A STICH IN TIME

BASICS OF SURGICAL SUTURING

Łukasz Łaziński
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Author:
Łukasz Łaziński
National Coordinator of the „Surgical Workshops” Project
International Association of Medical Students IFMSA-Poland
Medical University of Lodz

Substantive patronage:
prof. Bogusław Antoszewski MD, PhD
Head of the Clinic of Plastic, Reconstructive and Aesthetic Surgery
Medical University of Lodz
Voivodeship consultant in the field of plastic surgery

Substantive consultation:
Piotr Stabryła MD
Clinic of Plastic, Reconstructive and Aesthetic Surgery
Medical University of Lodz

Photographs:
Paulina Talarowska
Warsaw Medical University

Composition and preparation for printing:
Klaudia Zakrzewska

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Dear readers!

This manual was created for the participants of the „Surgical Workshops“ organized by the International Association of Medical Students IFMSA-Poland and for other students of medicine and dental medicine wishing to improve their practical surgical skills. Here you will find the issues covered in the Workshops, and you will be able to expand and consolidate the knowledge acquired during the surgery classes.

The material consists of several chapters: the description of basic surgical instruments, instructions for putting on sterile gloves, rules for skin anesthesia and techniques for putting on and removing sutures. The part devoted to the sutures has been divided in two: basic sutures for those who start to practice surgical suturing and advanced sutures - for those who have already mastered the basic level and want to further expand their knowledge.

The manual has been illustrated with numerous photographs showing each stage of suturing. In the photos pig feet were used, as they are useful training material. When training independently, always keep in mind the health and safety rules, including the use of disposable gloves and caution when working with sharp instruments.

I hope that this manual will meet your expectations and will allow you to put on sutures more efficiently during your future student and professional practice.

Good luck!

Łukasz Łaziński
National Coordinator of the „Surgical Workshops“
Project IFMSA-Poland
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Surgical suturing is a technique of wound dressing known since ancient Egypt several thousand years BC.

On the basis of scientific research and years of observation it is now known that surgical suturing brings about numerous advantages. Main reasons are:

- faster wound healing
- decreased infection risk through reducing the access of the external environment to the inside of the wound
- ensuring the most satisfying cosmetic effect possible

The degree and manner of skin damage can be very diverse depending on the type of traumatic agent. Nevertheless, wound-inducing injury always causes inflammation within it. There are five characteristic features describing the inflammatory process:

- swelling (tumor)
- redness (rubor)
- pain (dolor)
- warming (calor)
- loss of function (functio laesa)

Wound healing can occur through the so-called first intention healing - in cut and uninfected wounds or granulation - in wounds left without medical intervention. First intention healing provides better cosmetic effect and a smaller scar. Granulation brings a greater risk of infection, dysfunction of the surrounding skin and an unsightly scar.

Wound healing is influenced by systemic and local factors. The first group includes genetic factors, individual conditions, age, systemic diseases (diabetes, autoimmune diseases, neoplasms, circulatory insufficiency, immunodeficiency), nutritional status, taking medications (steroids, cytostatics) or cigarette smoking. The second group includes the size and location of the wound, the degree of blood supply, tension within the wound edges, the presence of infection, hematoma or necrosis.

It should be emphasized that the doctor may try to minimize the size of the scar, but is not able to completely eliminate it. The scar is the result of a physiological process of wound healing in the place where the dermis is broken, by replacing it with connective fibrous tissue, less elastic than the skin. Only damage to the epidermis in the form of small abrasions or superficial cuts can heal under the scab without traces of scars.
A set of basic instruments is necessary for surgical suturing (1). They are used to manipulate the needle with the suture. All surgical instruments used for suturing must be sterile.

(1) Basic set of surgical instruments.
From the left: surgical tweezers, anatomical tweezers, scissors, scalpel, Hegar needle holder, Mathieu needle holder.
Needle holder it is an instrument for holding a needle with the suture. It is characterized by multi-stage latches that allow blocking the arms. It provides a stable position of the needle fastened in the holder. The holder tips have gripping surfaces.

There are two types of holders: Hegar holder (more popular and used by the majority of surgeons) and Mathieu holder (less popular).

The Hegar holder should be held in the following way: place the thumb of the dominant hand in one handle and the ring finger (fourth) of the same hand in the second handle (2). The index finger can be placed on the holder arm to stabilize it.

The Mathieu holder should be covered from one side with the thumb of the dominant hand and on the other with the middle, ring and small finger of the same hand. The index finger, as with the Hegar holder, can be placed on the holder arm (3).

The gradual squeezing of the holder increases its closure (clicks of the consecutive latches). To open a closed holder, squeeze it until the last latch has clicked or expand the latch on which the holder is blocked. The above operations should be carried out with one hand, without involving the other hand.
Tweezers are used to capture tissues (skin, subcutaneous tissue, muscles, fascia), needle or suture in order to move them or keep them in a given position. In addition, using tweezers for needle manipulation reduces the risk of accidental needle stick injury of the operator.

There are two kinds of tweezers: anatomical and surgical (4).

**Anatomical tweezers** are characterized by a flat gripping surface. They are most often used for coagulation within the wound, as well as for gripping delicate, soft and non-taut structures which could be destroyed by sharp surgical tweezers. They are used relatively rarely in other applications, because of a high degree of tissue traumatization. This is due to the fact that a very large force should be used to obtain a firm grip of the tissue. Such pressure on captured tissues can crush them, which adversely affects the healing process.

**Surgical tweezers** can be recognized by characteristic teeth on the grip end. They are a universal instrument for holding tissues with minimal effort. Sharp ends guarantee that the tissue is maintained in the desired position without fear of being pulled out of the tweezers’ arms.

To hold both types of tweezers, the pencil grip should be used - between the thumb and forefinger and middle finger of the non-dominant hand - similarly to gripping a pencil (5).
They are basic surgical instruments for cutting tissues and suture.

A scalpel consists of a handle and a replaceable disposable blade. It is best to use a holder to install the blade on the handle. This minimizes the risk of an accidental cut with a very sharp blade. The scalpel should be grasped between the thumb and the middle finger, with the index finger on the scalpel's back (pencil grip) \(^{(6)}\) or with the power grip (table knife grip) (scalpel is covered by the hand) \(^{(7)}\).

The power grip is a more convenient method when the cutting of hard tissue requires more force from the operator. The index finger allows to increase the pressure of the scalpel to the tissue.

The use of scalpel requires proper cutting technique, because the blade should be directed at the right angle to the surface of the cut. Also the scalpel's smooth movement is important so as not to create ragged joints, which hampers wound healing and negatively affects the cosmetic effect.

When making all cuts, try to lead them along the line of reduced tension, i.e. Langer's lines. In the face area these lines coincide in their course with wrinkles, while on the limbs they form a circular pattern (perpendicular to the long axis of the muscles under the skin). Cuts within the Langer's line reduce the risk of spreading the wound edges during
the healing process and improve the cosmetic effect. If you have problems finding the Langer’s lines, you can do a simple maneuver of grabbing the skin between the thumb and forefinger in different directions. The wrinkling of the skin between the fingers means finding the course of the Langer’s line.

Scissors are used for tissue preparation and suture cutting. Hold them the same way as the Hegar holder (8).

Modern surgical sutures are permanently combined with the needle. The needle is held with a holder in order to avoid holding it in the hand due to the risk of accidental needle stick injury of the operator. Correct needle grip is described as (9):

• 1/3 of the needle length (counting from the suture end),
• in the further part of the gripping surface of the holder (the holder ends should gently protrude beyond the needle),
• perpendicular to the holder with the blade pointing up and to the left (looking from the operator’s side, assuming their right-handedness).

Clasping the needle too close to the suture may cause it to break easily, while placing it in the proximal part of the gripping surface of the holder can lead to the needle being bent.
There are many models of needles and sutures, as each of them is characterized by different parameters. The most important ones can be read from the packaging label of the needle and suture set (10).

SUTURE ABSORBABILITY

There is a huge variety of materials from which sutures are produced and cannot be all included in this manual. However, it is necessary to distinguish two main categories of suture: absorbable and non-absorbable. Here are materials most commonly used for the production of surgical suture:

- absorbable:
  - natural – catgut;
  - synthetic - polyglycolic acid (PGA), polylactic acid (PLA) polidioxanone;
- non-absorbable:
  - natural – silk;
  - synthetic – poliester, poliamide (nylon), poliprophylene.

The suture absorption occurs through enzymatic degradation or hydrolysis and its duration varies depending on the type of material (from several weeks to several months). Non-absorbable suture should be removed after several days (usually after a week).

SUTURE THICKNESS

The range of this parameter is wide due to the use of suture in various treatment fields of specific technical requirements: from microsurgery to orthopedics. The international size scale of the suture was established* (in ascending order according to the suture thickness): 11-0, 10-0, 9-0, 8-0, 7-0, 6-0, 5-0, 4-0, 3-0, 2-0, 0, 1, 2, 3, 4, 5, 6. The underlined sizes (from 6-0 to 3-0) are typically used in plastic surgery of the skin depending on the area of the body. The following rule applies here: the finer the structure, the thinner the suture.

PHYSICAL STRUCTURE OF THE SUTURE

Two types of suture are distinguished because of their physical structure: monofilament and polyfilament (braided) sutures.

Both models manifest advantages and disadvantages that should be considered before selecting the suture. Monofilaments are smooth and less likely to cause inflammation, but are difficult to tie in a knot. Braided sutures are easier to tie in a knot, however they have an irritating and rough structure that can cause inflammation and cut the tissue.

DEGREE OF NEEDLE CURVATURE

Surgical needles are semi-circular and depending on the model are 1/4, 3/8, 1/2 or 5/8 of the circle section. Optimal models used in skin plastics are 3/8, and also 1/2. There are also straight needles and straight curved ones, however, they are less frequently used.

* Suture written with additional zero, e.g. 5-0 (also as: 5/0) should be read: „five zero”.
SHAPE OF THE NEEDLE TIP

Needles are also produced in many variants of their tip shapes. The use of individual shapes depends on the tissue that will be sutured together. The most popular are cutting needles (▲, o with a triangular cross-section with a cutting edge on the inside curvature) and reverse cutting needleless (▼, with the cutting edge on the external curvature) and taper needles (●, round cross-section).

Taper needles are used to suture soft and delicate tissues that do not resist and are easily susceptible to damage. Cutting needles, however, are used to suture harder tissues that are less susceptible to damage.

In skin plastics, the reverse cutting needles are used most often.

SKIN STAPLER

An easy and quick alternative to needle suturing are skin staplers. Most often they are fully disposable devices with a factory-loaded set of metal staples. (11). The use of staples ensures a tight joint of the wound and is particularly useful in the case of wounds difficult to access or due to the nature of the operation. This method of suturing can be done when the aesthetics of the scar is not the most important, where the area is covered by hair or clothes. It should be remembered that traditional needle suturing gives greater control over the precise adjustment of the wound edges and usually provides a better cosmetic effect.

(11) Skin stapler.
3.

WOUND PREPARATION

Before starting surgical suturing, care should be taken to prepare the operating field. Always disinfect the skin within the wound area and apply adequate analgesia (description of anesthesia in Chapter 6). Next, hemostasis should be provided by compressing the bleeding site, electrocoagulation or ligation or undercutting of the vessel (description of the vessel undercut in Chapter 8.2). It is also advisable to rinse the wound with the 0.9% sodium chloride solution.

A very important stage in the preparation of the wound is its cleansing. If we do not deal with a surgical wound (under sterile conditions), so-called revision may be necessary. It involves cleaning the edges and the bottom of the wound from blood clots, foreign bodies and various types of contaminants, as well as removing necrotic or granulated tissue. In such situations, it is also important to use tetanus prophylaxis and to consider antibiotic therapy.

Often cleansing the wound is the only procedure performed, because not every wound can be sutured together. Therefore it is important to gather basic medical interview information before carrying out any procedures. It is necessary to withdraw from the suturing if:

• more than 8 hours have passed since the wound was formed,
• the wound is classified as bite, laceration or crush,
• the wound is contaminated with soil or faeces.

In the absence of contraindications for suturing, the so-called primary closure is advised. It is used for treating uninfected, cut wounds (with well-fitting edges) and fresh wounds (formed at a time interval not longer than 8 hours). Such procedure shortens wound healing time and provides a better cosmetic effect.

In case of infected wounds, after thoroughly cleaning them, a delayed primary closure should be put on. It is made without tightening and tying the suture - both can only be done after the infection resolves.
When performing procedures related to surgical suturing it is necessary to follow the principles of antisepsis and asepsis.

The former include primarily surgical handwashing by the operator and assistance. As these principles are generally known and widely available, they will not be described in detail in this manual.

However, more attention should be paid to the part of preparation for the procedure under the description of asepsis, namely the use of sterile surgical gloves. The way they are put on seems simple at first glance, but in practice it turns out to be much more problematic. In order to make each successive attempt more successful, first of all the right size should be selected. The scale is numeric - the higher the number, the larger the size. Women usually use sizes 6, 6½ or 7. Men usually use gloves size 7½ and 8.

It is worth noting that putting on surgical gloves can take place in various circumstances depending on the availability of assistance. The most comfortable situation is the preparation of gloves in sterile conditions by an operating-theatre nurse. Another option is to open the glove box by an assistant who is not wearing sterile gloves. The last, least comfortable situation is the need to do the whole procedure by oneself and this is what is described below.

4. PUTTING ON STERILE GLOVES

PUTTING ON STERILE GLOVES - Step by step

1. On a flat surface, carefully open the outer protective packaging of disposable gloves - use the outer edges on one of its sides (12). Make sure that the opened package does not close again, which would make it impossible for its contents to be reached after washing your hands (13). When opening the packaging, under any circumstances do not touch its contents. This way you will maintain the sterility of the inner packaging containing the gloves.
2. Wash your hands thoroughly according to the principles of antiseptics, using soap and a disinfectant.

3. Gently grip the inner package by one of the corners and open it (14).

4. Spread both wings of the inner packaging so that both gloves are visible. It is advisable to bend the bottom edge of the packaging under to prevent the wings from falling back (15).

5. Start by putting the glove on the dominant hand. For this purpose, use the non-dominant hand to grip the folded cuff of the glove and lift it to reveal access to the inside of the glove (16).
6. Place the dominant hand in the same direction as the glove (make sure that your thumb is on the same side as the thumb of the glove), and then slide your hand into the glove. Do not pull the glove completely, the cuff should remain folded (17).

7. Do not worry if one of your fingers is not exactly fitted to the glove or is not in the right place at all - you will correct it after putting on the second glove.

8. Insert the fingers of the dominant hand under the folded cuff of the second glove and then lift it to reveal access to the inside (18).

9. Insert the fingers of the dominant hand under the folded cuff of the second glove, and insert the non-dominant hand into the glove, remembering the correct position of the thumb again. Tighten the glove all the way to the end, and fully unfold the cuff (19).

10. Insert the fingers of the non-dominant a hand under the folded cuff of the dominant hand (20) and expand it to the end (21).

After putting on both gloves, you can touch only sterile instruments and the operating field. Any touching of an unsterile item or damage to the gloves requires their replacement for the new ones.
Suturing is a painful procedure. Therefore care should be taken to adequately protect the patient against this discomfort using local anesthesia (so-called infiltrative anesthesia). The substance most commonly used for this procedure is lidocaine (trade names: Lignocaine, Xylocaine). This anesthetic is administered in the form of intradermal and subcutaneous injection along the edges of the sutured wound. Lidocaine is available on the Polish market in the form of 1% and 2% solution for injection.

Sometimes, a solution of lidocaine with the addition of adrenaline is used, which shrinks the surrounding vessels and reduces bleeding. However, it should not be used for distal anesthesia of the body parts (ears, nose, hands, feet, fingers) due to the risk of ischemia in the absence of efficient collateral circulation. Caution should be exercised in patients with ischemic heart disease, cardiac arrhythmias (especially with AV II\textsuperscript{o} and III\textsuperscript{o} blocks), epilepsy or hyperthyroidism.

The contraindication to infiltrative anesthesia is an infection or hematoma at the injection site. Do not use this type of anesthesia in an abscess cutting procedure because anesthetics do not work in tissues in which the inflammatory process takes place.

In the case of allergy to lidocaine, bupivacaine or articaine is used. It should be kept in mind that they differ in their concentrations, dosages and duration of action.

For example, lidocaine starts working after about 30 - 60 seconds from the time of administration and its effect lasts from about 30 to 60 minutes.

Before giving anesthesia, it is advisable to warn the patient that this procedure involves a few needle pricks and an unpleasant feeling of stretching under the skin. After administering anesthesia the patient may feel touch but they should not feel pain. Therefore it is very important to establish cooperation and ask the patient to report any complaints during the suturing procedure.

**ADMINISTRATION OF LOCAL ANESTHESIA - Step by step**

1. Insert the needle as close as possible to the edge of the wound.

2. Remember to put the needle through the skin, not through the wound.

3. The needle should be inserted intradermally or subcutaneously (22).

4. Before injecting the substance, try aspiration to avoid unintentional intravascular administration.
5. Lidocaine, like other local anesthetics, should be given slowly.

6. Inject the substance as the needle is being removed from the skin.

7. Repeat steps 1-5 above for the entire length of both wound edges.

After a mistaken, intravascular administration of the test dose, the adrenaline contained therein induces a marked acceleration of cardiac function. Lidocaine may, however, induce cardiac arrhythmias.

Therefore, for 5 minutes after an intravenous infusion, ECG should be observed on the monitor screen. The lowest effective dose of lidocaine should always be used to reduce the risk of overdose.

It is very important to administer lidocaine along both edges of the sutured area (point 6) because the anesthesia works only at the site of administration. This minimizes the risk of pain in the patient.

If the patient reports pain while suturing, inject another dose of anesthesia in the sutured area.

(22) Proper intradermal needle insertion for the administration of an anesthetic agent.
6. BASIC SUTURES

Here are some of the most important rules for surgical suturing:

1. Needle penetration into the skin surface should be done at a right angle.

2. Moving the needle through the skin should be done by a smooth movement of turning (supination) of the forearm. This allows you to take full advantage of the semicircular shape of the needle.

3. The insertion distance from the edge of the wound on one side must be equal to the distance of the needle exit puncture at the opposite side of the wound on the other side. This distance is described as half the skin thickness in a given place.

4. The distance between consecutive stitches should be approximately the same as the width of the stitch - the distance between the point of needle entry and needle exit in the given stitch (23). Stitches put too sparsely will cause inadequate fitting of the wound edges. The stitches put too densely will cause local ischemia and will prolong or prevent wound healing.

5. The surface of the closed wound should be flat or slightly convex (23). Skin depression is undesirable due to the impeded wound healing process and the unsatisfactory cosmetic effect.

6. In the case of deeper wounds, also disturbing the continuity of subcutaneous tissue, fascia or muscle, a layered suture should be made. Two primary principles apply here:

   - the same type of tissue should be sutured together, e.g. muscle with muscle, subcutaneous tissue with subcutaneous tissue, etc.,
   - each layer should be sutured separately - it is not allowed to suture together two different layers at once.
   - The layered suture should be made with different types of stitches depending on the wound layer being sutured.

(23) The optimal distance between consecutive stitches and the flat surface of the sutured wound.
The most basic, fastest and easiest suture used in surgery is the simple interrupted suture. It is indispensable, because many other sutures are its extensions or modifications.

**All step-by-step instructions are written for right-handed persons. Left-handers should perform all activities on the principle of mirror reflection.**

**SIMPLE INTERRUPTED SUTURE**

- **Step by step**

1. Gently grasp the right side of the wound with tweezers and lift the skin slightly.

2. Using a holder with a needle attached, insert the needle at a right angle into the skin on the right side of the wound at a distance of about 3 - 5 mm from the edge of the wound (24).

3. Grasp the left side of the wound with tweezers and lift the skin.

4. Turning the forearm, guide the needle through the skin and insert it through the skin on the left side of the wound at the same distance from the edge of the wound as on the opposite side (25).
If you are not able to pierce through both edges at once because of the skin being too thick or of too large a distance between the edges of the wound - release the needle from the holder, fasten it again inside the wound and only then pierce through the skin on the left side of the wound.

5. Release the needle from the holder.

6. Using a holder or tweezers, pull the needle through the skin.

7. Use a hand or any instrument to pull the suture through the skin, leaving around 3 - 5 cm on the right side (26).

8. Tie the surgeon’s knot using instruments or manually (both methods described below).

SURGEON’S KNOT (instrument tie)

The standard and recommended method of tying the surgeon’s knot in skin plastics involves the use of a hand and an instrument (a holder). It is also possible to tie the knot using two instruments, however, this method is mainly used in microsurgery and is not included in this manual.

SURGEON’S KNOT - INSTRUMENT TIE - Step by step

1. With the left hand grab the longer part of the suture (on the left side of the wound), and with the right hand grab the holder.

2. Wrap the suture around the holder twice in a clockwise direction (when the suture is long - it is best to do this close to the skin surface, away from the needle) (27).

3. Open the holder and grab the short end of the suture as close as possible to its end (on the right side of the wound) (28).

4. Pull the short end of the suture through the loop formed on the holder. This is best done by moving the left hand apart and keeping the right hand at the same time in a fixed position (29).
5. Rotate both hands horizontally by 180 degrees so that a double loop is formed over the wound (in the shape of a double eight) (30).

6. Tighten the loop gently. Do not make it too tight because of the risk of tissue disruption or causing local ischemia. This action is only responsible for the close-up of the wound edge (tissue adaptation).

7. With your left hand, grasp the longer part of the suture and with your right hand – the holder.

8. Wrap the holder around the longer part of the suture once counter-clockwise (31).

9. Open the holder and grab the short end of the suture (32).

10. Pull the short end of the suture through the loop formed on the holder. This is best done by simultaneously moving both hands to the sides.

11. Securely tighten the formed surgeon's knot. A knot tightened inaccurately may spontaneously get untied (33).

12. Holding one end of the suture with the holder and the other one by hand, move the surgeon's knot to one side of the wound (34). 
**Do not leave the tied knot in the wound line.**

13. Repeat steps 8 - 12 to strengthen the knot.

14. Cut the two sutures about 1 cm above the knot with a scalpel or scissors (35).
Manual tying the surgeon’s knot is not indicated in skinoplastics. It is used more often in general surgery while suturing deeply located tissues.

There are a lot of methods for manual tying the surgeon’s knot and it is often an individual technique of a given operator. Regardless of which method you choose in the future - remember that a properly made surgeon’s knot consists of one double loop and two single loops of an opposite direction of turning.

**SURGEON’S KNOT - HAND TIE**

- Step by step

Before starting to make the knot, pull the suture a little above the skin surface on the right side of the wound for more convenient tying of the knot.

1. Grasp the left end of the suture between the thumb and index finger of the left hand and the right end of the suture between the thumb and index finger of the right hand. Place your hands so that their palms are facing up (36).

2. Holding the right hand motionlessly, wrap the middle finger of the right hand with the suture from below and from the side.

3. Arrange the suture on the middle, ring and little finger of the right hand towards the middle, parallel to the suture held by the right hand (37).

4. Repeat points 2 and 3, arranging subsequent suture loops subsequently distal to the others (38).

5. Bend the ring finger of the right hand and grab the suture in your right hand from the bottom (39).

6. Straighten the ring finger of your right hand so that the grabbed piece of suture is wrapped around the dorsal surface of this finger (40).

7. Tighten the middle and ring fingers of the right hand to prevent the suture from slipping, then release the suture from between the thumb and index finger of the right hand (41).
8. Still holding the suture between the middle and ring fingers of your right hand, gently pull the right hand towards you to make the suture slip from the fingers.

9. Tighten the suture, keeping the right hand motionless and moving the left hand away.

10. Grip both sutures in the starting position (as in point 1) (42).

11. Holding the left hand motionless, with the suture held in the right hand, wrap the middle finger of the left hand from the bottom and from the side.

12. Arrange the suture on the middle, ring and little finger of the left hand towards the middle, parallel to the suture held by the left hand (43).

13. Repeat points 5 - 9 similarly for the left hand (44, 45).

14. Strengthen the knot by repeating the procedure with wrapping the suture around the right hand (points 1 - 3 and 5 - 9).

15. Cut the suture about 1 cm above the knot (46).
In the case of high tension within the wound margins, where good tissue adaptation is particularly important, it is advisable to use the vertical mattress suture. It is a bit more complicated due to the necessity of making two needle entries and two exits. For its implementation, it may be convenient to memorize the pattern of entry and exit: far - far - close - close. All four passes of the needle through the skin must be done in one line (perpendicular to the wound line).

**VERTICAL MATTRESS SUTURE**

- Step by step

1. Grasp the right side of the wound with tweezers and lift the skin.

2. Insert the needle on the right side of the wound at a distance of about 6 - 10 mm from the edge of the wound - more or less twice as far as in the simple interrupted suture (47).

3. Release the needle from the holder and fasten it inside the wound.

4. Grasp the left side of the wound with tweezers and lift the skin.

5. The needle should exit symmetrically on the left side of the wound (48).

6. Release the needle from the holder.

7. Using a holder or tweezers, pull the needle and part of the suture through the skin.
8. Fasten the needle in the holder with the blade pointing to the right (*backhand*).

9. Grasp the left side of the wound with tweezers and lift the skin.

10. Insert the needle on the left side of the wound close to its edge (about 3 mm) (*49*).

11. Grasp the right side of the wound with tweezers and lift the skin.

12. The needle should exit symmetrically on the right side of the wound (*50*).

13. Use a hand or any instrument to pull the suture through the skin, leaving around 3 - 5 cm on the short end (*51*).

14. Tie the surgeon’s knot identically as in the description in section 6. The knot will not appear above the wound line, but to its right (*52*).
The horizontal mattress suture is used most often for suturing the muscles and their fascia. However, it is not routinely used for stitching the skin due to the poor cosmetic effect and a high risk of unsightly scarring.

Attention!
The technique of suturing is demonstrated below on the skin to better visualize it. Nevertheless, it is identical for the muscle layer.

**HORIZONTAL MATTRESS SUTURE**

- **Step by step**

1. Grasp the right side of the skin with tweezers and lift it.
2. Insert the needle into the skin about 5 mm from the edge (53).
3. Grasp the left side of the skin with tweezers and lift it.
4. Make the needle exit symmetrically on the left side of the wound.
5. Release the needle from the holder.
6. Using a holder or tweezers, pull the needle and part of the suture through the skin.
7. Fasten the needle in the holder with the blade pointing to the right (*backhand*).
8. Grasp the left side of the skin with tweezers and lift it.
9. Insert the needle on the left side of the skin approximately 1 cm below the previous needle exit (54).
10. Grasp the right side of the skin with tweezers and lift it.
11. Make the needle exit symmetrically on the right side of the wound (55).

12. Using a hand or any instrument, pull the suture through the skin, leaving around 3 - 5 cm on the right.

13. Tie the surgeon’s knot. The knot will not appear above the wound line, but to its right (56).

SIMPLE CONTINUOUS SUTURE

The simple continuous suture is put on the skin in situations when it is important to quickly close a long wound and / or when it is particularly desired to obtain its tightness.

SIMPLE CONTINUOUS SUTURE
- Step by step

1. At one of the wound ends tie a simple interrupted suture as described in section 6.1. Afterwards, do not cut off the long part of the suture - it will be used to make the continuous suture (57).
2. Grasping one end of the suture with the holder, with the other hand move the surgeon’s knot to the right side of the wound.

3. Insert the needle at the right side of the wound about 5 mm below the simple suture (at the same distance from the wound edge as in the first simple suture).

4. Make the needle exit symmetrically on the left side of the wound (58).

5. Pull the entire needle and suture through the wound so that the edges of the wound are close together.

6. Repeat points 3 - 5 perpendicularly to the wound axis up to its end. The suture should be laid slantwise at an angle of 45 degrees above the wound.

7. Using a holder or tweezers, loosen the last slanting part of the suture above the wound (59).

8. Make the surgeon’s knot by treating the loose part of the suture as its short end (60). After tying the knot a characteristic eyelet will be created (61).

9. Cut the suture forming the eyelet and the remaining part of the suture about 1 cm from the knot.
The subcuticular sutures are used to pre-adapt the wound edges before applying surface (skin) sutures. This reduces the tension on the skin, which minimizes the risk of splitting. The subcuticular sutures also allow to avoid leaving open spaces under the sutured skin. Before their execution, the wound edges are usually initially prepared.

The simplest subcuticular suture covering both the subcutaneous tissue and the dermis is the simple inverted interrupted suture, also called buried or covered. Remember that while performing the subcuticular suture, the needle must not penetrate the skin surface.

**SIMPLE INVERTED INTERRUPTED SUTURE**
- **Step by step**

1. Grasp the left side of the wound with tweezers and lift it.
2. Insert the needle on the left side of the wound in the subcutaneous tissue and make an exit above in the dermis. The needle should be directed from the deeper to the upper layer and from the medial to the lateral side (62).
3. Release the needle from the holder.
4. Using a holder or tweezers, pull the needle and part of the suture through the skin.
5. Grasp the right side of the wound with tweezers and lift it.
6. Insert the needle on the right side in the dermis (at the same height as the needle exit on the left side) and make an exit below in the subcutaneous tissue (at the same height as the needle entry on the left side). The needle should be directed from the superficial layer into the wound and from the lateral side of the wound to the medial part (63).
7. Draw the suture together and make sure that both ends of the suture are on the same side in relation to the needle transition plane (64). If not - put one of them on the other side under the suture passing between the edges of the wound.

8. Make the surgeon’s knot (65).

9. Cut the sutures just under the knot, the remaining ends should be as short as possible. When cutting the suture, watch out for the surgeon’s knot, because its incision will destroy the entire stitch.

10. The knot and the ends of the suture after cutting should go into the wound (66).
CONTINUOUS INTRADERMAL SUTURE

The last stage of the layered suture is the suturing of the skin. Any suture described here in the basic part can be used (simple interrupted, vertical mattress or continuous). If, however, the cosmetic effect is particularly important, an intradermal suture can be made, which perfectly adapts the edges of the wound and after healing does not leave a trace in the form of so-called „ladder”. It is not a durable suture, so it should not be used if the lower layers of the skin are not previously brought closer with other types of sutures. It is only used for simple wounds.

The intradermal suture can be made with non-absorbable or absorbable suture. The use of the latter allows the patient to avoid the obligation to have it removed. Below are the rules for applying the intradermal suture depending on the material selected.

*In descriptions of intradermal sutures, the term „distal” refers to the end of the wound placed further from the operator (in the picture it is the upper end of the wound), while „proximal” - to the closer end of the wound (in the picture - bottom end).*

NON-ABSORBABLE INTRADERMAL SUTURE - Step by step

1. Insert the needle into the skin in the wound line approximately 1 cm above the distal end of the wound and bring it out inside the wound (67).

2. Pull the suture, leaving a few centimeters above the surface of the skin. When proceeding with the suture do not allow this end to pass through the skin, as this will make it impossible to secure the suture later.

3. Insert the needle into the skin at the dermis level on one side of the wound. Make sure that the insertion is done at the very distal end of the wound. Guiding the needle intradermally (in the skin plane) and performing a semicircular movement, make the needle exit on the same side of the wound also at the dermis level (68). *It is absolutely forbidden to pierce the skin surface!*
4. Follow steps 3 and 4. alternately on both sides of the wound (69). **The needle insertion on one side of the wound should be at the same height as the last needle exit on the other side of the wound.** Always grasp the skin with the tweezers proximally to the point where you plan the next needle insertion. Pass the whole suture through the skin as you make the next insertion, each time remembering to keep the free end of the suture over the distal end of the wound. This will ensure control over the correct adaptation of the wound edges.

5. The last needle exit should be made exactly at the proximal end of the wound (70).

6. Pull the suture carefully to check that the wound is sufficiently closed at all its length.

7. Guide the needle through the skin in the wound line - insert it in the wound, and exit about 1 cm under the proximal end of the wound (71, 72).
8. The intradermal suture can be finished:
   • without the knots - secure both ends of the suture with an adhesive;
   • by placing the knots on both ends of the suture (74):
     a) grip the suture close to its end with your left hand, and use the right hand to wrap the suture twice around the holder,
     b) open the holder and grab the suture just above the skin surface (73),

     c) pull the grasped end of the suture through the loop formed on the holder (after pulling the suture a characteristic eyelet will be formed),
     d) wrap the suture once around the holder in the opposite direction,
     e) open the holder, grip the loop of the eyelet and pull the suture - this will create the surgeon’s knot,
     f) repeat points d. and e. to strengthen the knot.

ABSORBABLE INTRADERMAL SUTURE
- Step by step

1. Near the distal end of the wound, attach one simple subcuticular suture (see section 7). Remember, however, not to cut off the long end of the suture after completing it (75).

2. Pass the needle under the formed knot, and then pierce through the dermis of one of the wound edges. The needle should be directed from the deeper to the upper layer and
from the medial to the lateral side (76, 77).

3. Make an intradermal puncture on either side of the wound from the distal to the proximal end. Make sure that the puncture starts at the most distal end of the wound.

4. Then perform next intradermal punctures by alternating wound edges (like in non-absorbable intradermal suture).

5. The last puncture should be located exactly at the proximal end of the wound. After it has been done, pull the suture tightly to check that the wound is properly aligned over its entire length.

6. Make an additional intradermal puncture through the edge of the wound opposite to the last puncture (in the standard direction, i.e. towards the proximal end) (78).

7. Pull part of the suture through the wound, leaving a loose fragment between the edges of the wound (79).
8. Make the surgeon’s knot by treating the loose part of the suture as its short end. This way a characteristic loop will be created over the knot (80).

9. Cut the loop just above the knot. Be careful not to cut the knot or the remainder of the suture with the needle.

10. Guide the needle through the skin in the wound line. For this purpose, enter it in the light of the wound and exit about 1 cm below the end of the wound (81).

11. Pull the needle with the suture until you feel resistance, which will solidly anchor the knot within the wound.

12. Tighten the suture and cut it as close to the skin as possible (82, 83).
CONTINUOUS PURSE-STRING SUTURE

This type of suture is very rarely used in skin plastics. However, it is largely applied in closing of round or oval tissue defects within the gastrointestinal tract. This suture is particularly useful for dentists for suturing a tooth socket after tooth extraction.

The photographs show the installation of the purse-string suture on the skin, but this technique is identical for all other locations.

During needle insertions around the wound, the method of clamping the needle in the holder (standard and backhand) should be adjusted to the direction of the puncture.

CONTINUOUS PURSE-STRING SUTURE
- Step by step

1. Pierce the tissue about 5 mm from the margin of the wound in the direction parallel to the edge of the wound.

2. Make the needle exit at the same distance from the edge of the wound (84).

3. Make subsequent punctures through the tissue, leaving a few millimeters of space between the exit and the previous insertion. Keep the circular run of the suture along the edge of the wound and the same distance between the needle insertions and exits from the edge of the wound (85).
4. The last needle exit should be made in the immediate vicinity of the first needle insertion (86, 87).

5. Using your hands or instruments, pull the two ends of the suture to bring the edges of the entire wound closer together.

6. Put on the surgeon’s knot using both ends of the suture (88).
This suture is also very rarely used for stitching the skin due to the unsatisfactory cosmetic effect. However, it is useful for problematic bleeding that does not respond to pressure or electrocoagulation or when the source of bleeding is difficult to locate accurately. The insertion of the cross suture in such situations performs a hemostatic function.

Another colloquial name for the cross suture often used in everyday surgical practice is “Z-shaped” or “Figure 8 stitch”.

**CROSS SUTURE - Step by step**

1. Make a deep puncture including the vessel that is the source of bleeding (89).
2. Make an equally deep puncture in the opposite direction (at the right angle to the previous puncture) (90, 91).
3. Put on the surgeon’s knot using both ends of the suture (92).
The skin sutures are removed within a period depending on the area in which they were made (the skin thickness and tension are particularly important), the rate and the wound healing process, as well as the patient’s systemic diseases (e.g. 5-7 days for the eyelids up to 14 days for the skin of the back).

You should always avoid pulling through the skin the part of the suture that was above the surface of the skin during the wound healing. This helps to avoid secondary infection of the wound with a non-sterile part of the suture.

**SUTURE REMOVAL - Step by step**

1. Disinfect the patient’s skin with a disinfectant agent.

2. With a holder or tweezers grasp the ends of the suture left over the knot (93).

3. Lift the captured sutures until the short sections of the suture under the knot are visible.

4. Use a scalpel or scissors to cut one of the two identified suture sections (94).

5. While still holding both ends of the suture with a holder or tweezers, pull the cut stitch vertically up.

The most important moment of removing the stitch is cutting the suture described in point 4. It is necessary to pay attention not to cut both sections of the suture at the same time. This involves the risk of leaving a piece of suture in the skin without the possibility of atraumatic removal, which may result in a local infection of the wound.
BIBLIOGRAPHY


