SUTURES
- MATERIALS AND TECHNIQUES -

Virginia Gallo, MD
SC Chirurgia Generale II
Head: Prof. A. Pietrabissa

INTRODUCTION

The term “suture” derives from the Latin “suere” meaning to sew; in fact, the purpose of the suture is to bring together the edges of a wound in a stable manner in order to restore its continuity. The suture represents the last desirable step in the management of a wound, regardless of its nature, traumatic or surgical, as the approximation of the margins speeds up the healing process, significantly reduces the incidence of tissue infection and, last but not least, allows the creation of aesthetically acceptable scars.

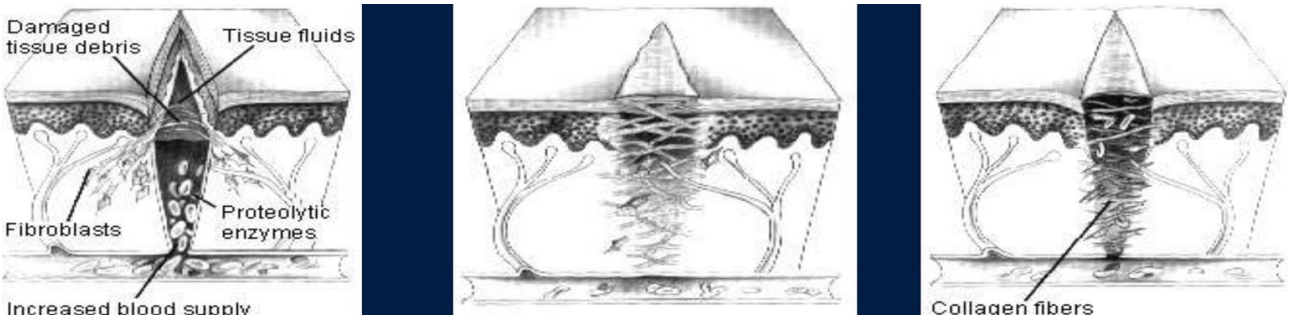

Fig 1. The healing process is highly variable and poorly defined. It depends above all on the extent of tissue perfusion and oxygenation as well as on factors such as the patient's immune response, nutritional status, age, nature and location of the wound and the presence of concurrent infection.

However, not all wounds can be sutured as this possibility depends on some factors that must be evaluated during their treatment:

- Localization of the wound
- Dimensions
- The extent of involvement of the underlying tissues
- Presence of foreign bodies
- Bacterial contamination/infection

This is true regarding injuries of traumatic origin; surgical wounds deserve separate mention, as they are usually carried out according to anatomical and aseptic dictates such as to allow their synthesis with stitches in almost all cases. Traumatic wounds, on the other hand, require careful evaluation and specific management aimed at limiting bacterial contamination and subsequent infection. All traumatic wounds are considered contaminated and it is important to distinguish contamination

from actual infection during which bacteria not only replicate but can cause tissue damage. The extent of contamination of the wound at the time of evaluation is of primary importance as it allows us to establish whether it is susceptible to synthesis by suture (healing by primary intention) or whether it is instead necessary to "leave it open", thus promoting healing by secondary intention during which various measures will be implemented with the aim of reducing the degree of contamination. Generally, wounds that are adequately treated within 6 hours of trauma can be converted to clean or clean-contaminated wounds and therefore suturing may be considered. This period of time is called the "golden period" which corresponds to the time necessary for the bacteria to reach a concentration above 10^5 per gram of tissue; therefore, a delay in treatment is associated with increased bacterial proliferation, tissue invasion and subsequent infection.

What are the steps for the treatment of traumatic wounds?

As anticipated, the aim of managing contaminated wounds, such as those of traumatic origin, is to reduce the bacterial load and therefore the degree of contamination and eliminate any foreign bodies that can carry bacteria and cause infection. This objective can be achieved by carefully irrigating the wound with simple physiological solution instilled in a pulsatile manner at high pressure, as the force of the irrigation must be greater than the forces that promote the adhesion of foreign bodies and bacteria to the wound surface. Although antiseptic solutions are able to reduce bacterial concentrations on intact skin, their application on an open wound can be cytotoxic. The debridement of the wound is also fundamental, i.e. the removal of any non-vital or necrotic tissue which constitutes the ideal growth medium for bacteria and compromises the healing process as well as the rectification of ecchymotic or irregular margins in order to make them as linear as possible. At the end of these first fundamental steps of the wound management process, suture synthesis can be taken into consideration for all those that can be classified as clean or clean-contaminated wounds at the end. On the contrary, if there is full-blown infection or necrotic material, the suture must be postponed until the wound has been adequately cleaned (delayed primary closure) and on average no longer than 3 - 5 days. In still other cases (deep, infected wounds, subjected to tension, ...) healing must take place by second intention (the wound is kept open), assisted by the application of specific medical devices with the function of forming a physical barrier that prevents further contamination and subsequent infection and equipped with antimicrobial properties, stimulating tissue regeneration and re-epithelialization.

SUTURES

Making a suture is the most commonly performed practice in surgery; however, not only surgeons, but any doctor, from the family doctor to the emergency room doctor, should have some knowledge of how to put a stitch on a wound and how to remove it. This is because it will be very frequent in your clinical practice that a patient comes to you for removal stitches from a surgical scar or to have a traumatic wound evaluated. Unfortunately, until now the learning of suturing techniques has never been entrusted to formal training, but was and still is an expertise that is learned during clinical practice directly on the patient.

There are different techniques by which it is possible to suture a wound, manual, chemical or mechanical; we will focus on manual sutures, i.e. those that we make ourselves with needle and thread.

Manual sutures

This expression refers to sutures made using a needle and thread.

To make them you need the following basic tools:

1. A needle holder

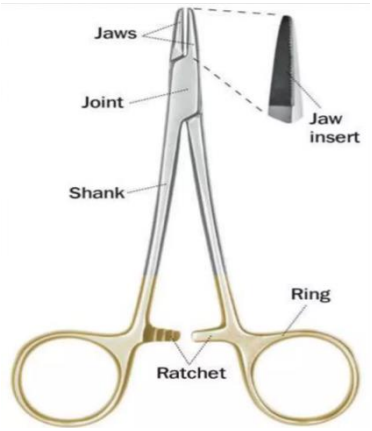

Fig 2.

Fig 3.

Fig 4. Thumb and ring finger in the rings. Index along the stem to give stability and control

2. A forcep

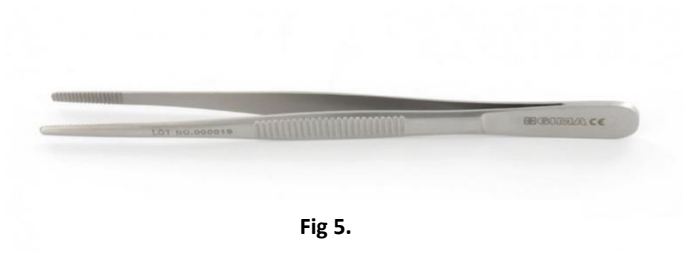

Fig 5.

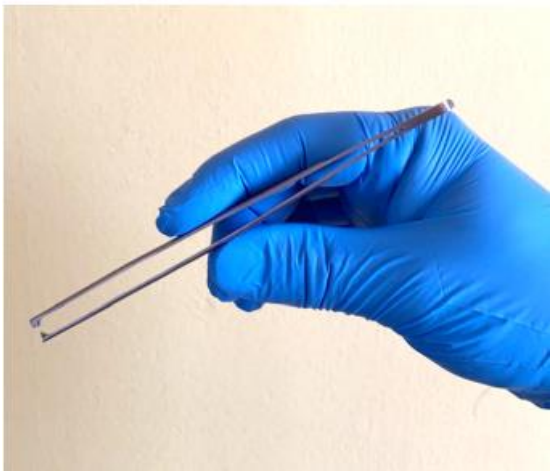

Fig 6.

3. A pair of scissors

Fig 7.

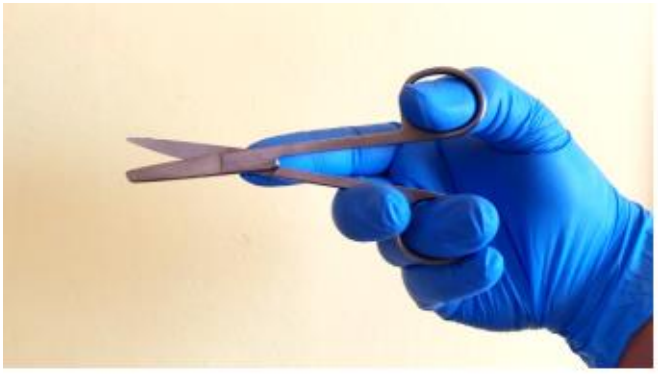

Fig 8.

4. Suture thread composed of needle and suture material

Fig 9.

NEEDLE

Suture needles are made of martensitic stainless steel, i.e. equipped with a reinforced structure containing a greater quantity of carbon in order to give greater hardness and toughness. The needle is made up of 3 parts:

- The eye
- The body
- The tip

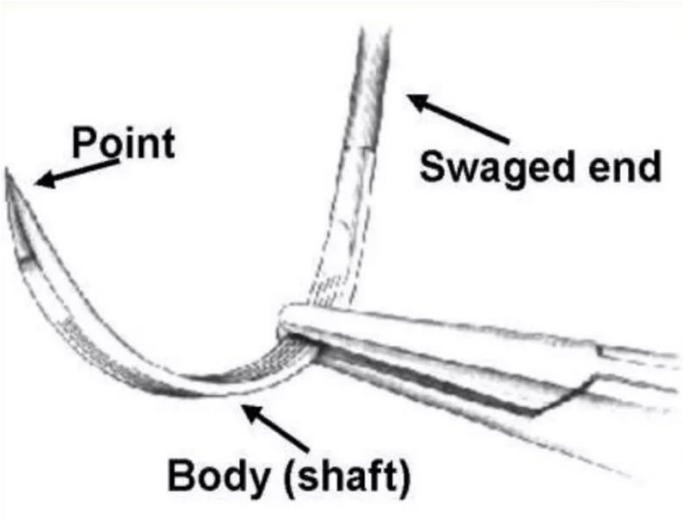

Fig 10.

The structure of the needle has undergone considerable evolution over time, especially as regards the so-called "eye". Initially, in fact, the needle was very similar to those usually used in tailoring, equipped with an eye for the passage of the thread and for this reason they were particularly traumatic when crossing the tissue. With the advent of the laser, the eye was transformed into a flattened extremity directly connected to the suture material as a single unit without variations in caliber, thus resolving the trauma (Fig. 11).

Fig 11.

The body of the needle connects the end with the tip and can have different sections (triangular, round, rectangular or trapezoidal) which lead to variations in terms of handling, ease of penetration into the tissues and degree of trauma.

Fig 12.

Another characteristic of the needles is the curvature, the choice of which is mainly conditioned by the depth of the tissue we want to suture and the narrowness of the space in which we have to move the needle. For example, the needle with half circle curvature is used in narrow spaces that require a large pronation/supination range of the wrist. Needles with a 5/8 circle curvature are usually chosen to suture deep tissues in confined spaces, such as for example the suturing of the muscle fascia through a laparoscopic access (Fig. 13).

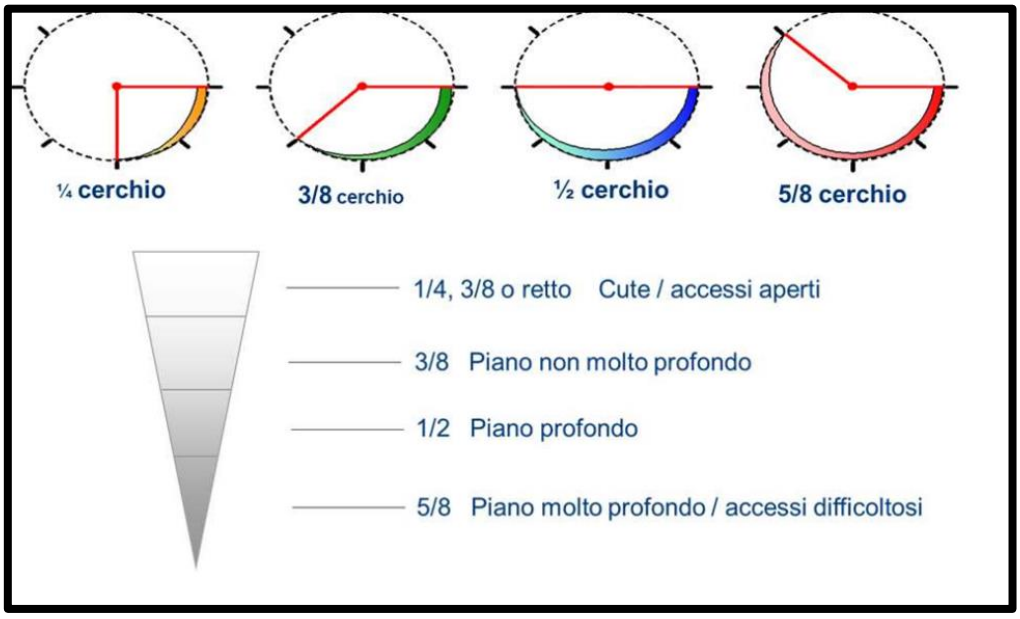

Fig 13.

SUTURE MATHERIAL

The suture material corresponds to the suture thread; it is equipped with numerous and variable characteristics in order to adapt to the multiplicity of tissue. Theoretically, the suture material should be endowed with ideal properties:

- Biocompatibility
- Inertia
- Sterility
- Wound support
- Atraumatic
- Minimize the local inflammatory response

Suture material can be classified according to the following parameters:

1. **Origin: natural or synthetic**

   The natural filament derives from raw materials of natural origin, vegetal (silk, ...) or animal (Catgut, ...), while the synthetic one derives from the polymerization of molecules or compounds of chemical origin such as polypropylene (prolene), polyester, nylon, polyglactin.

Natural filaments have the advantage of being easy to handle, despite inducing a strong local inflammatory response. On the contrary, synthetic filaments are difficult to handle as they have memory but have greater tensile strength than natural fibers thanks to a minimal local inflammatory response.

2. **Biodegradability: absorbable or non-absorbable**

Both natural and synthetic filaments can be absorbable or non-absorbable. The natural material undergoes enzymatic degradation promoted by proteases released by phagocytes called up by the inflammatory process. The synthetic one, on the other hand, is degraded through the hydrolysis process of the monomers: different combinations of monomers in the composition of the synthetic filaments give them different degradation times and therefore greater or lesser strength (Fig.14).

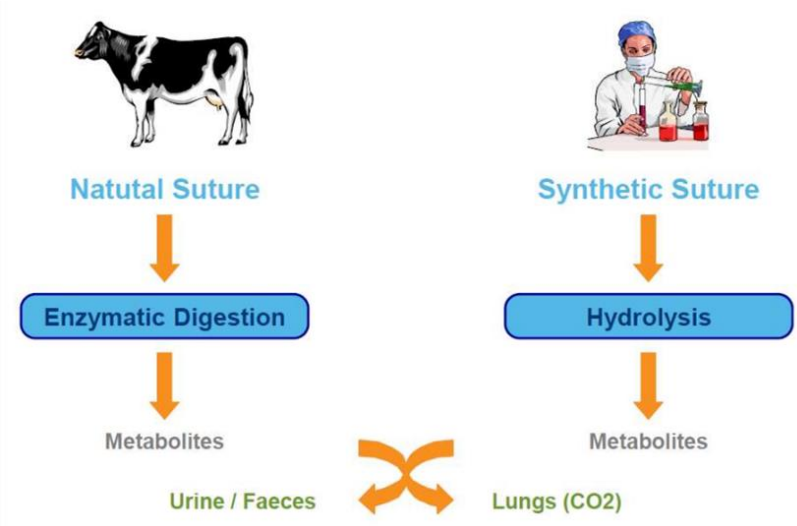

Fig 14.

3. **Structure: monofilament or multifilament**

Monofilaments, as the name suggests, are composed of a single filament that constitutes their structure. They have a uniform, low-traumatic surface and low capillarity which translates into little possibility of transmitting bacteria. On the other hand, monofilaments are equipped with memory which makes them difficult to handle and require more knots to ensure stitch retention considering the uniformity of the surface (Fig. 15).

Fig 15.

Multifilaments are instead composed of several thin monofilaments which can be wrapped around a central core (braided sutures) or twisted on themselves (twisted sutures). Unlike monofilaments, they are much more manageable given the absence of shape memory and, given the irregularity of the surface, they guarantee greater knot strength. For the same reason, however, they are more traumatic when crossing the tissues and, due to their capillarity, they favor bacterial colonization (Fig. 16).

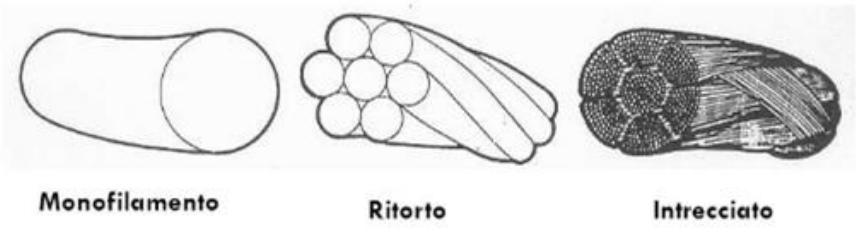

Fig 16.

4. Caliber

Suture threads are named according to their calibre, which is classified according to the USP scale. Larger caliber filaments are marked with numbers higher than 0: the higher the number, the greater the caliber. For example, a 2 filament will have a larger gauge than a 1 filament. On the contrary, those with a smaller gauge are characterized by a number of 0s inversely proportional to the gauge. For example, a 3-0 [000] filament will have smaller gauge than a 2-0 [00] filament (Fig. 17).

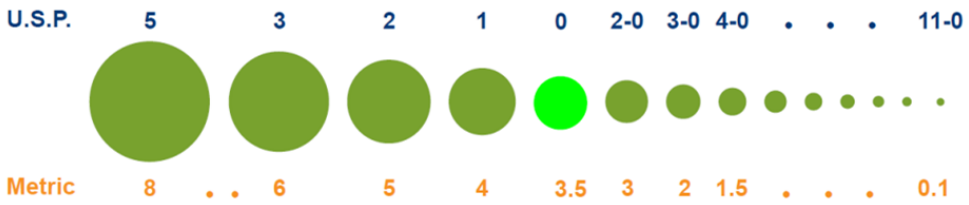

Fig 17.

All the characteristics, both for needled and suture material, are shown on the suture thread packaging to facilitate recognition.

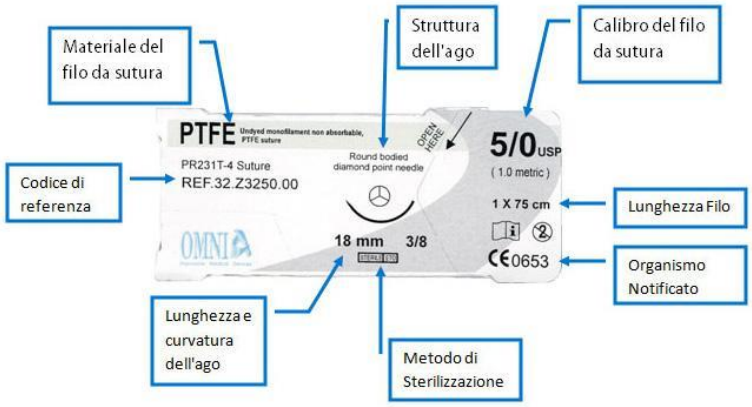

Fig 18.

The choice of filament and needle to use depends on many factors such as:

- The condition of the wound
- The location of the wound
- The resistance of the tissue
- The resistance of the wire
- The tightness of the knot
- The expected wound healing times

SUTURING PRINCIPLES

Sterile Gloves

To maintain asepsis and avoid further contamination of the wound, it is good practice to carry out disinfection practices and subsequent suturing while wearing sterile gloves.

The gloves are contained in a sterile package which is in turn inserted into a non-sterile plastic liner. Once this covering has been opened, the package containing the gloves must be placed on the work surface. The casing is then opened like a book inside which there are two pockets where the gloves are housed. Being careful not to touch the tips of the gloves, we pull the tab on the two sides of the package to expose them. We take the first glove at the cuff, lifting it between the thumb and forefinger and put it on the contralateral hand, always pulling at the level of the cuff, leaving it as it is and waiting to fix it until we have also put on the other **glove**.

Local anesthesia

Before proceeding with the wound closure it is necessary to inoculate a local anesthetic so that the patient does not feel pain during repeated passages of the needle through the skin. Anesthetics have the task of blocking the pain nerve fibers in a temporary and reversible manner, favoring the disappearance of the sensation of pain during the procedure. In the case of skin wounds, the most commonly used anesthesia is infiltration, i.e. the inoculation of the anesthetic substance via a needle. Anesthetics such as lidocaine and mepivacaine (aminoamides) are usually used which have poor systemic toxicity, hepatic metabolism, rarely cause allergic reactions and have a rapid onset anesthetic effect. Sometimes it is possible to add adrenaline to the solution which, thanks to its vasoconstrictor action, slows down the systemic diffusion of the drug, reduces bleeding and prolongs the duration of the anesthetic effect or sodium bicarbonate which relieves the burning sensation that the patient may feel during the injection.

Practical considerations

- Orientate the syringe needle almost parallel to the skin
- Insert the needle into the subdermal layer of the wound margin, not penetrating the skin and advance the needle to its end

- Aspirate to avoid administration of the anesthetic substance directly into the blood circulation and then inject the anesthetic while slowly retracting the needle, without however extracting it completely

- Redirect the needle in other directions at the unanesthetized skin and continue to administer the anesthetic

- Wait a few minutes for the anesthetic to become effective.

Suture

The execution of the suture must respect very precise rules in order to correctly bring together the edges of the wound and promote correct healing. We start from the correct **grip of the instruments**, in particular the needle holder, which is the instrument with which we grasp the needle and with which we apply the necessary force so that the latter can pass through the tissue. The needle holder must be held by inserting the thumb and ring finger into the rings, while the index finger is kept extended along the stem in order to give stability to the gesture. With the branches of the needle holder we grasp the needle 2/3 of the way from the tip (Fig. 19) and, with the help of the forceps, we let it penetrate perpendicularly through one of the two edges of the wound, approximately 3-4 mm from the edge (Fig. 20 - 21) and we let it come out on the other edge equidistant manner. The depth of penetration must be symmetrical on both sides of the wound (Fig. 22).

Fig 19.

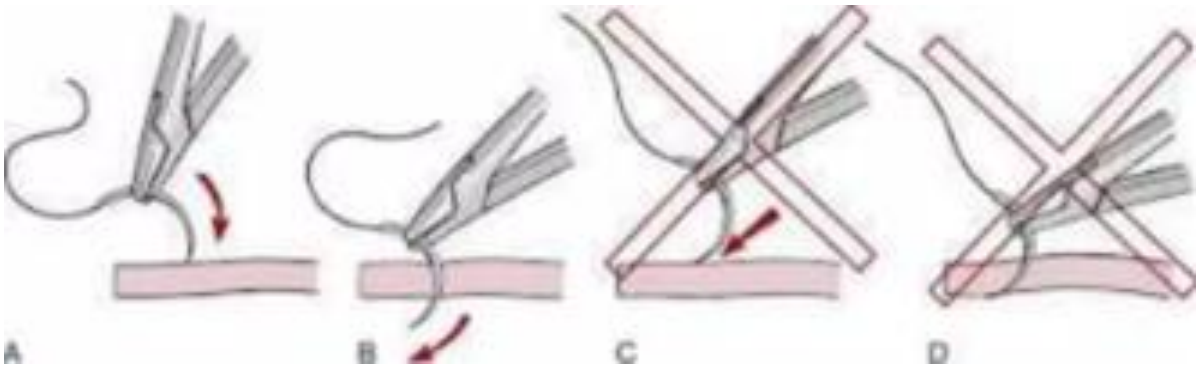

Fig 20.

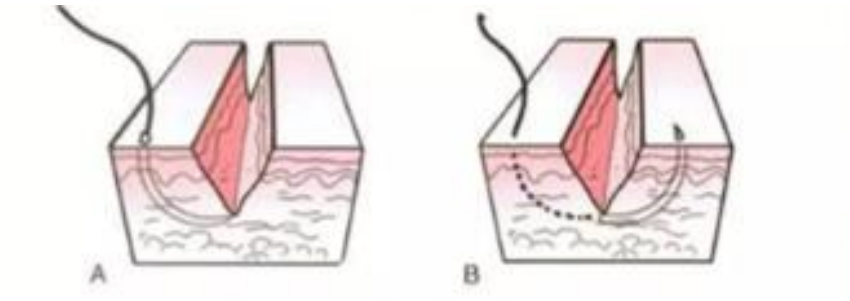

Fig 21.

Fig 22.

TYPES OF SUTURE

Suturing techniques are divided into two broad categories:

- Interrupted sutures
- Continuous sutures

Interrupted sutures consist of the creation of detached stitches, spaced about one cm apart from each other (Fig. 23). It is the most commonly used suture for addressing the skin, dermal, subcutaneous or deep plane margins. They require longer execution times, are less hermetic and haemostatic but ensure greater tightness as they allow the tension of each individual point to be dosed. Furthermore, in the event that some stitches give way, dehiscence of the entire wound does not occur, the edges of which remain close to the stitches still in place.

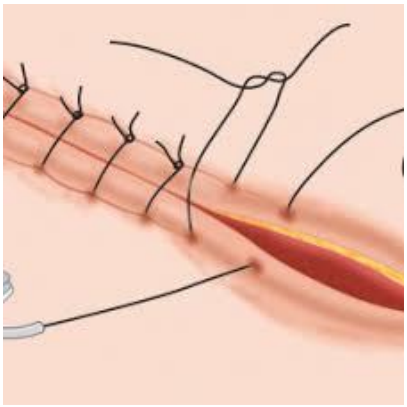

Fig 23.

Continuous sutures, on the other hand, are made with the same thread which is not interrupted as in detached stitch sutures (Fig. 24). This makes them quick to perform and hemostatic. However, the failure of just one of the passages leads to dehiscence of the entire wound. Running sutures are rarely used for skin fixation; more commonly they are used for the juxtaposition of the deep planes, muscle fascia and subcutaneous tissue, or in the creation of intradermal sutures.

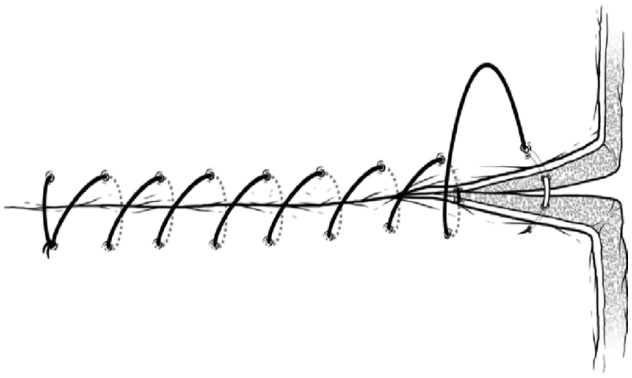

Fig 24.

Let's see two examples of interrupted sutures:

1. **Simple stitches:** frequently used to suture the skin, for which an extroflexing stitch is performed which allows good extroflexion of the skin edges in order to obtain the best possible approach. After each stitch, knotting is performed and the knot must fall on one side of the wound. Each individual stitch ensures proper wound closure without tension and the wound will not open if a stitch breaks. The disadvantage is that it takes more time as every single stitch requires knotting (Fig. 25). Absorbable or non-absorbable materials, monofilaments or multifilaments can be used to suture the skin, depending on the characteristics of the wound and its location. If non-absorbable threads are used, it will be necessary to remove the stitches once the wound has consolidated.

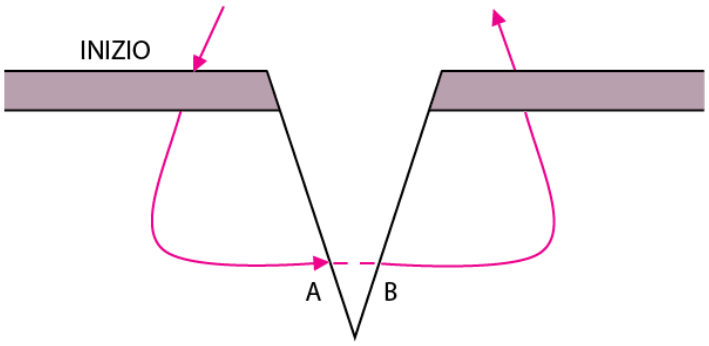

Fig 25.

2. **Detached stitches according to Donati:** it is a 2-layer skin suture with a sealing and haemostasis function. It consists of a deep passage involving the skin and subcutaneous tissue and a return point involving the edges of the skin (allowing the edges to approximate). The two passages are on a vertical plane, perpendicular to the wound (Fig. 26).

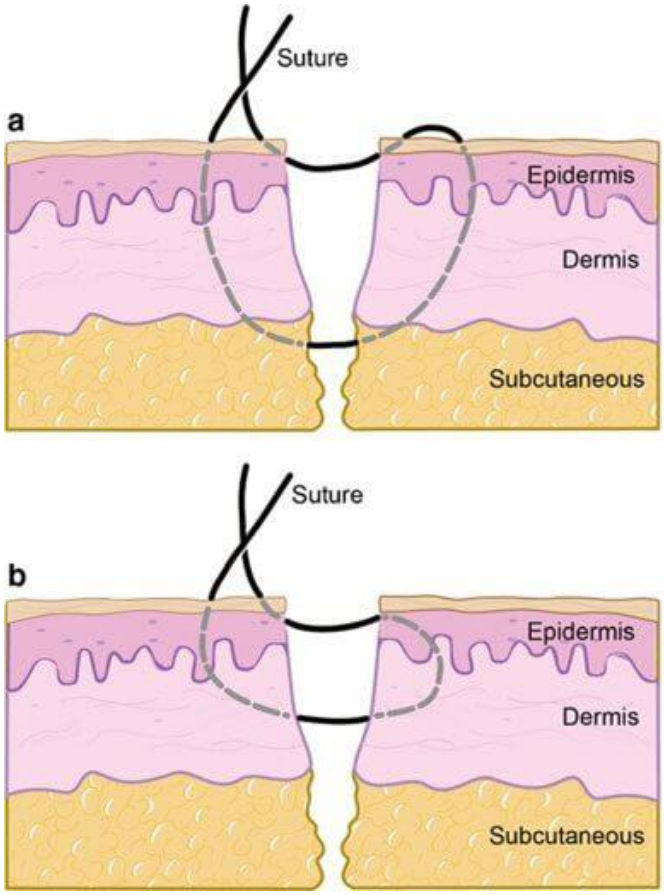

Fig 26.

Now two examples of continuous sutures:

1. **Overlocking:** start from one end of the wound by making the first stitch and tightening it with a knot. The long end of the thread is not cut but used to give subsequent stitches, equidistant, up to the other end of the wound where it is knotted a second time. This technique does not allow check the tension of the intermediate points which tend to loosen (Fig. 27).

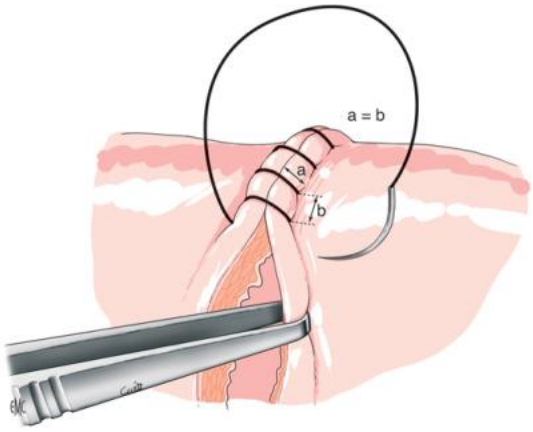

Fig 27.

2. **Intradermal:** continuous suture made in the thickness of the dermis which proceeds from one end of the wound to the other producing invisible scars. Used for suturing clean surgical wounds to achieve the best aesthetic results. It can actually also be made with detached stitches in absorbable material (Fig. 28).

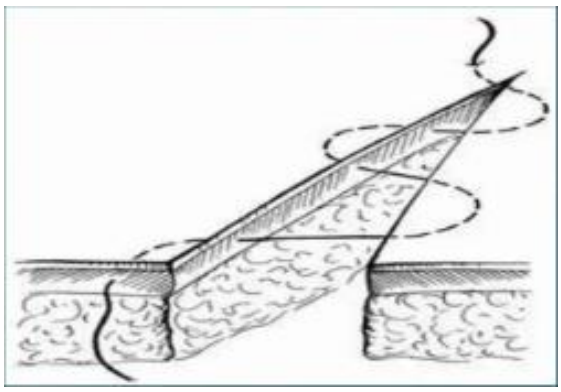

Fig 28.

KNOTS

The fixation of the stitches is carried out by tying knots. The knot, or complete knot, is made up of the sequence of two semi-nodes.

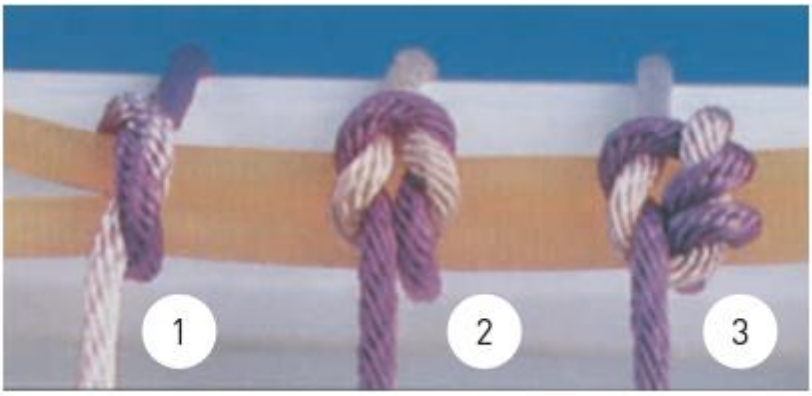

Fig 29. 1) Semi-knot, 2) Square-knot, 3) Surgical knot

A knot must be tied correctly in order to guarantee its tightness which depends not only on the intrinsic variables of the different suture materials but also on the speed of its execution which can compromise its perfect realization. Some general principles govern the execution of all nodes:

- The knot must be tightened so that the tendency to loosen is theoretically impossible
- The knot must be as small as possible to avoid excessive tissue reaction when using absorbable suture materials.
- The sutures must not be tied too tightly to avoid strangulation of the tissues which inevitably leads to tissue ischemia and suture failure.

Basic knots

Square or flat knot: consists of creating a simple straight half knot followed by an additional knot called a flat knot.

Surgical knot: consists of creating a double straight half knot (twice braided) followed by the additional super knot. Usually, a third definitive fixing knot is made but, depending on the materials used, it may be necessary to make numerous additional knots to ensure the tightness of the knot.

Fig 30.

Fig 31.

Knots can be made with two hands, with **one hand** or with the **aid of a needle holder**.

Removal of stitches

The stitch removal times vary depending on the type of wound and its location, generally no earlier than 7 days. To remove the detached stitches we will need a scalpel blade and forceps. It is necessary to grab one of the tails of the suture stitch and pull it upwards so as to lift the knot from the skin surface and cut the thread near the knot with the scalpel blade. In this way the thread can subsequently be removed (Fig. 32).

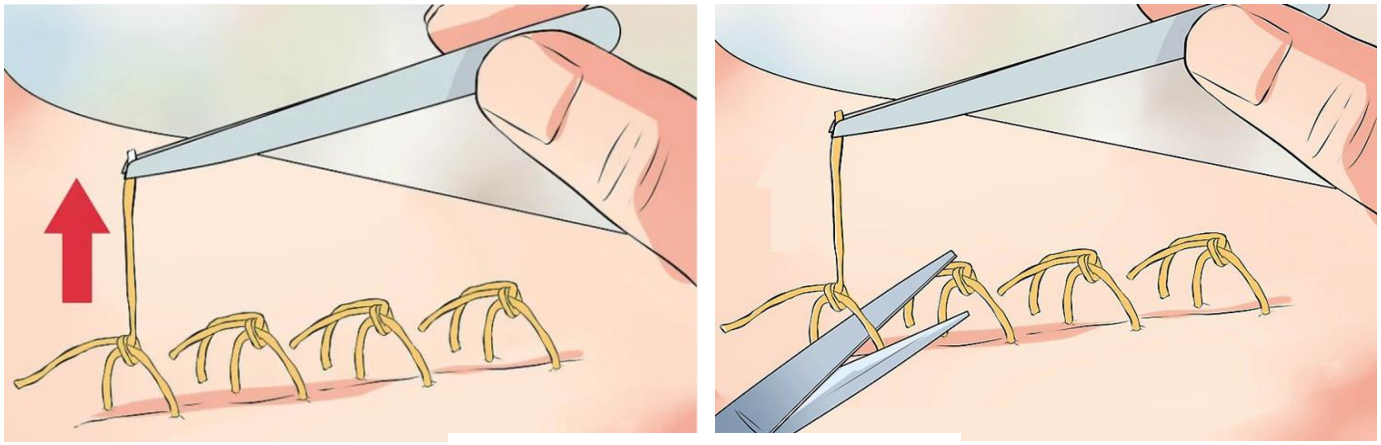

Fig 32.