ВОЛГОГРАДСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ

Surgical instruments and Suturing a Wound

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Surgical instruments

Surgical instruments are tools or devices that perform such functions as cutting, dissecting, grasping, holding, retracting, or suturing. Most surgical instruments are made from stainless steel. Other metals and alloys, including titanium and vitallium, are also used.

Surgical instruments

Basic categories of instruments include:

- cutting and dissecting
- clamping
- grasping and holding
- probing
- dilating
- retracting
- suctioning

Surgical instruments

- As with every medical procedure, specific equipment is required for each surgical operation. Some equipment is reusable (most instruments fall into this category), whilst other equipment is single-use only. With few exceptions, all equipment used in operations is sterile.

Surgical instruments

There are a couple of “basic” sets containing the most commonly used instruments, which may be all that is required for something simple (e.g. the excision of a mole). Depending on the operation, surgical staff may also use other trays containing more specialised instruments (e.g. laparotomy set, rectal set, vascular set).

Surgical instruments

There are two basic categories of surgical instruments:

Instruments of general use

Special instruments

Surgical instruments

A surgeon may use the following instruments to interact, dissect and handle tissues or needles within the surgical field (the bit being operated on).

Dissecting forceps

Also known as dissectors, pick-ups, grabbers and thumb forceps. This is one of the instruments you are most likely to be familiar with. Dissecting forceps look like a large pair of tweezers and generally vary in size and shape

Surgical instruments

Surgical forceps may be broadly divided into two categories, thumb forceps (frequently called surgical tweezers or pinning forceps) and ring forceps (also called hemostats, hemostatic forceps and locking forceps). Thumb forceps are spring forceps used by compression between your thumb and forefinger and are used for grasping, holding or manipulating body tissue.

Surgical instruments

For example, you could use thumb forceps to hold or move tissue during surgery or to move dressings.

Surgical instruments

Dissecting forceps (toothed)

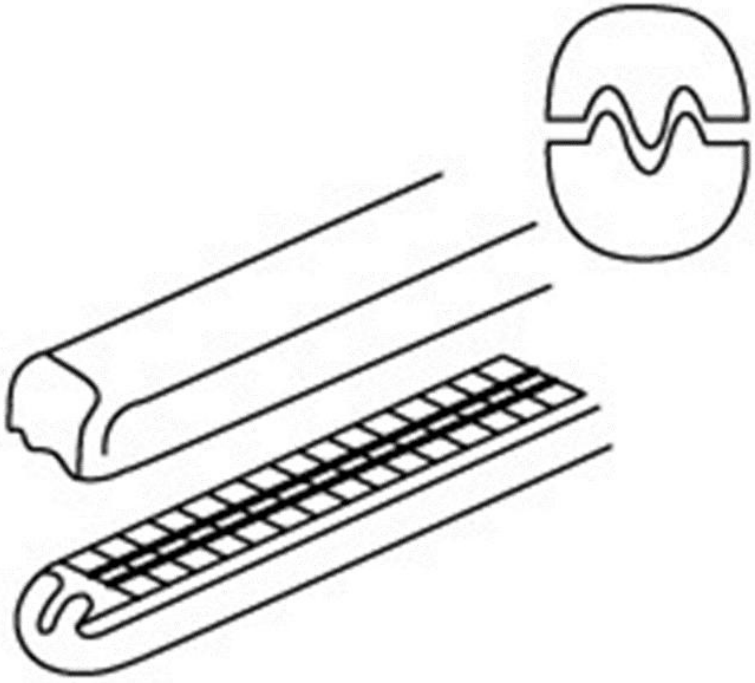
Surgical instruments

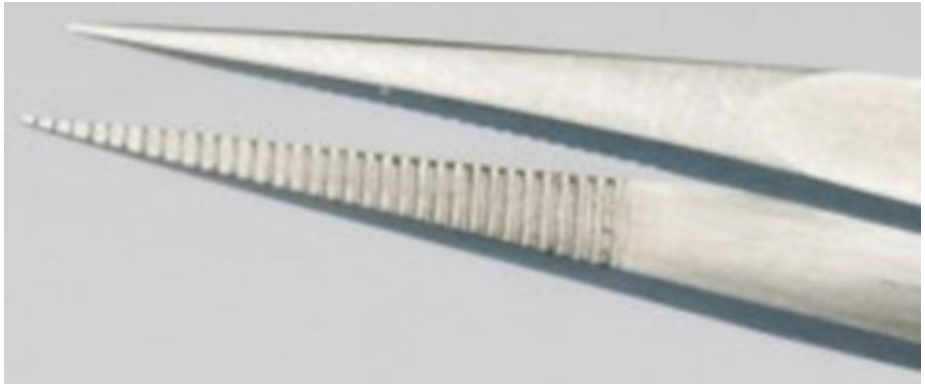
Forceps are used to grasp and manipulate tissue as well as equipment such as needles or swabs. You would use them as you would use your finger and thumb. Importantly, the tip of the forceps can be non-toothed (atraumatic) or toothed (traumatic).

Surgical instruments

Thumb forceps are available with a variety of tips. The tips may be flat, serrated, cupped, ringed, grooved, diamond dusted or have teeth. The tips may also be straight, curved or angled. See the images below. Serrated tweezers (thumb forceps) are designed for use with tissues. The serrations or teeth actually cause less damage than flat forceps, because it requires less pressure to maintain a firm grip. Use smooth or cross-hatched forceps for removing sutures, moving dressing or other drapes.

Surgical instruments





Surgical instruments

Ring forceps (also called hemostatic forceps) are hinged and look like ring scissors. Frequently, hemostatic forceps have a locking mechanism called a ratchet, which is used for clamping. The jaws of the locking forceps gradually come together as each increment of the ratchet is employed. Ring forceps are used for grasping, holding firmly or exerting traction upon objects.

Surgical instruments

For especially delicate operations, generally ring handles with a locking ratchet are preferred over thumb forceps.

Locking hemostatic forceps may be called clamps and are used to securely hold tissue. When they are used to control blood flow, they are called hemostats. Hemostats are typically used to compress blood vessels or other tubular structures to obstruct the flow of blood or fluids.

Surgical instruments

The jaws can be straight, curved or right angle. They come in a variety of sizes depending on your application. For example, Mosquito hemostats clamp small blood vessels, and Kelly hemostats can be used to clamp larger vessels or grasp tissue. Kelly hemostats and Rochester forceps look similar. However, Kelly hemostats have shorter serrations. Rochester hemostats can reach a little deeper.

Surgical instruments

Hinged forceps

Resembling a pair of scissors but instead of two blade-like parts, two arms which meet to press together instead of cut. The size and shape of the arms, as well as the shape of the surfaces which meet vary dependent upon the type of hinged-forceps. This design is common amongst many instruments, for example, needle holders (for suturing, see below) and artery forceps (for vessel ligation).

Surgical instruments

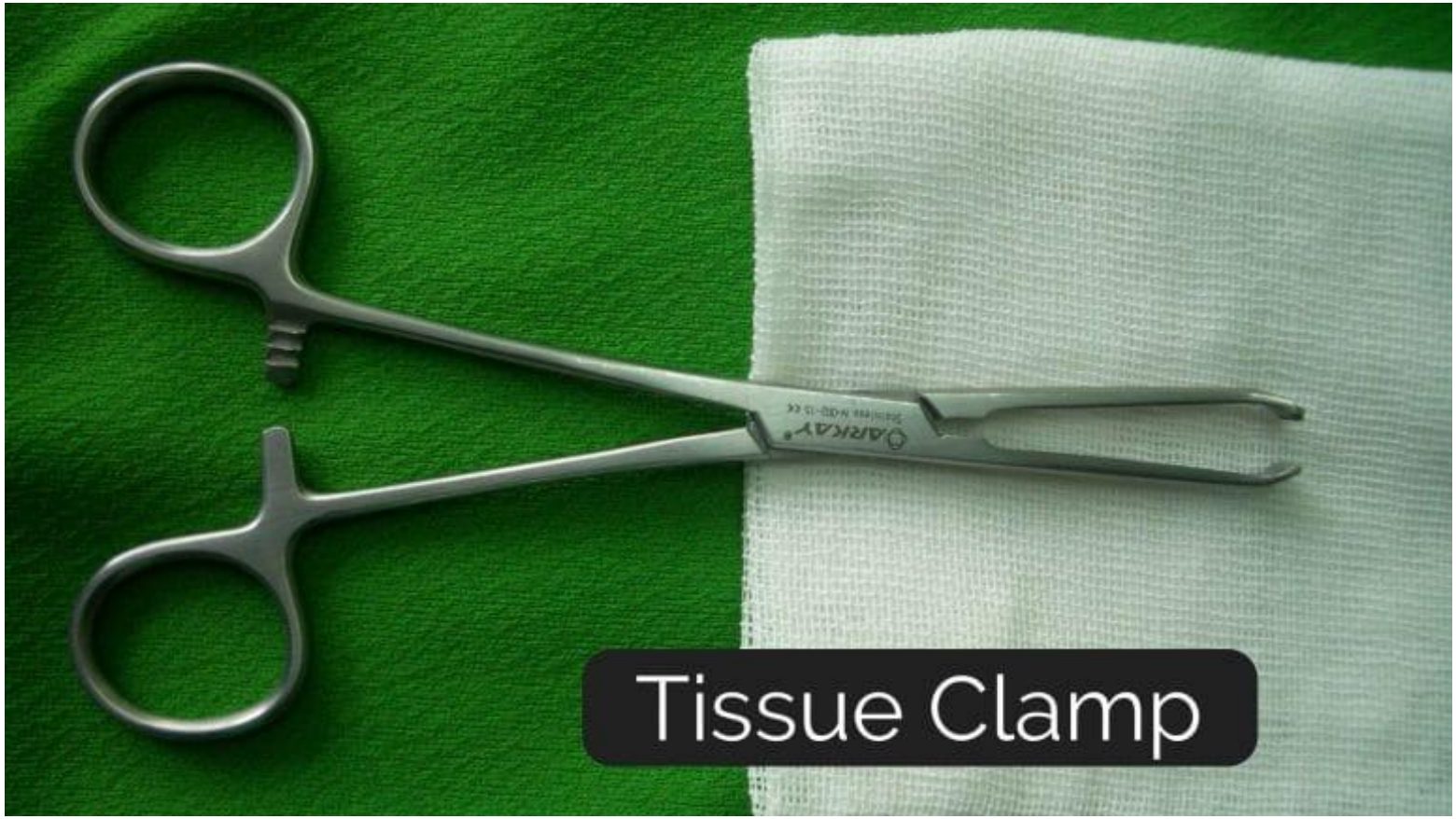
Hinged Forceps

Surgical instruments

Clamps

Tissue clamps have a similar design to hinged-forceps and are used to block or occlude blood vessels or other luminal tissues (such as bowel). Depending on their use, clamps can be atraumatic (e.g. for use on bowel), designed to crush tissue, or have features specific to them so they don’t slip (e.g. for vessel occlusion).

Surgical instruments



Surgical instruments

Probes

Long, slender and uncomplicated instruments, probes also vary in size and the functional ends. Generally, probes are used for exploring or examining anatomy as well as fistulae or sinus tracts.

Surgical instruments

Surgical instruments

Surgical

grooved

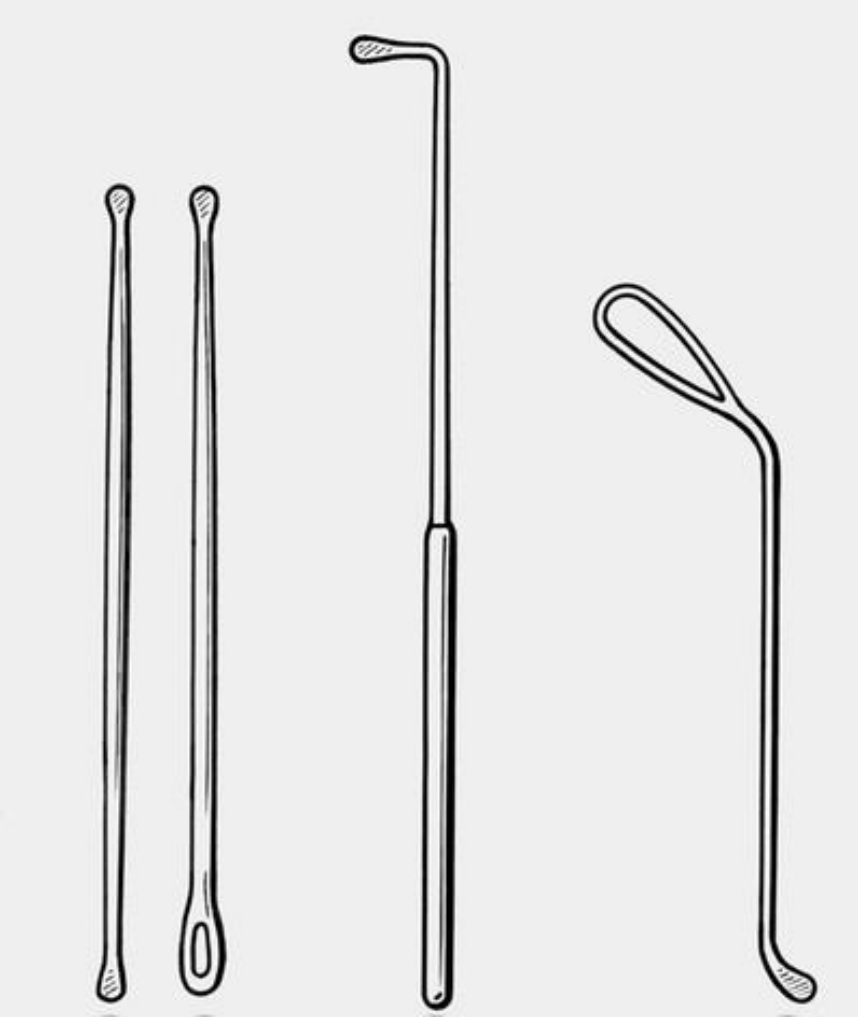
(hollow) probe

Surgical instruments

Olive-pointed

(bulb-headed)

probes



Surgical instruments

Retraction

To improve the view of the surgical field by tissue or organs out of the way the following instruments may be used.

Handheld retractors

Simple, versatile instruments which need to be held and manipulated by an assistant. They have three main parts: a handle which goes in the assistant's hand, a blade which goes into the patient and a shaft in-between. The blades come in many different shapes, including hooks, teeth, right angles and curves.

Surgical instruments

Handheld Retractor

Surgical instruments

Self-retaining retractors

Varying significantly in design from simple hinged ratchet's to complex operating-table-mounted frames, self-retaining retractors hold themselves in place after they have been positioned and applied. This is very useful, as it frees up the assistant's hands to do other more exciting things, reduces muscle fatigue and allows the continuous provision of safe and stable levels of traction during longer procedures.

Surgical instruments

Surgical instruments

Cutting

To open up tissue, such as the skin during the beginning of an operation in the abdomen, and also to separate tissues apart during an operation.

Scissors

Whilst it would be an almost incredible feat to have never used or seen scissors in your life up to now, there are many different types of surgical scissors. The majority look like simple metal scissors, though curved and angled scissors are also commonly used.

Surgical instruments

Surgical instruments

Scalpels

The blades themselves come as disposables whilst scalpel handles are often within an instrument set, often called a ‘B.P. handle’. They vary in size and how they are best held, so have a close look at how the surgeon holds the scalpel.

Surgical instruments

Surgical instruments

Needle holders are a specific type of hinged-forceps that are specifically designed to hold suture needles between their teeth. They are used for passing needles through tissue when suturing.

Surgical instruments

Needle Holders

Surgical instruments

Suction

Suction is used to clear the surgical field by removing blood or other fluids. The suction tip is attached to a vacuum piping outside of the sterile field. There are many different shapes of suckers (small and fine-tipped, or large to prevent blockages) depending on the operation being performed.

Surgical instruments

Surgical suture

The **surgical suture** is used to hold body tissues together after injury or surgery. Sutures (or stitches) are typically **applied using a needle** with an attached piece of thread and are secured with **surgical knots**.

Suturing a wound is an **important surgical skill** to learn and become competent in.

Surgical suture

Sutures could be made of natural materials such as silk, or synthetic materials such as nylon. Stitching, or suturing, is the most common form of repairing a wound. Other methods include surgical staples, skin closure tapes, and adhesives. Sutures hold a wound or cut closed so that it can heal. When the cut is healed, the sutures have done their job and are removed (some types of suture will automatically dissolve).

Surgical suture

Wound suturing and closure is important in order to:

- Reduce dead space
- Support and strengthen wounds until healing
- Approximation of skin edges to reduce scaring
- Reduce the risk of bleeding and wound infection

Types of sutures

Sutures are divided into two general categories, namely, absorbable and nonabsorbable:

- **Dissolvable sutures (absorbable sutures)** – these are absorbed by the body naturally and don’t need to be removed; they are very useful when stitches are needed under the skin’s surface. Absorbable sutures rapidly break down in the tissues and lose their strength within 60 days.

Types of sutures

- **Regular (non-absorbable) sutures** – a non-absorbable suture resists the body's attempt to dissolve it. Nonabsorbable sutures, on the other hand, maintain their strength for longer than 60 days. Non-absorbable sutures are used to close skin, external wounds, or to repair blood vessels, for example. Non-absorbable sutures may be removed by a surgeon after a surface incision has healed.

Table 1. Absorbable Suture Materials

Material	Structure	Strength	T ½	Uses
Gut	Natural	++	5-7 days	Mucosal closure, rare
Chromic Gut	Natural	++	10-14 days	Mucosa, perineal
Dexon	Braided	+++	25 days	Subcuticular closures
Vicryl	Braided	++++	28 days	Mucosal closures
Maxon	Monofilament	+++++	28-36 days	Subcuticular closures

Table 2. Non-absorbable Suture Materials

Material	Structure	Strength	Knot security	Uses
Silk	Braided	++	++++	Easy to handle
Nylon	Monofilament	+++	++	Common for skin closure
Prolene	Monofilament	++++	+	High memory, subcuticular pull
Dacron	Braided	++	++++	Good knot security

Suture Materials

- Sutures are made from both man-made and natural materials. Natural suture materials include silk, linen, and catgut, which is actually the dried and treated intestine of a cow or sheep. Synthetic sutures are made from a variety of textiles such as nylon or polyester, formulated specifically for surgical use.

Suture Materials

- Absorbable synthetic sutures are made from polyglycolic acid or other glycolide polymers. Most of the synthetic suture materials have proprietary names, such as Dexon and Vicryl. The water-resistant material Goretex has been used for surgical sutures, and other sutures are made from thin metal wire.

Suture Materials

- Sutures are also classified according to their form. Some are monofilaments, that is, consisting of only one thread-like structure. Others consist of several filaments braided or twisted together. Surgeons choose which type of suture to use depending on the operation. A monofilament has what is called low tissue drag, meaning it passes smoothly through tissue.

Suture Materials

- Braided or twisted sutures may have higher tissue drag, but are easier to knot and have greater knot strength. Braided sutures are usually coated to improve tissue drag. Other sutures may have a braided or twisted core within a smooth sleeve of extruded material. These are known as pseudo-monofilaments. A suture can also be classified according to its diameter.

Alternative methods

Wounds or cuts can also be held together in other ways such as:

- **A special glue for skin**, which falls off of its own accord in a few weeks. This material is applied to the edges of the wound somewhat like glue and should keep the edges of the wound together until healing occurs. Adhesive glue is the newest method of wound repair and is becoming a popular alternative to stitches, especially for children. The adhesive simply falls off or wears away after about 5-7 days.

Alternative methods

Wounds or cuts can also be held together in other ways such as:

- **Adhesive tape (such as steri-strips)**, which also falls off naturally. Skin closure tapes, also known as adhesive strips, have recently gained popularity. The advantages of skin closure tapes are plenty. The rate of wound infection is less with adhesive strips than with stitches. Also, it takes less time to apply skin closure tape.

Alternative methods

For many people, there is no need for a painful injection of anesthetic when using skin closure tapes. Disadvantages of using skin closure tapes include less precision in bringing wound edges together than suturing. Not all areas of the body can be taped. For example, body areas with secretions such as the armpits, palms, or soles are difficult areas to place adhesive strips. Areas with hair also would not be suitable for taping.

Alternative methods

- **Metal staples**, which must be removed by a doctor or nurse. Surgical staples are useful for closing many types of wounds. Staples have the advantage of being quicker and may cause fewer infections than stitches. Disadvantages of staples are permanent scars if used inappropriately and imperfect aligning of the wound edges, which can lead to improper healing. Staples are used on scalp lacerations and commonly used to close surgical wounds.

Sutures

Suture sizes

- In the United States, suture diameter is represented on a scale descending from 10 to 1, and then descending again from 1-0 to 12-0. A number 9 suture is 0.0012 in (0.03 mm) in diameter, while the smallest, number 12-0, is smaller in diameter than a human hair.

Suture selection

- Much of the process surrounding suture selection depends on surgeon training and preference. A wide variety of suture materials are available for each surgical location and surgical requirement. Generally, the surgeon selects the smallest suture that adequately holds the healing wound edges. The tensile strength of the suture should never exceed the tensile strength of the tissue. As the wound heals, the relative loss of suture strength over time should be slower than the gain of tissue tensile strength.

Suture selection

- Certain general principles can be applied to suture selection. Sutures are no longer needed when a wound has reached maximum strength. Therefore, nonabsorbable suture should be considered in skin, fascia, and tendons (slowly healing tissues), whereas mucosal wounds (rapidly healing tissues) may be closed with absorbable sutures.

Suture selection

- Aesthetic concerns are at a premium in regions of the head and neck such as the eyelid, periorbital area, nose, pinna, lip, and vermillion. In these areas, tensile strength requirements tend to be less, and smaller suture sizes are preferred. However, the mobility of the lip and vermillion requires a relatively higher suture tensile strength.

Suture selection

- The activity and mobility of the face, anterior and posterior neck, scalp, superior trunk, and nasal and oral mucosa demand higher tensile strength requirements in suture selection. Additionally, major musculocutaneous flaps tend to be closed under significant tension, requiring maximal long-term tensile strength.

Suture selection

- Because the presence of foreign bodies in contaminated tissues may facilitate infection, special consideration of suture selection in these locations (eg, a contaminated posttraumatic wound) is imperative. Multifilament sutures are more likely to harbor contaminants than monofilament sutures are; accordingly, monofilament sutures are generally preferable in potentially contaminated tissues. The smallest inert monofilament suture materials (e.g., nylon or polypropylene) should be sued in this setting.

Suture selection

- The optimal suture size is generally the smallest size that can still effectively achieve the desired tension-free closure. If wound tension is high, smaller-diameter sutures may actually injure tissues by cutting through them. Therefore, the tensile strength of the suture and that of the tissue should be closely matched.

Table 3. Suture sizing by indication

Location	Superficial non-absorbable suture	Deep absorbable suture
Scalp, torso (chest, back, abdomen), extremities	3-0 to 5-0	3-0 or 4-0
Face, eyebrow, nose, lip	6-0	5-0
Ear, eyelid	6-0	n/a
Hand*	4-0 or 5-0	5-0
Foot or sole*	3-0 or 4-0	4-0
Penis	5-0 or 6-0	n/a

Suture selection

- **Footnote:** * deep sutures are to be avoided in the hands and feet unless being used to repair a tendon – they may increase the risk of wound infection.

Needle selection

- No standardized sizing system or nomenclature is available for needles. The main consideration in needle selection is to minimize trauma.

Suture selection

Needle selection

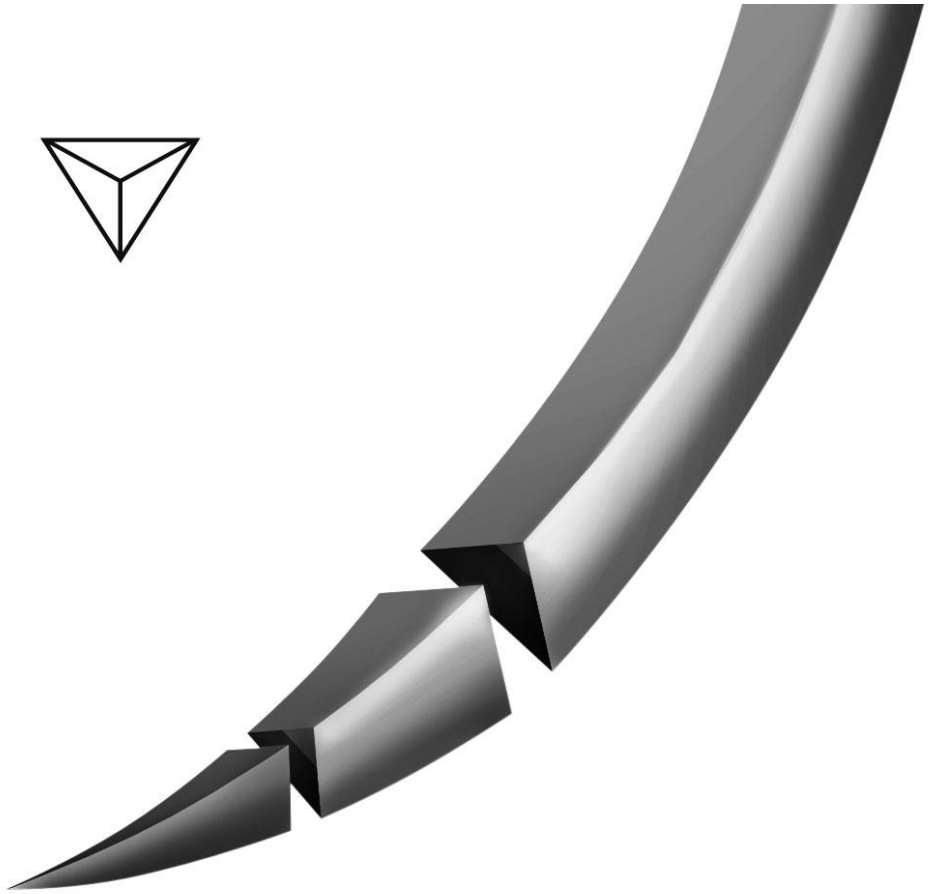
- A taper-point needle is sufficient for tissues that are easy to penetrate. Cutting needles are typically reserved for tough tissues. As a general rule, taper-point needles may be used for all closures except skin sutures. The length, diameter, and curvature of the needle influence the surgeon's ability to place a suture. Ideally, the needle-body diameter matches the suture size.

Suture selection

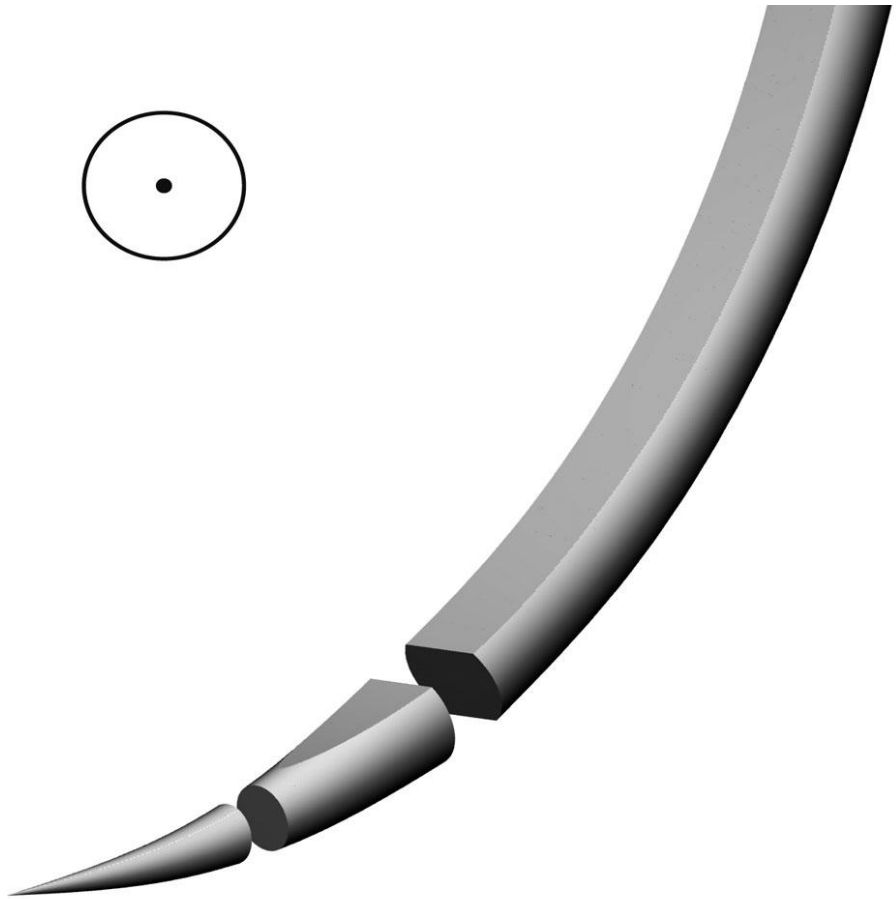
Needles

- All surgical needles have a Spring Eye which allows the suture to be pressed into the eye instead of threaded. Taper point surgical needles pierce and spread tissue without cutting it. They are ideal for suturing delicate, soft tissue when minimal trauma is desired. Surgical needle measurements are taken across needle from eye to tip. Cutting edge surgical needles have sharp edges that penetrate easily through tough tissue. They are ideal for suturing skin and dense dermal tissue.

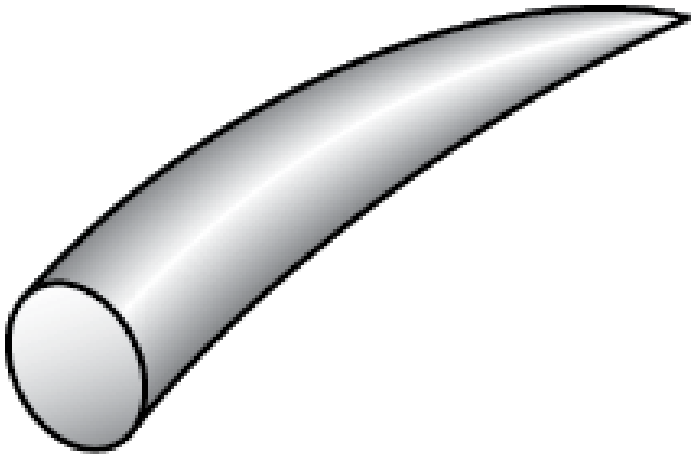
Surgical needle

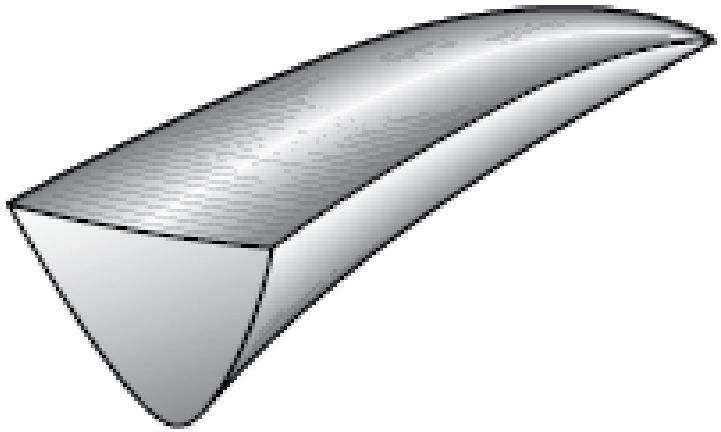


Surgical needle



Surgical needle





Suture selection

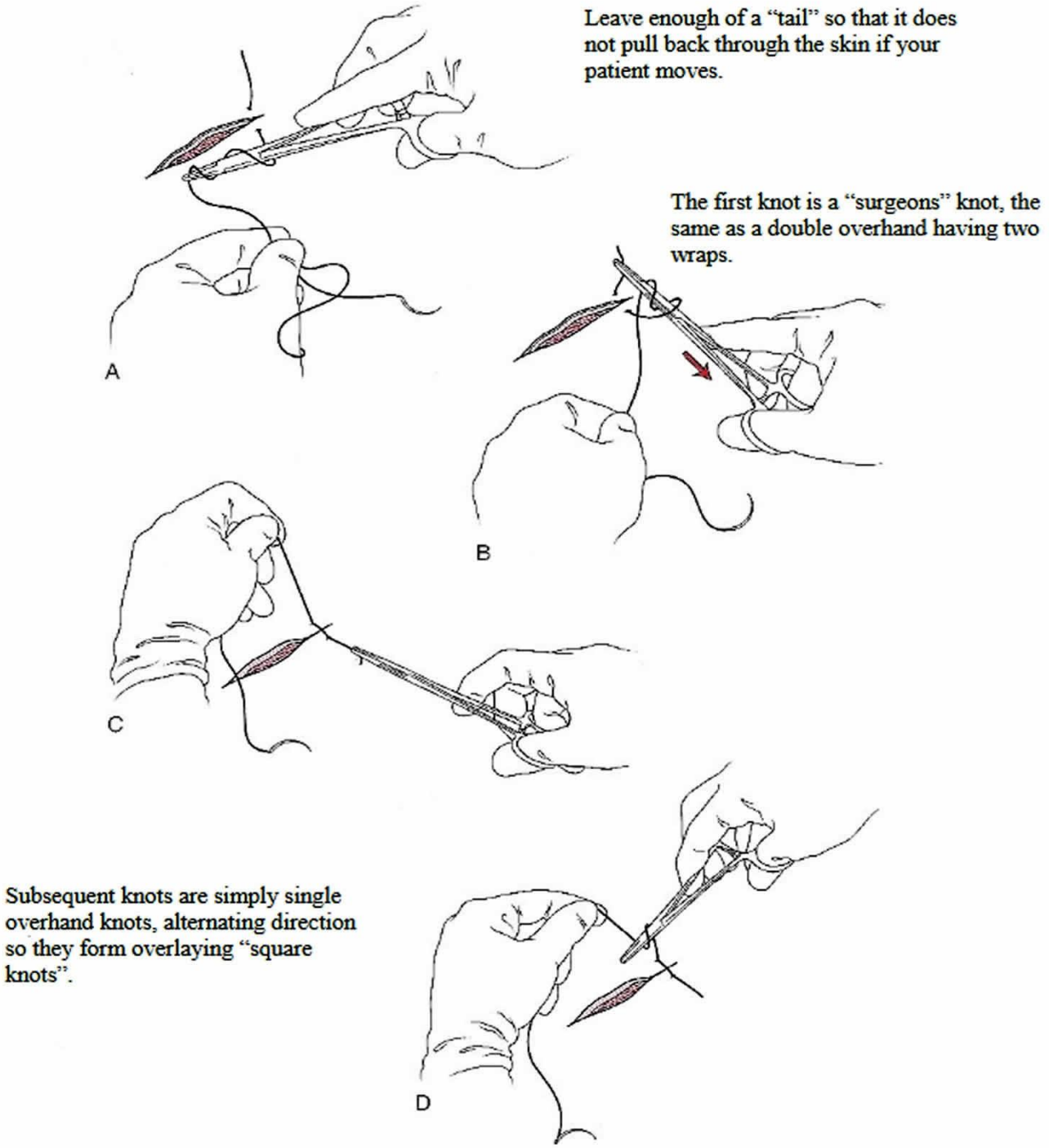
We shall look at three types of suture – the interrupted suture, the continuous suture, and the mattress suture

Interrupted suture

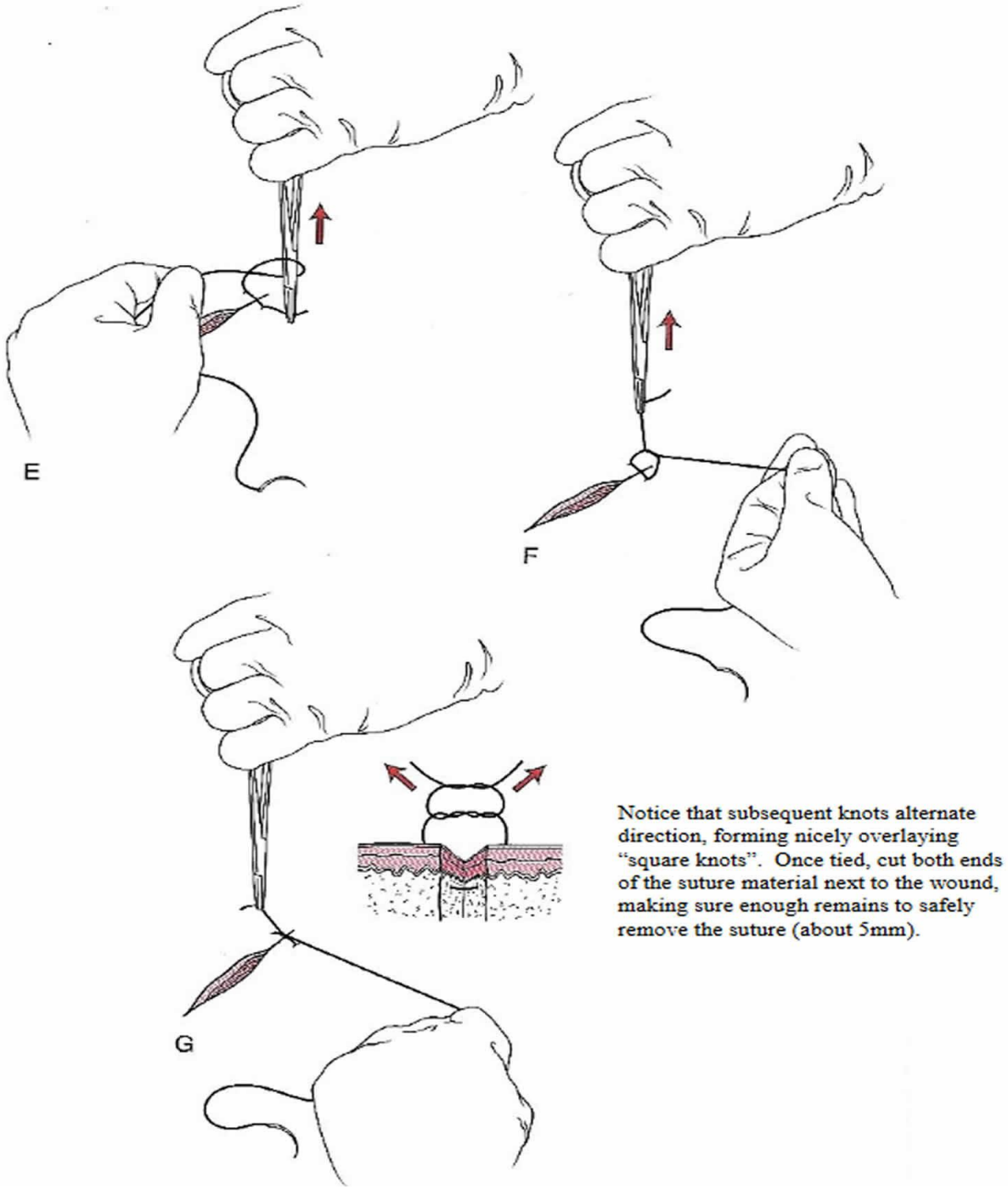
The **interrupted suture** is the most commonly used technique in wound closure. Its name is derived from the fact that the individual stitches are not connected.

Sutures performed with this technique have the advantage of being easy to place and have a **high tensile strength**. In addition, **individual sutures can be removed** (e.g in cases of infection) without jeopardising the closure.

Simple interrupted suture



Simple interrupted suture



Interrupted suture

However, they require a relatively **long time** to be placed and, as each suture requires its own knot, are at a greater risk of inducing **infection**.

Procedure

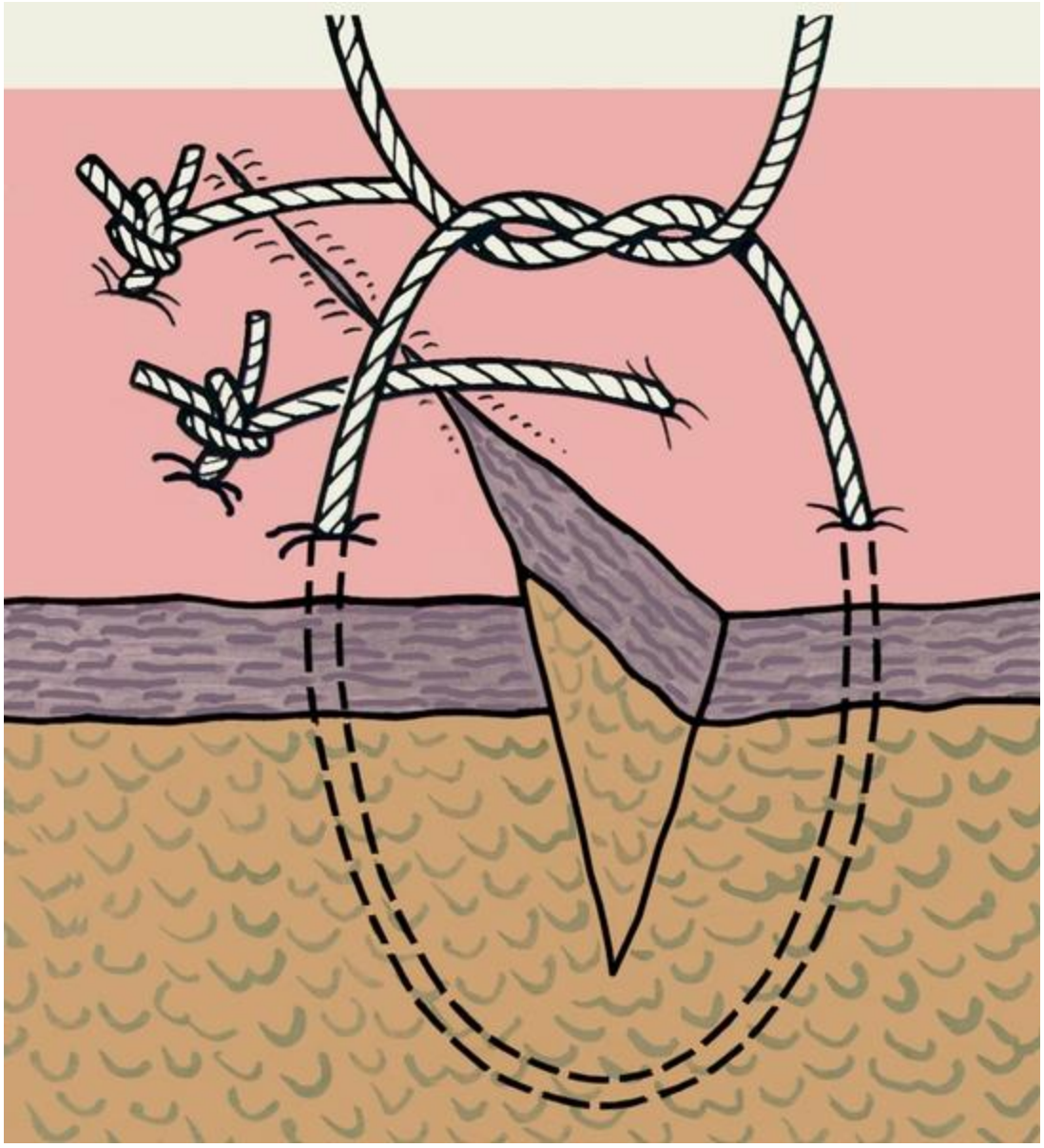
- Start in the middle of the wound, place sutures at 1cm intervals until wound is approximated without tension.
- For each suture, grasp and evert the skin edge (gently with the non-dominant hand).

Interrupted suture

Procedure (continued)

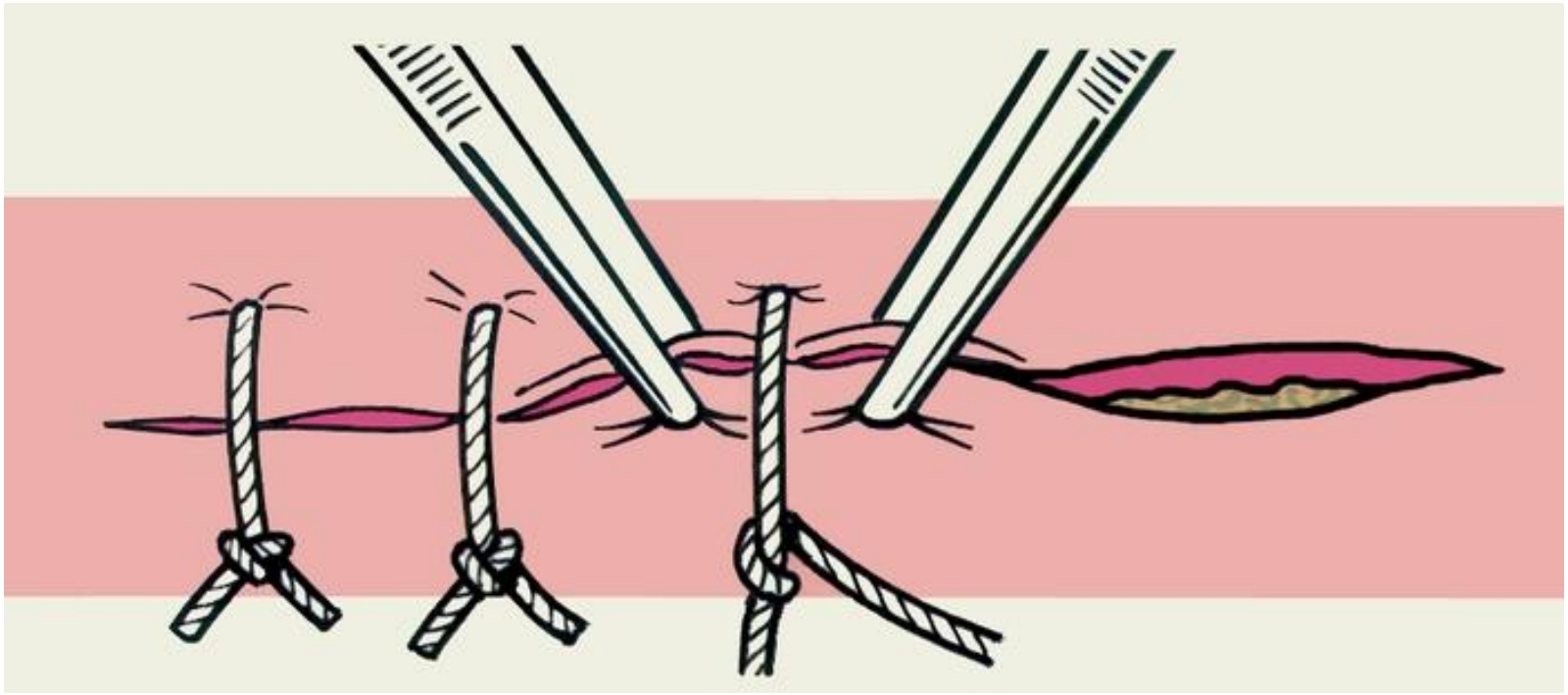
- Pronate the dominant hand so that the needle will pierce perpendicular to the skin and drive the needle through the skin by supinating the hand before picking up the needle (2/3 from the tip) with the needle holders. A no touch needle technique is important, reducing sharps injury and infection risk

Interrupted Suture



Schematic representation of applying a simple nodular (**interrupted**) suture to a linear skin wound

Interrupted suture



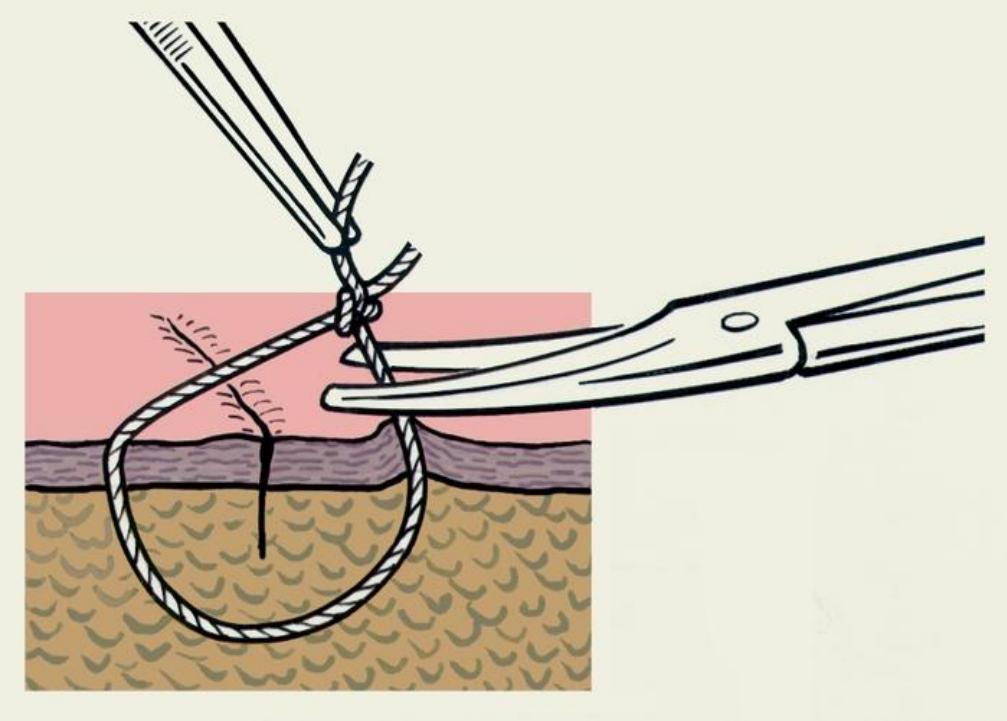
Schematic representation of adaptation of the edges of a skin wound with tweezers when applying a simple **interrupted** suture

Interrupted suture

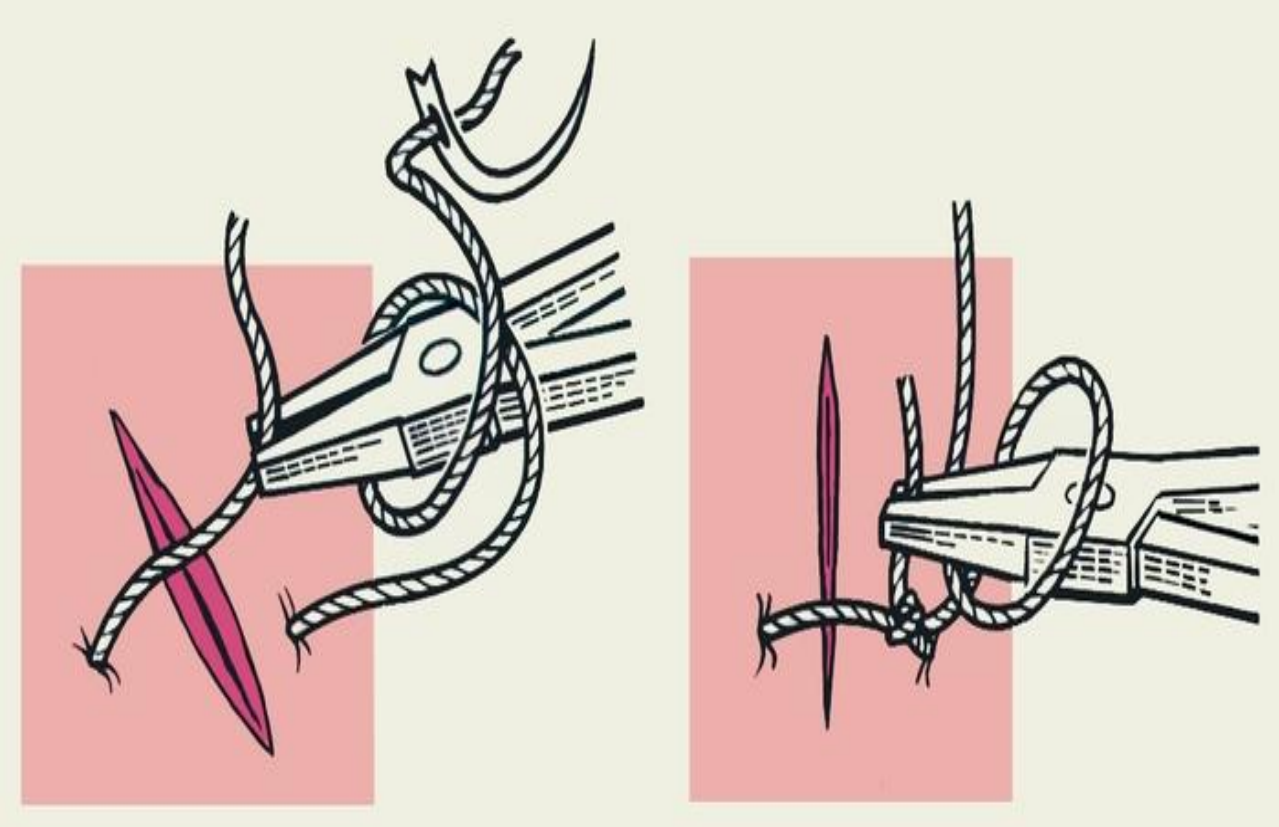
Procedure (continued)

- Finish by carefully gathering the thread to create a long thread (with needle) and short thread, before performing a hand or instrument tie.
- Repeat with separate sutures to close the wound.

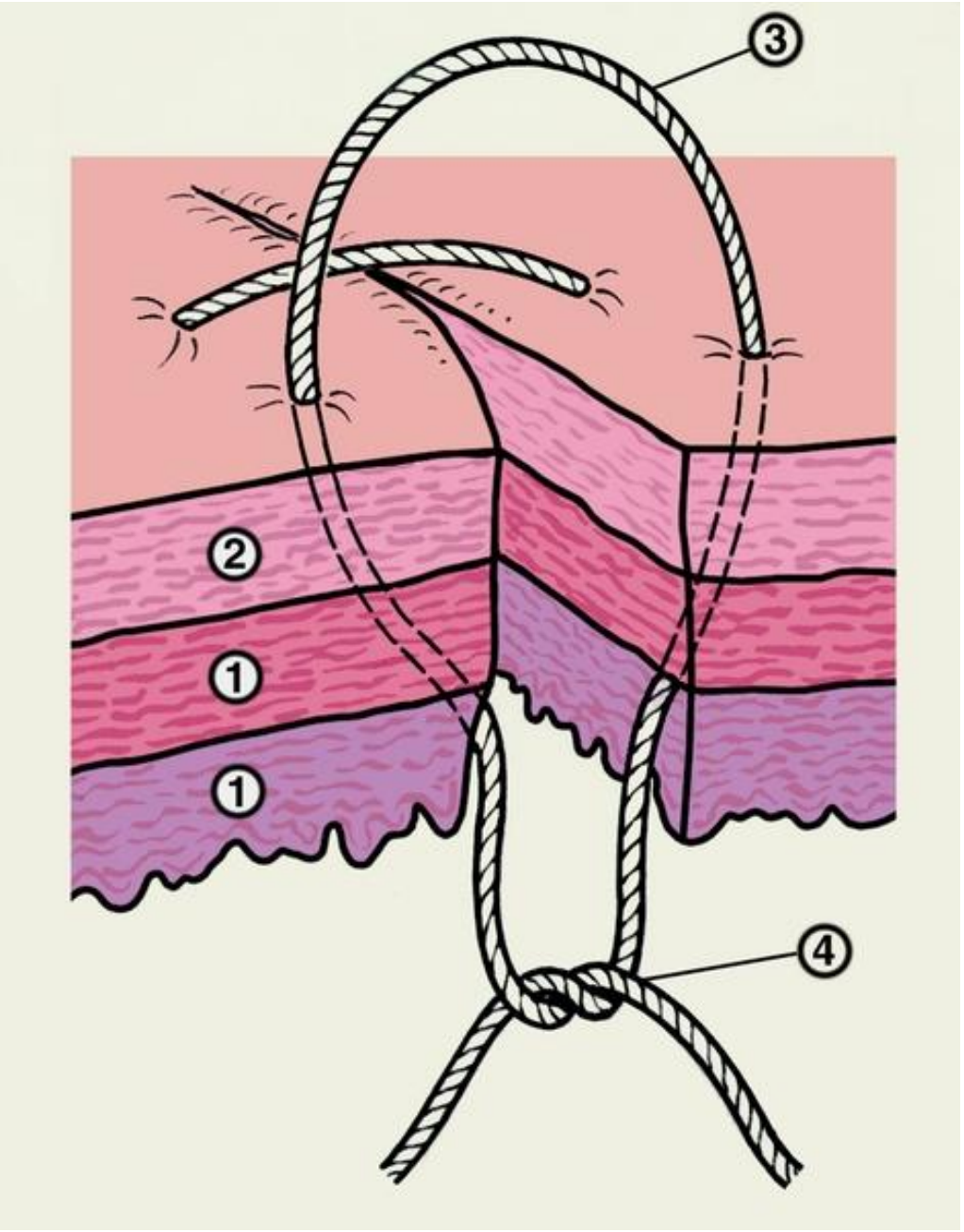
Interrupted suture



Schematic representation of the stage of removing of simple **interrupted** suture: pulling the node to the surface under-the-skin section of the thread is displayed, which is crossed with scissors.



Schematic representation of the instrumental (apodactyl) method of tying a surgical knot: a - after pricking the needle long end of the thread wrapped around the needle holder, which captures the short end of the thread; b — after tightening the first loop the long end of the thread wrapped around the needle holder in the opposite direction.



Schematic representation of a Pirogov — Mateshuk screw-in suture imposed on the intestinal wall:

1 — mucosa and muscle layer of the bowel wall;

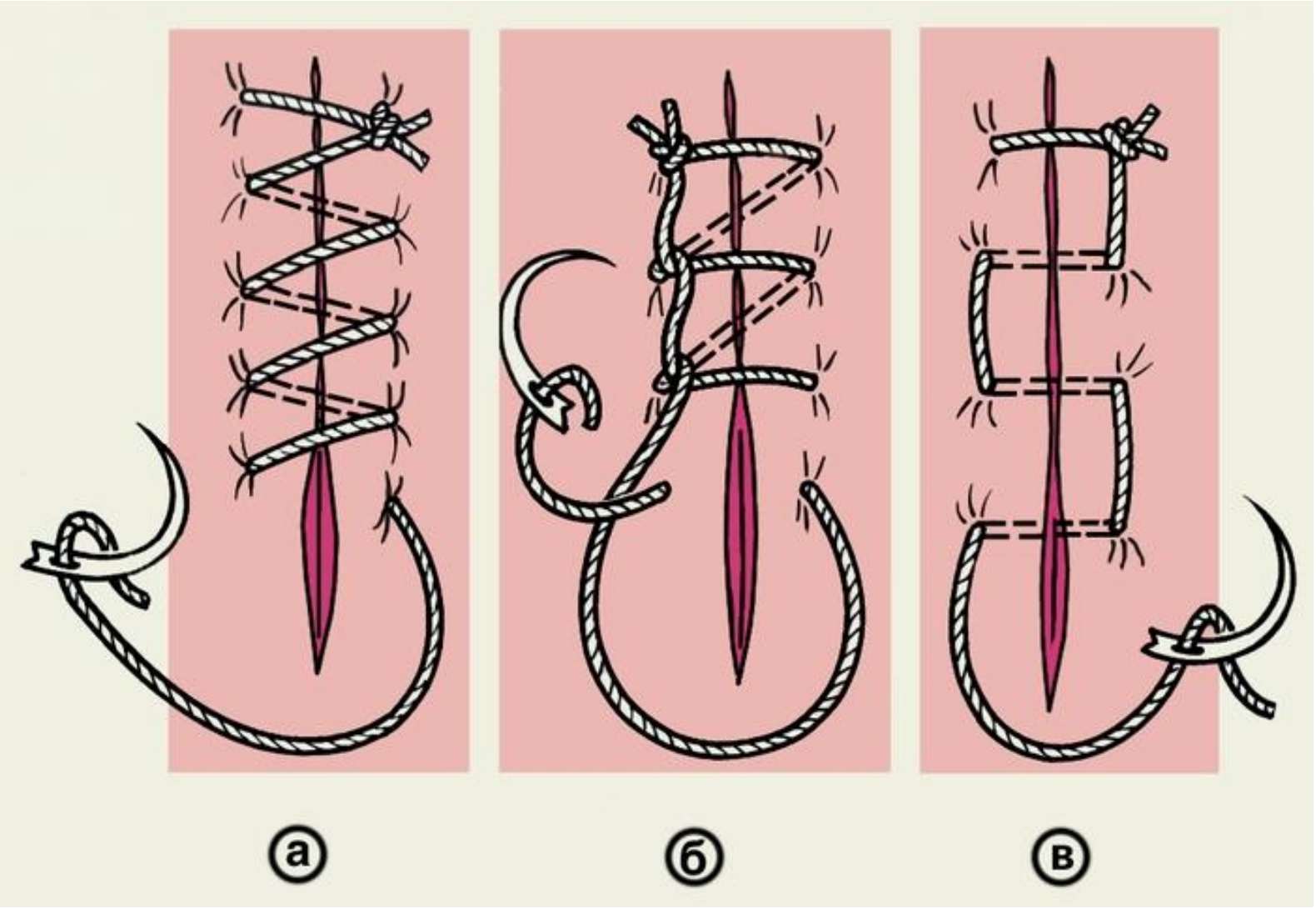
2 — serous membrane;

3 — suture thread is drawn through the serous and muscular sheath;

4 — knot tied from the mucosa.

Continuous suture

- In the **continuous suture**, the stitches are **connected along the wound**. This technique tends to be **faster**, particularly for long wounds. However, the wound is at **greater risk of dehiscence** if the suture material breaks.



Schematic representation of a simple (linear) continuous wrap suture and its variants: a-simple wrap suture; b — Multanovsky wrap suture; в -mattress suture.

Continuous suture

Procedure

- Start at the wound edge and work along the wound (traditionally this is done working towards yourself).
- For each suture, grasp and evert the skin edge (gently with the non-dominant hand).
- Pronate the dominant hand so that the needle will pierce perpendicular to the skin and drive the needle through the skin by supinating the hand (using the curve of the needle) before picking up the needle (2/3 from the tip) with the needle holders. A no touch needle technique is important, reducing sharps injury and infection risk.

Continuous suture

Procedure(continued)

- Place each suture as above, at 1cm intervals, until wound is approximated without tension. Carry this on along the wound.
- Finish by carefully gathering the thread to create a long thread (with needle) and short thread before performing a hand tie or instrument tie.

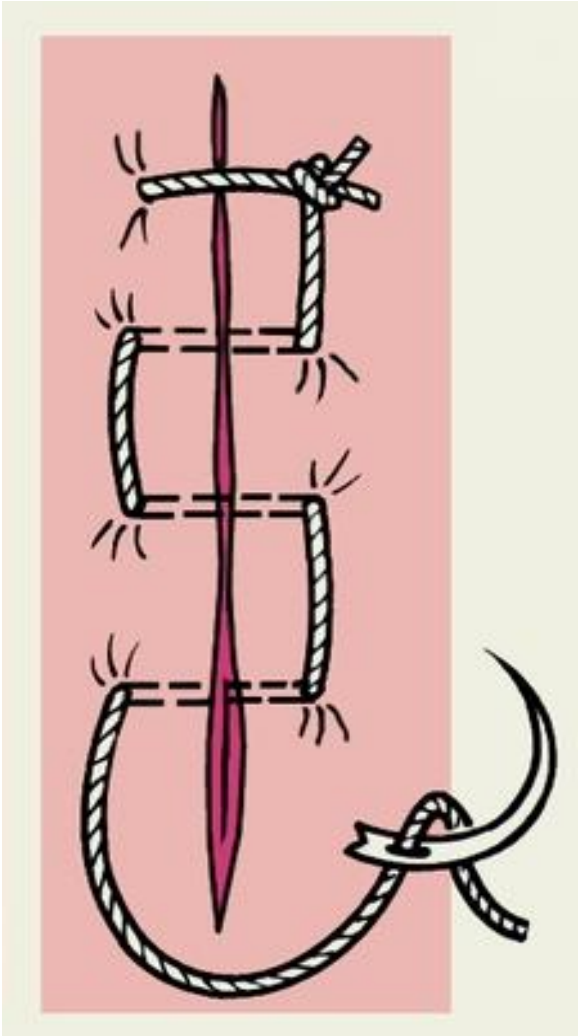
Note: care should be taken to apply the correct amount of tension to the suture material – if too much the skin becomes strangulated, if too little the wound edges may not be opposed correctly.

Mattress suture

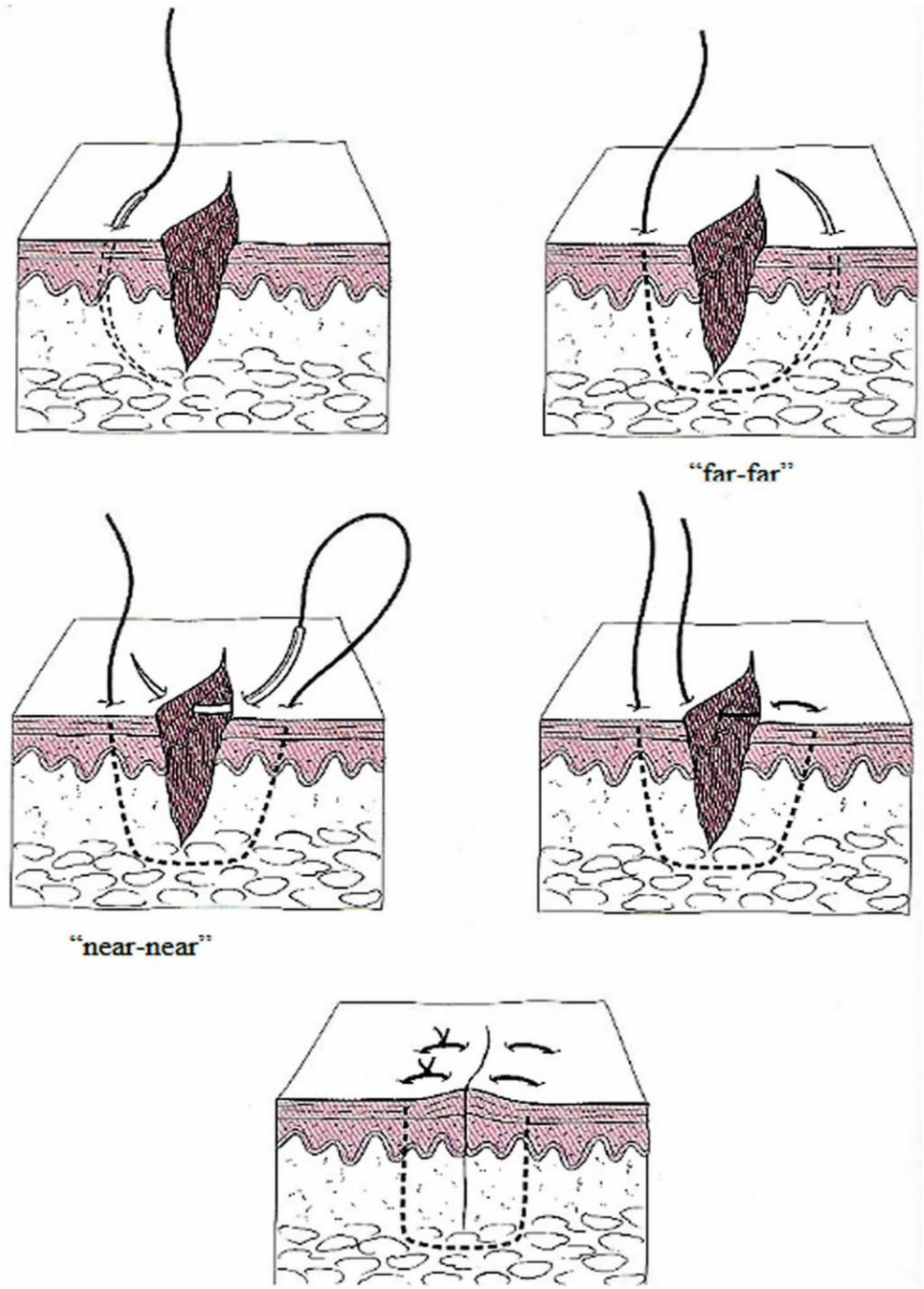
- The **mattress sutures**, both horizontal and vertical, are one of the most commonly used methods for skin closure. Mattress sutures are used, especially when skin edges, must be **closed under tension**, as they achieve good **skin eversion** (which aids wound healing and produces less prominent scaring).

Mattress suture

- This type of suture tends to be performed using **non-absorbable suture material**, with the sutures removed 10-14 days on average after wound closure (however, typically less than this for closures on the head and neck).



Vertical mattress suture



Vertical mattress suture

The vertical mattress suture is ideal for equalizing high-tension forces across a wound edge. A vertical mattress suture is especially useful in maximizing wound eversion, reducing dead space, and minimizing tension across the wound. The vertical mattress sutures are also helpful in areas where wound edge approximation and proper “tenting” is difficult. These can be intermixed with simple interrupted sutures and removed earlier to prevent scarring.

Vertical mattress suture

A helpful mnemonic is "**far-far … near-near**" meaning that you begin your first suture further away from the wound margin, and aim further away on your follow-through. The second pass through the tissue follows a similar tract, but closer (near-near) to the wound margin.

One of the disadvantages of the vertical mattress suture is crosshatching. The risk of crosshatching is greater because of increased tension across the wound and the four entry and exit points of the stitch in the skin.

Horizontal mattress suture

The horizontal mattress suture is useful for wounds under high tension because it provides strength and wound eversion. This suture may also be used as a stay stitch for temporary approximation of wound edges, allowing placement of simple interrupted or subcuticular stitches. The temporary stitches are removed after the tension is evenly distributed across the wound.

Horizontal mattress suture

Horizontal mattress sutures may be left in place for a few days if wound tension persists after placement of the remaining stitches. In areas of extremely high tension at risk for dehiscence, horizontal mattress sutures may be left in place even after removal of the superficial skin sutures. However, they have a high risk of producing suture marks if left in place for longer than 7 days.

Mattress suture

Procedure

- Grasp the wound edge with the forceps.
- Drive the needle through the skin, using the needle holder, around 4-8mm away from the wound edge, passing the suture deep through the dermis.
- Pick up the needle with the forceps at the wound edge, before reloading the needle onto the needle holder.

Mattress suture

Procedure (continued)

- Grasp the opposing wound edge with the forceps, drive the needle deep through the other side of the wound, piercing the skin to re-emerge around 4-8mm away from the wound on the opposite side.
- Backwards load your needle in your needle holder.
- Grasp the second wound edge again with the forceps and drive the needle through the skin, in vertical alignment with the other puncture site, around 1-2mm away from the wound edge. This near placement should occur at a shallow depth and should pass though the upper dermis.

Mattress suture

Procedure (continued)

- Pick up the needle with the forceps at the wound edge, before reloading the needle onto the needle holder.
- Grasp the opposing wound edge with the forceps, drive the needle deep through the other side of the wound (also in the upper dermis layer), piercing the skin to re-emerge around 1-2mm away from the wound on the opposite side (also in vertical alignment with the other puncture site).
- Gently pull the suture to achieve the desired skin tension, as the wound edges close.
- Finish by performing a hand tie or instrument tie.