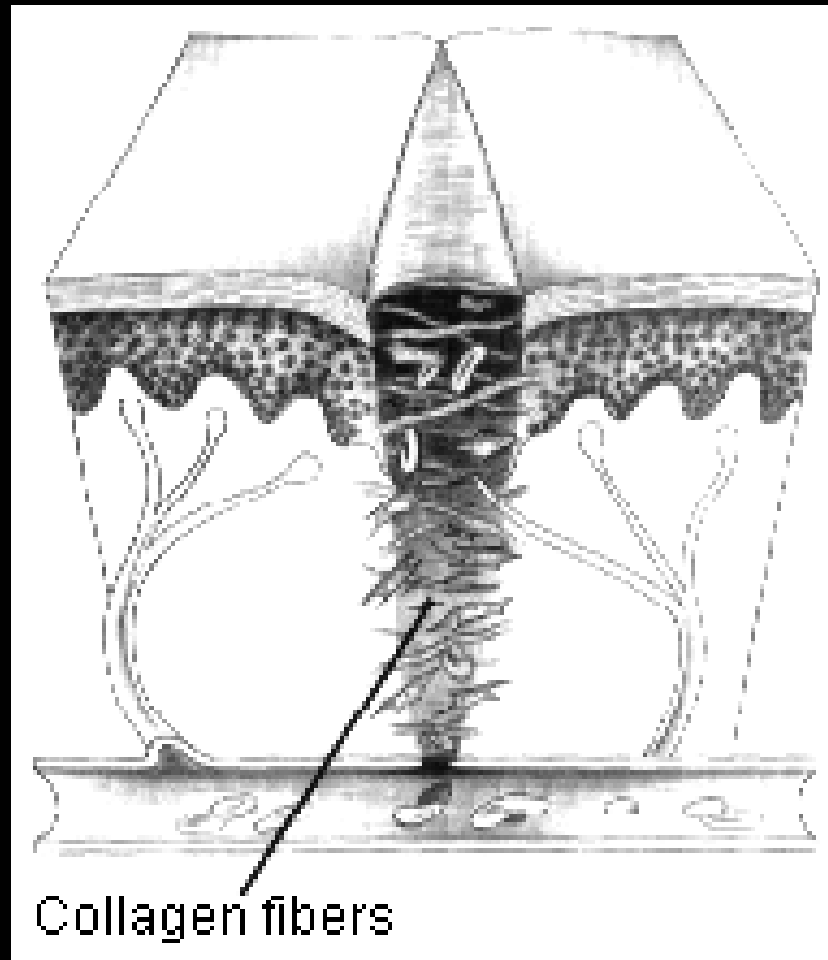


### ❖ Phase – 2:

- ❖ After the debridement process is well along, fibroblasts begin to form collagen fibers in the wound
- ❖ Collagen, a protein substance, is the chief constituent of connective tissue
- ❖ Collagen fiber formation determines the tensile strength and pliability of the healing wound



## COLLAGEN FORMATION (SCAR TISSUE)

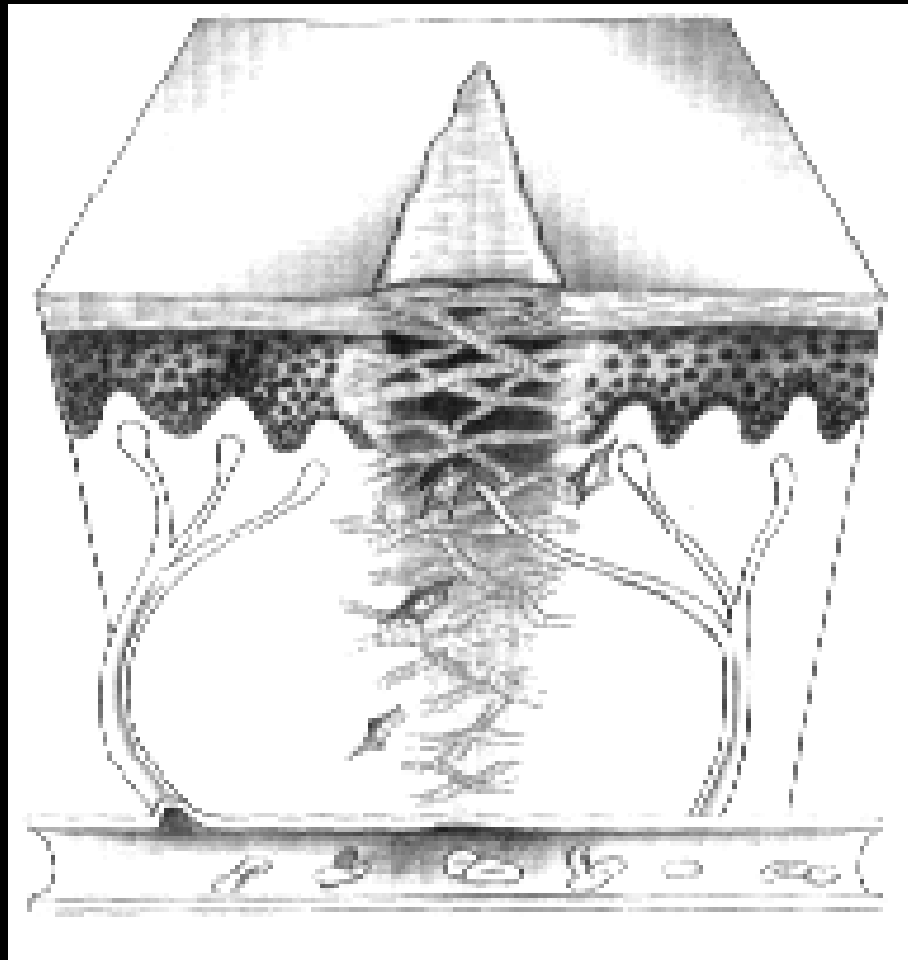


### ❖ Phase – 3:

- ❖ In time, sufficient collagen is laid down across the wound so that it can withstand normal stress
- ❖ The length of this phase varies with the type of tissue involved and the stresses or tension placed upon the wound during this period



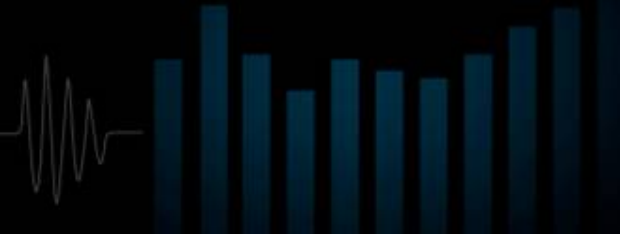
## Sufficient Collagen Laid Down



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- ❖ **Open tray in a sterile fashion.**
- ❖ **Place all materials needed on tray before gloving**
- ❖ **Glove**
- ❖ **Cleanse wound with three separate Betadine soaked 4 X 4's**
  - ❖ **Use a circular motion beginning at the wound edges, and slowly working outward**
- ❖ **Surround cleansed wound in sterile drapes**



- ❖ **Agents used: Lidocaine 1 or 2 % or Lidocaine with Epinephrine**
- ❖ **Infiltrate the smallest amount possible subcutaneously, NOT intradermally**
- ❖ **Use a 27 gauge needle, circumferentially about the wound**
- ❖ **Wait 5 minutes for the lidocaine to take effect**



- ❖ **Do not inject anesthetics intravenously or into an artery**
- ❖ **Patients can have allergic reactions to anesthetics, rarely life-threatening**
- ❖ **Be sure to inquire about allergies before administering any medication**
- ❖ **If Lidocaine with Epi is used areas not to be injected are fingers, toes, penis and nose**





- ❖ **The suture material supplied to you on your projects will be monofilament**
- ❖ **Monofilament sutures are made of a single strand of material**
- ❖ **Because of their simplified structure, they encounter less resistance as they pass through tissue than multifilament suture material**



- ❖ **Monofilament sutures also resist harboring organisms which may cause suture line infection**
- ❖ **Monofilament sutures tie down easily**



- ❖ **Due to monofilament suture construction, extreme care must be taken when handling and tying these sutures**
- ❖ **Crushing or crimping of monofilament suture material can nick or create a weak spot in the strand**
- ❖ **This may result in suture breakage**



- ❖ **Interrupted sutures use a number of strands to close the wound. Each strand is tied and cut after the insertion**
- ❖ **Interrupted sutures provide a secure closure, because if one suture breaks, the remaining sutures will hold the wound edges together**



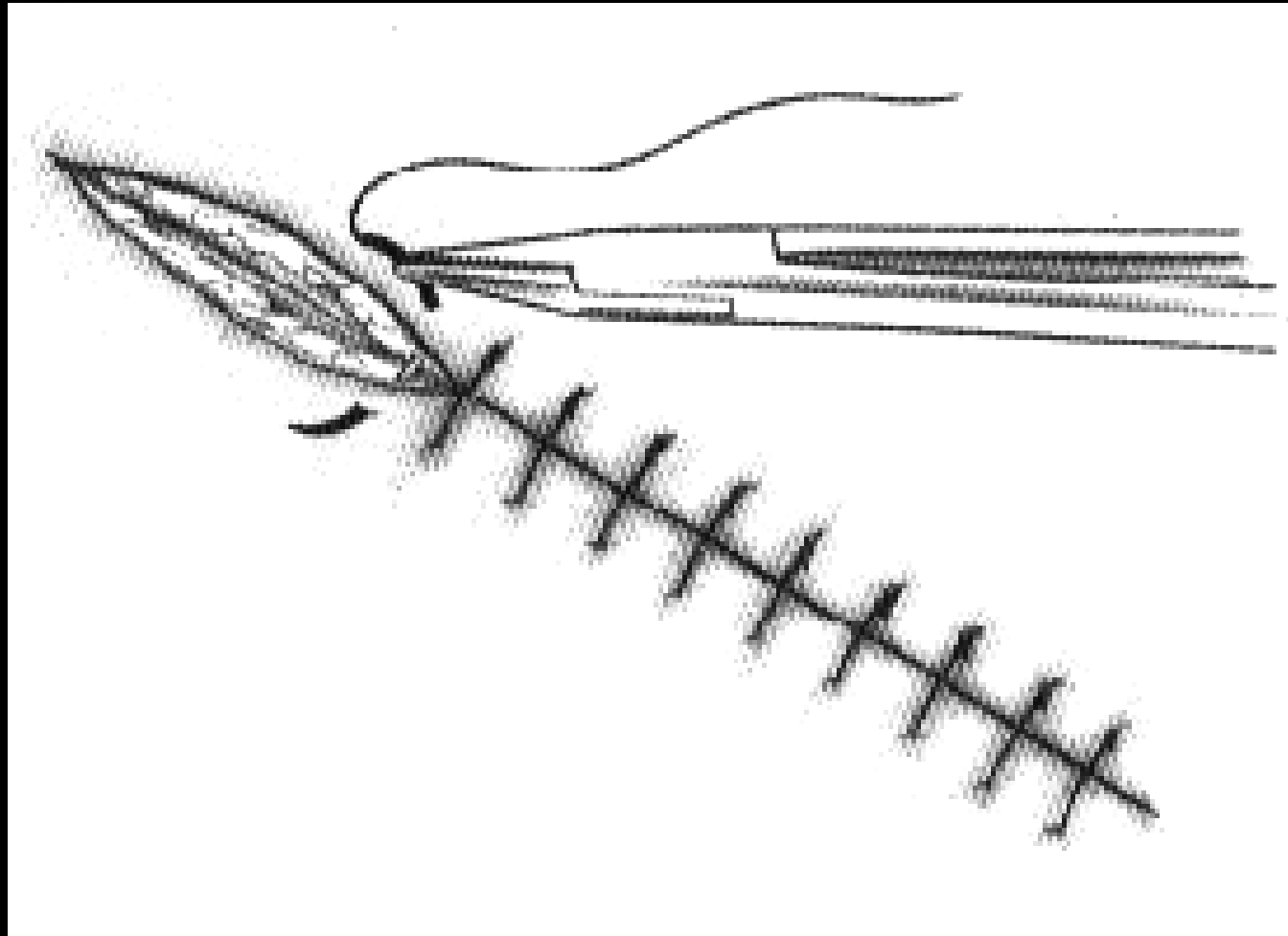
# The Three Types of Interrupted Sutures

❖ **Simple Interrupted Suture**

❖ **Vertical Mattress Suture**



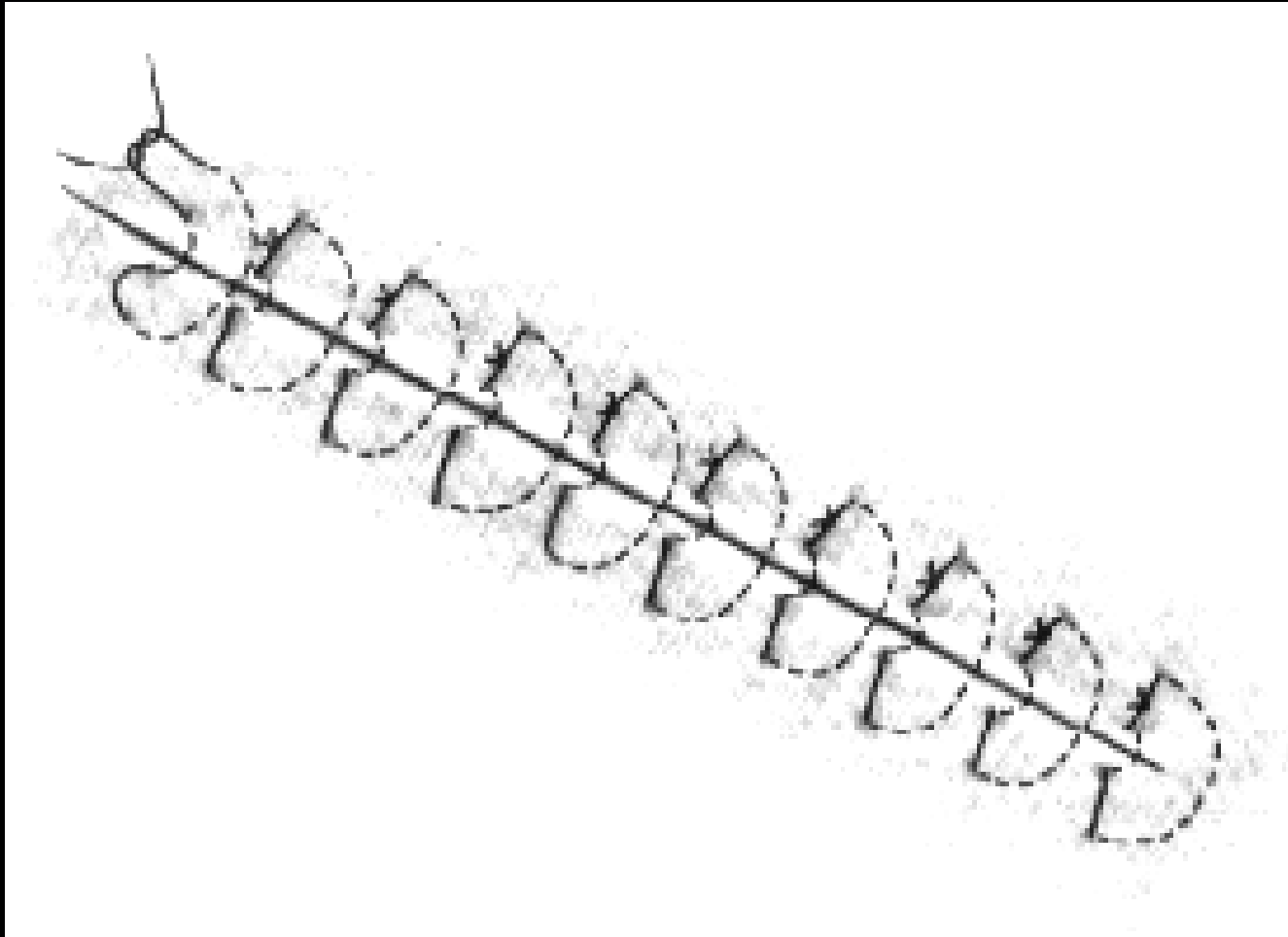
## Simple Interrupted Sutures



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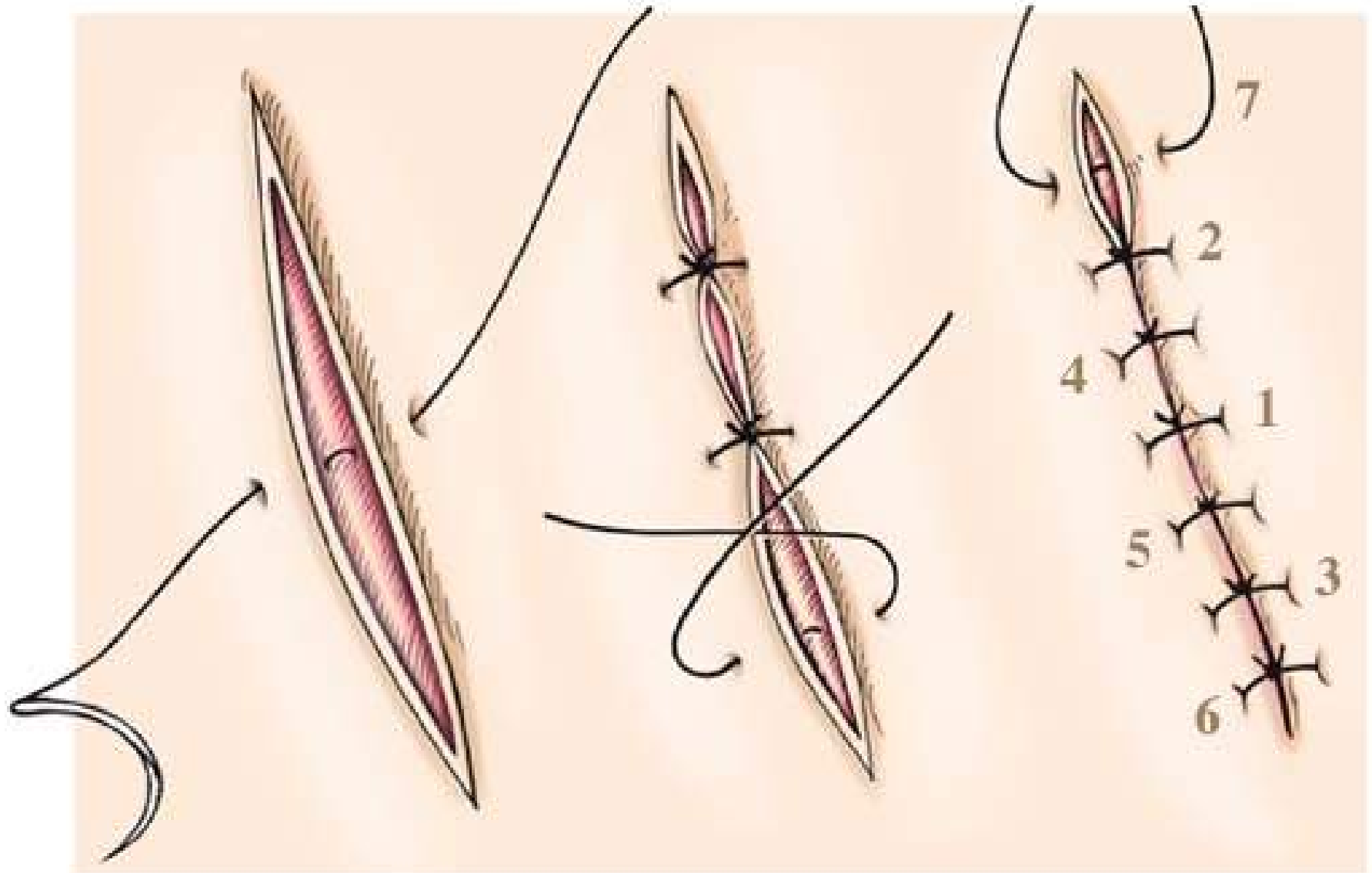
## Vertical Mattress Sutures



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## Suturing Basics: Proper alignment and number of sutures



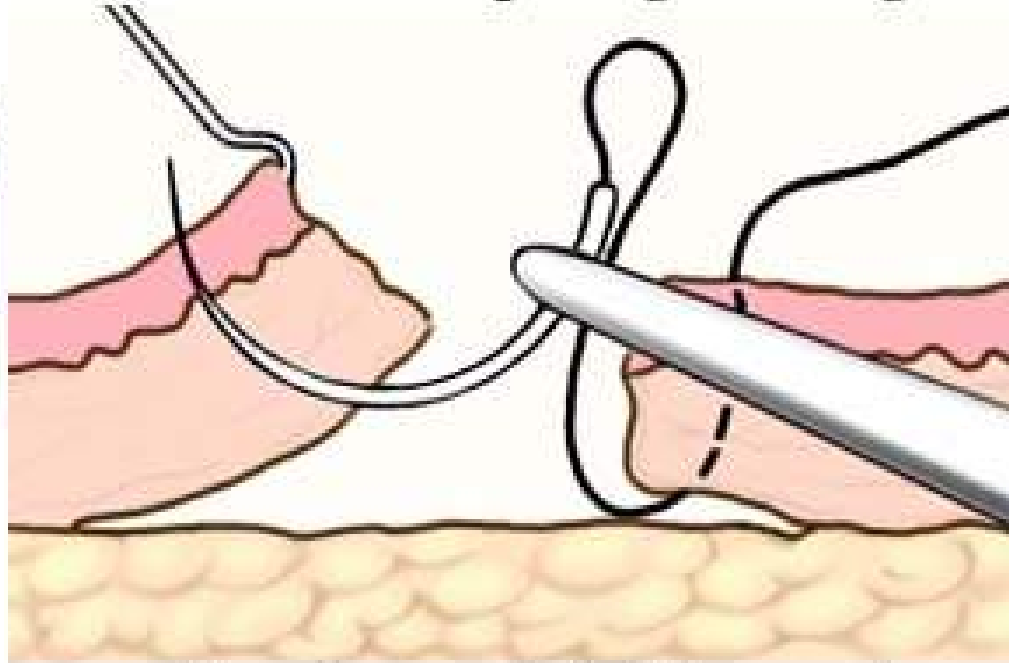
**To facilitate proper alignment, close the wound in segments. To minimize tissue strangulation, use just enough tension to approximate the skin edges, and just enough sutures to prevent gaping.**



# Simple Percutaneous Sutures

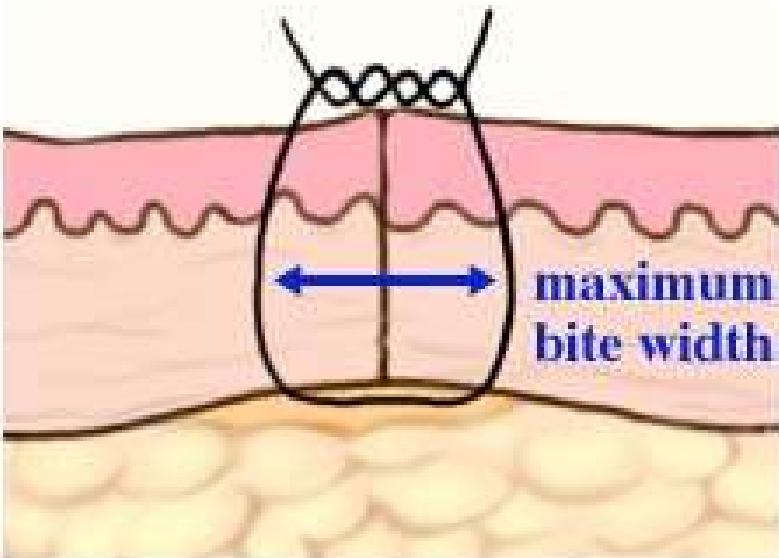
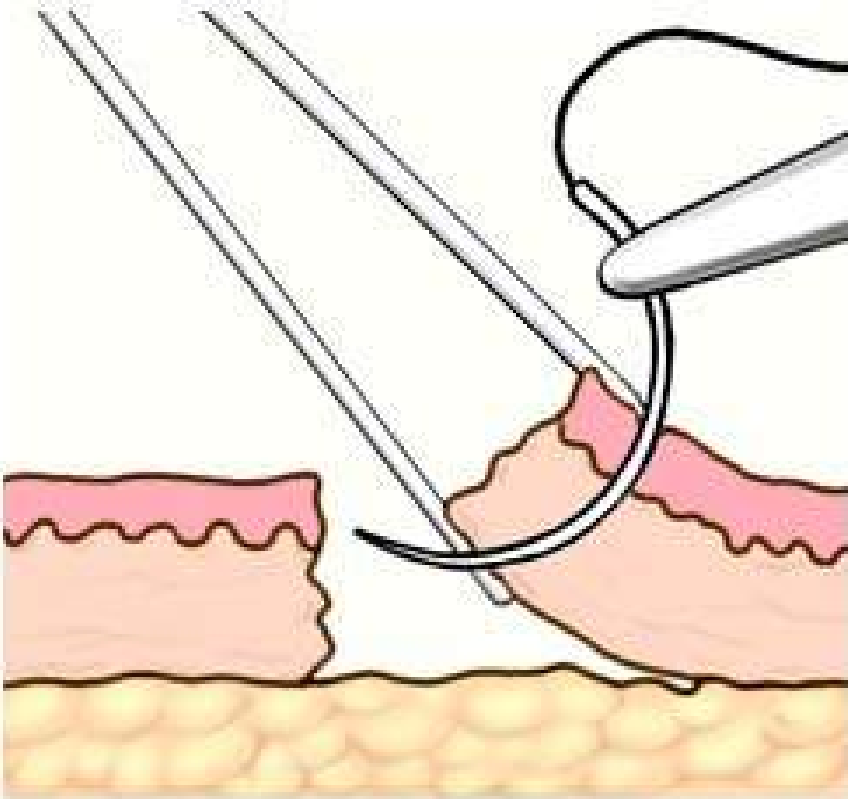
**1. Pass the needle through the skin on one side of the wound.**

**2. After grasping the needle inside the wound and pulling it through,**

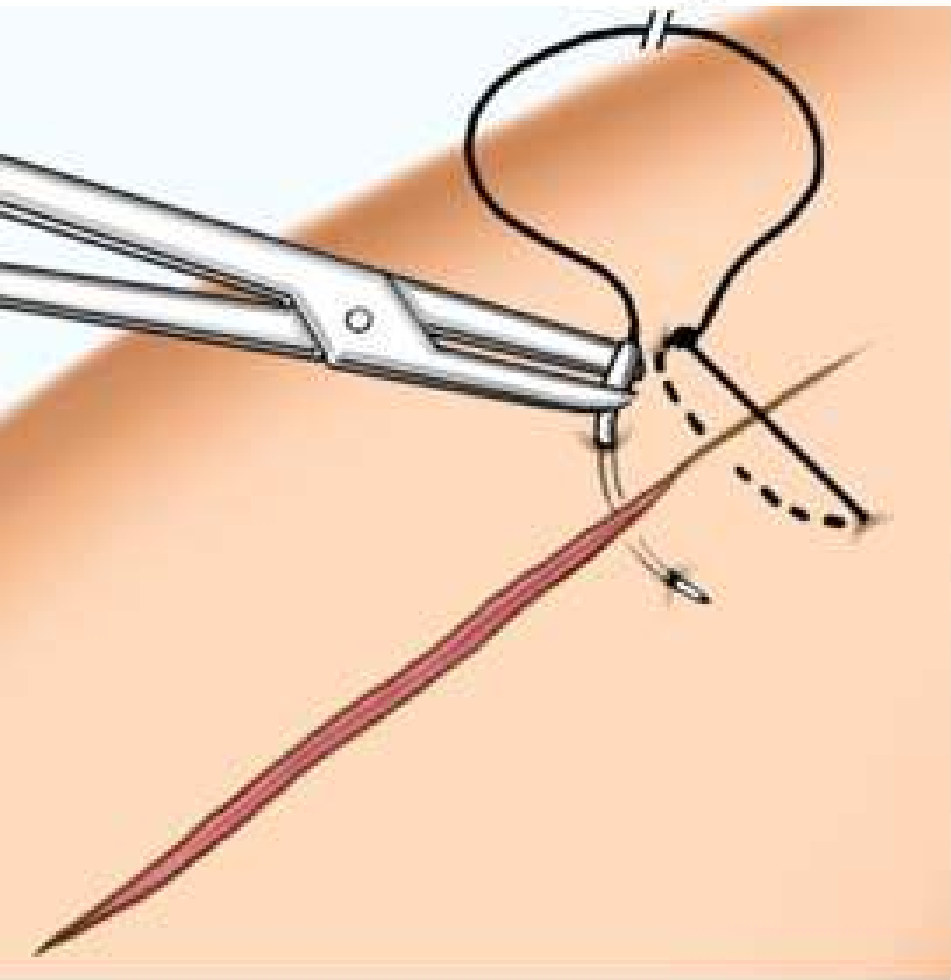


**reposition the needle holders on the needle shank and pass it through the skin on the opposite side of the wound.**

**3. Use a surgeon's knot with multiple throws to secure the suture.**



# Running Percutaneous Sutures

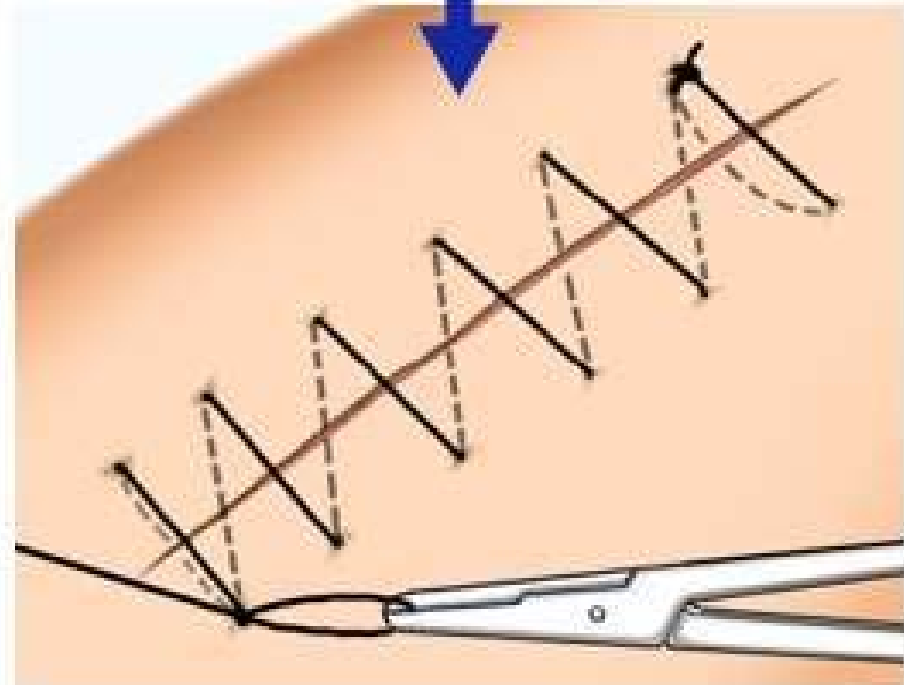
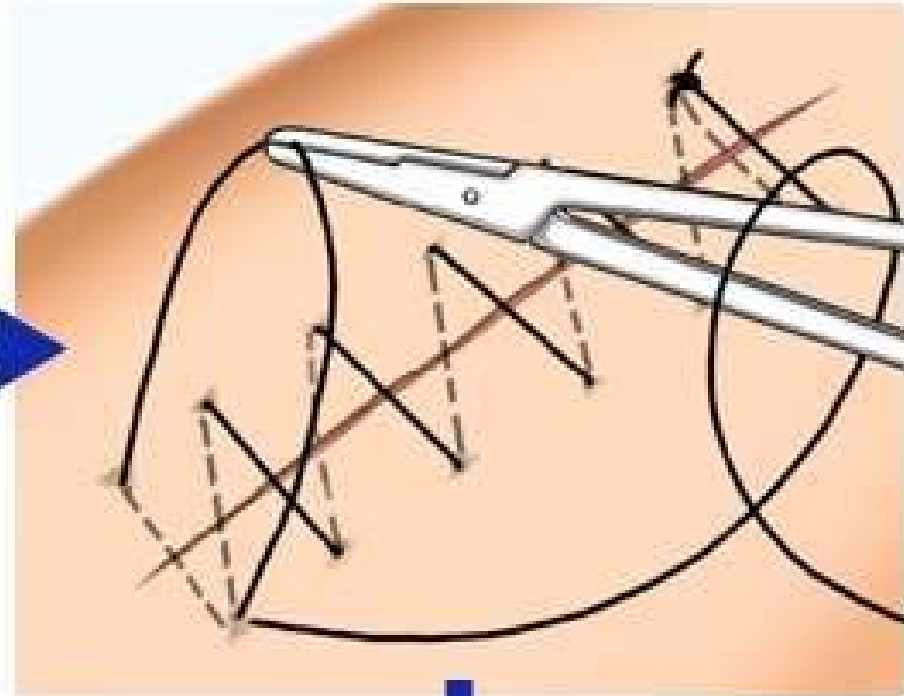
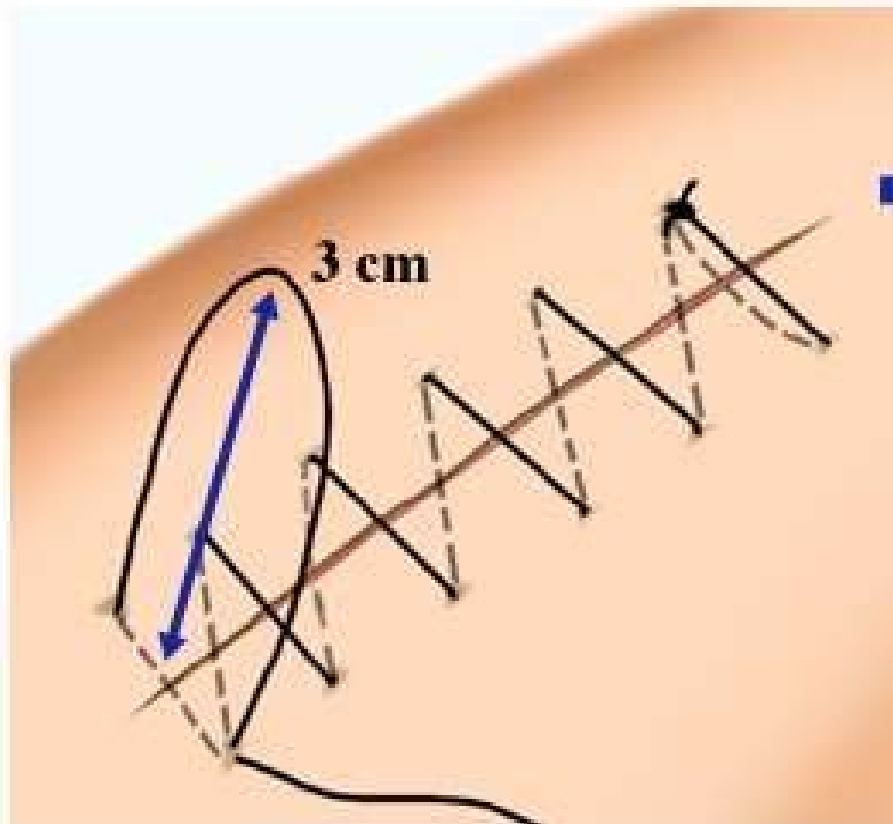


**1. Starting the run. Securely tie a regular percutaneous suture, but don't clip the suture from the needle. Then take a diagonal bite adjacent to the knot.**



**2. Running the suture. Maintain sufficient tension to approximate the wound edges.**

# Tying the Running Suture



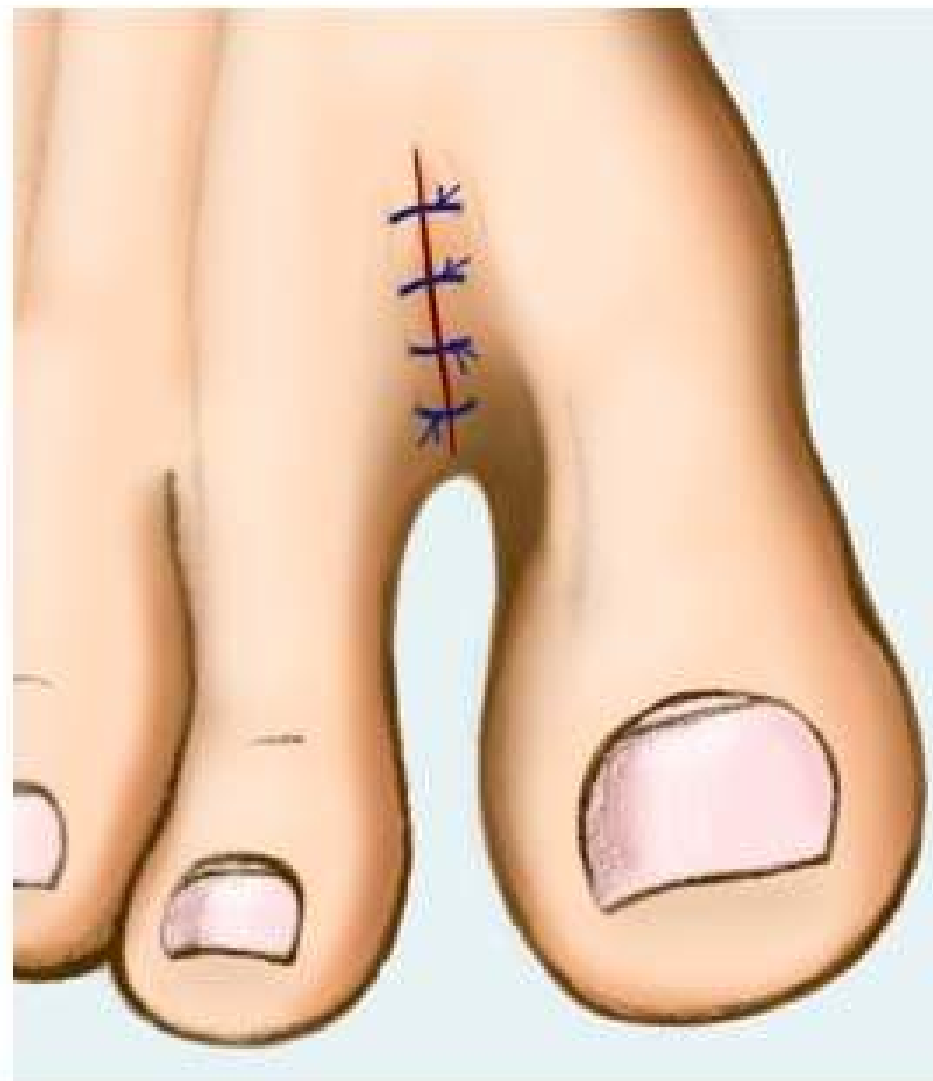
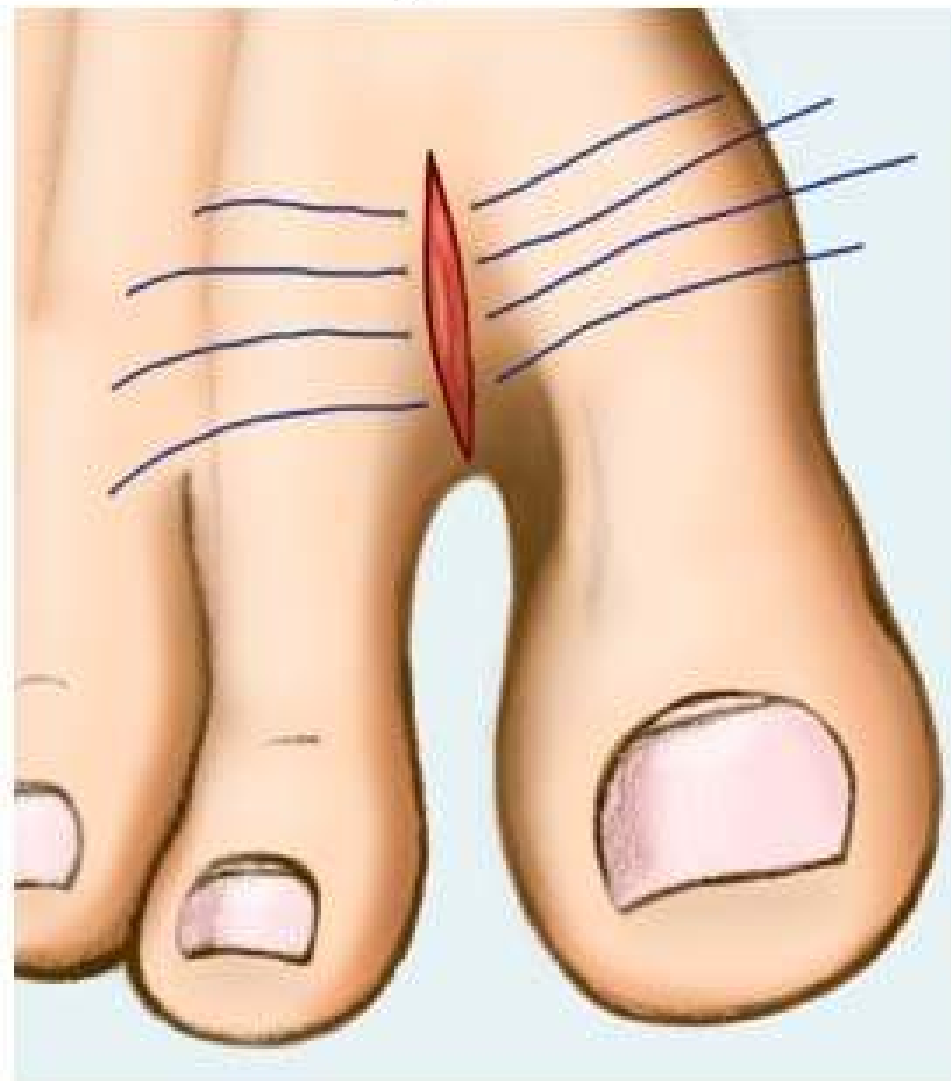
**1. Tying the end. Leave the last external loop protruding about 3 cm.**

**2. Tie a surgeon's knot or multiple square knots using the protruding loop as the free suture end.**

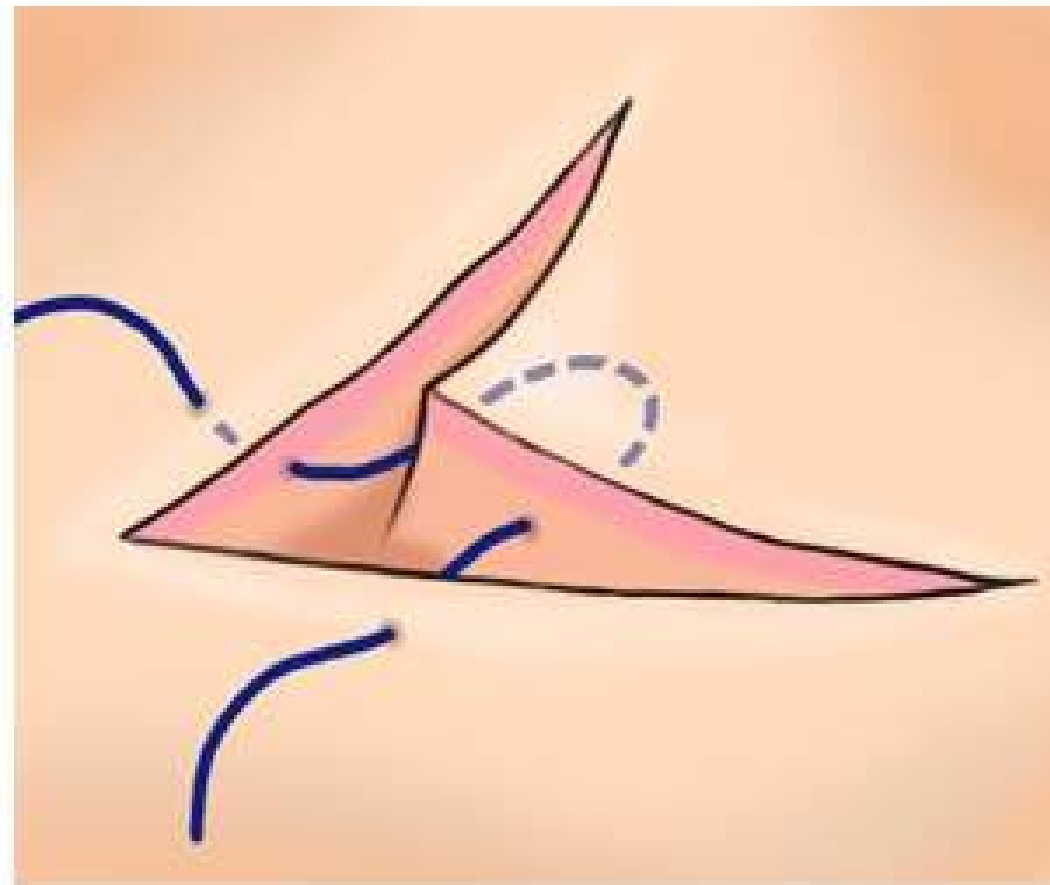
# Repair of Recessed Lacerations

**1. An adequate number of sutures is placed without tying, leaving both ends long.**

**2. All sutures are tied and trimmed to complete the closure.**

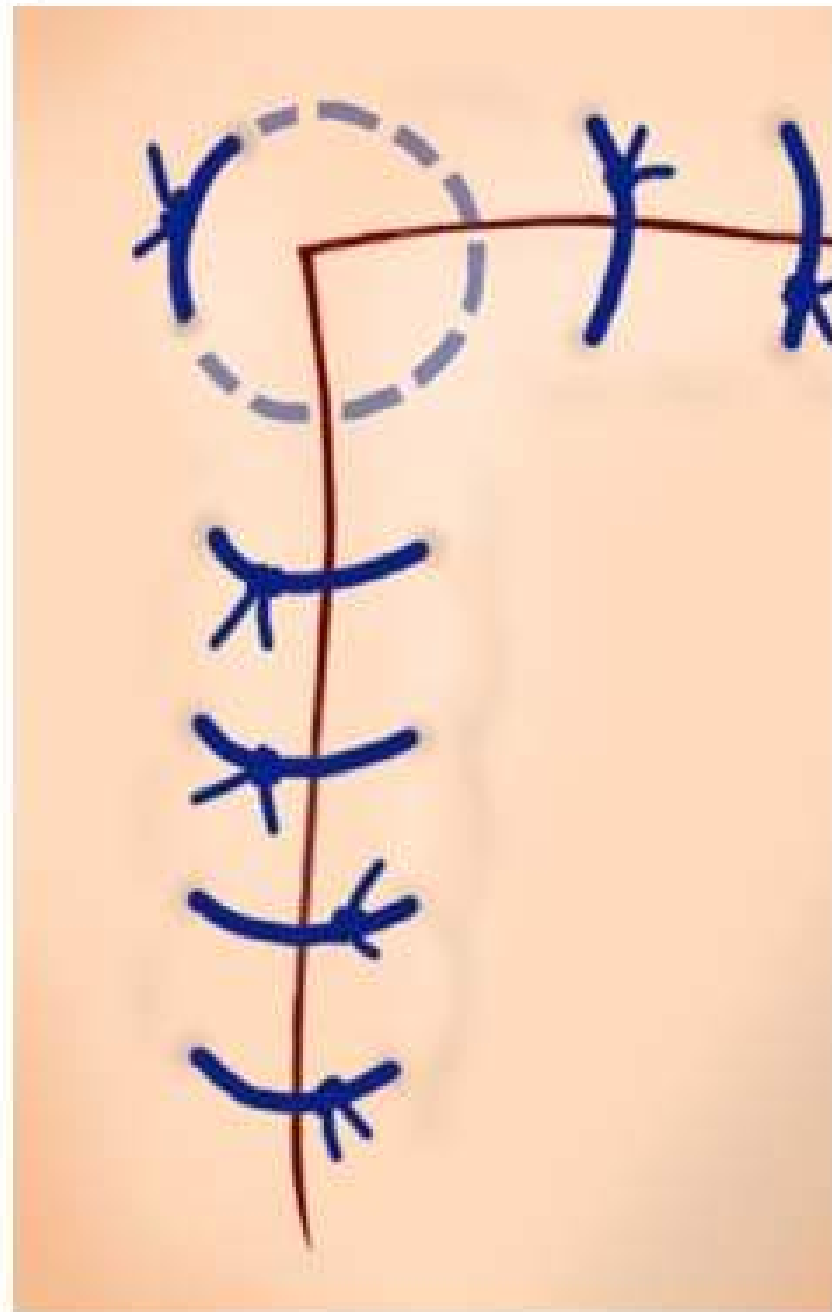


# Closure of Corner Flap Lacerations

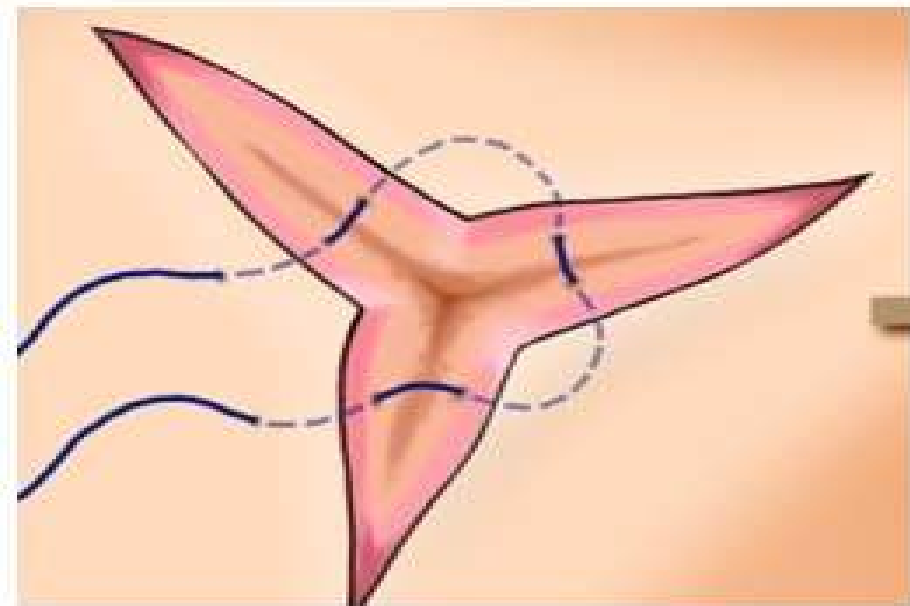


**1. Place the corner stitch(es) first to reappose the flap.**

**2. Then use interrupted percutaneous sutures to close the arms of the flap.**



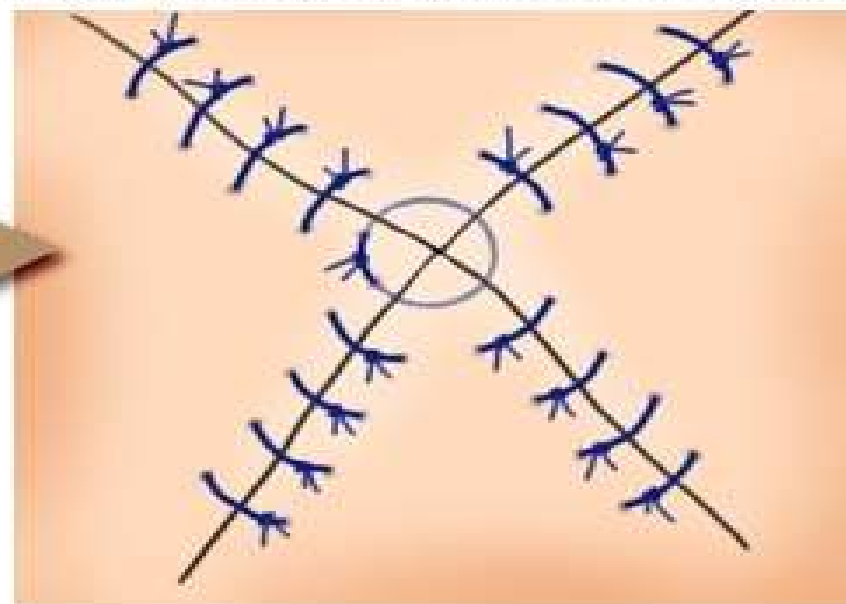
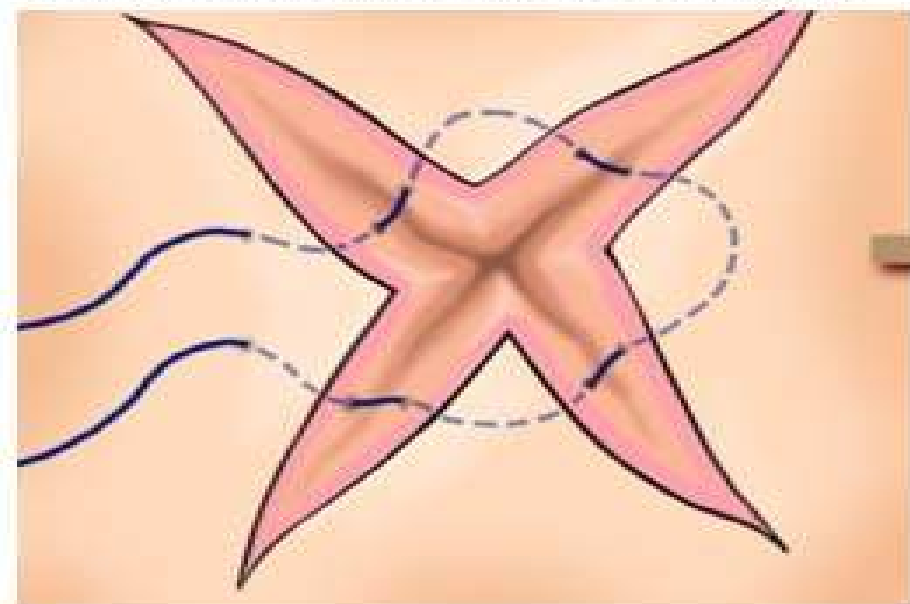
# Closing Stellate or Multi-Flap Lacerations



**1. Use a multi-corner stitch to anatomically reappose the flaps.**

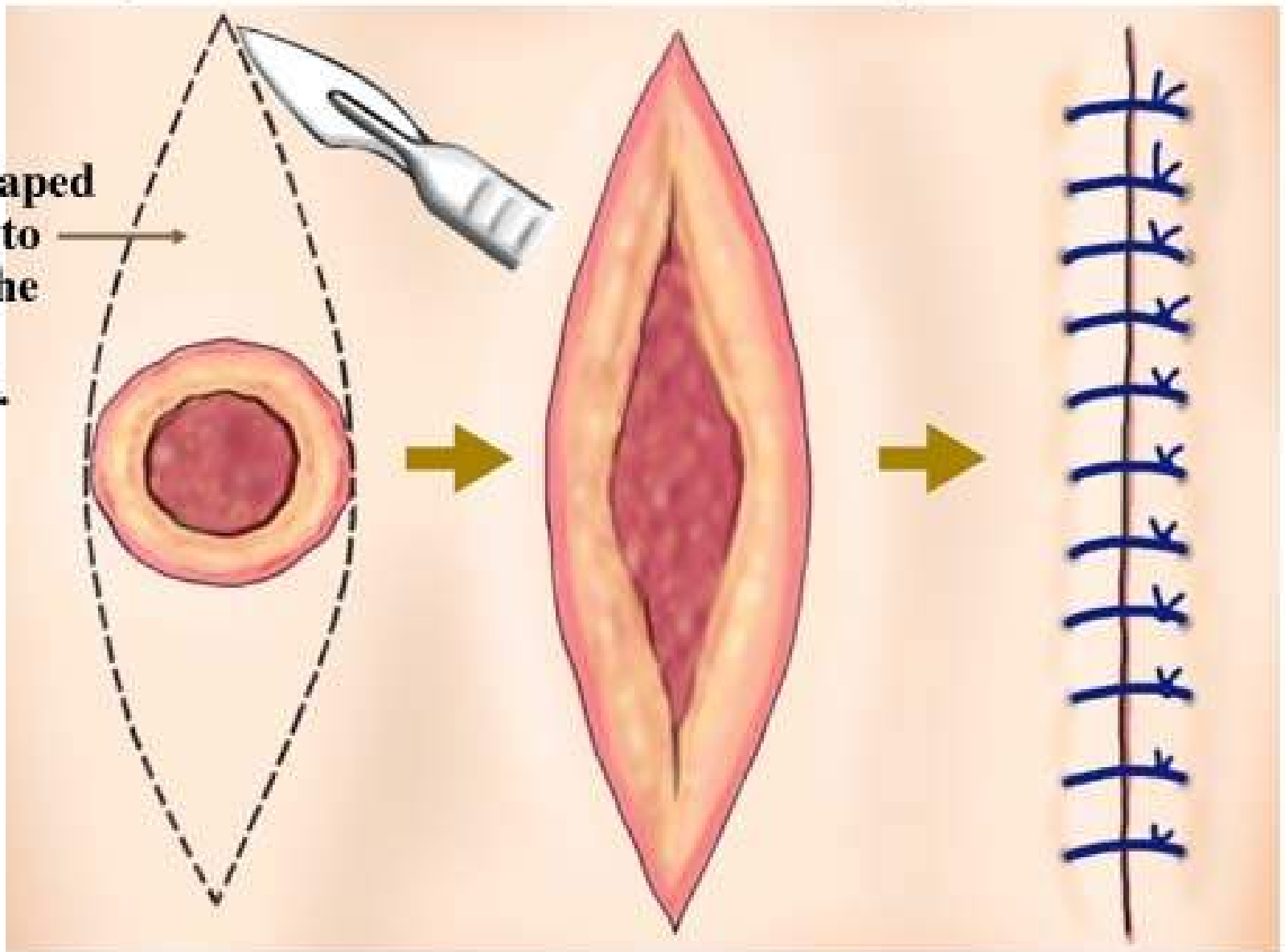


**2. Then close the arms with interrupted percutaneous sutures.**



# Repair of Circular Wounds: Ellipse Method

**1. Make wedge-shaped excisions to convert the defect to an ellipse.**

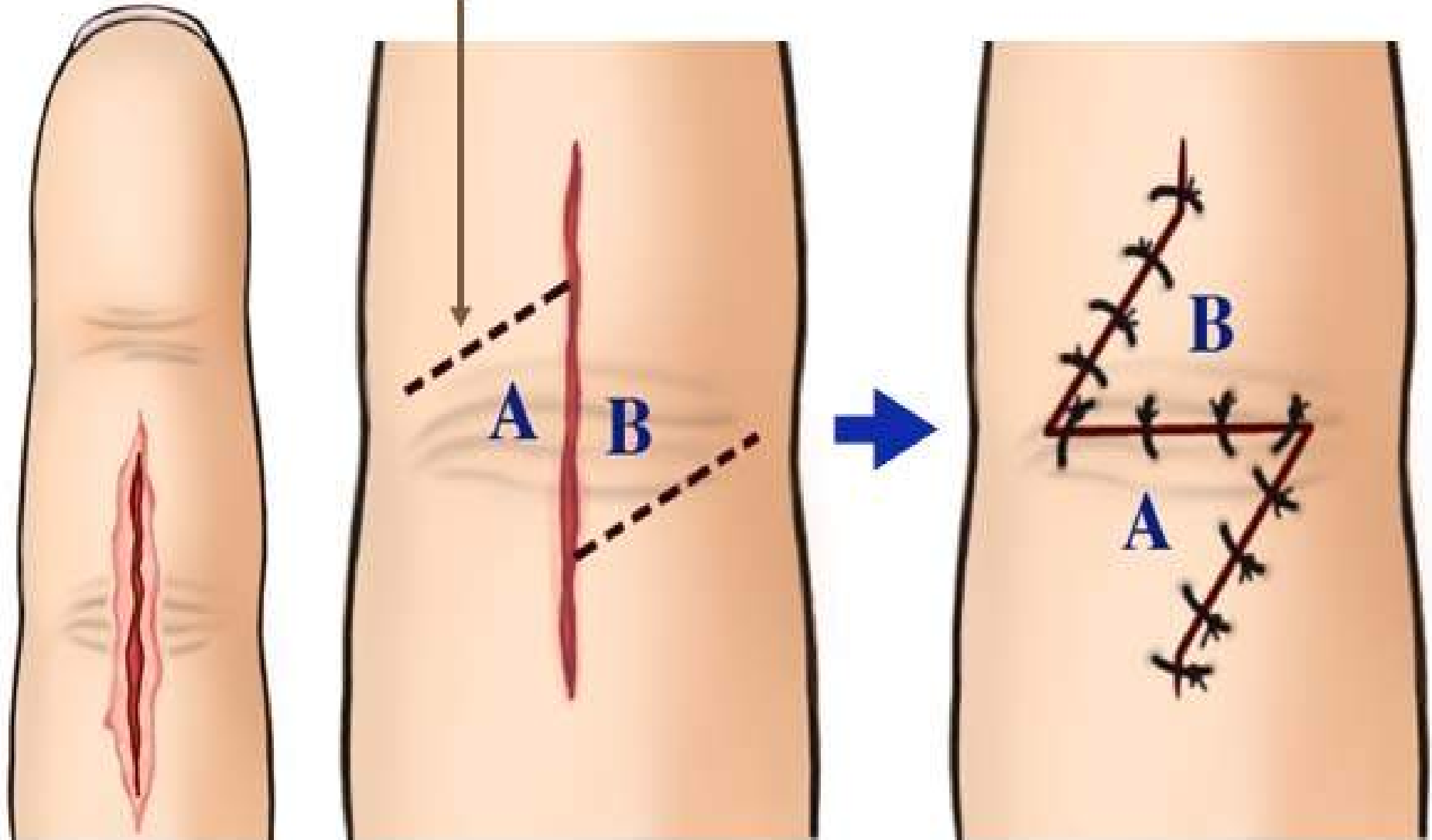


**2. Use a layered closure with interrupted sutures to reapproximate the wound edges as with a linear laceration.**

# Z-Plasty

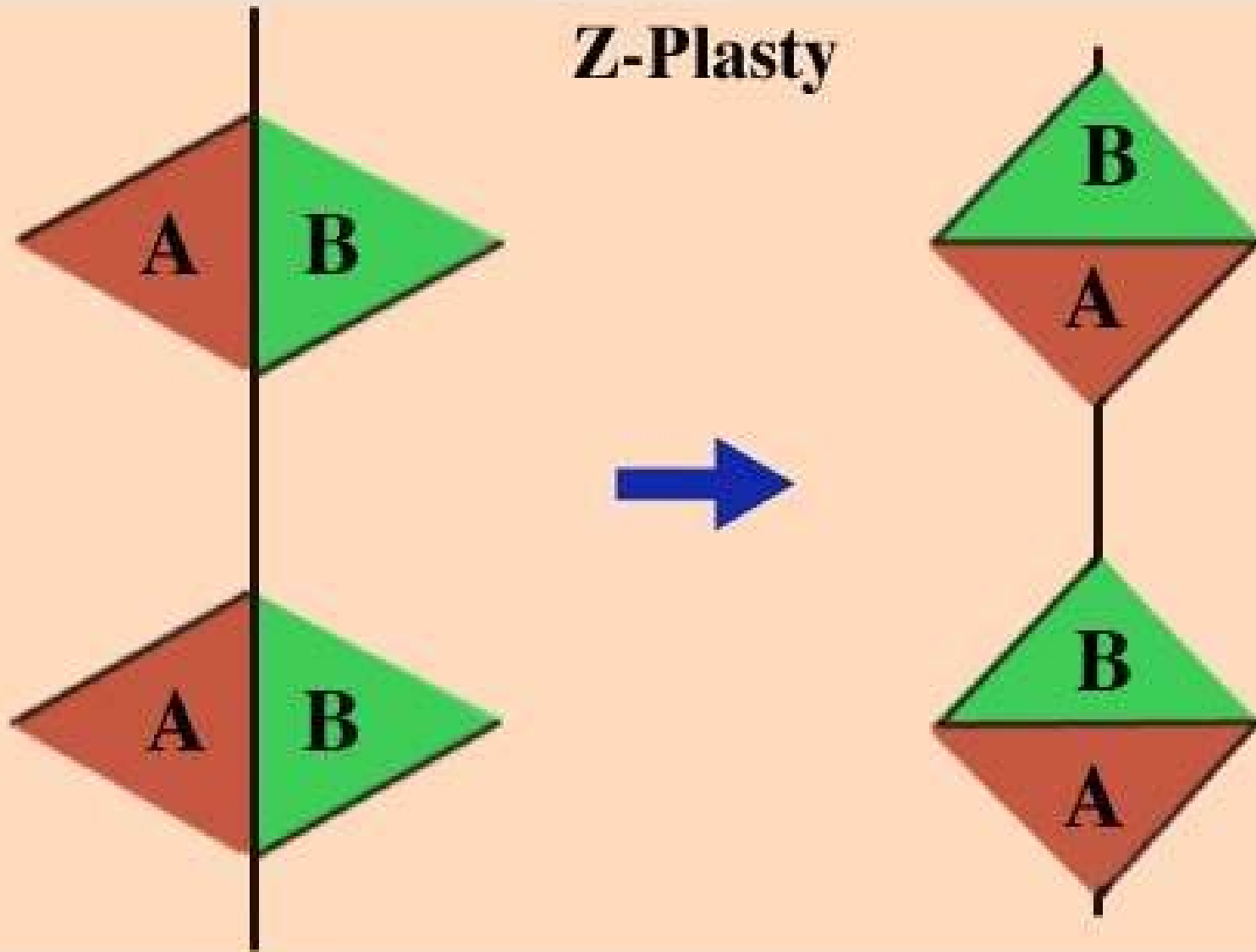
1. Make 2 incisions at 60° angles to the laceration, equidistant from the crease and equal in length to the distance between them.

2. Reverse the positions of the two triangular flaps and suture the resulting Z-shaped laceration.





## Z-Plasty

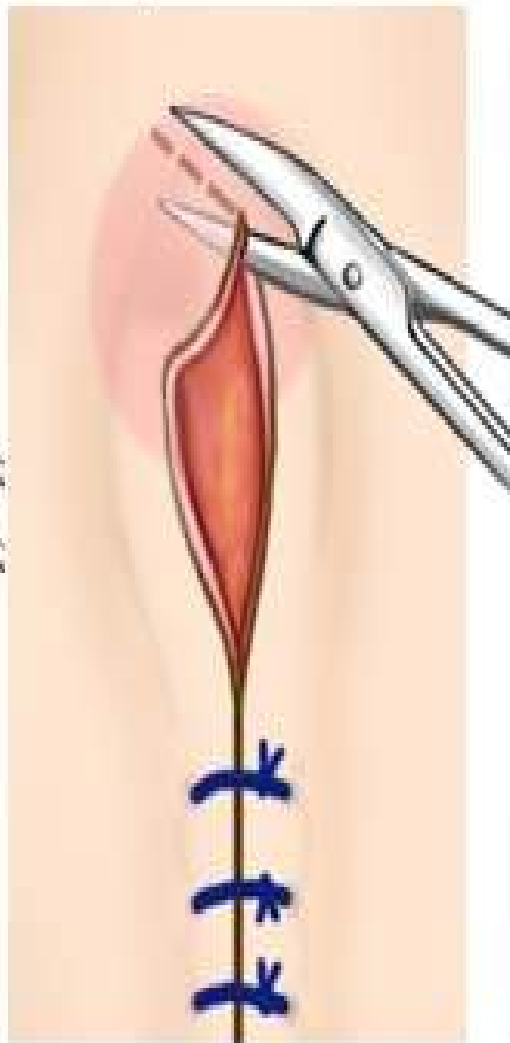


**Note:** For long lacerations, multiple Z-plasties should be used to avoid excessive circumferential tightening.

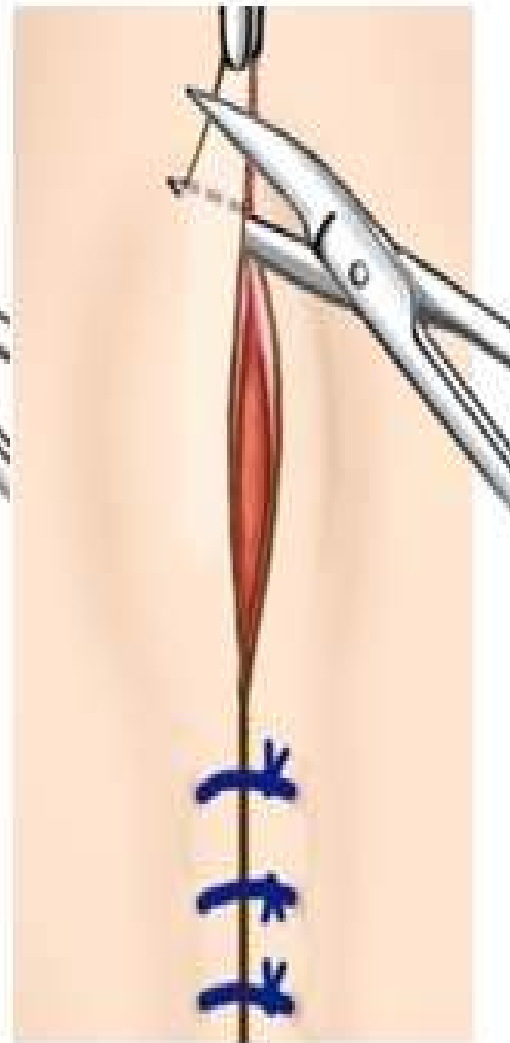
# Dog-Ear Deformity: Correction of Unilateral Excess Skin



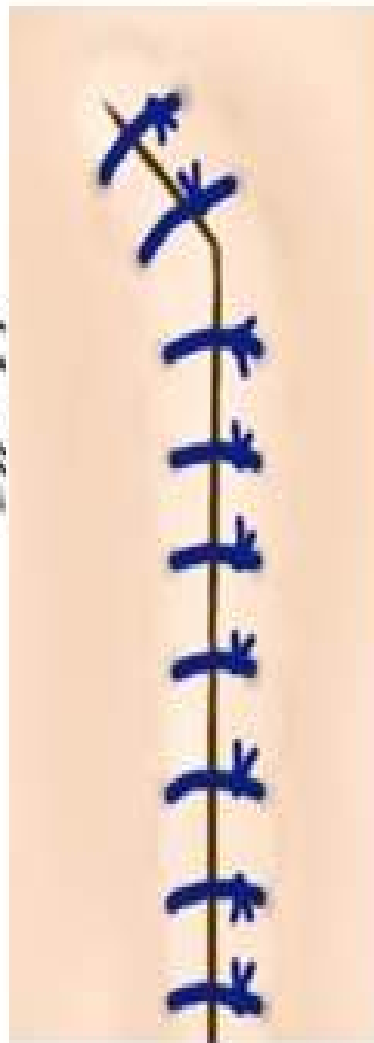
**1. Undermine area beneath the excess skin.**



**2. Make a diagonal cut extending the laceration.**



**3. Pull skin over the cut and remove the excess.**



**4. Complete the closure.**

# Dog-Ear Deformity: Correction of Bilateral Excess Skin



**1. Excise excess skin with a scalpel.**

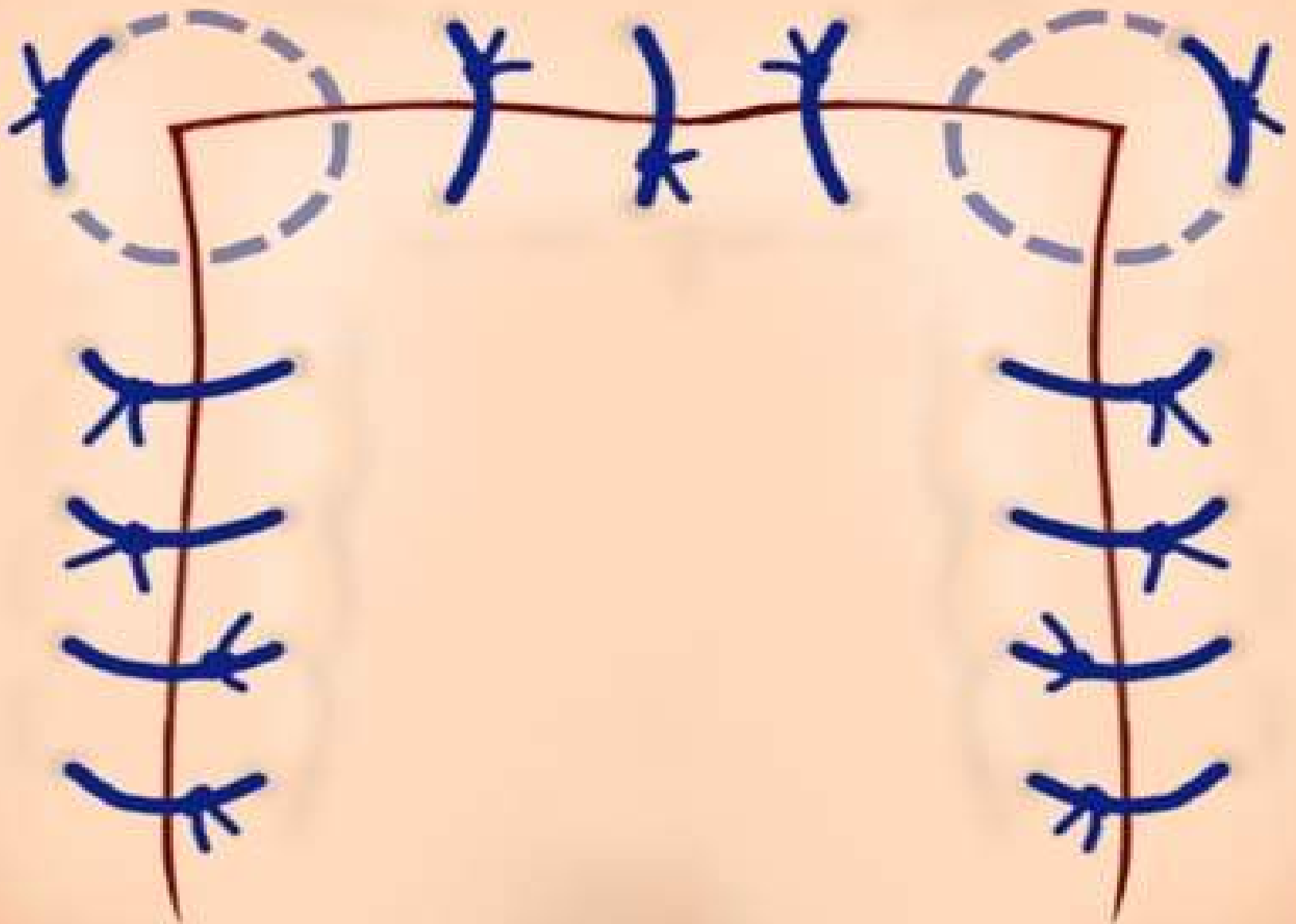


**2. Continue to close laceration.**

**3. Final appearance**



# Closure of Corner Flap Lacerations



# Closure of Parallel Lacerations: Skin Tape Closures

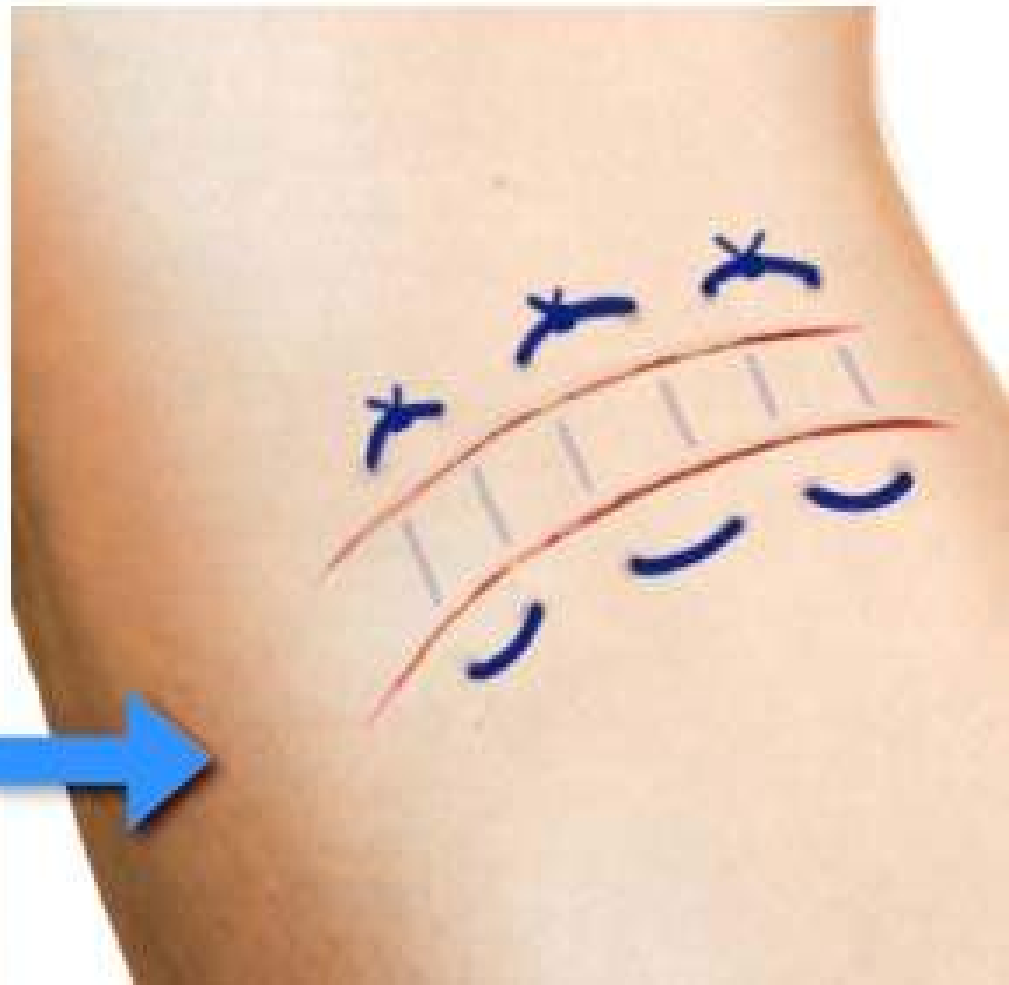
Apply benzoin to the skin adjacent to the wounds to increase adhesion, and apply multiple skin tapes to closely reapproximate all wound edges.

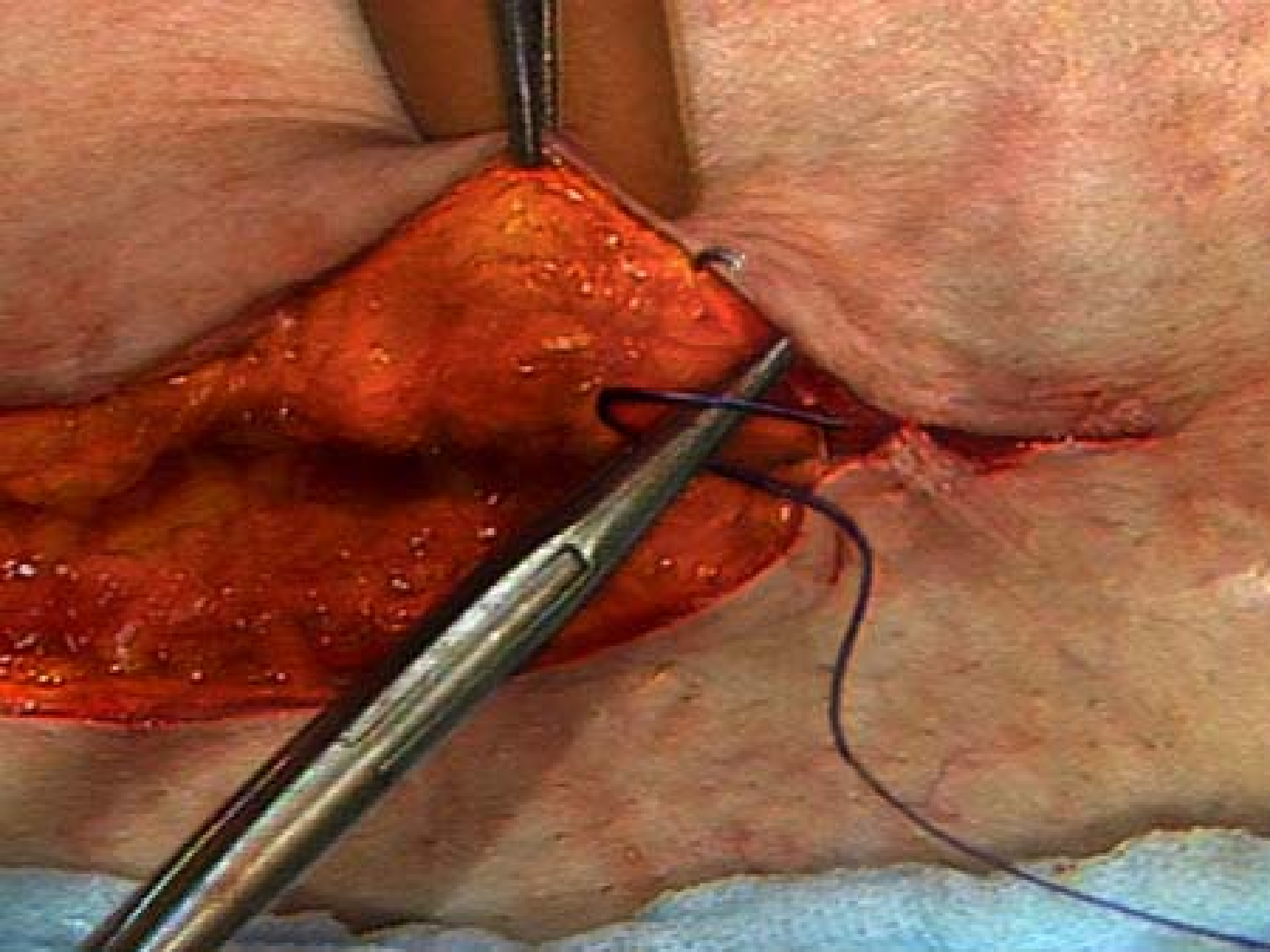


# Closure of Parallel Lacerations: Horizontal Mattress Sutures

**1. Place a sufficient number of sutures for wound closure, leaving the ends long and untied.**

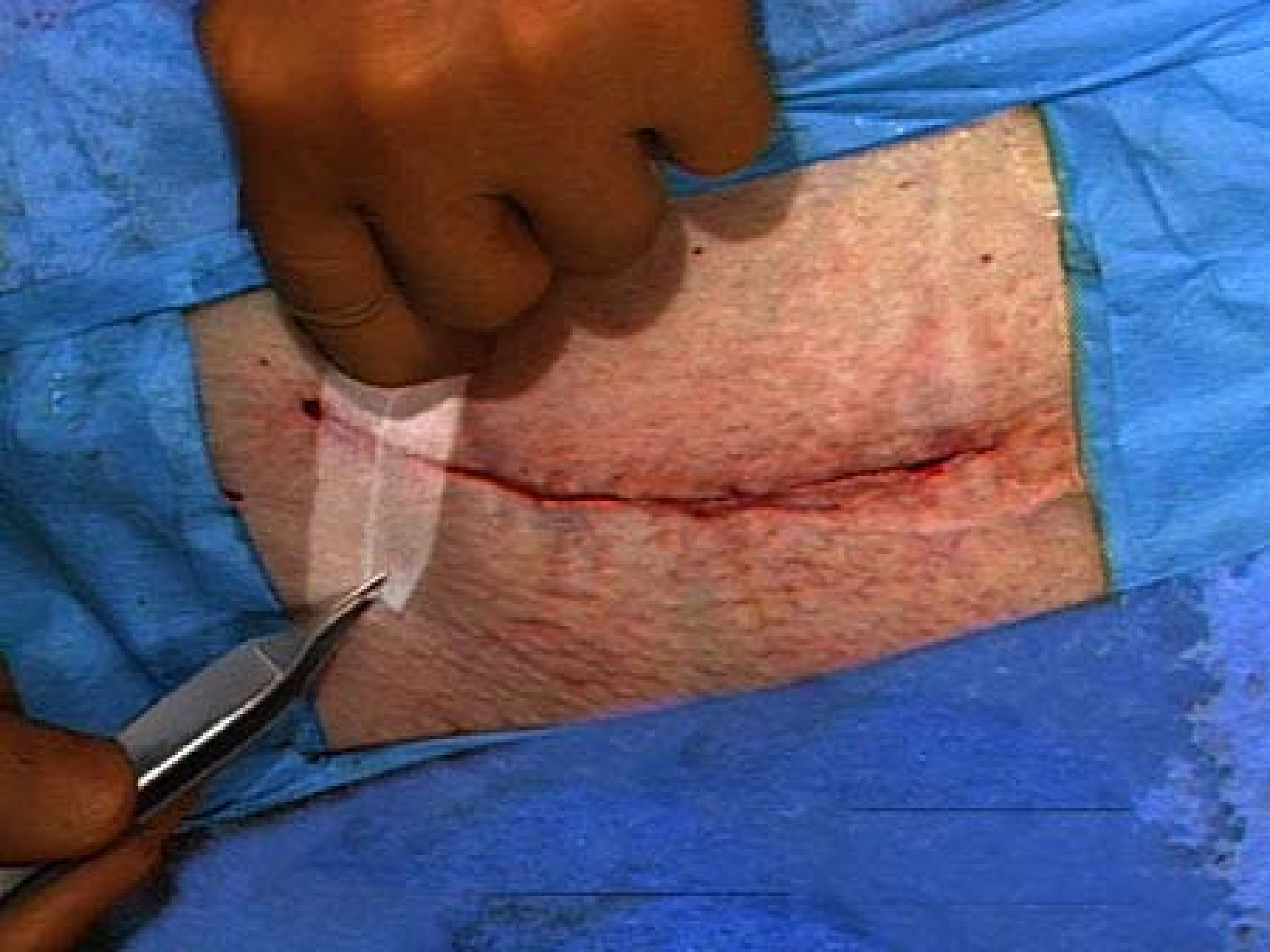
**2. After all sutures are placed, tie them with sufficient tension to approximate the wound edges.**











- ❖ **The completed knot must be firm to virtually eliminate slippage**
- ❖ **The simplest knot for the material used is the most desirable**
- ❖ **Tie the knot as small as possible to minimize foreign body reaction**
- ❖ **Avoid friction**
  - ❖ **“Sawing” between strands may weaken suture integrity**



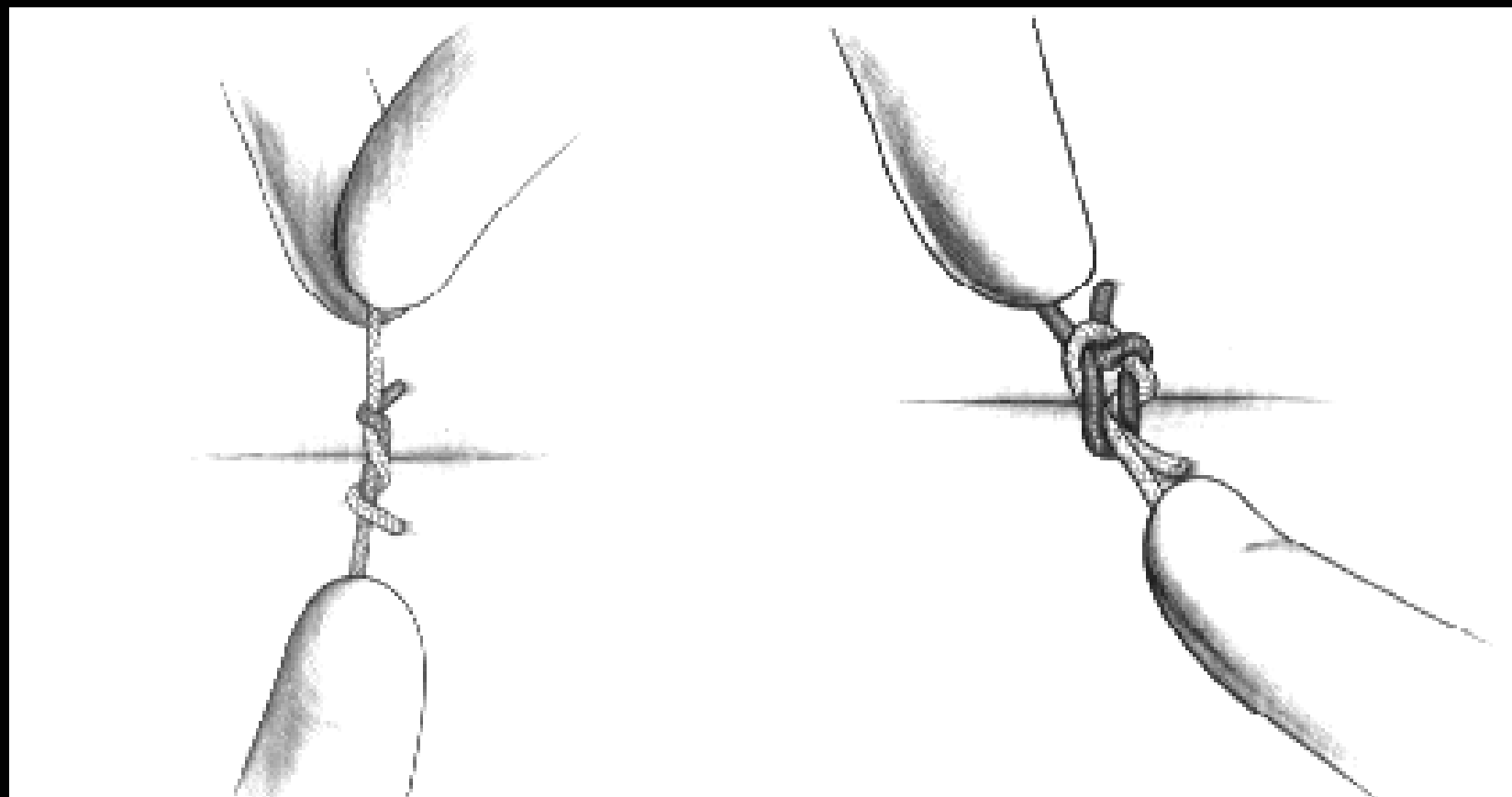
- ❖ **Avoid damage to the suture material during handling, especially when using instruments**
- ❖ **Avoid excessive tension which may break sutures and cut tissue**
- ❖ **Approximate, do not strangle**
- ❖ **Maintain traction at one end of the strand after the first loop is tied to avoid loosening of the throw**



- ❖ **Make the final throw as nearly horizontal as possible**
- ❖ **Do not hesitate to change stance or position in relation to the patient in order to place a knot securely and flat**
- ❖ **Extra throws do not add to the strength of the knot, only to it's bulk**



## The Surgeon's Knot



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## Time for Healing vs. Suture Locations

❖ Skin on the face

❖ 5 days

❖ Scalp

❖ 7 - 10 days

❖ Trunk

❖ 10 - 14 days

❖ Extremities

❖ 10 - 14 days



- ❖ **Sutures fall out**
- ❖ **Infection**
- ❖ **Dehiscence**
- ❖ **Scars and Lost Sutures**



- ❖ **When the wound has healed so that it no longer needs the support of sutures, they must be removed**
- ❖ **The length of time the sutures remain in place depends upon the rate of healing and the nature of the wound**
- ❖ **Sutures should be removed using aseptic technique**





- ❖ **Step 1 - Cleanse the area with an antiseptic.**  
**Hydrogen peroxide can be used to remove dried serum encrusted around the sutures**
- ❖ **Step 2 - Pick up one end of the suture with forceps, and cut as close to the skin as possible where the suture enters the skin**



- ❖ **Step 3 - Gently pull the suture strand out through the side opposite the knot with the forceps**
- ❖ **To prevent risk of infection, the suture should be removed without pulling any portion that has been outside the skin back through the skin**



- ❖ **Extensive delays in wound repair allow bacterial proliferation and potential subsequent infection**
- ❖ **In the Field, Paramedics will not be expected to perform delayed sutures**



- ❖ **Tetanus is a disease caused by the bacterium *Clostridium Tetani***
- ❖ **If the bacteria proliferates the wound, it releases a neurotoxin capable of causing severe and life threatening muscle spasms**



- ❖ **Tetanus immunization is given as a deltoid intramuscular injection of 0.5 cc of diphtheria-tetanus toxoid**
- ❖ **Five to Ten percent of patients receiving the injection will have local redness and swelling for several days**
- ❖ **Uncommonly, some patients will develop generalized body aches and fever**



- ❖ **Anaphylaxis is very rare**
- ❖ **Contra-indicated in patients with allergies to the medication**
- ❖ **Patients who have received immunization within the last five years are up to date**



- ❖ **Purpose of Wound Closure**
- ❖ **Wound Closure Theory**
- ❖ **Procedure**
- ❖ **Supporting Activities**
  
- ❖ **Questions?**

