

# **SURGICAL KNOTS AND SUTURES**

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## **Learning objectives**

### ***What you should know***

- What is a surgical suture
- What are the main types of surgical sutures
- What are the materials required for a suture
- How to use a needle holder
- How to assess whether surgical suturing and knot tying have been correctly performed
- How and when to remove sutures

### ***What you should do***

- Choose the materials required for a surgical suture
- Open the package of the swaged needle and the package of the scalpel blade
- Thread the suture on the needle and mount the needle on the needle holder
- Apply interrupted sutures
- Apply continuous sutures
- Tie a surgical knot
- Maintain the sterility of materials during the entire procedure
- Remove sutures
- Mount and dismount a blade to / from the scalpel handle
- Throw the needle and the scalpel blade to the container for sharp objects

## **Definition**

*A surgical suture* is used to bring and maintain together different anatomical structures, injured by accidental or deliberately induced wounds during surgery.

Sutures are applied to all anatomical structures, and to designate the sutures of various body parts, the *rrhaphy* suffix is used, preceded by the name of the organ concerned (myorrhaphy, neurorrhaphy, arteriorrhaphy, tenorrhaphy, etc.).

***Removal of sutures*** is performed at variable time intervals from application, depending on the vascularization of the region

involved. In the *cervicofacial region* and the hairy skin of the head, sutures are removed at 5 postoperative days. In the *limbs*, sutures can be removed at 7-10 days from application, and in the *sole*, at 10-14 days. *Inflammation* or *suppuration of the wound* will prolong the period until suture removal, and so will *associated disorders* known to delay cicatrization (neoplasms, diabetes mellitus, anemia or hypoproteinemia).

Depending on the time period elapsed from the occurrence of a wound to suturing, the following are described:

- *Primary suture* – applied within 6-12 hours of induction of a wound.
- *Delayed primary suture* – applied 2-3 days after occurrence of a usually complicated wound, with a high susceptibility to infection, when bacteriological examination is negative.
- *Secondary suture* – applied in the case of an infected wound, in which the septic process has been eradicated and granulation has occurred.

#### **Indications of surgical suturing**

- Cutting wounds – within 6-12 hours of injury
- Contusion wounds – within 6-12 hours of injury, if these are not contaminated and if the wound edge tissue allows it (depending on tissue vitality and lack of substance)
- Surgical wounds

#### **Contraindications of surgical suturing**

- Infected wounds
- Complicated wounds, with a high susceptibility to infection

#### **Elements of anatomy and physiology**

A good vascularization of the suture site is extremely important for correct skin healing.

Regardless of the nature of the suture thread and the anatomical region in which the suture is applied, its action is always temporary, the essential and long lasting element being the cicatrization function of each region. Suturing only favors the healing process (cicatrization). Suturing tends to suppress the retraction of elastic fibers in order to maintain the contact of the wound sides.

## **Materials required for surgical suturing**

- Antiseptic solutions
- Needle holder
- Surgical needles
- Suture threads
- Surgical hemostat
- Péan's forceps
- Mosquito forceps
- Straight or curved scissors
- Sterile compresses

## **Suture threads**

Suture threads are classified into:

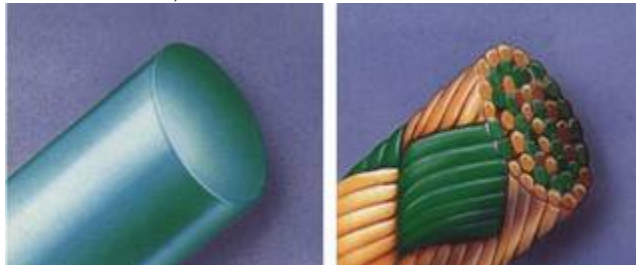
- Resorbable and non-resorbable
  - Resorbable suture threads are enzymatically lysed and lose their breaking resistance in a 60-day period<sup>1</sup>
  - Non-resorbable suture threads are resistant to degradation by tissue enzymes and maintain their integrity and resistance for months or years<sup>2</sup>
- Natural and synthetic
  - Natural suture threads are organic (of vegetal origin) or inorganic (steel sutures)
  - Synthetic suture threads are obtained by chemical synthesis
- Monofilament and braided (multifilament) sutures
  - Monofilament sutures are formed by a single thread; their knotting is usually more difficult, they require a great number of knots for secure tying, but are not impregnated with biological fluids (as a result they do not form bacterial colonies around them)
  - Multifilament sutures are formed by braiding of thin threads; they are easier to handle, allow more secure knots, but are impregnated with fluids by capillarity (higher risk of bacterial colonization)

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<sup>1</sup> Examples of resorbable sutures: catgut (which is currently used only in veterinary surgery) is the only resorbable suture of natural origin; the other resorbable suture threads are synthetic: polyglycolic acid, polydioxanone, poliglecaprone, polytrimethylene carbonate.

<sup>2</sup> Examples of non-resorbable sutures: silk, cotton, linen or steel sutures are of natural origin; other sutures are synthetic: nylon, polypropylene, polyester.

- Unswaged (without a needle) and swaged (attached to a disposable needle)



**Figure 1.** Monofilament and multifilament sutures

In the case of swaged sutures, the following information is marked on the package:

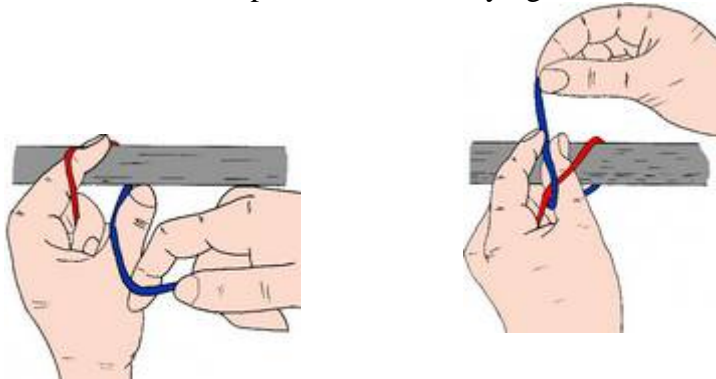
- Name of the commercial product
- Substance of which the suture is made
- Type of suture
  - Resorbable or non-resorbable
  - Monofilament or multifilament
- Length of the suture
  - Thickness of the suture on the USP (United States Pharmacopeia) scale
- Information about the needle (type, size and shape of the needle)

### **Surgical knot technique**

#### ***Tying a surgical knot***

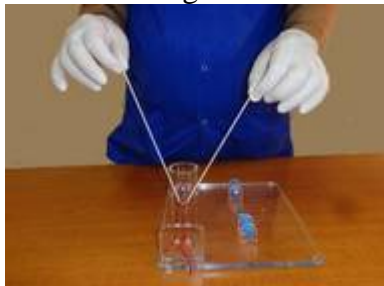
- A knot can be tied with either hand.
- The sutures are kept in moderate tension.
- The sutures are crossed.
- The distal suture thread is held between the third and fourth fingers, and the proximal suture thread is held between the thumb and the index.
- The free thumb passes laterally to the other thread and returns laterally to the initial thread, creating a loop through which the thumb is inserted.
- The lateral thread is applied to the palmar surface of the thumb and is held between the thumb and the index, while the other hand is freed.
- Through a rotation movement, the thumb and the index that hold the thread pass it through the loop, then the free hand regrips the thread.

- If this movement of grasping the free thread between the thumb and the index is repeated, as well as the rotation movement repassing the thread through the loop, a double knot is tied.
- The knot is secured and guided with the index.
- At least 3 knots are placed for secure tying.



**Figure 2.** Surgical knot

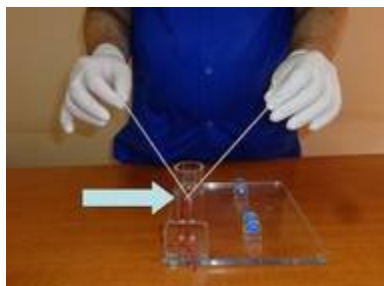
A variant of a surgical knot tied with the left hand is shown in the figure below:



**Starting position.** Each thread is held between the thumb and the index.



**Crossing the suture threads.** The thread in the right hand is passed to the left hand (anterior, distal to the operator). The thread in the left hand is passed to the right (posterior, proximal to the operator).



**Crossed suture threads.** The thread in the right hand is towards the operator, the thread in the left hand is on the side opposite to the operator.



**Securing the suture in the left hand.** The left hand rotates from lateral to medial so that the third-fifth fingers are placed along the thread.



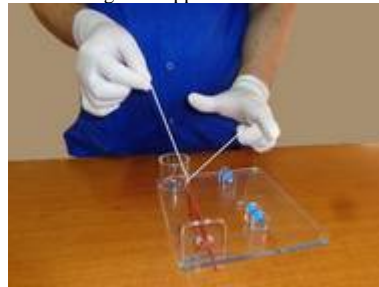
**Securing the suture in the left hand.** The thread is grasped with the third-fifth fingers; the thread is immediately released from the first-second fingers, which remain free.



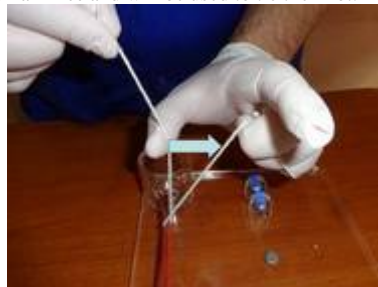
**Securing the suture in the left hand.** With the thread held with the third-fifth fingers and the first-second fingers of the free left hand, the hand rotates so that the volar surface of the third-fifth fingers is applied on the thread.



**Securing the suture in the left hand.** The thread is grasped with the middle finger of the left hand. In this way, the thread is firmly secured in the left hand. The thumb and index remain free and will be used to tie the knot.



**Tying the knot.** Starting position: the right thread is held between the index and the thumb; the left thread is secured with the third-fifth fingers, and the thumb and index of the left hand are free.



The right thread is grasped with the thumb of the left hand. The thread in the right hand is drawn with the thumb of the left hand.



The thumb (with the right thread over it) passes behind the left thread. In this way, a loop with the two threads is made.



The thread in the right hand is applied over the pulp of the left thumb.



The index is placed on the thread; the thread is secured between the thumb and the index.



The thread held between the thumb and the index is passed through the loop.



The thread passed through the loop is picked up with the right hand.



**Guiding the knot.** The two threads are maintained tensioned; for the thread in the left hand, tension is maintained using the thumb.



The left hand rotates so that the index of the left hand is placed above the knot.



The index of the left hand is placed on the thread in the left hand. In this way, tension in both threads can be controlled, so that they are equally tense.



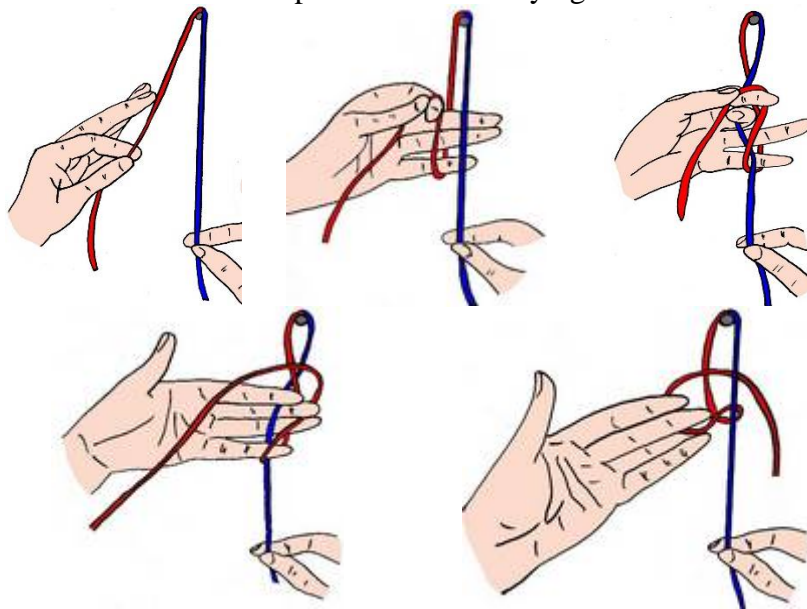
**Securing the knot.** Both threads are equally drawn against each other, without pulling the ligated structure. The threads are maintained equally tense for the next knot.

**Figure 3.** “Square” knot technique: securing the thread in the left hand; tying the knot; guiding and securing the knot.

### *Tying a gynecological knot*

- The knot can be tied with either hand.
- The sutures are kept in moderate tension.
- The sutures are crossed.
- Both threads are held between the thumb and the index.
- The proximal thread is placed in the palm through the lateral side, so that the two threads are subsequently positioned parallel to each other.

- The third finger of the hand that holds the threads in the palm is passed over the distal thread and under the proximal thread.
- At this point, the thread held between the thumb and the index of the hand that keeps the threads in the palm is released, while the third and fourth fingers of this hand hold this thread.
- The third and fourth fingers with the thread between them are withdrawn through the created loop.
- Then, this thread is regrasped between the thumb and the index.
- The knot is secured and guided with the index finger.
- At least 3 knots are placed for secure tying.

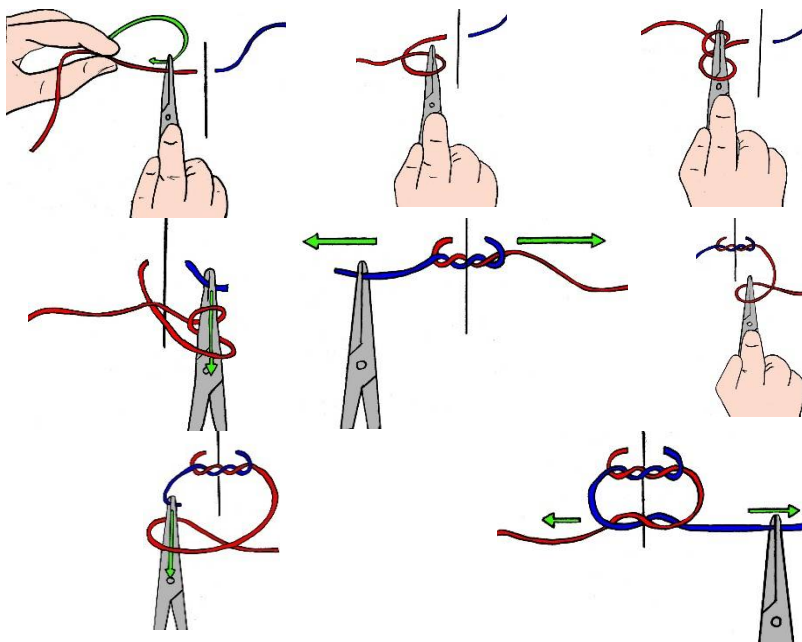


**Figure 4.** Gynecological knot technique

#### ***Tying a knot with a Péan's forceps***

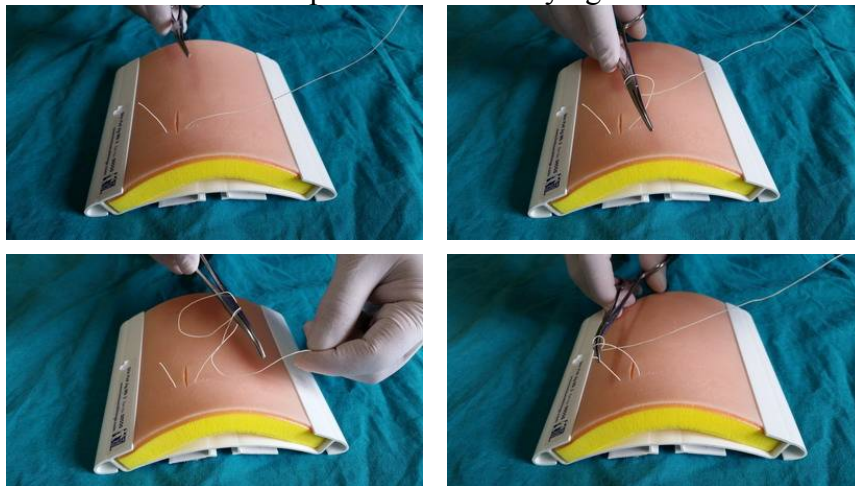
- One end of the thread is held between the thumb and the index, the other hand being free.
- NO crossing of the suture threads is performed!
- The thread is rotated once or twice (double knot) around the needle holder, thus creating a loop.

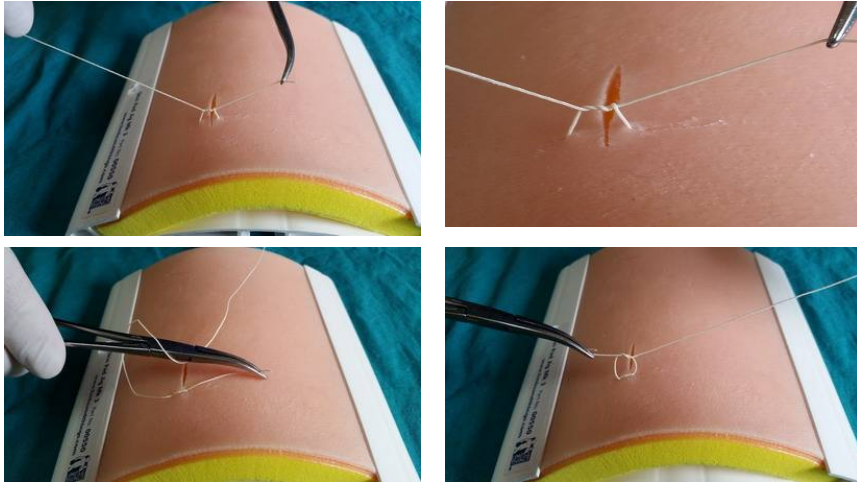




**Figure 5.** Knot with a Péan's forceps

- With the needle holder passed through the loop, the other end of the thread is grasped.
- The end held by the needle holder is drawn through the loop.
- The knot is secured by crossing the threads at 180°, and the thread is guided with the index finger.
- At least 3 knots are placed for secure tying.



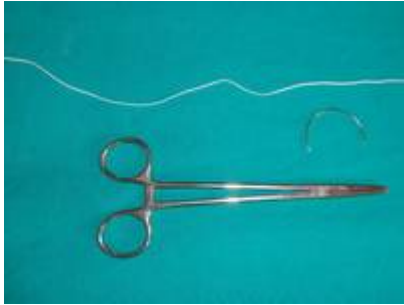


**Figure 6.** Knot with a Péan's forceps

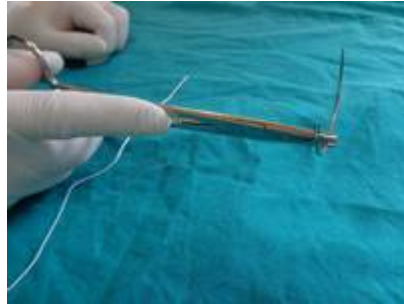
### **Surgical suture technique**

- The identity of the patient undergoing wound suturing is checked.
- Asepsis of the surgical field is performed:
  - Hair shaving in the region concerned;
  - Application of antiseptic solutions to the skin;
  - Isolation of the region with sterile drapes.
- Anesthesia:
  - Local or regional with lidocaine 1%;
  - For more extensive or deeper lesions, spinal anesthesia or general anesthesia is preferred.
- The surgeon is positioned on the side of the lesion, facing an assistant.
- The placement of the suture threads, as well as the correct approximation of anatomical layers will ensure adequate and rapid cicatrization.
- The needle should puncture the wound edges at the same distance, and the successive suture threads should be equidistant on both sides of the wound.
- A suture always starts at one end of the wound.
- The needle is mounted on the needle holder at 1/2 or 2/3 from its tip.
- The suture thread is attached to the needle by holding in the closed palm both the thread and the needle holder, after which the thread is passed under the needle and is directed towards

the eye of the needle, through which it is inserted by counterpressure, with the thumb placed on the needle holder.



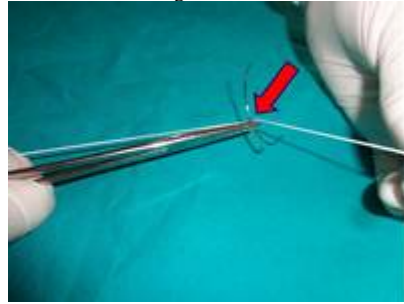
Materials used: needle holder, Hagedorn needle, suture



The needle is mounted on the needle holder either at half or at two-thirds of its length, measured from the tip. The position depends on the size and the design of the needle.



The thread and the needle holder are held with the same hand. The other hand stretches the thread along the needle holder.



The thread is rotated around the needle holder, with the needle mounting site as a point of support.



The thread is placed on the eye of the needle.



The thread is driven with the thumb into the eye of the needle, through the blades of the needle holder.

**Figure 7.** Threading a Hagedorn needle

- The surgical hemostat is held in the left hand like a pencil, between the thumb and the third finger, while the index performs closing and opening movements.

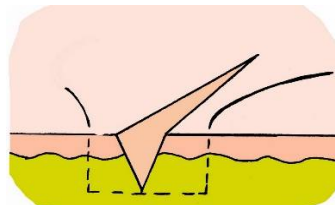
- Using the surgical hemostat, the wound edges are drawn to achieve counterpressure to the needle and to visualize the depth of the wound.
- The needle will also be grasped with the surgical hemostat after its penetration through the edge of the wound until its regripping with the needle holder after changing the hand position from supination to pronation, so that the needle is always manipulated with its curvature through tissues.
- The needle holder is held in the right hand, with the thumb and the fourth finger, the index, respectively, on the arms of the needle holder.
- The needle holder can be manipulated either from right to left or in the opposite (reverse) direction in certain types of sutures (Blair-Donatti).
- The needle must penetrate perpendicular to the wound edges, through all skin layers.
- Both wound edges can be penetrated with a single movement, or they can be penetrated separately.

### **Types of sutures**

Suturing can be performed with separate threads or with continuous threads (overlock). The most frequently used types of sutures are briefly presented below.

#### ***Interrupted suture***

- The needle is introduced in both wound edges.
- A surgical knot is tied (at least 3 knots).
- Both threads are cut at 1.5-2 cm above the knot, and this procedure is repeated, several Suture threads being applied until the wound is closed.



**Figure 8.** Scheme of simple interrupted suture



Suture in a learning model



The edge of the wound is grasped with a surgical hemostat.



The needle is introduced perpendicular, then it is advanced following the needle curvature.



The needle is passed through the opposite side of the wound; the needle puncture should be the same on the two edges.



With the needle grasped by the needle holder, tissues are elevated. The 2 edges of the wound are grasped with the surgical hemostat (for approximation<sup>3</sup>) and the needle is removed.



The assistant ties the suture (at least 3 knots). Until completion of the first knot, the wound edges are held together by the surgical hemostat.

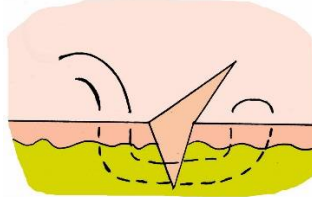
**Figure 9.** Simple interrupted suture

<sup>3</sup> Approximation means the correct apposition of the planes: epidermis to epidermis, dermis to dermis.



### ***Vertical mattress suture (Blair-Donatti suture)***

- Donatti suture ensures a good approximation of the wound edges.
- The needle is introduced into both edges of the wound from right to left, leaving a greater distance between these points.
- The position of the needle is changed, the needle holder being manipulated in the opposite (reverse) direction, and the needle only penetrates the dermis on the same suture line, again in both edges of the wound, between the initial points.
- A surgical knot is tied (at least 3 knots), which will be placed on one side of the wound, adjacent to the suture line.
- Both threads are cut at 1.5-2 cm above the knot, and this procedure is repeated, several suture threads being applied until the wound is closed.



**Figure 10.** Scheme of Donatti suture



Blair-Donatti suture in a learning model



The needle and suture are passed through the wound edges, like in the case of simple suturing.



The needle is rotated by 180° and is placed in reverse position in the needle holder. The needle penetrates very close to the wound edge and exits through the dermis.

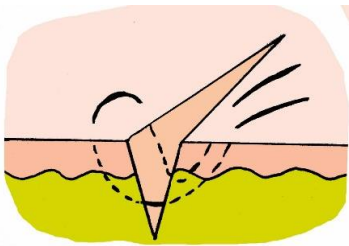


On the opposite side, the needle penetrates the dermis and exits through the epidermis, very close to the wound edge.

**Figure 11.** Blair-Donatti suture

### ***Horizontal mattress suture***

- The needle is introduced into both edges of the wound from right to left.
- The position of the needle is changed, the needle holder being manipulated in the opposite (reverse) direction, and the needle penetrates laterally at 0.5-1 cm from the initial points, again in both edges of the wound.
- A surgical knot is tied (at least 3 knots), which will be placed on one side of the wound.
- Both threads are cut at 1.5-2 cm above the knot, and this procedure is repeated, several suture threads being applied until the wound is closed.



**Figure 12.** U-shaped suture

### ***Simple running suture (overlock)***

- The needle is introduced into both edges of the wound.
- A surgical knot is tied around the hemostat (at least 3 knots).
- The thread is NOT cut!
- The same thread is used by introducing the needle from one side of the wound to the other, maintaining this alternation up to the end of the wound.
- The assistant's task is to keep the thread tensioned, otherwise the suture will not be tight. The last suturing step will use the last loop as a partner of the suture thread to tie the surgical knot.
- The threads are cut at 1.5-2 cm above the knot.



**Figure 13.** Scheme of simple continuous suture



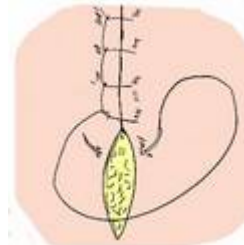
**Figure 14.** Simple overlock for suturing of subcutaneous adipose tissue (lining); the thread is tensioned by the assistant



**Figure 15.** Finishing the overlock: the last loop is used as a single thread; the knot is tied between the end of the thread and this last loop.

### ***Running interlocking suture (Reverdin-Ford suture)***

- The needle is introduced into both edges of the wound.
- A surgical knot is tied around the hemostat (at least 3 knots).
- The thread is NOT cut!
- The same thread is used by introducing the needle from one side of the wound to the Other, maintaining this alternation up to the end of the wound.
- The assistant's task is to keep the thread tensioned, otherwise the suture will not be tight.
- The first and the last steps of the continuous suture are simple continuous suture steps.
- The rest of the suture steps involve the introduction of the needle into both edges of the wound, followed by the exit of the needle through the anterior loop, generating in this way a continuous Interlocking suture appearance.
- The last suture step will use the last loop as a partner of the suture thread to tie the surgical knot.
- The threads are cut at 1.5-2 cm above the knot

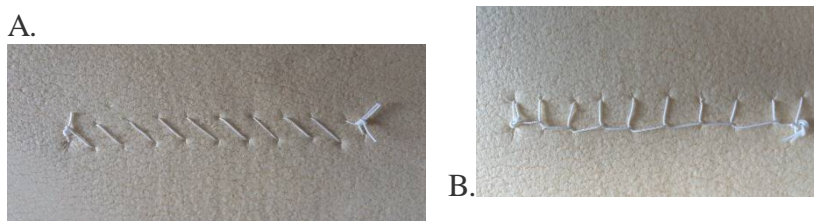


**Figure 16.** Scheme of continuous interlocking suture



**Figure 17.** Continuous interlocking suture. The assistant tensions the thread and holds a loop in the suturing direction





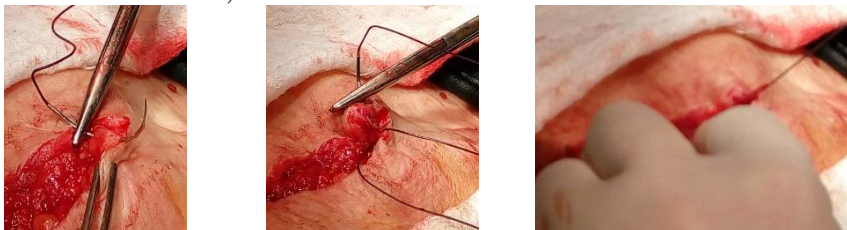
**Figure 18.** Continuous (overlock) suture in a learning model. A. Simple continuous suture; B. Continuous interlocking suture

### *Subcuticular suture*

In the case of intradermal suturing, the thread passes only through the dermis, not the epidermis. A non-resorbable monofilament continuous suture thread is most frequently used; resorbable interrupted sutures, with the knot buried under the dermis, are more rarely used.

### *Interrupted intradermal suture*

- Thin resorbable suture threads are used<sup>4</sup>
- The needle is introduced from down upwards, right below the lower edge of the dermis, and is extracted right below the epidermis
- On the opposite side, the needle enters the dermis, right below the epidermis, and exits below the lower edge of the dermis
- A knot is tied, which remains under the dermis



**Figure 19.** Interrupted intradermal suture

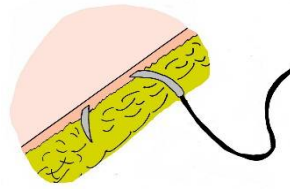
### *Continuous intradermal suture*

- The needle is introduced at 1 cm from the edge of the wound, in longitudinal direction, and is extracted from the wound.
- On the end of the thread outside the wound, 3 knots (loops) are tied.

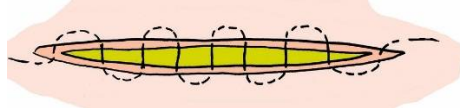
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<sup>4</sup> 3-0 or 4-0 suture threads

- The knot is checked to make sure that it cannot penetrate inside the wound.
- The thread is NOT cut!!!
- The same thread is used by introducing the needle from one side

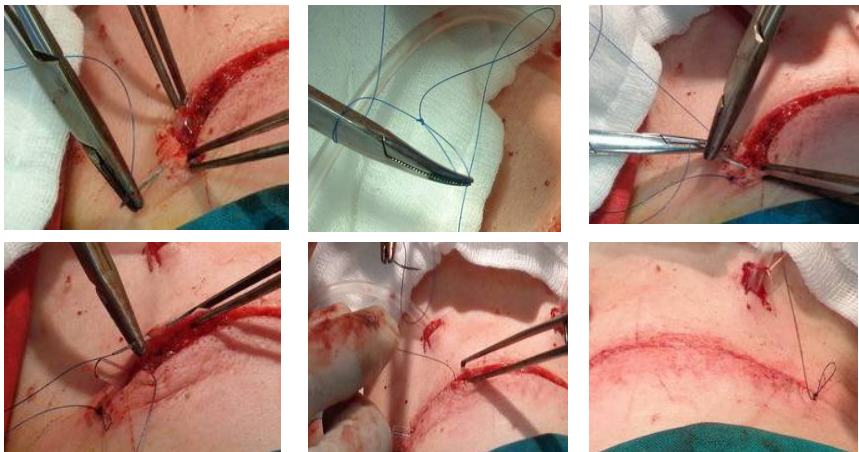


Of the wound to the other only through the dermis, penetrating from inside the



**Figure 20.** Scheme of continuous intradermal suture

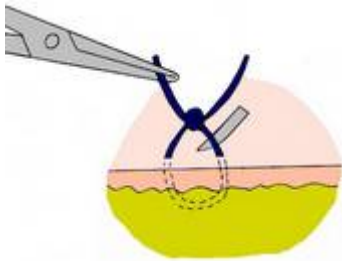
- Wound and maintaining this alternation up to the end of the wound.
- The operator's assistant has the task to maintain the suture thread tensioned, otherwise the suture will not be tight.
- The last suture step will introduce the needle from inside the wound out, in longitudinal direction, at 1 cm distance from the wound.
- On the end of the thread outside the wound, 3 knots (loops) are tied.
- The knot is checked to make sure that it cannot penetrate inside the wound.
- The threads are cut at 1.5-2 cm above the knot.



**Figure 21.** Intradermal suture

### **Suture removal technique**

- The identity of the patient undergoing removal of sutures is checked.
- Cleaning of the wound with antiseptic solutions.
- The surgeon is positioned on the side of the wound.
- The ends of the suture thread are located with a surgical hemostat or a Péan's forceps.
- With a slight traction movement, the surgical knot is exposed.
- The suture thread is cut under the surgical knot with the scalpel blade or scissors.
- The thread is gently pulled until it is removed, while protecting the wound by counterpressure with the hemostat.
- An extremely important rule to follow is that no portion of the exterior suture (which has come into contact with the external environment and implicitly with microorganisms) should penetrate inside the wound (considered a sterile environment).
- Dressing of the wound.



**Figure 22.** Extraction of a suture thread

### **Incidents and accidents of surgical suturing**

- Lipothymia
- Anaphylactic shock to anesthetics
- Hemorrhage on needle puncture, which requires complete and thorough hemostasis
- Injury to vessels, nerves, tendons in underlying spaces
- Devitalization or necrosis of the skin and subcutaneous tissue
- Contamination of the wound due to non-compliance with asepsis rules
- Wound dehiscence as a result of insufficient knot tying, tension in the suture or imperfect approximation
- Suture granuloma

**Assessment / self-assessment form**

Stage / Criterion	Correct	Incorrect
Materials required for surgical suturing		
Asepsis of the surgical field		
Anesthesia		
Mount and dismount a needle and a suture thread		
Handle a needle holder and a surgical hemostat		
Tie a surgical knot (simple and double)		
Tie a gynecological knot		
Tie a knot using a hemostat		
Interrupted suture		
Horizontal mattress suture (U-shaped suture)		
Vertical mattress suture (Blair-Donatti suture)		
Running suture (continuous suture)		
Running (continuous) interlocking suture		
Suticular (intradermal) suture		
Incidents and accidents of surgical suturing		
Removal of suture threads		