Suture Materials and Techniques

In the days of the Giant black ants……

The earliest written records date back to ancient India and Egypt, Sushruta in 400 BC described the use of flax and hemp to close wounds.

Celcius is 30 AD described the use of sutures and clips. Since then, many materials have been tried including the heads of giant black ants, catgut (sheep intestine), and tree bark.

- A suture is a strand of material used to approximate tissues together.
- To suture is the act of sewing or bringing tissues together and holding them in apposition until healing has taken place.

Dorland`s Medical Dictionary

Goals of Wound Closure

- Obliteration of dead space
- Even distribution of tension along deep suture lines
- Maintenance of tensile strength across the wound until tissue tensile strength is adequate
- Approximation and eversion of the epithelial portion of the closure.

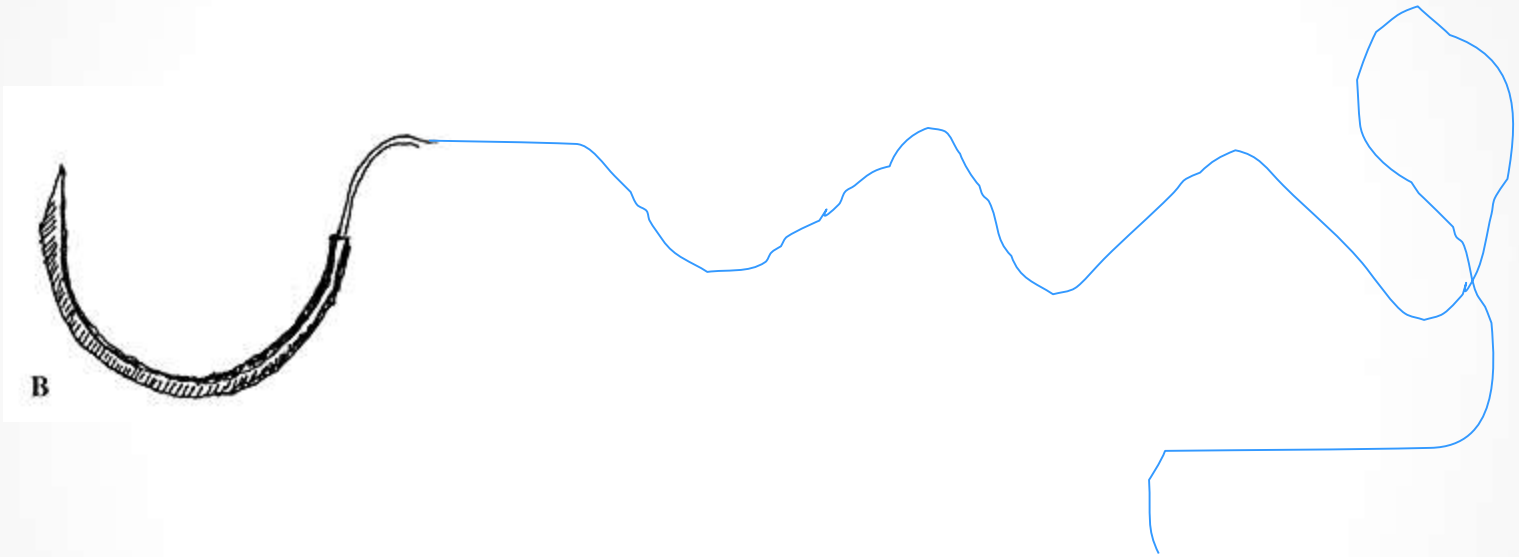
Methods for mechanical wound closure

…..The Art and Science

Suturing….. Needlework to healing

The needle

The suture material



Skillful wound closure requires not only knowledge of proper surgical techniques but also knowledge of the physical characteristics and properties of the suture and needle.

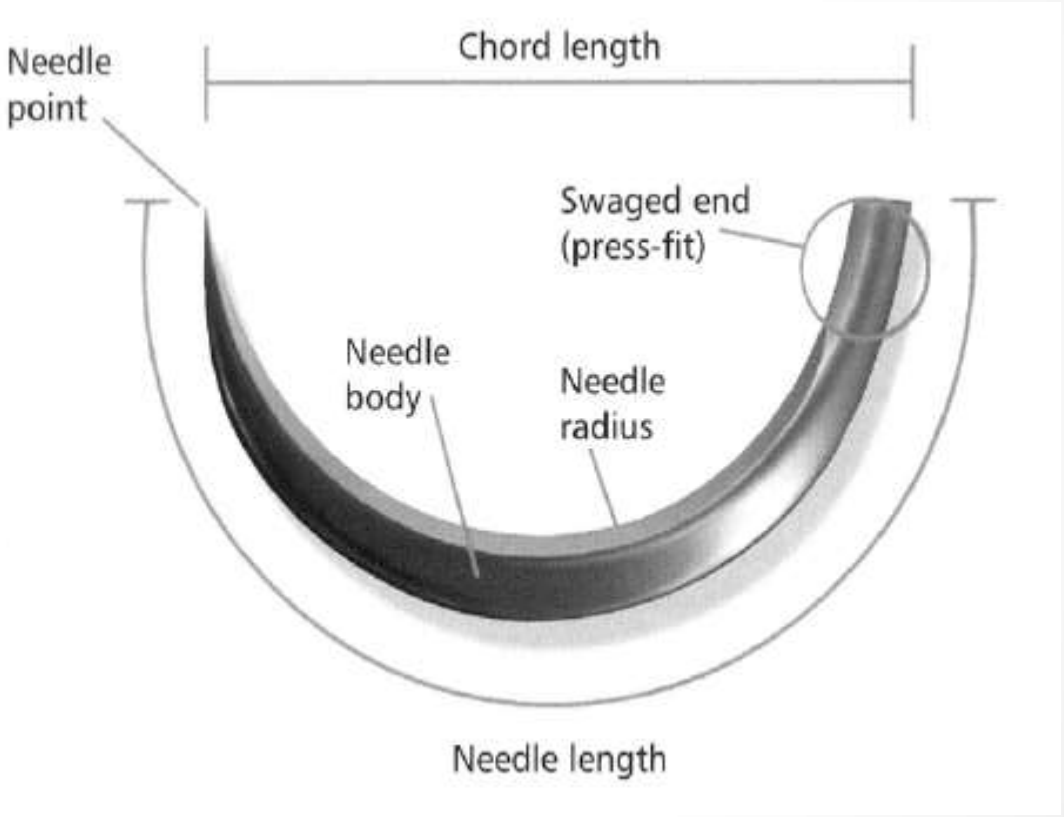
The Needle

The "Ideal surgical needle " . . . . .

- Made of High-quality stainless steel
- Smallest diameter possible
- Stable in the grasp of the needle holder
- Capable of implanting suture material through tissue with minimal trauma
- Sharp enough to penetrate tissue with minimal resistance
- Sterile and corrosion-resistant to prevent introduction of microorganisms or foreign materials into the wound

PARTS OF A NEEDLE

- **Point**
- **Body**
- Swage/eye



Point types

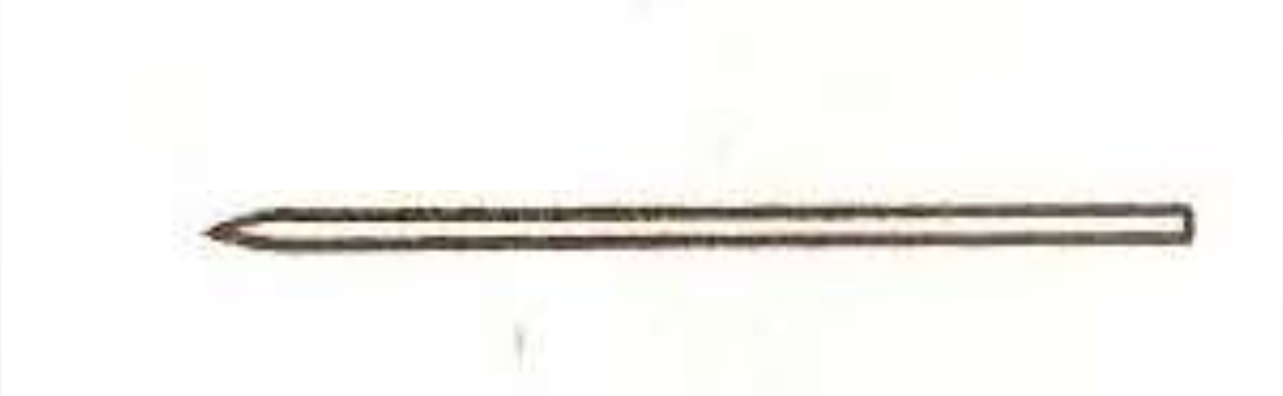
針尖型式	POINT TYPE	SYMBOL
	TAPER POINT	●
	BLUNT TAPER POINT	○

Point types

針尖型式	POINT TYPE	SYMBOL
	CUTTING EDGE	▲
	REVERSE CUTTING EDGE	▼
	TAPERCUT	☮

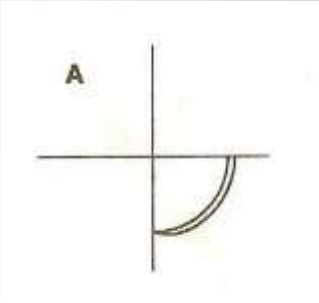
Body types

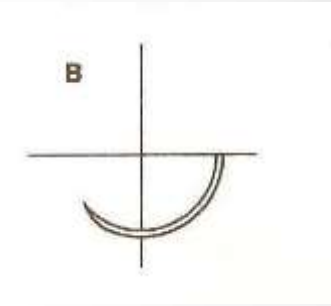
- May be plain or silicone coated
- Straight:
  - used to suture easily accessible tissue that can be manipulated directly by hand.
  - Eg. of straight-body needles include the
    - Keith needle, which is a straight cutting needle used for skin closure of abdominal wounds,
    - Bunnell needle, which is used for tendon/GI tract repair.

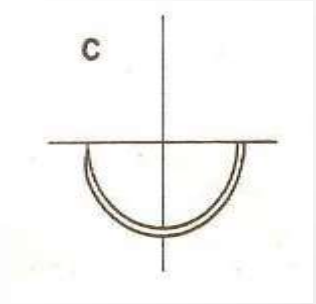


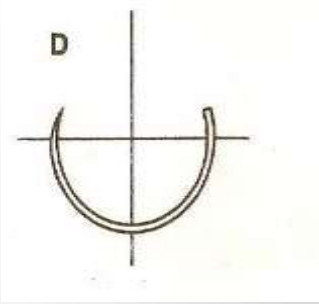
Body types

- Curved:
  - The needle has a predictable path through tissue
  - requires less space for maneuvering than a straight needle.
  - provides an even distribution of tension.
  - Body curvature commonly is a portion of a circle of
    - quarter
    - three-eighths,
    - half,
    - five-eighths
  - The three-eighths–inch circle is used most commonly for skin closure.
  - The half-inch circle is designed for confined spaces





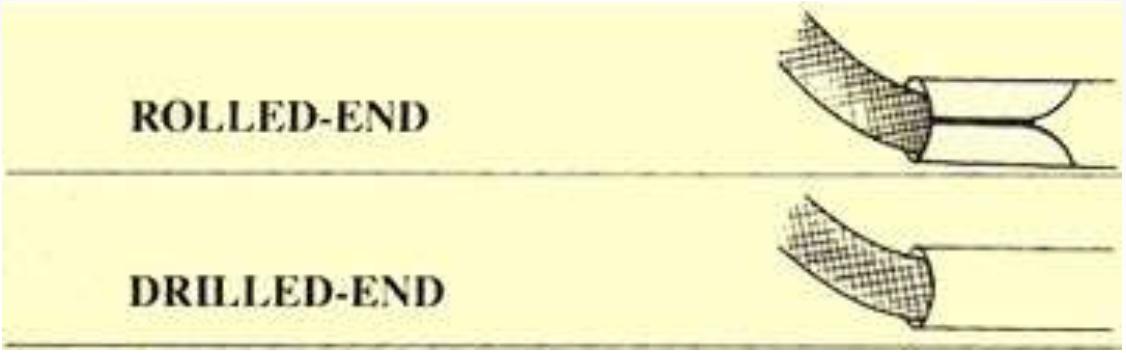




Body types

- Compound curved:
  - Originally designed for anterior segment ophthalmic surgery.
  - The body has a tight 80° curvature at the tip, which becomes a 45° curvature throughout the remainder of the body.
  - A microvascular compound curved needle also may facilitate vessel approximation in microvascular surgery.

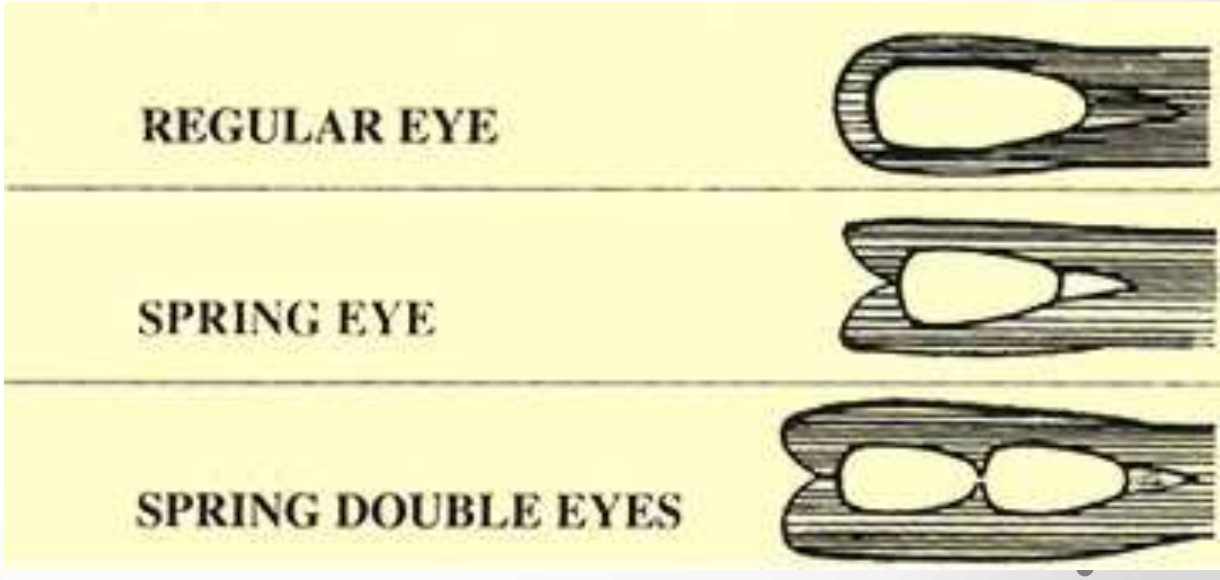
Needle suture attachment



- Channel swage:
  - A needle is created with a channel into which the suture is introduced, and the channel is crimped over the suture to secure it into place.
  - The diameter of the channel swage is greater than the diameter of the needle body.
- Drill swage:
  - Material is removed from the needle end (sometimes with a laser), and the needle is crimped over the suture.
  - The diameter of the drill swage is less than the diameter of the needle body.

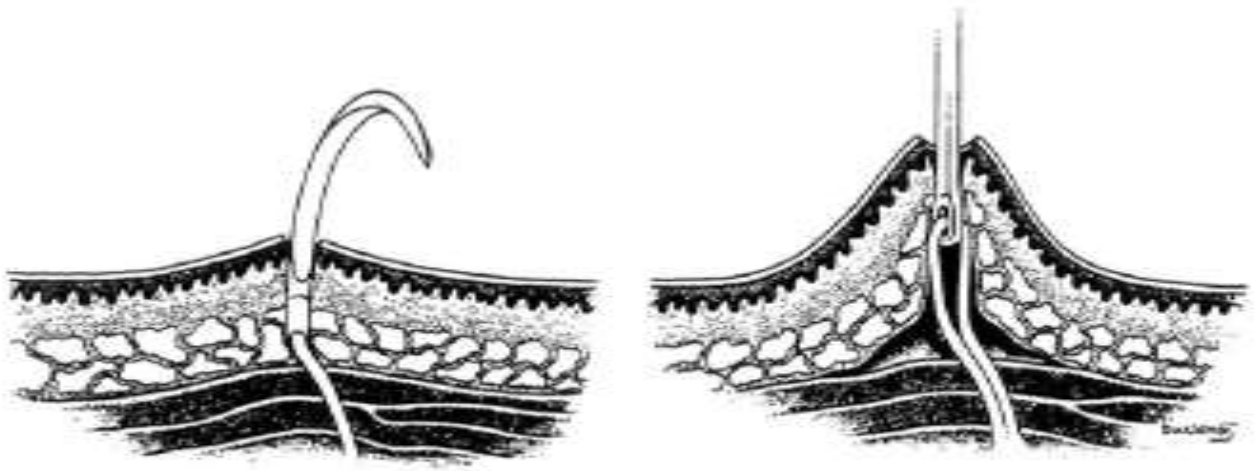
Needle suture attachment

- Nonswaged/Eye:
  - Alternatively, the suture may be passed through an eye, similar to that found in a sewing needle. In a closed-eye configuration, the shape may be round, oblong, or square.
  - In a French (split or spring) eye, a slit is in the end of the needle with ridges that catch and hold the suture in place.



Advantages of Swage over Eye

- Tissue passage of a double strand of suture as in eyed needles, leads to more tissue trauma.
- In a swaged needle, the suture is less likely to become unthreaded prematurely.
- Decreased handling helps maintain suture integrity.
- Swaged sutures are not subject to suture fraying or damage due to sharp corners in the eye of eyed needles



Suture with ATRAUMATIC®"eyeless" needle (left) causes less tissue damage on passage through tissues than when eyed needle is used (right).

The Suture Material

Ideal characteristics

- Sterile
- All-purpose (composed of material that can be used in any surgical procedure)
- Causes minimal tissue injury or tissue reaction (ie, nonelectrolytic, noncapillary, nonallergenic, noncarcinogenic)
- Easy to handle
- Holds securely when knotted (ie, no fraying or cutting)
- Uniform diameter and size
- High and uniform tensile strength
- Favorable absorption profile
- Resistant to infection

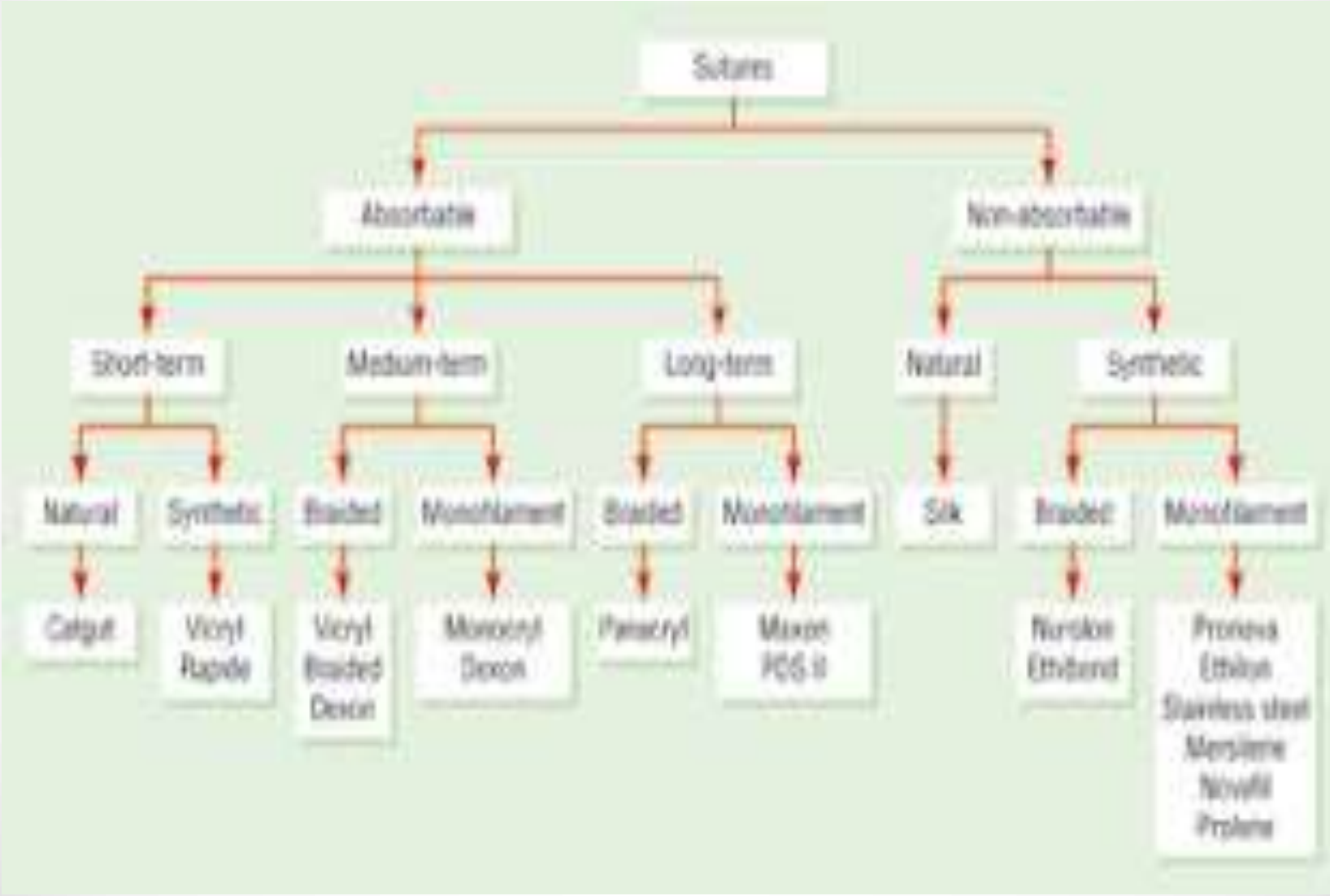
Suture size

- The United States Pharmacopeia classification system which was established in 1937, proposed the standardization of suture materials, corresponding to metric measures.
- Size refers to the diameter of the suture strand and is denoted as zeroes.
- The more zeroes characterizing a suture size, the smaller the resultant strand diameter (eg, 4-0 or 0000 is larger than 5-0 or 00000). The smaller the suture, the less tensile strength of the strand.

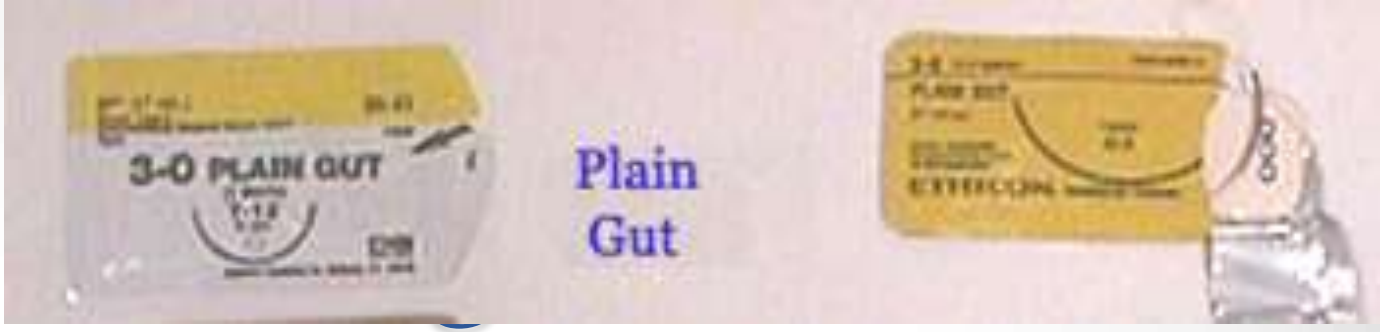
What size….? Where?....

Uses of different sizes of suture	
Size	Uses
7/0 and smaller	Ophthalmology, microsurgery
6/0	Face, blood vessels
5/0	Face, neck, blood vessels
4/0	Mucosa, neck, hands, limbs, tendons, blood vessels
3.0	Limbs, trunk,, back,, gut, blood vessels
2/0	Trunk, fascia, viscera, blood vessels
0 and larger	Abdominal wall closure, fascia, drain sites, arterial lines, orthopaedic surgery

Classification of Suture Materials



- ABSORBABLE SUTURES
  - Plain Gut
  - Chronic gut
  - Dexon (polyglycolic acid, Davis & Geck)
  - Vicryl (polyglactin 910, Ethicon)
- NONABSORBABLE SUTURES
  - Silk
    - Twisted or braided
  - Cotton
    - Twisted
  - Dacron Polyester
    - Braided
  - Dacron (Deknatel, Davis & Geck)
  - Mersilene (Ethicon)
    - Braided, impregnated with Teflon
  - Ethiflex (Ethicon)
  - Tevdek (Deknatel, heavily impregnated)
  - Polydek (Deknatel, lightly impregnated)
    - Braided, treated with Silicone
  - Ti-cron (Davis & Geck)
    - Braided, coated with Polybutilate
  - Ethibond (Ethicon)
  - Nylon
    - Monofilament
    - Braided (Neurolon, Ethicon; Surgilene, Davis & Geck)
  - Polypropylene
    - Monofilament (Prolene, Ethicon; Surgilene, Davis & Geck)
  - Stainless Steel
    - Monofilament
    - Braided



- Oldest known absorbable material first described by Galen in 175 AD.
- Origin of word– “Kitgut - Kitstring” , meaning “The string of a dancing masters fiddle”.
- Classified as monofilament, but microscopically composed of several twisted fibers.
- Stored in Isopropyl alcohol, which is rinsed with saline prior to use.

- Absorbed by proteolytic degradation and phagocytosis.
- Accompanied by considerable inflammation and tissue reaction.
- Tensile strength is maintained for 7-10 days post-implantation, and in mucosal surfaces, it lasts for 3-5 days.
- Absorption is complete within 70 days.
- This type of suture is used for
  - (1) repairing rapidly healing tissues that require minimal support,
  - (2) ligating superficial blood vessels,
  - (3) suturing subcutaneous fatty tissue.

Chromic catgut

- Plain gut tanned with chromium salts prior to processing.
- Chromium salts act as
  - cross-linking agent
  - increases the tensile strength of the material,
  - increases the resistance to resorption.
- Tensile strength is maintained for 10-14 days,7-8 days in mucosal surfaces.
- Absorption complete by 90-100 days
- This type of suture may be used in the presence of infection.
- Tissue reaction is due to the non-collagenous material present in these sutures.

- Braided, siliconised protinaceous thread of silkworm cocoons, which is processed to remove natural waxes and sericin gums.
- Although classified as a non-absorbable material, silk is an organic substance which undergoes slow degradation; totally resorbed in 2 years.

- Most popular material, cheap and best.
- Braided, with excellent handling characteristics
- Remains soft and pliable in tissues; doesn't cut through tissues.

- Low tensile strength
- Poor knot holding ability, needing at least 3 ties.
- Cannot be used in infected wounds.

Cotton

- Popularized by Mead and Ochsner in 1940 when silk became rare during World war II.
- Strength less than silk, handling characteristics and tissue reaction less similar.
- Used only when Cost factor dictates it.

Collagen

- Derived and processed from bovine tendons.
- Undergoes premature resorption.
- Not widely used as a suture material.

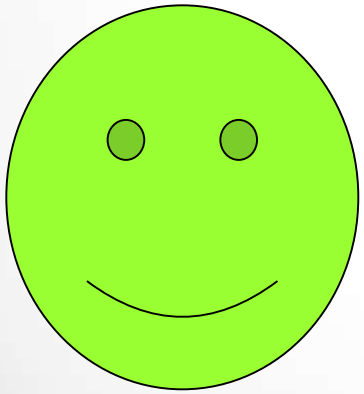
Synthetic absorbable sutures

Glycolic Acid Homopolymer/ Dexon

- Introduced in 1970 is the 1st synthetic absorbable suture material.
- Chemically a polymer of Glycolic acid, available in multifilament braided configuration.
- Greater Knot pull and tensile strength than gut.
- Absorbed by hydrolysis.
- Relatively difficult knottability
- Cannot be used in infected sites.

Glycolic Acid/ Maxon

- Monofilament Strand composed of polyglycolic acid+trimethylene carbonate.
- Greastest tensile strength among all resorbable sutures.
- Retains upto 55% of strength at 21th day.



Degradation products- Glycolic acid, 1,6 hexane diamine, Adipic acid are POTENT ANTIBACTERIAL AGENTS.

Poliglecaprone 25 (Monocryl)

- This synthetic suture is a monofilament suture that is a copolymer of glycolide and E-caprolactone.
- Superior pliability, leading to ease in handling and tying.
- Tensile strength is high initially, 50-60% at 7 days, and is lost at 21 days.
- Absorption is complete at 91-119 days.
- Poliglecaprone sutures are used for subcuticular closure and soft tissue approximations and ligations.

Polyglactin 910/ Vicryl

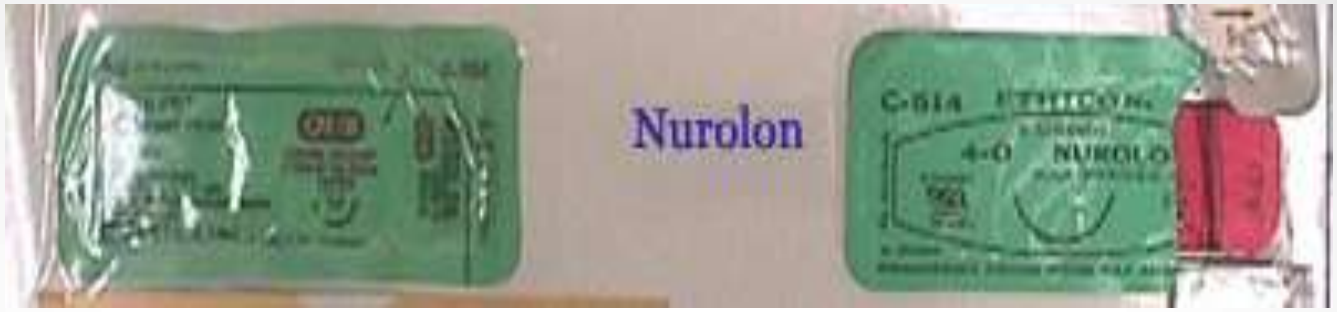
- Composed of mixture of lactide and glycolide acid and calcium stearate, available in a braided configuration.
- Tensile strength retained upto 40% at 21 days.
- Degrsded by hydrolysis and byproducts excreted via urine.
- Rapidly looses strength in urine.

- Coated with polygalactin-370 and calcium Stearate, which allows easy passage through tissues and easy knot placement.
- Can be used in infected tissues.
- Avaible as purple dyed and colourless variants.

Polydioxanone/PDS II

- Made from polyester derivative of poly-p-dioxamine available in monofilament configuration.
- Excellent tensile strength and passes through tissues easily.
- Retains 50% strength at 28 days and 25% at 42 days.
- Has significant memory; less ease in knotting.
- Can be used in contaminated tissues.
- Resorption minimal until 90 days, complete in 6 months.

Synthetic Non Resorbable



Braided Nylon/Surgilon/ Nurilon

- Composed of inert polyamide polymer.
- Fibres braided and sealed in silicone coating
- Excellent knottability and tensile strength.
- Looses 20%of strength yearly.
- Handles like silk, but with tissue compatibility.

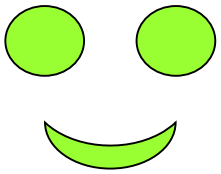
Nylon Monofilament/ Dermalon/Ethilon

- Uncoated
- Best suited for skin closure and retention b`coz of elastic nature.
- Has some memory and usually needs a 4 throw knot for retention.

Polyester

- Multifilament fiber of polyester, a polymer of polyethylene terephthalate.
- Excellent tensile strength, maintained indefinitely.
- Mersilene/Tycron-
  - Uncoated; hence rougher and stiffer
  - High drag through tissue.

- **Ti-Cron- coated with silicone**
- **Dacron/Ethibond- coated with polybutilate**

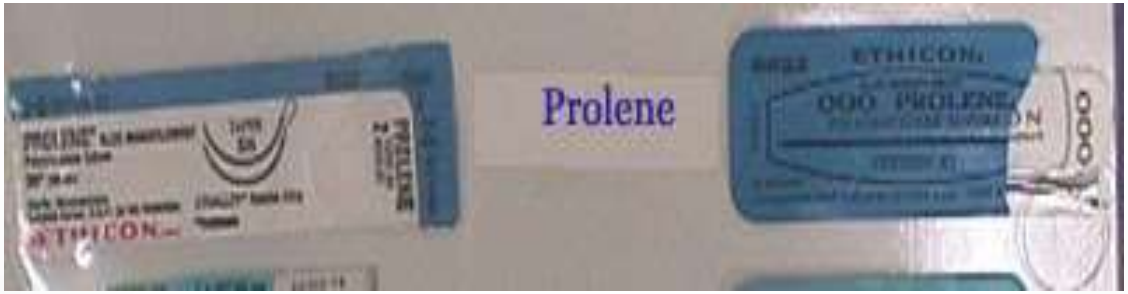


- Low infection rate
- Secure knot tie.
- Smooth removal.
- Low reactivity
- Easy passage through tissues

Polypropylene/

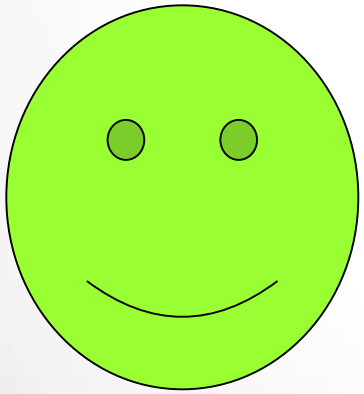
Prolene

- Isostatic crystalline stereoisomer of a linear hydrocarbon polymer, with little or no saturation.
- Extremely inert, and may hold on for 2 years.
- Excellent knottability, minimal tissue reaction.
- Can be used in infected/ contaminated wounds.



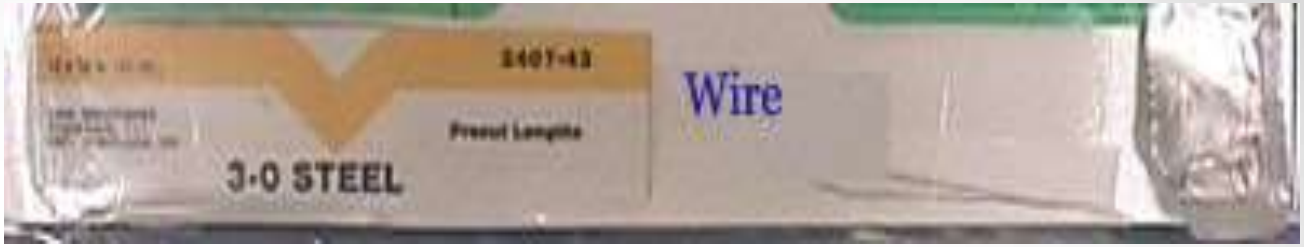
Polybutester/Novofil

- New monofilament non-absorbable suture material that is made up of polyglycol terephthalate and polybutylene terephthalate.
- Twice as flexible as nylon or prolene.
- Minimal tissue reactivity



Capacity to elongate/stretch- compensates for wound edema.

Stainless Steel wires



- Made of stainless steel (iron-chromium-nickel-molybdenum alloy) as a monofilament and twisted multifilament.
- Has high tensile strength with little loss over time.
- Low tissue reactivity.
- Good knottability.
- Used primarily in orthopedic, neurosurgical, and thoracic applications. This type of suture also may be used in abdominal wall closure, sternum closure, and retention.
- This material can be difficult to handle because of kinking, fragmentation, and barbing, which renders the wire useless and may present a risk to the surgeon's safety.

All that ok, but….

HOW DO I SUTURE?!?!?!?

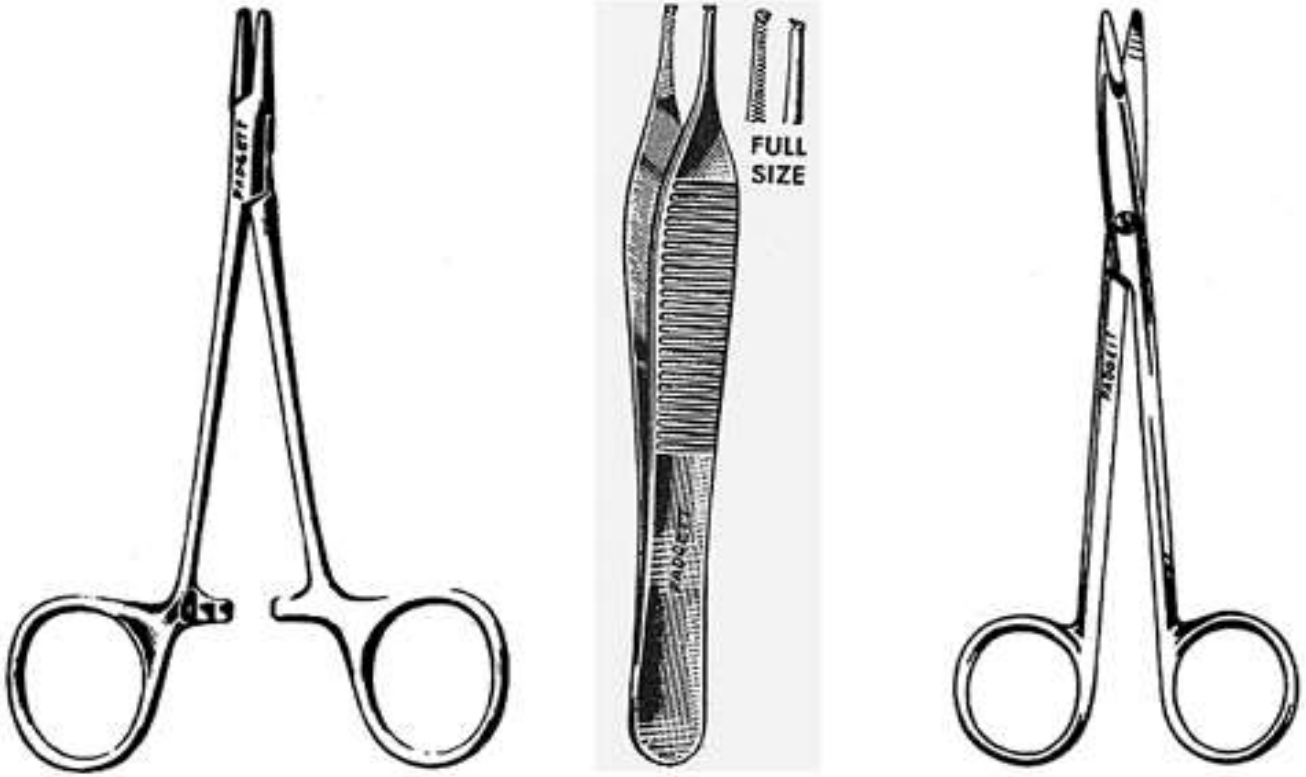
Armamentarium

Instruments Needed

Needle holder: used to grab onto the suture needle

Forceps: used to hold the tissues gently and to grab the needle

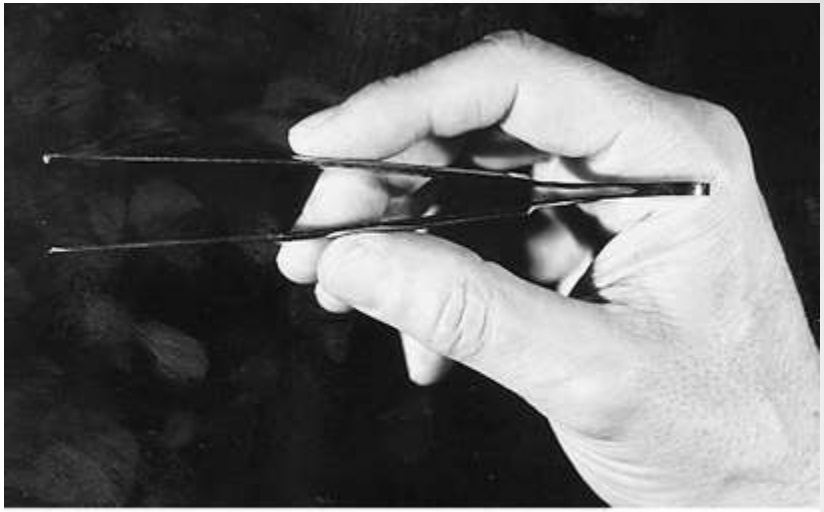
Suture scissors: used to cut the stitch from the rest of the suture material



Left, Needle holder. *Center*, Forceps with teeth. *Right*, Suture scissors. (Courtesy of Padgett Instruments, Inc.)

Handling the instruments

The needle holder and scissors are handled similarly. For maximal control, place the tips of your thumb and ring finger into the rings of the instrument. Your thumb does most of the work to open and close the instrument.

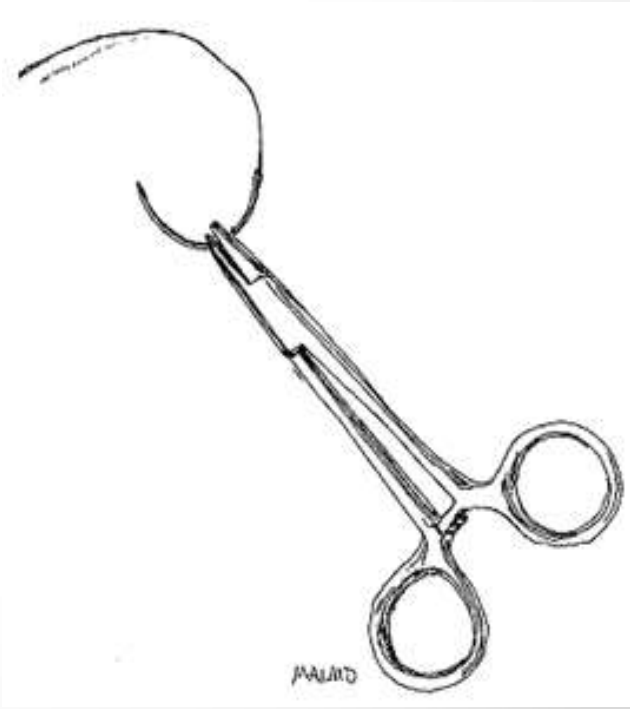


Hold the forceps as you would hold a writing instrument.

Principles of suturing

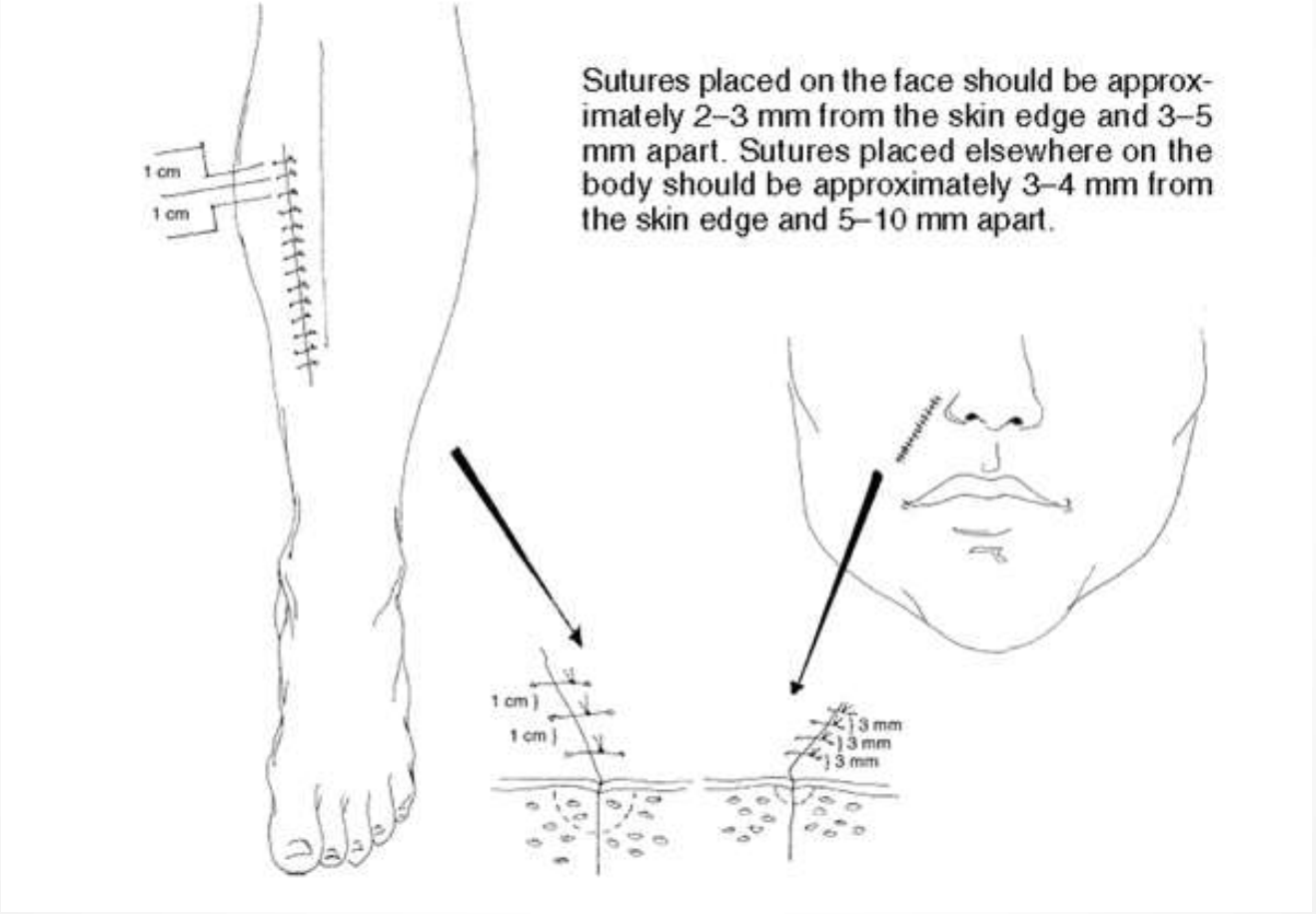
1. The needle holder should grasp the needle at approximately ¾ of the distance from the point.

The suture end of the needle is the weakest area because either it is hollow, as in the case of swaged needle, or it contains the eye. Grasping the suture end will result in needle breakage



2. The needle should be passed through the tissue following the curve of the needle.
3. The needle should enter the tissue perpendicular to the surface. If it pierces obliquely, a tear may result.
4. The suture should be placed at an equal distance of 2-3 mm from the incision on both sides and at equal depth.

   The closeness of the sutures depends on the anticipated tension across the suture line. Closer spaced sutures are indicated in areas of underlying muscular activity such as the tongue or in other areas of increased tension.


1 cm
1 cm
Sutures placed on the face should be approximately 2–3 mm from the skin edge and 3–5 mm apart. Sutures placed elsewhere on the body should be approximately 3–4 mm from the skin edge and 5–10 mm apart.
1 cm
1 cm
3 mm
3 mm
3 mm

5. If one tissue side is free, (as with a flap) and the other fixed, the needle should be passed from the free to the fixed side.
6. If one tissue side is thinner than the other, then the needle should be passed from thinner to the thicker side.
7. If one tissue plane is deeper than the other, then the needle should be passed from the deeper to the superficial side.

8. The distance that the needle is passed into the tissue should be greater than the distance from the tissue edge. This will ensure a degree of tissue aversion. Some degree of aversion is desirable in anticipation of scar contracture.
9. The tissues should not be closed under tension, since they will either tear or necrose around the suture. If tension is present , the tissue layer should be undermined to relieve it.
10. The suture should be merely tied, so that the tissue is merely approximated, not blanched.
11. The knot should not be placed in the incision line.

Knots and Knots…

Square Knot and the Surgeons Knot

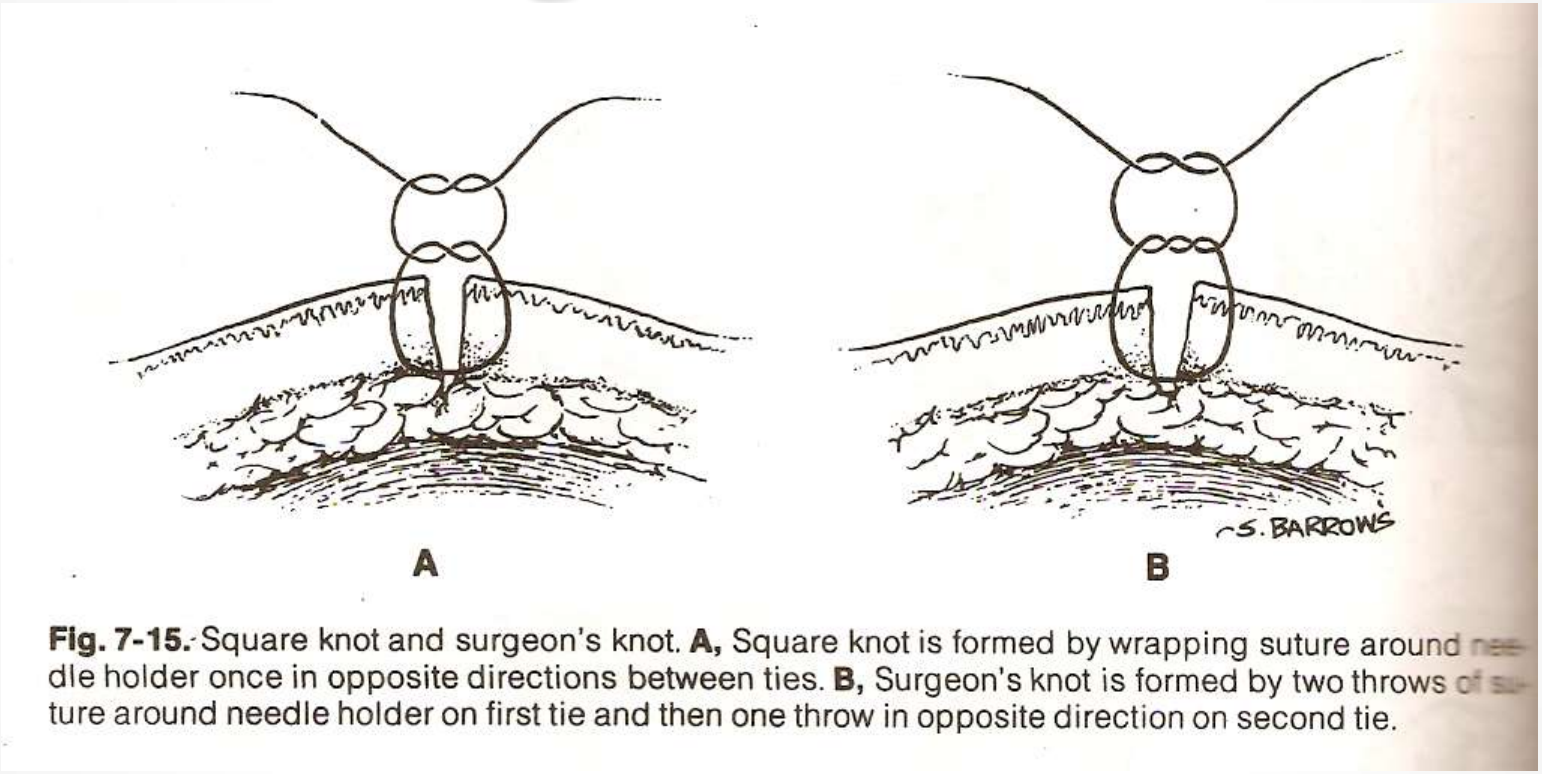
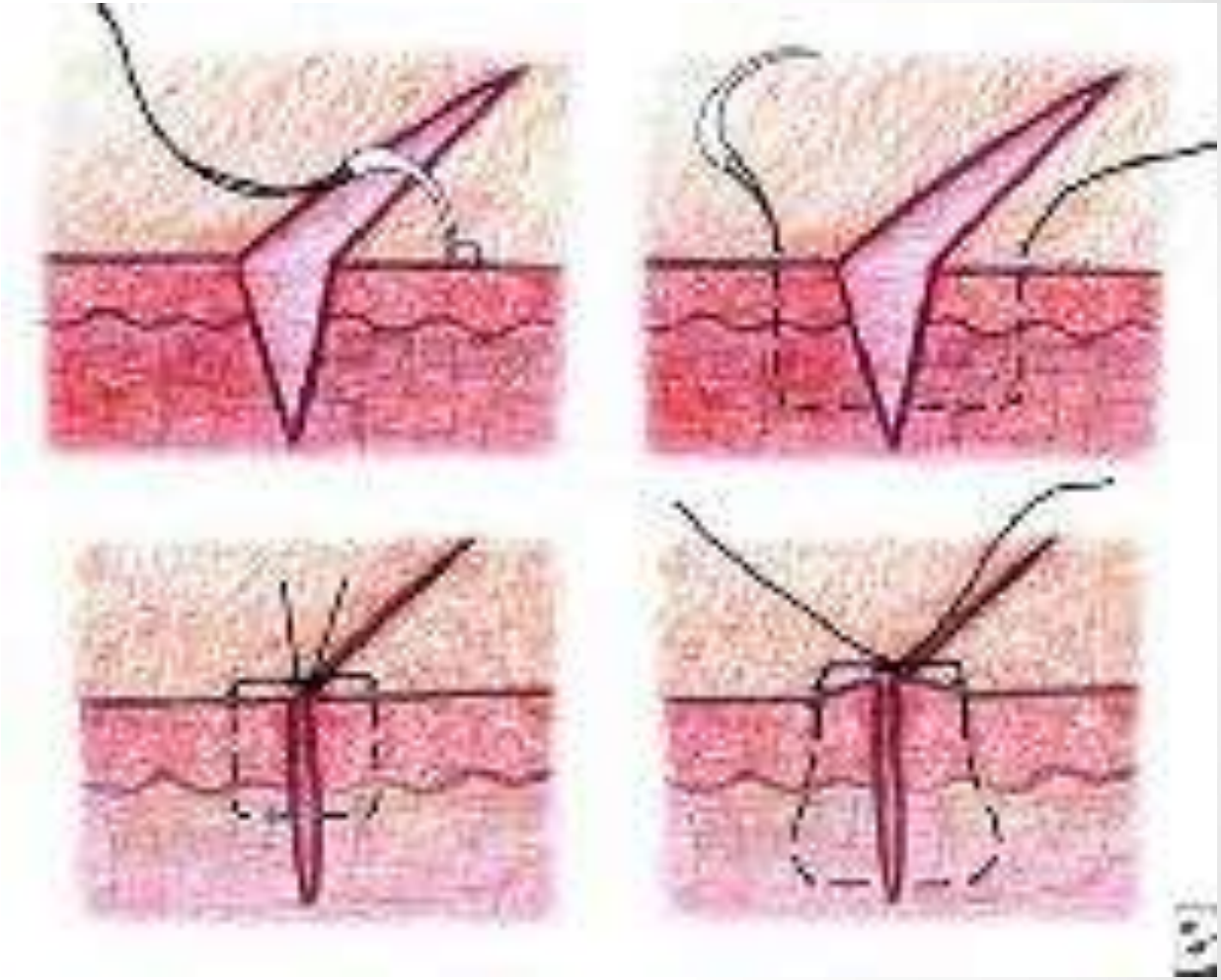


Fig. 7-15. Square knot and surgeon's knot. **A,** Square knot is formed by wrapping suture around needle holder once in opposite directions between ties. **B,** Surgeon's knot is formed by two throws of suture around needle holder on first tie and then one throw in opposite direction on second tie.

Grannys knot: Two consecutive ties in the same direction, followed by a third in the opposite direction.

Suture Methods

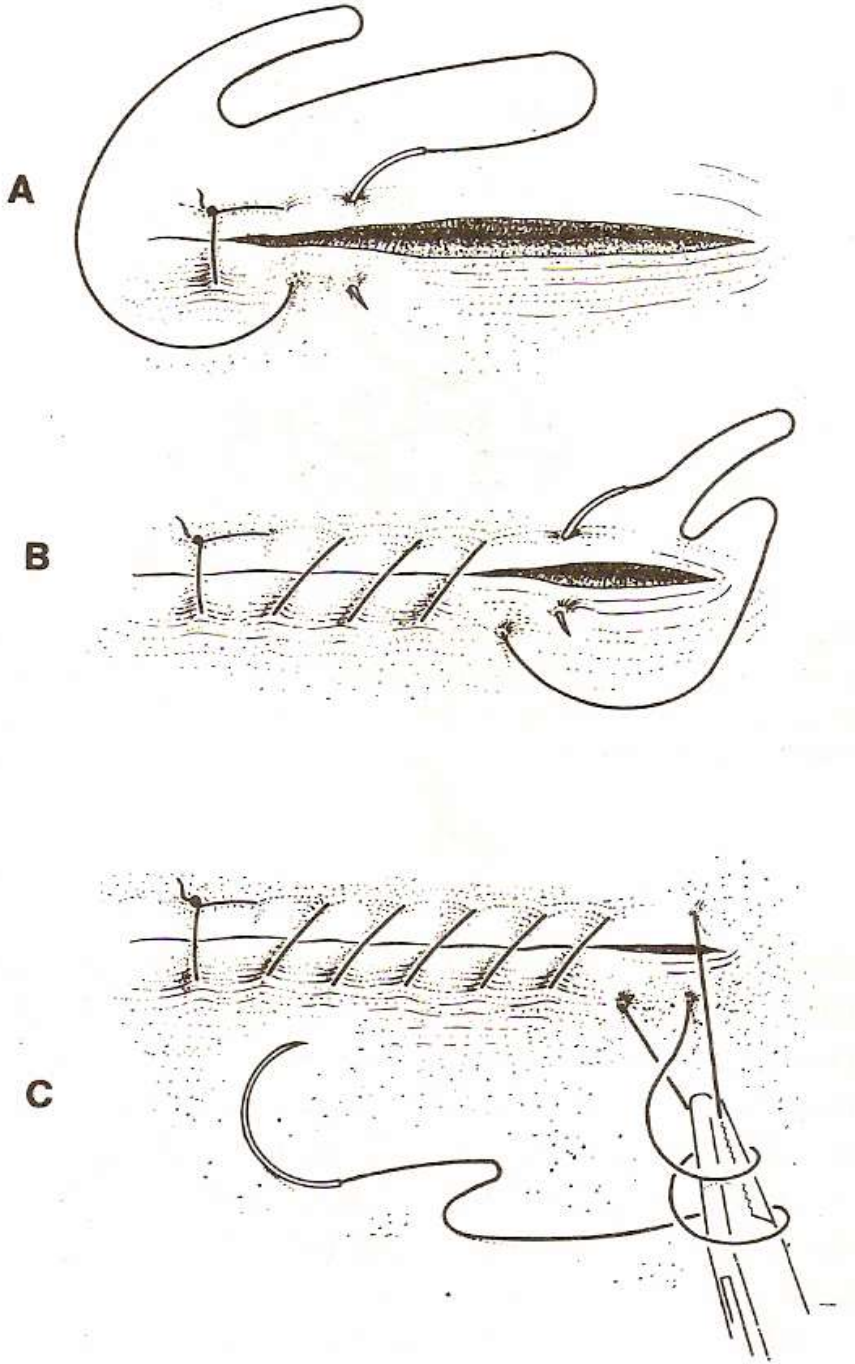
Interrupted sutures



Uses of Interrupted sutures

- Interrupted sutures are easy to place
- Have greater tensile strength
- Have less potential for causing wound edema and impaired cutaneous circulation.
- Interrupted sutures also allow the surgeon to make adjustments as needed to properly align wound edges as the wound is sutured.
- Disadvantages:
  - More time required for their placement
  - Greater risk of crosshatched marks (ie, train tracks) across the suture line.
- The risk of crosshatching can be minimized by removing sutures early to prevent the development of suture tracks.

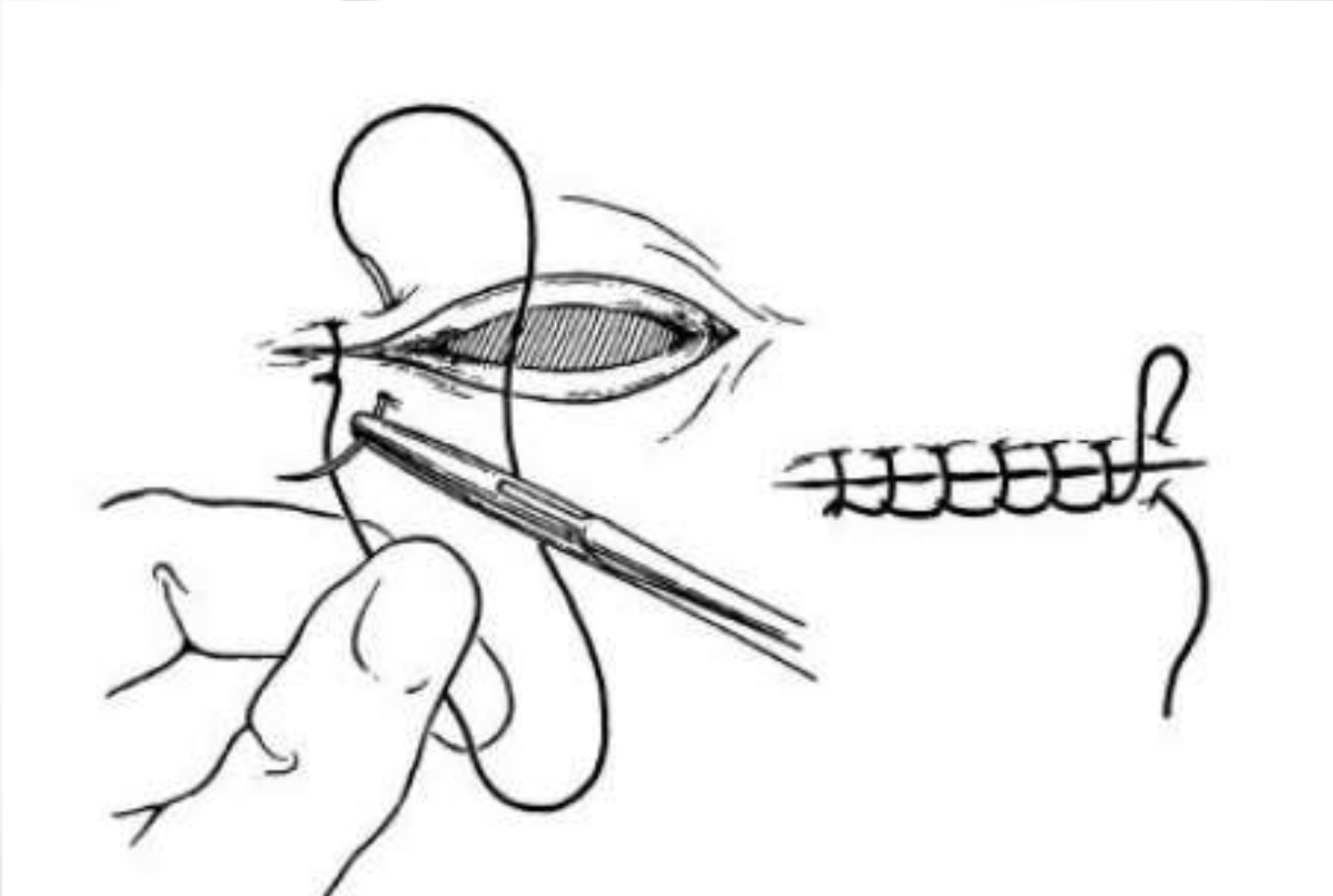
Simple Running Sutures



Uses of Simple running suture

- Running sutures are useful for long wounds in which wound tension has been minimized with properly placed deep sutures and in which approximation of the wound edges is good.
- This type of suture may also be used to secure a split- or full-thickness skin graft.
- Less scarring occurs with running sutures compared with interrupted sutures because fewer knots are made with simple running sutures; however, the number of needle insertions remains the same.
- Advantages
  - quicker placement
  - more rapid reapproximation of wound edges, compared with simple interrupted sutures.
- Disadvantages
  - possible crosshatching
  - the risk of dehiscence if the suture material ruptures,
  - difficulty in making fine adjustments along the suture line
  - puckering of the suture line when the stitches are placed in thin skin.

Running locked sutures



Uses of Continuous Locking Suture

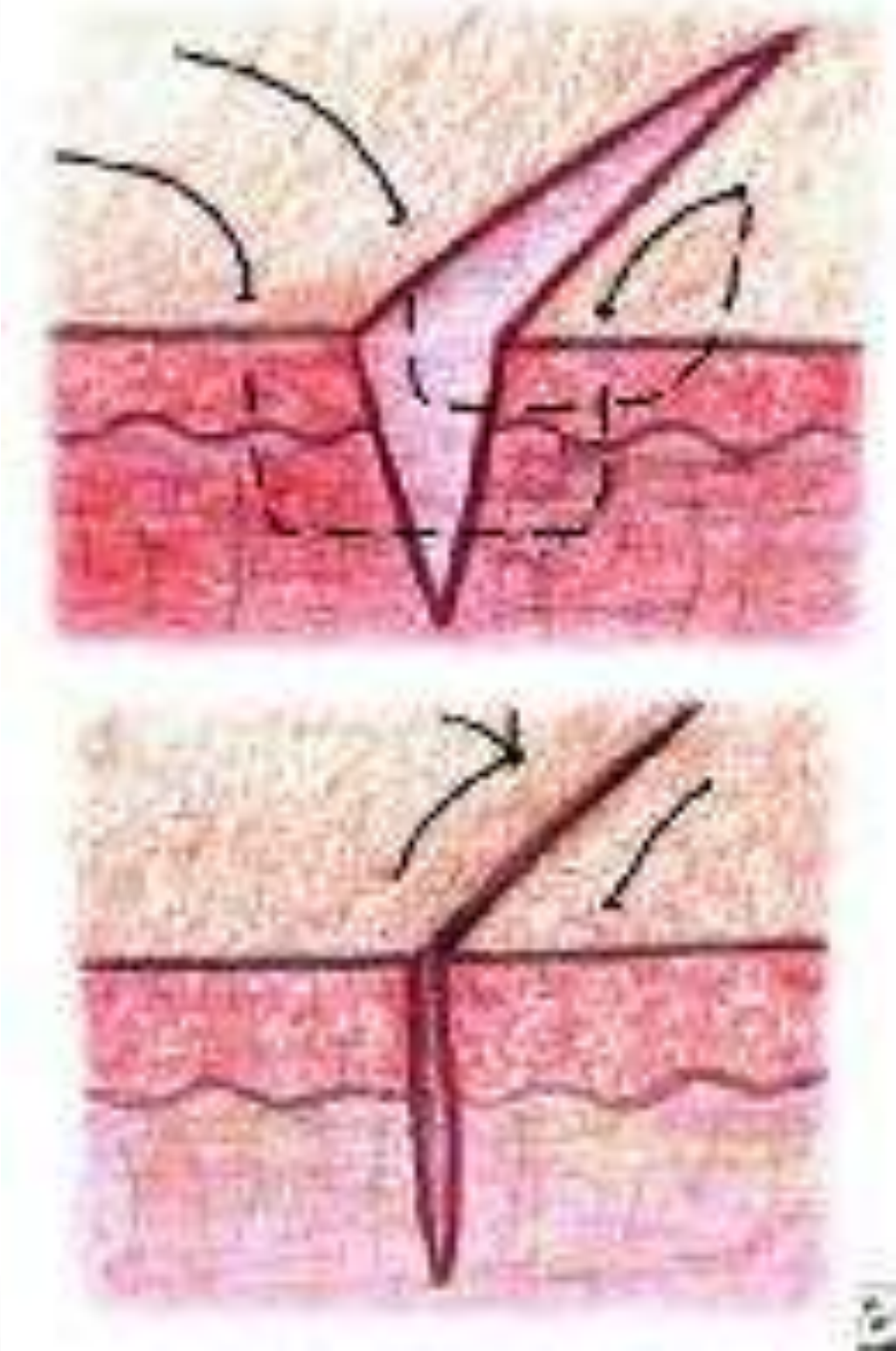
- Locked sutures have increased tensile strength; therefore, they are useful in wounds under moderate tension or in those requiring additional hemostasis because of oozing from the skin edges.
- Running locked sutures have an increased risk of impairing the microcirculation surrounding the wound, and they can cause tissue strangulation if placed too tightly. Therefore, this type of suture should be used only in areas with good vascularization.
- In particular, the running locked suture may be useful on the scalp or in the postauricular sulcus, especially when additional
- hemostasis is needed.

Vertical Mattress Suture

Uses of Vertical Mattress Suture

- Especially useful in maximizing wound eversion, reducing dead space, and minimizing tension across the wound.
- One of the disadvantages of this suture is crosshatching. The risk of crosshatching is greater because of increased tension across the wound and the entry and exit points of the stitch in the skin.
- The recommended time for removal of this suture is 5-7 days (before formation of epithelial suture tracks is complete) to reduce the risk of scarring.
- If the suture must be left in place longer, bolsters may be placed between the suture and the skin to minimize contact.

Horizontal mattress suture



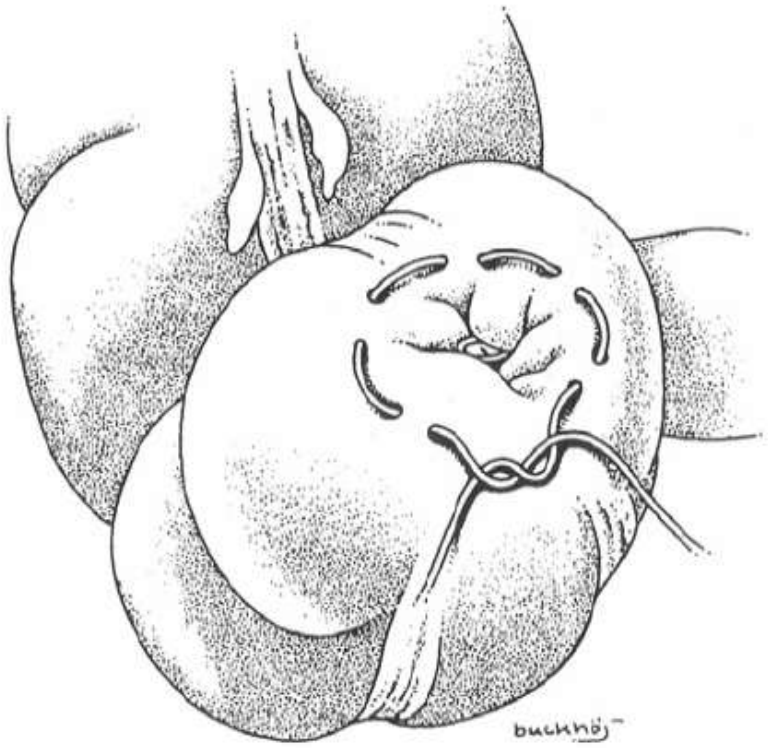
Uses of Horizontal Mattress Suture

- Used in wounds under high tension because it provides strength and wound eversion.
- As a stay stitch to temporarily approximate wound edges, allowing placement of simple interrupted or subcuticular stitches. The temporary stitches are removed after the tension is evenly distributed across the wound.
- They have a high risk of producing suture marks if left in place for longer than 7 days.
- Horizontal mattress sutures may be placed prior to a proposed excision as a skin expansion technique to reduce tension. Improved eversion may be achieved with this stitch in wounds without significant tension by using small bites and a fine suture.
- Horizontal sutures have a high risk of tissue strangulation and wound edge necrosis if tied too tightly.
- Placing sutures at a greater distance from the wound edge facilitates their removal.

Buried horizontal mattress suture/purse string suture

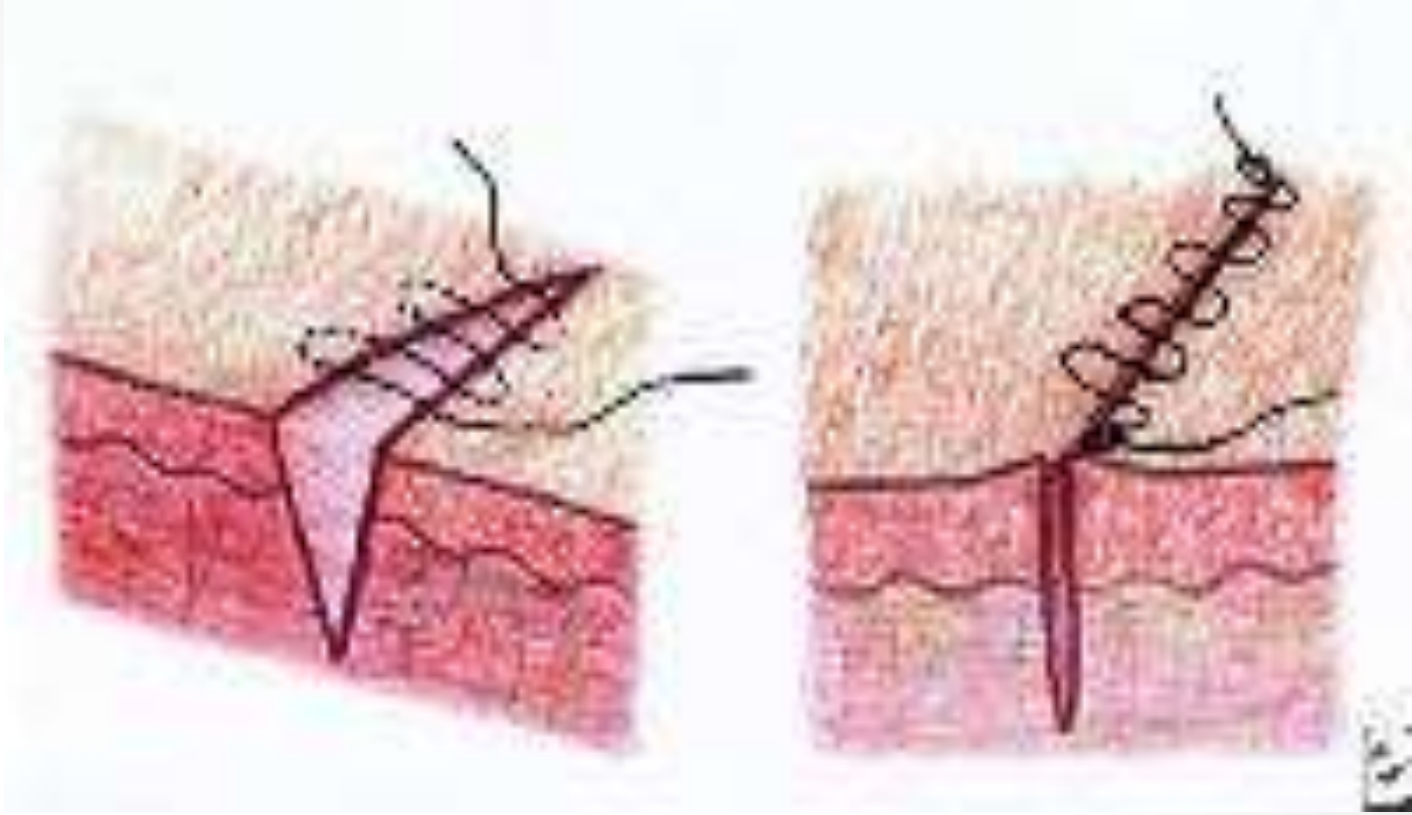
Uses

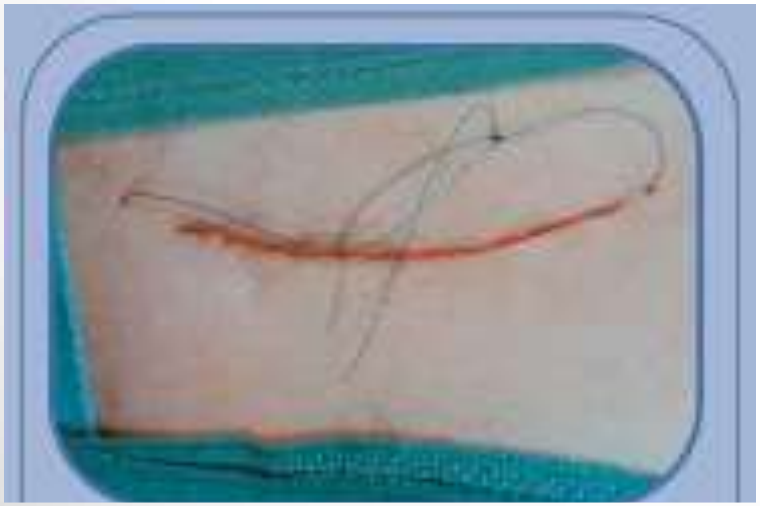
- The buried horizontal mattress suture is used to eliminate dead space, reduce the size of a defect or reduce tension across wounds.

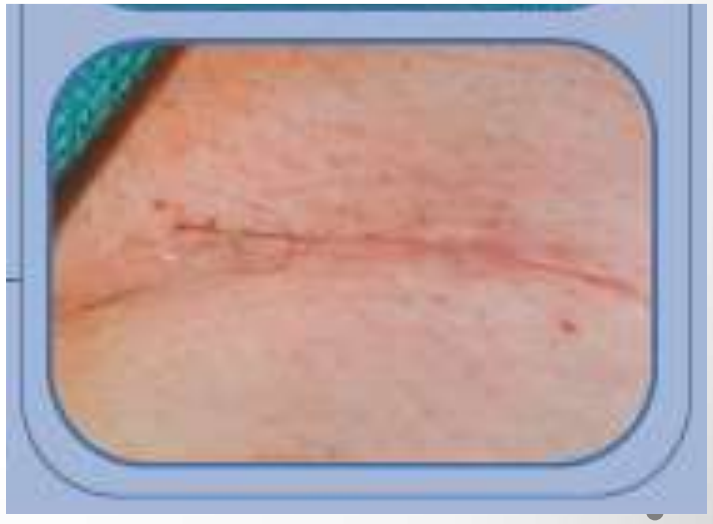


Purse-string suture.

Subcuticular Suture







Subcuticular Suture

Uses

- Used in areas in which the tension is minimal, the dead space has been eliminated, and the best possible cosmetic result is desired.
- Because the epidermis is penetrated only at the beginning and end of the suture line, the subcuticular suture effectively eliminates the risk of crosshatching.
- The suture does not provide significant wound strength,
- It does precisely approximate the wound edges.
- Therefore, the running subcuticular suture is best reserved for wounds in which the tension has been eliminated with deep sutures, and the wound edges are of approximately equal thicknesses.

Depuckering the pucker/ dog ear

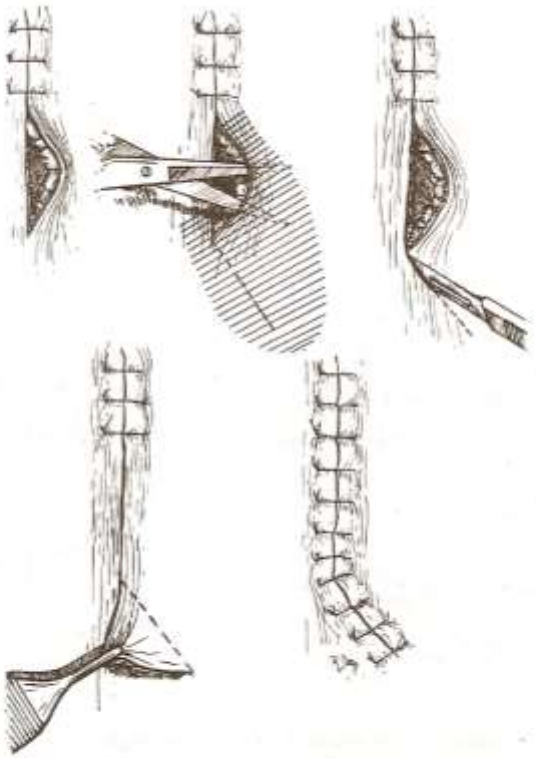


Fig. 7-12. Eliminating "dog-ear" at end of incision. After undermining excess tissue, incision is made at approximately 30 degrees to parent incision directed toward undermined side. Extra tissue is pulled over incision and the appropriate amount is excised. Incision is then closed in normal manner.

Suture removal timing

- Scalp: 6-8 days
- Face, Eyelid, Eyebrow, Nose, Lip: 3-5 days
  - Follow with papertape or steristrips
- Ear: 10-14 days
- Chest and abdomen: 8-10 days
- Back: 12-14 days
- Extremities: 12-14 days
- Hand: 10-14 days
- Foot and sole: 12-14 days

What, if not, Sutures?

Suture Alternatives

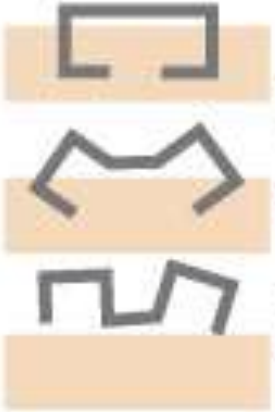
Surgical Staples

It's all come a long way from the Egyptian technique of pressing ant mandibles against a wound, then cutting the ant's head off so the mandibles contract and hold the wound edges together...

- Staples provide a fast method for wound closure and have been associated with decreased wound infection rates.
- Staples are composed of stainless steel, which has been shown to be less reactive than traditional suturing material.
- The act of stapling requires minimal skin penetration, and, thus, fewer microorganisms are carried into the lower skin layers.
- Staples are more expensive than traditional sutures and also require great care in placement, especially in ensuring the eversion of wound edges. However, with proper placement, resultant scar formation is cosmetically equivalent to that of other techniques.

This is what the staples look like under your skin.

You can't pull them straight out without causing pain and more bleeding.



Surgical staple removers work by 'uncurling' the staple under your skin. The staple, once removed, resembles the final step on the left.

Surgical staple removers work by placing pressure on the center of the staple (the red dot), and lifting up at the edges (blue dots).

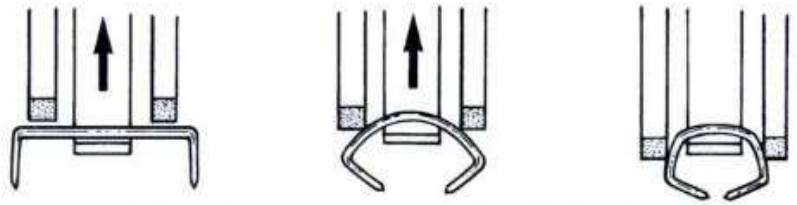


Fig. 2.19 The principle of skin staplers. Since there is no anvil beneath the skin, the staples must be formed from without. The sequence of action proceeds from left to right. The central column of the stapler has a tip beneath the middle section of the staple to hold it, while the outer pillars descend to bend the staple, creating a closed ring.

This is what the staples look like under your skin.

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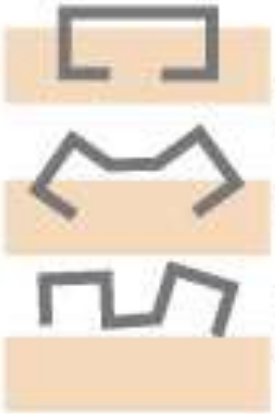

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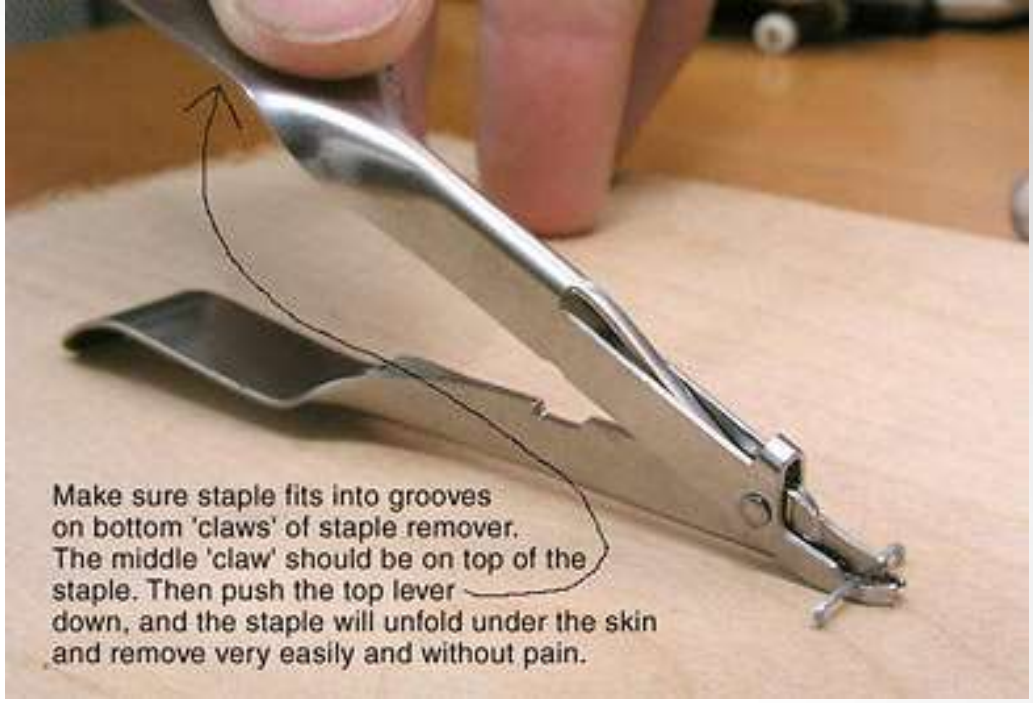
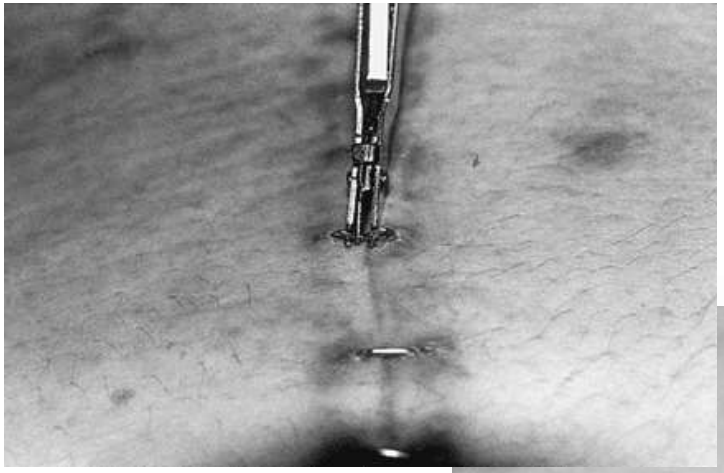
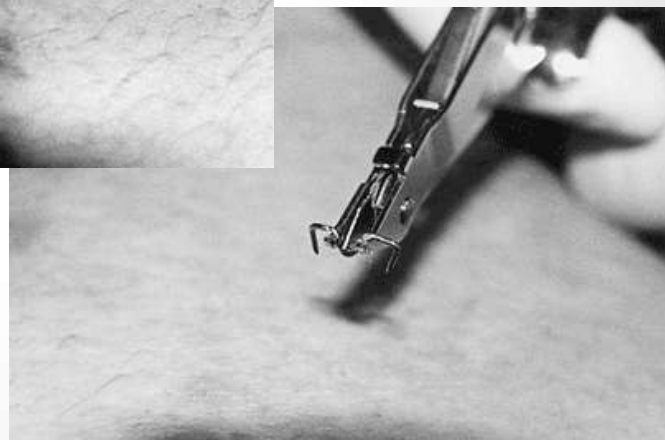


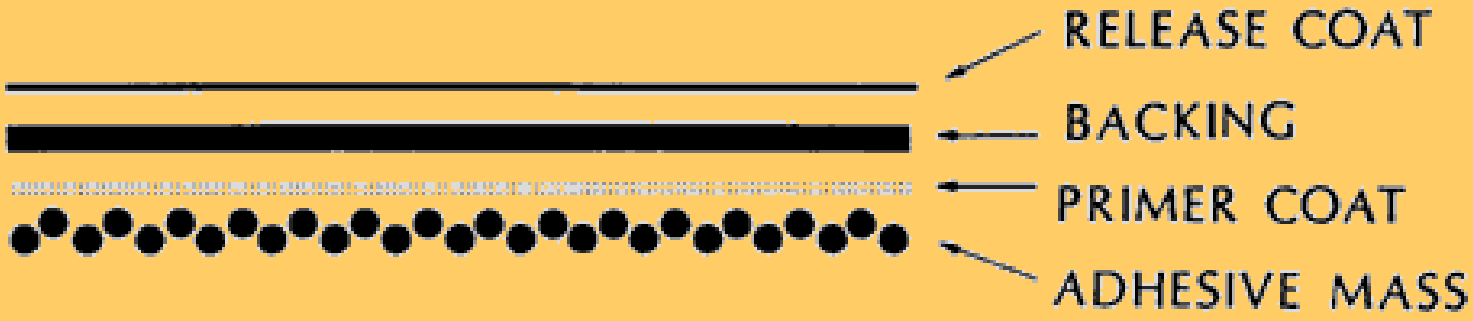




The Stapled Wound

Surgical Tape

- Closure using adhesive tapes or strips was first described in France in the 1500s, when Pare devised strips of sticking plaster that were sewn together for facial wounds.
- This method allowed the wound edges to be joined and splinted. The porous paper tapes (eg, Steri-Strips) in use today are reminiscent of these earlier splints and are used to ensure proper wound apposition and to provide additional suture reinforcement.
- These tapes can be used either with sutures or alone. Often, skin adhesives (eg, Mastisol, tincture of Benzoin) aid in tape adherence.



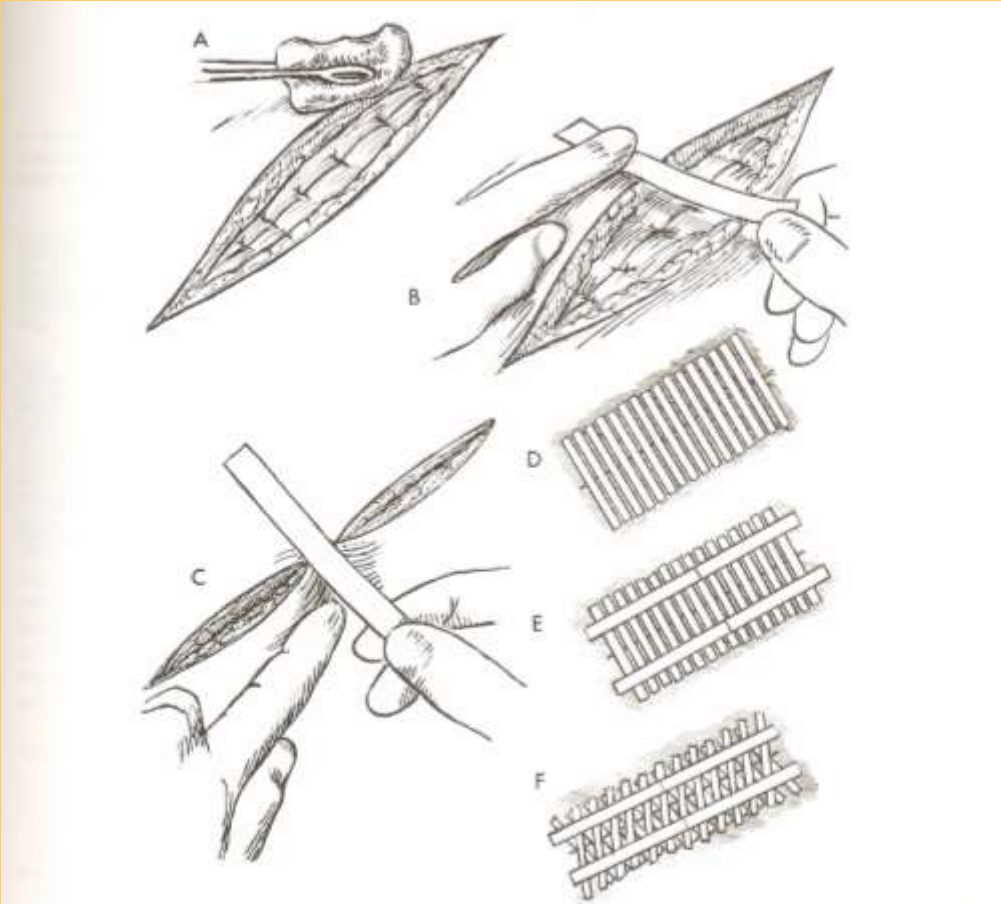


Figure 1–45. The Steri-tape technique of skin closure. *A*, The deep layers of the wound have been sutured. The skin surface around the periphery of the wound is cleansed with a solvent and an adhesive solution is applied. *B*, *C*, First strip is applied and the center of the wound approximated. *D* to *F*, Completion of adhesive strip closure.

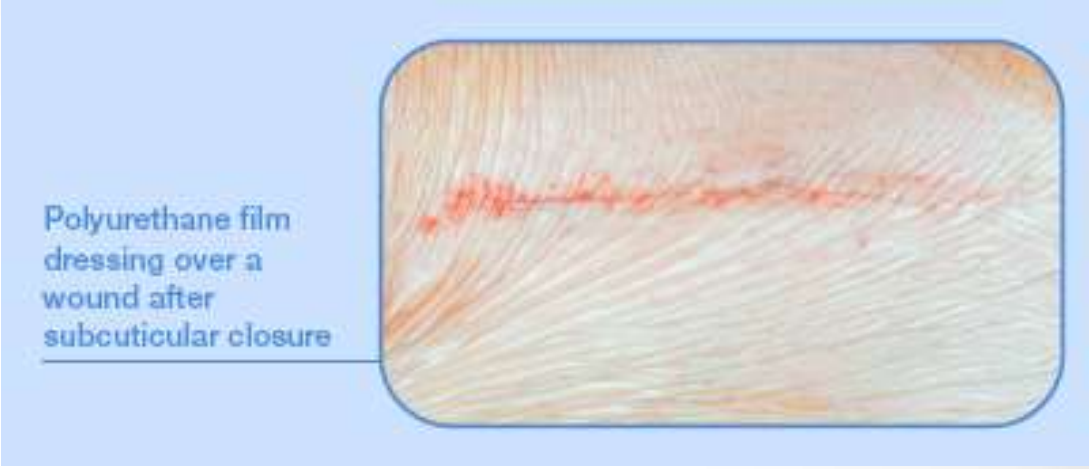

First Aid
CLOTH TAPE


HY-TAPE


3M


3M
Transpore


First Aid
Hurt-Free Tape



- Newer products such as the ClozeX (Wellesley, Mass) adhesive strip and polyurethane films allows for rapid and effective wound closure that results in adequate cosmesis.
- Wound closure with adhesive strips can be significantly cheaper than suturing or using a tissue adhesive. However, adhesive strips are not appropriate for many types of lacerations.

Tissue adhesives

Cyanoacrylates

- Cyanoacrylates were first manufactured in 1949 as methyl cyanoacrylate. The first adhesives were noted to have extreme inflammatory effects on tissues.
- *N*-butyl-2-cyanoacrylate, which was developed in the 1970s, was the first adhesive to have negligible tissue toxicity and good bonding strength, as well as acceptable wound cosmesis.
- 2-octylcyanoacrylate (Dermabond), the latest in cyanoacrylate technology, has less toxicity and almost four times the strength of *N*-butyl-2-cyanoacrylate.

  This adhesive reaches maximum bonding strength within two and one-half minutes and is equivalent in strength to healed tissue at seven days post repair.

Good results. . .

FIGURE 3A. Laceration to chin.

FIGURE 3B. Three months after treatment with adhesive.

- When clinically compared with sutures alone or with several traditional methods (sutures, staples, or adhesive tape) for closure of surgical and/or traumatic wounds, 2-octylcyanoacrylate was credited for faster and less painful closure, similar or improved cosmetic outcome, and similar rates of dehiscence .
- Wound closure with 2-octylcyanoacrylate, as opposed to traditional methods, requires less training . Indeed, whereas the cosmetic appearance of wounds closed by suture has been found to depend on practitioner experience , the 3-month cosmetic result of wound closure with 2-octylcyanoacrylate tissue adhesive was judged independent of such experience .

P.N.V. Blondeel et al. / The American Journal of Surgery 188 (2004) 307–313

Steps in use of Dermabond ™

1. Apply topical anesthetic as needed.
2. Prepare wound with antiseptic.
3. Appose wound edges.
4. Crush Dermabond vial and invert.
5. Gently brush adhesive over laceration.
6. Avoid pushing adhesive into wound.
7. Apply three layers of adhesive

FIGURE 2A. Laceration to lower eyebrow.

FIGURE 2B. Closed wound with adhesive.

FIGURE 2C. Three months after treatment with adhesive.

Precautions

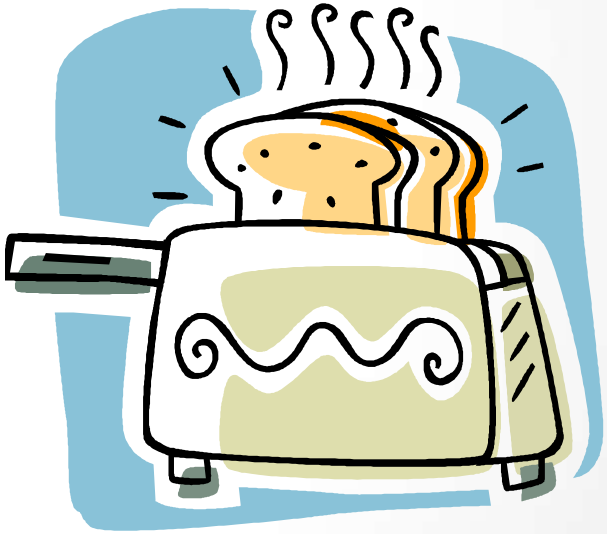
- Cyanoacrylate tissue adhesives should not be used:
  - in the presence of infection
  - in the presence of ongoing bleeding
  - in the presence of incomplete debridment
  - on mucosal or hair covered surfaces.
- Cyanoacrylate tissue adhesives should not be used on wounds that are:
  - wet
  - dirty
  - complex
  - not easily approximated
  - non-acute
  - poorly perfused
  - located in areas where device run-off into unintended sites cannot be prevented

Fibrin-based tissue adhesives

- Fibrin-based tissue adhesives can be derived from autologous sources or pooled blood.
- They are typically used for hemostasis and can seal tissues.
- While they do not have adequate tensile strength to close skin, fibrin tissue adhesives can be used to fixate skin grafts or seal cerebrospinal fluid leaks.
- Commercial preparations such as Tisseel (Baxter) and Hemaseel (Haemacure) are FDA-approved fibrin tissue adhesives made from pooled blood sources. These fibrin tissue adhesives are relatively strong and can be used to fixate tissues.
- Autologous forms of fibrin tissue adhesives can be made from patient's plasma. The concentration of fibrinogen in the autologous preparations is less than the pooled forms;
- therefore, these forms have a lower tensile strength.

At last....

THAT'S ALL FOLKS….



Any questions???