EUROPEAN MEDICAL STUDENTS' ASSOCIATION
CRIMEA STATE MEDICAL UNIVERSITY CHAPTER

HANDBOOK OF SURGICAL SUTURES AND KNOTS

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EMSA-CSMU

FOREWORD

Although surgery bears upon all sciences, yet, surgery itself can be seen as an art. What differentiates the best surgeon from the better one, is the ability of not just being able to manage the immediate and critical situations dynamically and to analyze the diseases interdisciplinarily , but his ability to perform perfect, aimful and economical coordination of operational movements. The refined technique of the handling and uniting the tissues –in the case of manual skills– is attainable by many practices, and the good surgeon works on the perfection of this technique in his daily operating activities. Dexterity and speed in tying knots correctly constitute an art which only practice can make perfect.

This handbook explains and demonstrates the principle maneuvers of knot tying along with step by step descriptions of each maneuver. The most commonly used suture patterns and knots are described and illustrated, along with Information on suture materials and surgical needles used for sutures and knots

It is our hope that this handbook will be useful to medical students and residents as a quick guide to basic suture patterns and methods of knot tying.

Special thanks to the members of the EMSA-CSMU academic team for putting in their best and time into writing this manual

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INTRODUCTION TO SUTURING

WHAT IS A SUTURE?

The word "suture" describes any strand of material used to ligate (tie) blood vessels or approximate (bring close together) tissues. *Sutures* are used to close wounds

SUTURE COMPONENTS

A) **THREAD**
B) **NEEDLE**

TYPES OF THREAD

Surgical suture material can be classified on the basis of the characteristics absorbability, origin of material and thread structure.
They can be absorbable or non-absorbable; synthetic or natural; mono- or multi- filamentous.

ABSORPTION

Absorption can occur enzymatically, as with catgut, or hydrolytically, as with the absorbable synthetic polymers. An important measure of absorbability is the absorption time or halflife, which is defined as the time required for the tensile strength of a material to be reduced to half its original value. Dissolution time is the time that elapses before a thread is completely dissolved. These times are influenced by a large number of factors including thread thickness, type of tissue, and, not least, the general condition of the patient.
The most important absorption and dissolution times are shown in the following table:

Approximate absorption times of synthetic suture materials

Material	Half-life (days)	Dissolution time (days)
Serapid®	6 - 8	30 - 42
Serafit®	15 - 20	60 - 90
Serasynth®	28 - 42	180 – 210

ORIGIN OF MATERIAL

Suture materials can be classified as being of natural or synthetic origin. The former include silk and catgut. The other main groups of suture materials are those produced from synthetic polymers such as polyamide, polyolefines and polyesters. This group also includes absorbable polymers derived from polyglycolic acid.

STRUCTURE OF THREAD

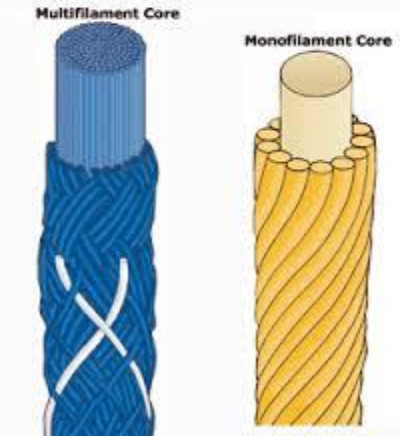
Monofilament and multifilament thread structures are distinguished.

Monofilament threads

Synthetic monofilament threads are produced by a special extrusion process in which molten plastic is extruded under high pressure through fine spinnerets. The monofilament structure is used mostly for thinner threads. With thicker threads the wiriness that is a characteristic of all monofilament threads impairs handling and in particular renders knot-tying more difficult. Because of their smooth, closed surface and completely closed interior, monofilament threads have no capillarity. On the other hand, the ease with which they pass through tissue is unsurpassed.

Multifilament threads

Multifilament threads are composed of many fine individual threads either twisted or braided together. The direction of the twist is generally right-handed. Twisted multifilament threads include e.g. silk threads. All twisted threads show considerable variation in diameter. Their surface is mostly rough. The longitudinal orientation of the individual filaments within the thread results in relatively high capillarity. In braided threads the individual filaments lie more or less obliquely to the longitudinal axis of the thread. This tends to impede the passage of fluid. The capillarity of braided threads is therefore less than that of twisted threads. Multifilament threads have a rough surface that impairs passage through tissue but results in considerably better knot holding security. Multifilament threads are generally coated. The coating smoothes out the irregular surface and thus facilitates passage through tissue without impairing knot-holding security. Coated multifilament threads are less stiff and wiry than monofilament threads. The coating also reduces capillarity.



Absorbable Suture Materials

Material	Structure	Tis. rxn	Strength	T ½	Uses
Gut	Natural	++++	++	5-7d	Mucosal closure, rare
Chromic Gut	Natural	++++	++	10-14d	Mucosa, perineal
Dexon	Braided	++	+++	25d	Sub Q closures
Vicryl	Braided	++	++++	28d	Mucosal closures
Maxon	Monofil	+	+++++	28-36d	Sub Q closures

Non-absorbable Suture Materials

Material	Structure	Tis. Rxn	Strength	Knot sec.	Uses
Silk	Braided	++++	++	++++	Easy to handle
Nylon	Monofil	++	+++	++	Common for skin cl.
Prolene	Monofil	+	++++	+	High memory, sub Q pull
Dacron	Braided	+++	++	++++	Good knot security

SUTURE SELECTION

- **Do not use dyed sutures on the skin**
- **Use monofilament on the skin as multifilament harbor BACTERIA**
- **Non-absorbable cause less scarring but must be removed**
- **Plus sutures (monocryl for E. coli, Klebsiella)**
- **Location and layer, patient factors, strength, healing, site and availability**
- **Absorbable for GI, urinary or biliary**
- **Non-absorbable or extended for up to 6 mos for skin, tendons, fascia**
- **Cosmetics = monofilament or subcuticular**
- **Ligatures usually absorbable**

Suture sizing by indication

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

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

NEEDLES

Necessary for the placement of sutures in tissue, surgical needles must be designed to carry suture material through tissue with minimal trauma. They must be sharp enough to penetrate tissue with minimal resistance. They should be rigid enough to resist bending, yet flexible enough to bend before breaking. They must be sterile and corrosion-resistant to prevent introduction of microorganisms or foreign bodies into the wound.

The best surgical needles are:

- **Made of high quality stainless steel.**
- **As slim as possible without compromising strength.**
- **Stable in the grasp of a needleholder.**
- **Able to carry suture material through tissue with minimal trauma.**
- **Sharp enough to penetrate tissue with minimal resistance.**
- **Rigid enough to resist bending, yet ductile enough to resist breaking during surgery.**
- **Sterile and corrosion-resistant to prevent introduction of microorganisms or foreign materials into the wound.**

Note:

The penetration force of a needle depends in the first line on its shape and the polished and etched microsection of the tip, and less on the quality of the steel

· Ductility: how often a needle can be bent back and forth before it breaks

· Austenite: microstructure of steel. Austenitic microstructure is face-centred cubic, forms at high temperatures above approx. 1300°C and only remains stable at these temperatures. The addition of alloy components such as nickel and manganese, however, maintains this structure at room temperature.

· Martensite: microstructure of steel. Martensitic microstructure forms at high temperatures. It is extremely hard and the structure can be maintained by rapid cooling ("quenching").

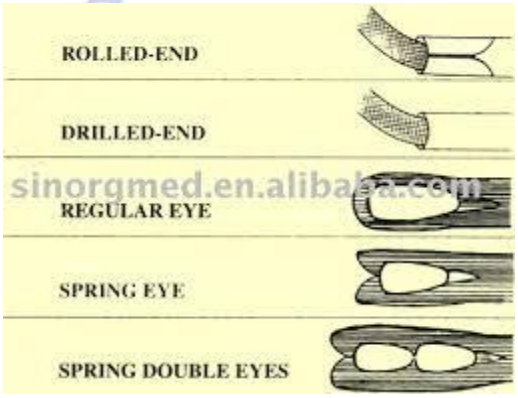
TYPES OF NEEDLES

ATRAUMATIC NEEDLES

Atraumatic sutures are defined as needle-suture combinations, where the needle is firmly attached to the suture in order to reduce tissue trauma.

SPRING-EYED NEEDLES

Spring eye surgical needles are made of 300-series stainless steel. This generation of needles is characterised by optimum resistance to bending, the best possible ductility and outstanding tissue penetration. This guarantees safe and simple working conditions.

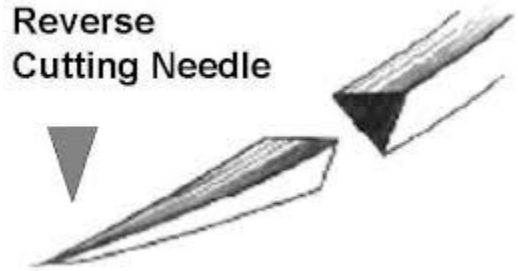


REVERSE CUTTING NEEDLE

These needles were created specifically for tough, difficult to penetrate tissue such as skin, tendon sheath, or oral mucosa. Reverse cutting needles are used in ophthalmic and cosmetic surgery where minimal trauma, early regeneration of tissue, and little scar formation are primary concerns.

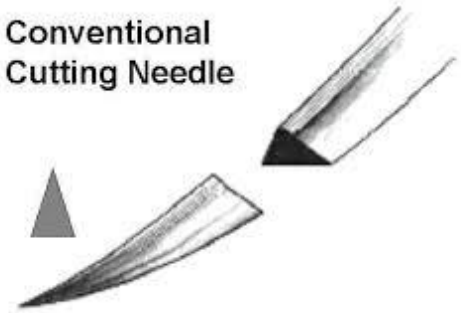
ADVANTAGES

- **Reverse cutting needles have more strength than similar-sized conventional cutting needles.**
- **The danger of tissue cutout is greatly reduced.**
- **The hole left by the needle leaves a wide wall of tissue against which the suture is to be tied.**



CONVENTIONAL CUTTING NEEDLES

In addition to the two cutting edges, conventional cutting needles have a third cutting edge on the inside concave curvature of the needle. The shape changes from a triangular cutting blade to that of a flattened body on both straight and curved needles. This needle type may be prone to cutout of tissue because the inside cutting edge cuts toward the edges of the incision or wound.



SURGICAL SUTURES

Classification of suture types

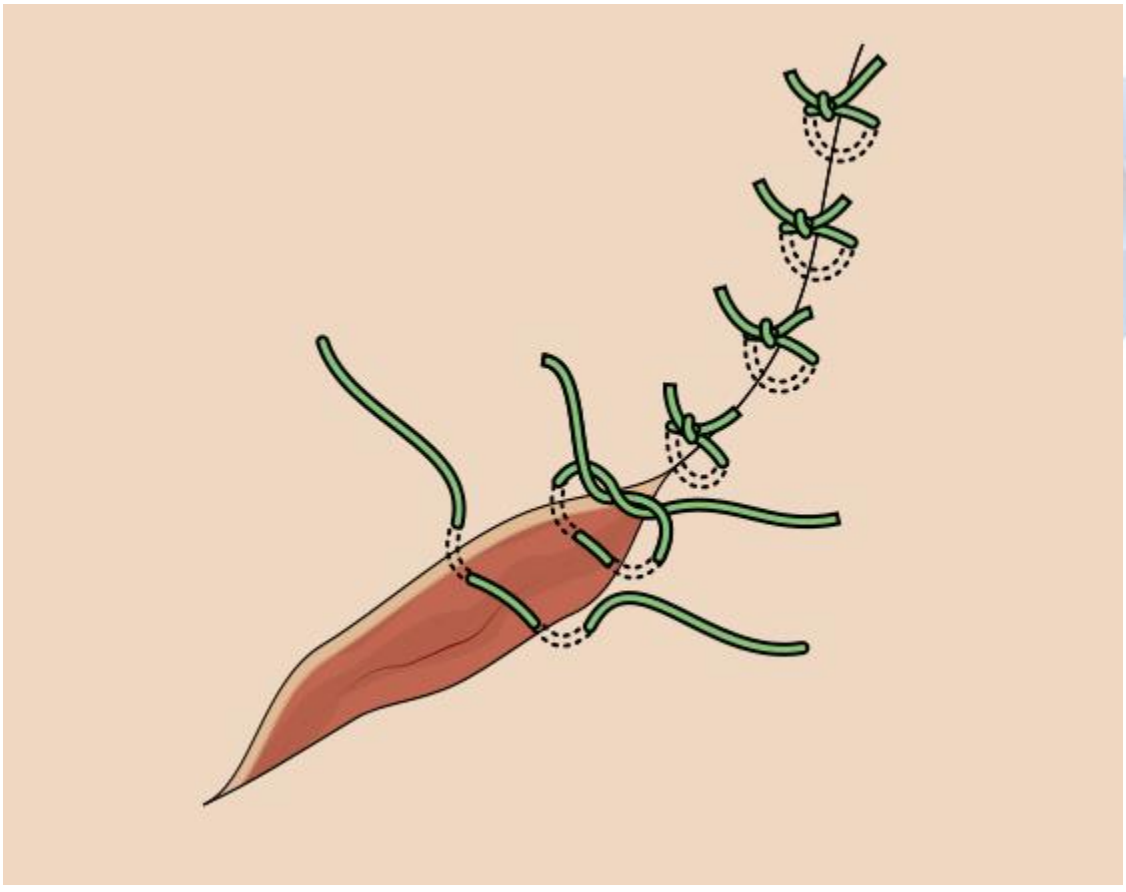
- **According to layer: One layer (if we approximate only one layer of tissues), two or more layers**
- **According to depth: one or two lines (rarely more lines)**
- **According to length: interrupted or continuous suture line**

General rules of the stitches:

- **Not too close to the margin of the wound**
- **Stitches should be placed in the same distance**
- **Knots should be placed out of the wound line**
- **No wrinkles or gaps**
- **Avoid the overturn of the edges of the wound (exception purse-string ligature)**

Simple interrupted sutures

The most commonly used and versatile suture in cutaneous surgery is the simple interrupted suture. This suture is placed by inserting the needle perpendicular to the epidermis, traversing the epidermis and the full thickness of the dermis, and exiting perpendicular to the epidermis on the opposite side of the wound. The 2 sides of the stitch should be symmetrically placed in terms of depth and width. In general, the suture should have a flask-shaped configuration, that is, the stitch should be wider at its base (dermal side) than at its superficial portion (epidermal side). If the stitch encompasses a greater volume of tissue at the base than at its apex, the resulting compression at the base forces the tissue upward and promotes eversion of the wound edges. This maneuver decreases the likelihood of creating a depressed scar as the wound retracts during healing (see image below). Simple interrupted suture placement.

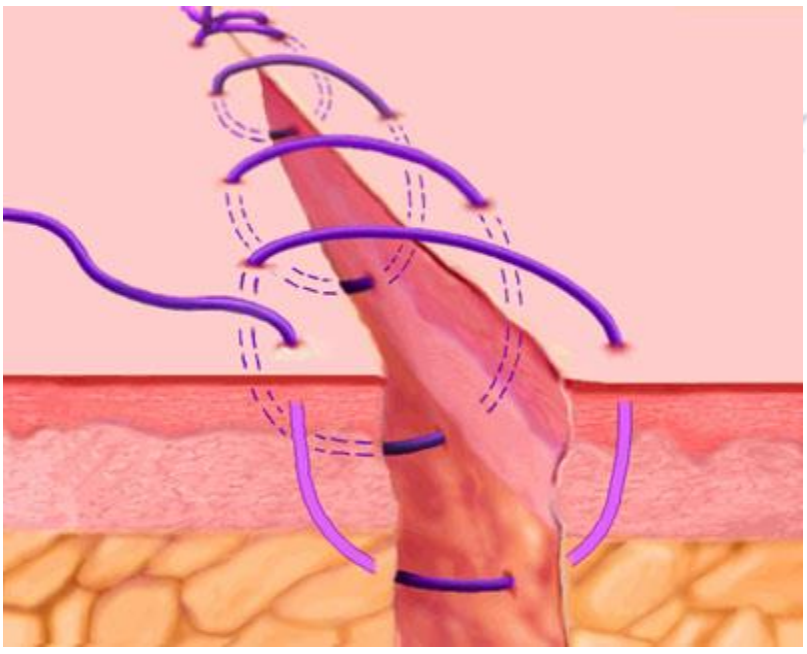


Simple interrupted suture placement. Image shows a flask-shaped stitch, which maximizes eversion.

In general, tissue bites should be evenly placed so that the wound edges meet at the same level to minimize the possibility of mismatched wound-edge heights (ie, stepping). However, the size of the bite taken from the 2 sides of the wound can be deliberately varied by modifying the distance of the needle insertion site from the wound edge, the distance of the needle exit site from the wound edge, and the depth of the bite taken. The use of differently sized needle bites on each side of the wound can correct preexisting asymmetry in edge thickness or height. Small bites can be used to precisely close wound edges. Large bites can be used to reduce wound tension. Proper tension is important to ensure precise wound approximation while preventing tissue strangulation.

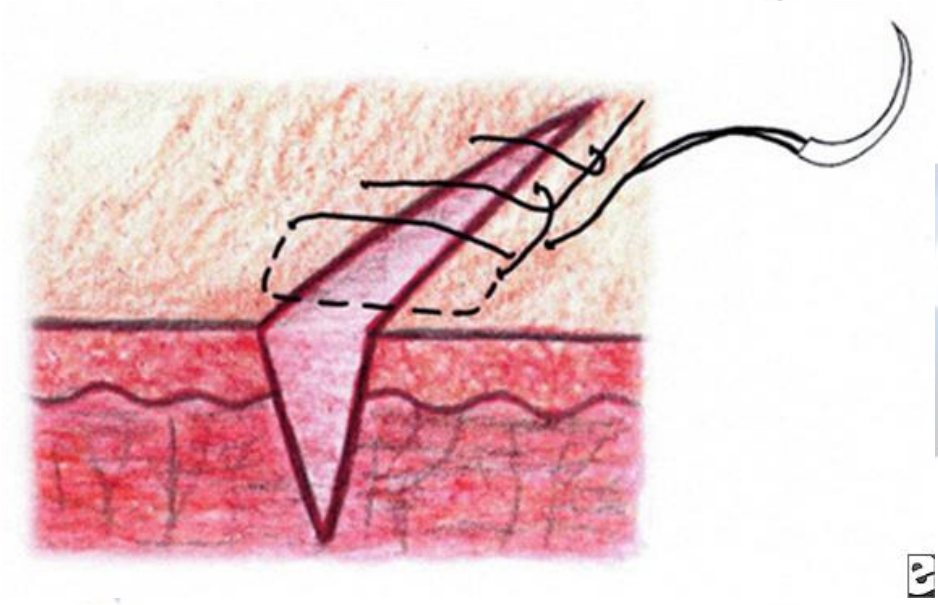
Simple running sutures

The simple running suture is an uninterrupted series of simple interrupted sutures. The suture is started by placing a simple interrupted stitch, which is tied but not cut. A series of simple sutures are placed in succession without tying or cutting the suture material after each pass. Sutures should be evenly spaced, and tension should be evenly distributed along the suture line. The line of stitches is completed by tying a knot after the last pass at the end of the suture line. The knot is tied between the tail end of the suture material where it exits the wound and the loop of the last suture placed.



Running locked sutures

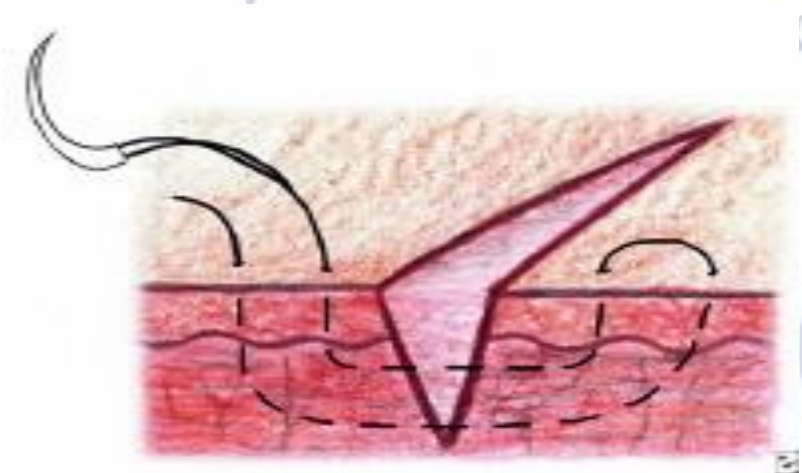
The simple running suture may be locked or left unlocked. The first knot of a running locked suture is tied as in a traditional running suture and may be locked by passing the needle through the loop preceding it as each stitch is placed. This suture is also known as the baseball stitch (see image below) because of the final appearance of the running locked suture line.



Running locked suture.

Vertical mattress sutures

The vertical mattress suture is a variation of the simple interrupted suture. It consists of a simple interrupted stitch placed wide and deep into the wound edge and a second more superficial interrupted stitch placed closer to the wound edge and in the opposite direction. The width of the stitch should be increased in proportion to the amount of tension on the wound. That is, the higher the tension, the wider the stitch (see image below).



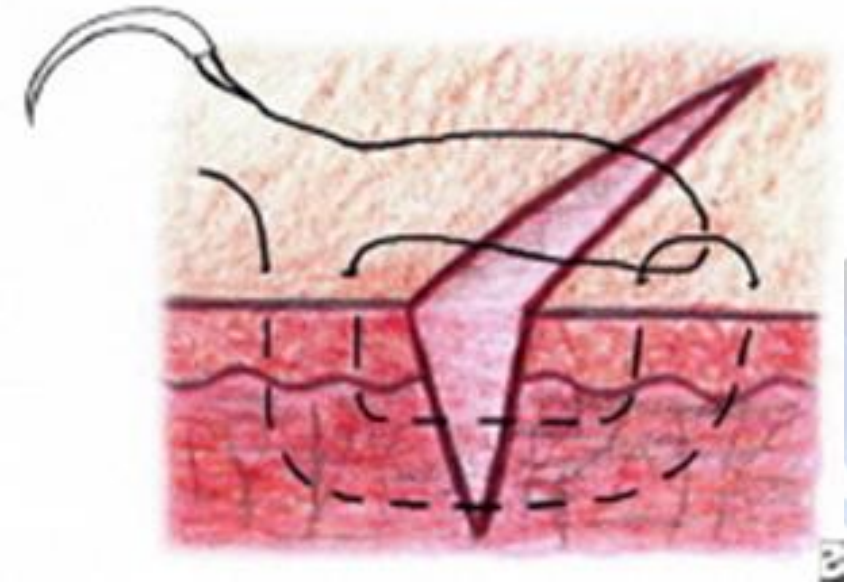
Vertical mattress suture.

Half-buried vertical mattress sutures

The half-buried vertical mattress suture is a modification of the vertical mattress suture and eliminates 2 of the 4 entry points, thereby reducing scarring. The half-buried vertical mattress suture is placed in the same manner as the vertical mattress suture, except that the needle penetrates the skin to the level of the deep part of the dermis on one side of the wound, takes a bite in the deep part of the dermis on the opposite side of the wound without exiting the skin, crosses back to the original side of the wound, and exits the skin. Entry and exit points therefore are kept on one side of the wound.

Pulley sutures

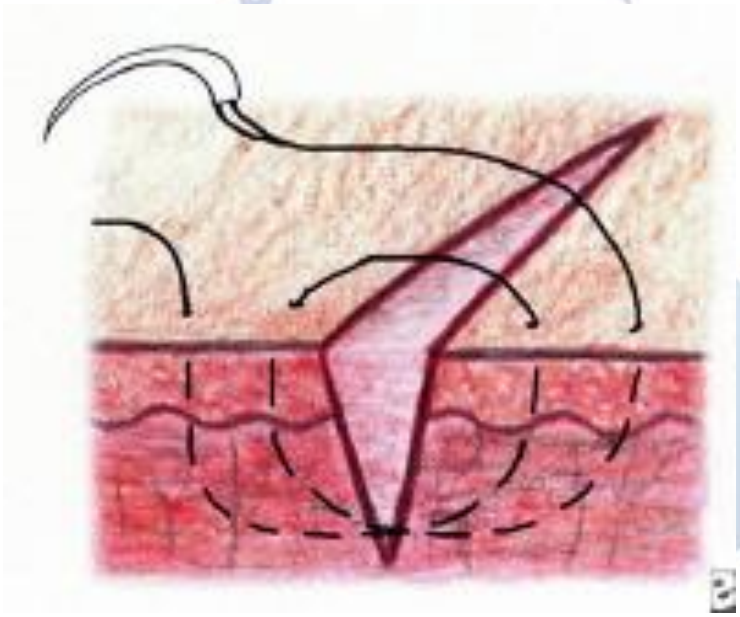
The pulley suture is a modification of the vertical mattress suture. When pulley sutures are used, a vertical mattress suture is placed, the knot is left untied, and the suture is looped through the external loop on the other side of the incision and pulled across. At this point, the knot is tied. This new loop functions as a pulley, directing tension away from the other strands (see image below). Pulley stitch, type 1.



***Pulley stitch, type 1*.**

Far-near near-far modified vertical mattress sutures

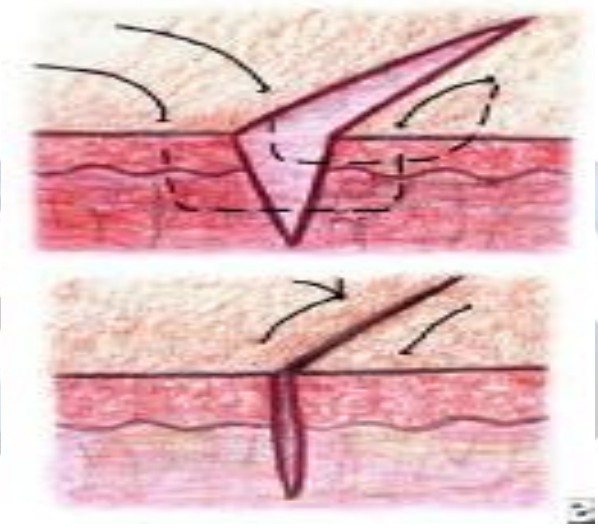
Another stitch that serves the same function as the pulley suture is the far-near near-far modification of the vertical mattress suture. The first loop is placed approximately 4-6 mm from the wound edge on the far side and approximately 2 mm from the wound edge on the near side. The suture crosses the suture line and reenters the skin on the original side at 2 mm from the wound edge on the near side. The loop is completed, and the suture exits the skin on the opposite side 4-6 mm away from the wound edge on the far side. This placement creates a pulley effect (see image below).



Far-near near-far pulley stitch.

Horizontal mattress suture

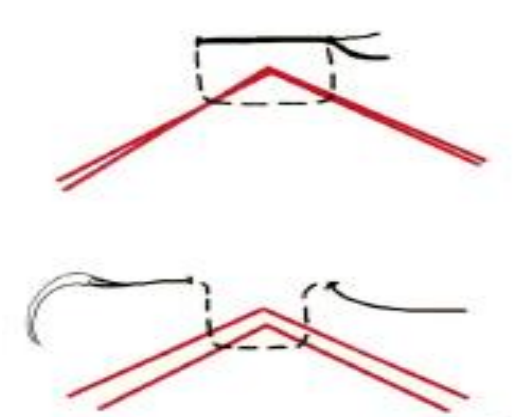
The horizontal mattress suture is placed by entering the skin 5 mm to 1 cm from the wound edge. The suture is passed deep in the dermis to the opposite side of the suture line and exits the skin equidistant from the wound edge (in effect, a deep simple interrupted stitch). The needle reenters the skin on the same side of the suture line 5 mm to 1 cm lateral of the exit point. The stitch is passed deep to the opposite side of the wound where it exits the skin and the knot is tied .



***Horizontal mattress suture*.**

Half-buried horizontal sutures or tip stitches or 3-point corner stitches

The half-buried horizontal suture or tip stitch begins on the side of the wound on which the flap is to be attached. The suture is passed through the dermis of the wound edge to the dermis of the flap tip. The needle is passed laterally in the same dermal plane of the flap tip, exits the flap tip, and reenters the skin to which the flap is to be attached. The needle is directed perpendicularly and exits the skin; then, the knot is tied (see image below).



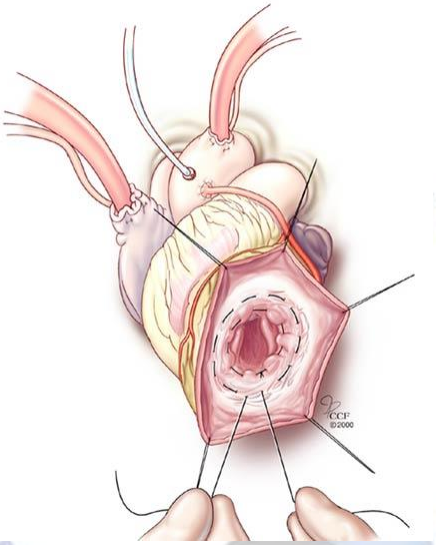
Tip stitch.

Dermal-subdermal sutures

The suture is placed by inserting the needle parallel to the epidermis at the junction of the dermis and the subcutis. The needle curves upward and exits in the papillary dermis, again parallel to the epidermis. The needle is inserted parallel to the epidermis in the papillary dermis on the opposing edge of the wound, curves down through the reticular dermis, and exits at the base of the wound at the interface between the dermis and the subcutis and parallel to the epidermis. The knot is tied at the base of the wound to minimize the possibility of tissue reaction and extrusion of the knot. If the suture is placed more superficially in the dermis at 2-4 mm from the wound edge, eversion is increased.

Buried horizontal mattress suture

The buried horizontal mattress suture is a purse-string suture. The suture must be placed in the mid-to-deep part of the dermis to prevent the skin from tearing. If tied too tightly, the suture may strangulate the approximated tissue.



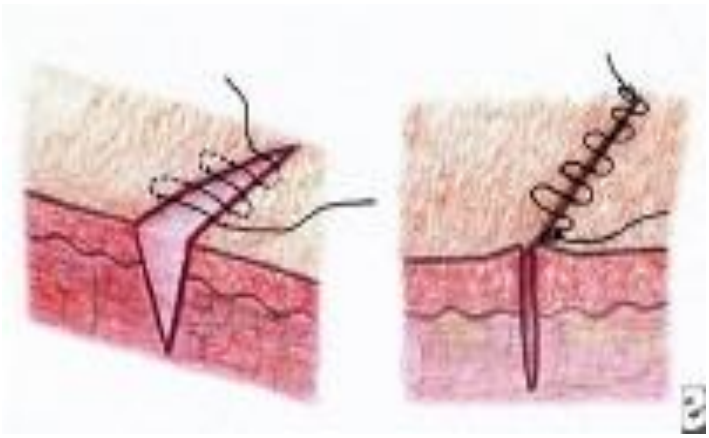
purse-string suture

Running horizontal mattress sutures

A simple suture is placed, and the knot is tied but not cut. A continuous series of horizontal mattress sutures is placed, with the final loop tied to the free end of the suture material.

Running subcuticular sutures

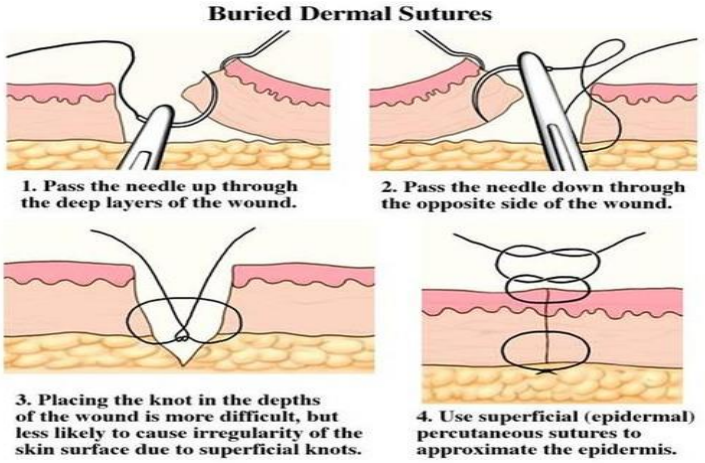
The running subcuticular suture is a buried form of the running horizontal mattress suture. It is placed by taking horizontal bites through the papillary dermis on alternating sides of the wound. No suture marks are visible, and the suture may be left in place for several weeks



Subcuticular stitch. The skin surface remains intact along the length of the suture line.

Running subcutaneous sutures

The running subcutaneous suture begins with a simple interrupted subcutaneous suture, which is tied but not cut. The suture is looped through the subcutaneous tissue by successively passing through the opposite sides of the wound. The knot is tied at the opposite end of the wound by knotting the long end of the suture material to the loop of the last pass that was placed.



Running subcutaneous corset plication stitches

Before inserting the needle, forceps are used to pull firmly on at least 1-2 cm of tissue to ensure tissue strength. The corset plication includes at least 1-2 cm of adipose tissue and fascia within each bite. After the first bite is tied, bites are taken on opposite sides of the wound in a running fashion along the defect. The free end is pulled firmly reducing the size of the defect, and the suture is then tied.

Variations of tip (corner) sutures

Modified half-buried horizontal mattress sutures

This stitch places an additional vertical mattress suture superficial to the half-buried horizontal mattress suture. A small skin hook instead of forceps is used to avoid trauma of the flap.

Deep tip stitch

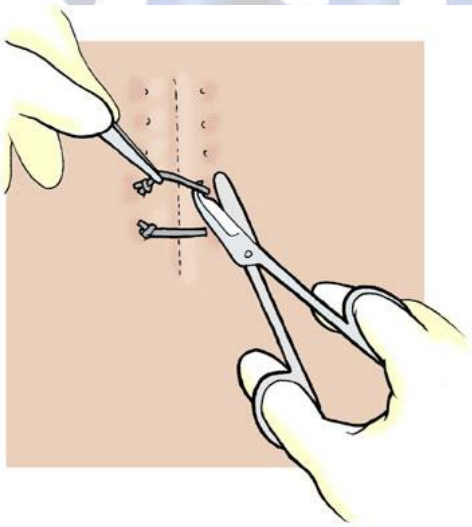
The deep tip stitch is essentially a full-buried form of the 3-corner stitch. The suture is placed into the deep dermis of the wound edge to which the flap is to be attached, passed through the dermis of the flap tip, and inserted into the deep dermis of the opposite wound edge.

SUTURE REMOVAL

Sutures should be removed within 1-2 weeks of their placement, depending on the anatomic location. Prompt removal reduces the risk of suture marks, infection, and tissue reaction. The average wound usually achieves approximately 8% of its expected tensile strength 1-2 weeks after surgery. To prevent dehiscence and spread of the scar, sutures should not be removed too soon.

As a general rule, the greater the tension across a wound, the longer the sutures should remain in place. As a guide, on the face, sutures should be removed in 5-7 days; on the neck, 7 days; on the scalp, 10 days; on the trunk and upper extremities, 10-14 days; and on the lower extremities, 14-21 days. Sutures in wounds under greater tension may need to be left in place slightly longer. Buried sutures, which are placed with absorbable suture material, are left in place because they dissolve.

Proper suture removal technique is important to maintain good results after sutures are properly selected and executed. Sutures should be gently elevated with forceps, and one side of the suture should be cut. Then, the suture is gently grasped by the knot and gently pulled toward the wound or suture line until the suture material is completely removed. If the suture is pulled away from the suture line, the wound edges may separate. Steri-Strips may be applied with a tissue adhesive to provide continued supplemental wound support after



the sutures are removed.

KNOTS

Of the more than 1,400 different types of knots described in *THE ENCYLCOPEDIA OF KNOTS*, only a few are used in modern surgery. The type of knot tied will depend upon the material used, the depth and location of the incision. The amount of stress that will be placed upon the wound postoperatively.

The suture 'Hand'

The term is the most subtle of all suture quality aspects. It relates to the feel of the suture in the surgeon's hands, the smoothness with which it passes through tissue and ties down. The way in which knots can be set and snugged down. And most of all, to the firmness or body of the suture.

Knot Extensibility

This relates to the way in which the suture will stretch slightly during knot tying and then recover. The stretching characteristics provide the signal that alerts the surgeon to the precise moment when the suture knot is snug.

GENERAL PRINCIPLES OF KNOT TYING

Certain general principles govern the tying of all knots and apply to all suture materials.

1. The completed knot must be firm, and so tied that slipping is virtually impossible. The simplest knot for the material is the most desirable.

2. The knot must be as small as possible to prevent an excessive amount of tissue reaction when absorbable sutures are used, or to minimize foreign body reaction to nonabsorbable sutures. Ends should be cut as short as possible.

3. In tying any knot, friction between strands ("sawing") must be avoided as this can weaken the integrity of the suture.

4. Care should be taken to avoid damage to the suture material when handling. Avoid the crushing or crimping application of surgical instruments, such as needleholders and forceps, to the strand except when grasping the free end of the suture during an instrument tie.

5. Excessive tension applied by the surgeon will cause breaking of the suture and may cut tissue. Practice in avoiding excessive tension leads to successful use of finer gauge materials.

6. Sutures used for approximation should not be tied too tightly, because this may contribute to tissue strangulation.

7. After the first loop is tied, it is necessary to maintain traction on one end of the strand to avoid loosening of the throw if being tied under any tension.

8. Final tension on final throw should be as nearly horizontal as possible.

9. The surgeon should not hesitate to change stance or position in relation to the patient in order to place a knot securely and flat.

10. Extra ties do not add to the strength of a properly tied knot. They only contribute to its bulk. With some synthetic materials, knot security requires the standard surgical technique of flat and square ties with additional throws if indicated by surgical circumstance and the experience of the surgeon.

An important part of good suturing technique is correct method in knot tying. A seesaw motion, or the sawing of one strand down over another until the knot is formed, may materially weaken sutures to the point that they may break when the second throw is made or, even worse, in the postoperative period when the suture is further weakened by increased tension or motion.

If the two ends of the suture are pulled in opposite directions with uniform rate and tension, the knot may be tied more securely. This point is well illustrated in the knot tying techniques shown in the next section of this manual.

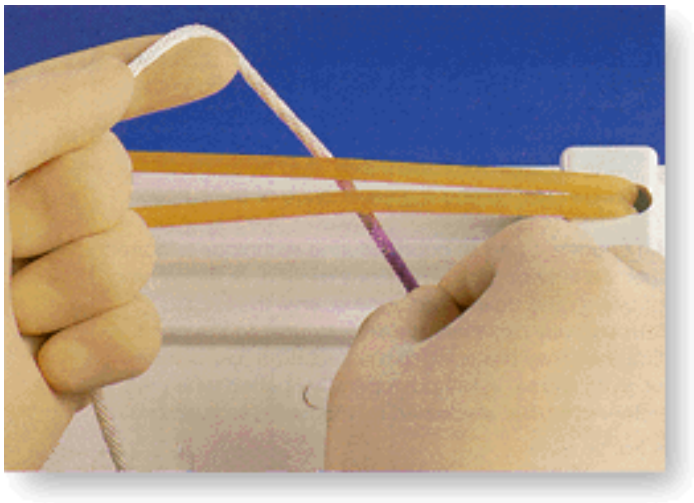
Square Knot

Two-Hand Technique

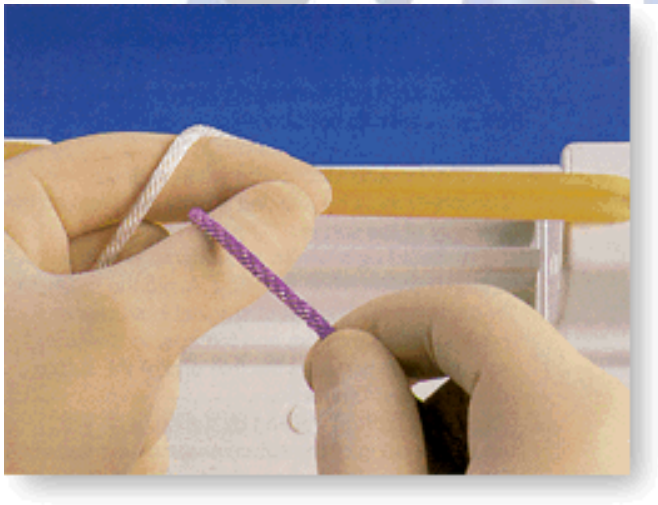
The two-hand square knot is the easiest and most reliable for tying most suture materials. It may be used to tie surgical gut, virgin silk, surgical cotton, and surgical stainless steel.

Standard technique of flat and square ties with the additional throws if indicated by the surgical circumstances and the experience of the operator should be used to tie BIOSYN (poliglecaprone 25) suture, Coated POLYSORB (polyglactin 910), TICTON polyester suture, SOFSILK silk suture, and SURGIPRO polypropylene suture.

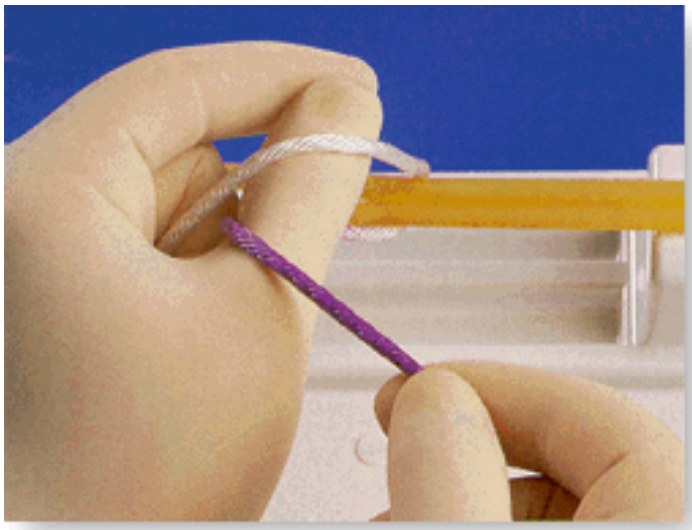
1. **White strand placed over extended index finger of left hand acting as bridge, and held in palm of left hand. Purple strand held in right hand.**



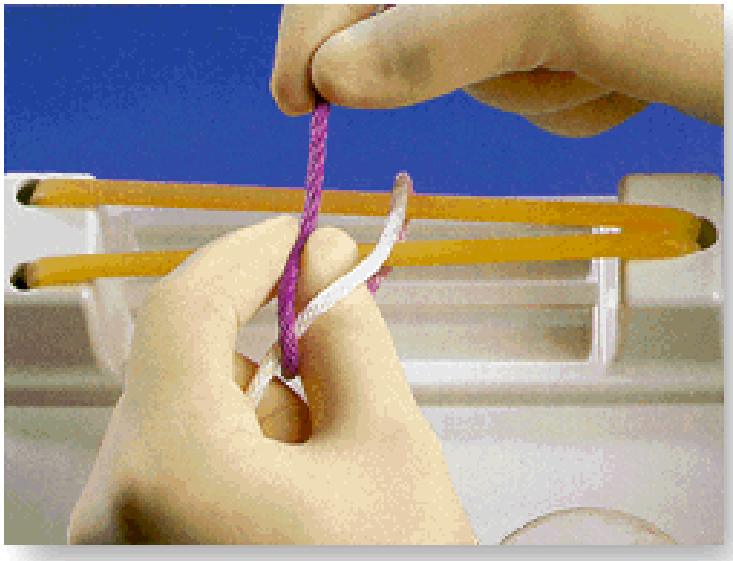
2. **Purple strand held in right hand brought between left thumb and index finger.**



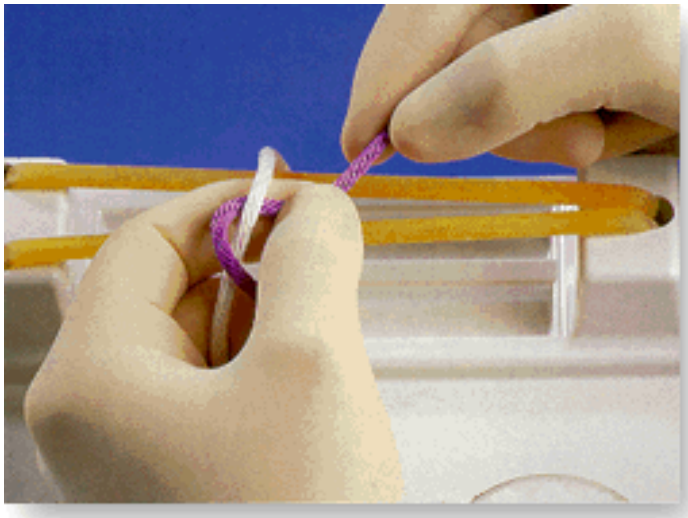
3. **Left hand turned inward by pronation, and thumb swung under white strand to form the first loop.**



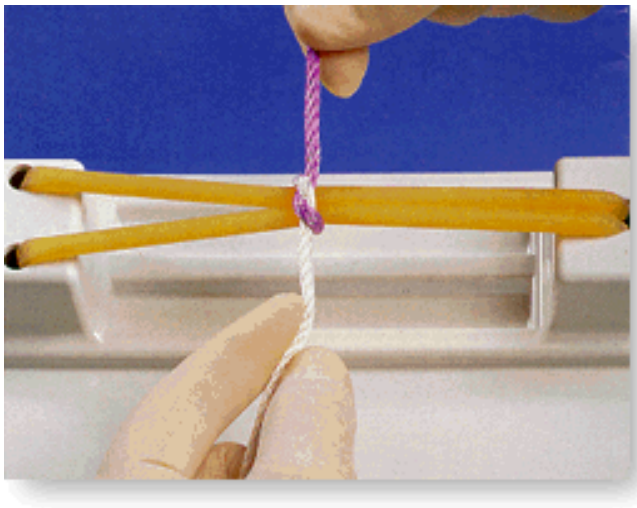
4. **Purple strand crossed over white and held between thumb and index finger of left hand.**



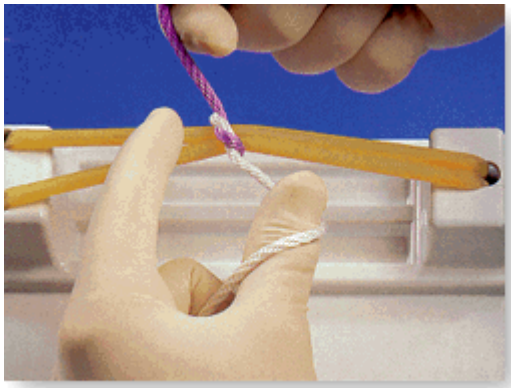
5. **Right hand releases purple strand. Then left hand supinated, with thumb and index finger still grasping purple strand, to bring purple strand through the white loop. Regrasp purple strand with right hand.**



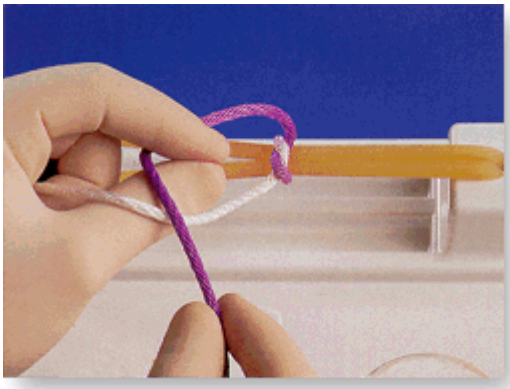
6. **Purple strand released by left hand and grasped by right. Horizontal tension is applied with left hand toward and right hand away from operator. This completes first half hitch.**



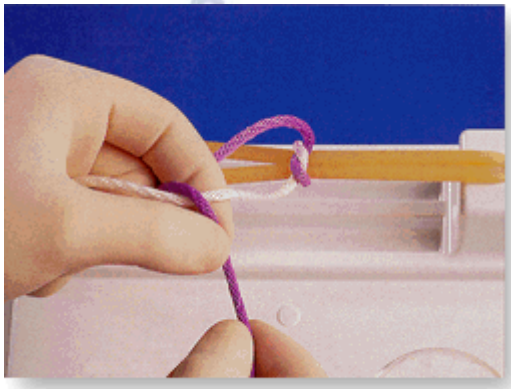
7. **Left index finger released from white strand and left hand again supinated to loop white strand over left thumb. Purple strand held in right hand is angled slightly to the left.**



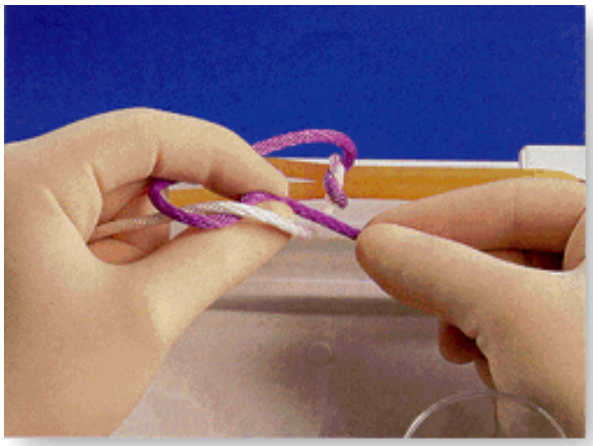
8. **Purple strand brought toward the operator with the right hand and placed between left thumb and index finger. Purple strand crosses over white strand.**



9. **By further supinating left hand, white strand slides onto left index finger to form a loop as purple strand is grasped between left index finger and thumb.**

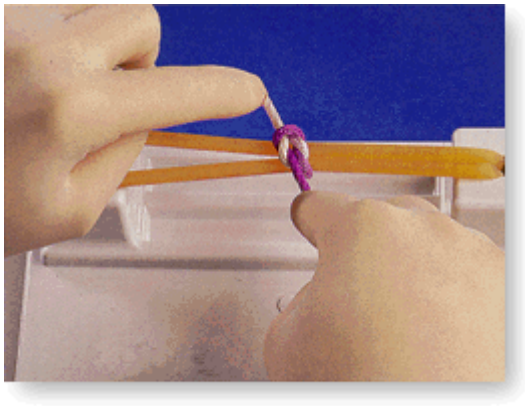


10. **Left hand rotated inward by pronation with thumb carrying purple strand through loop of white strand. Purple strand is grasped between right thumb and index finger.**



11. **Horizontal tension applied with left hand away from and right hand toward the operator. This completes the second half hitch.**

12. The final tension on the final throw should be as nearly horizontal as possible.

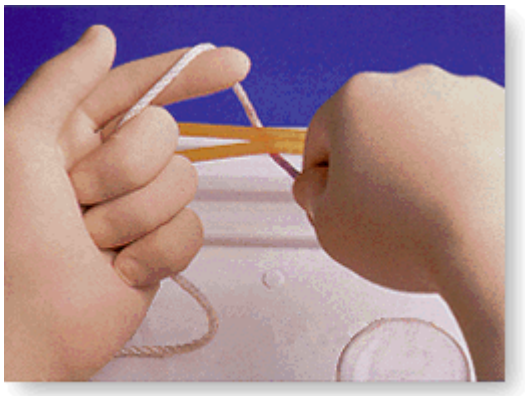


Square Knot: One-Hand Technique

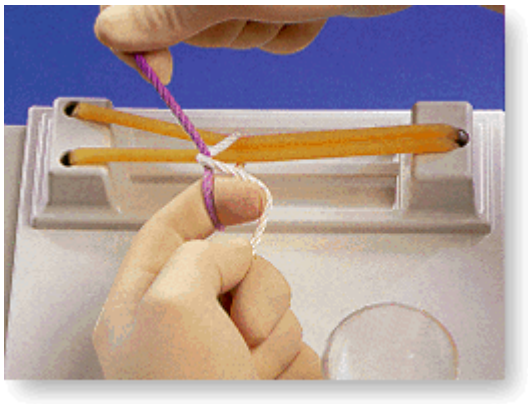
Wherever possible, the square knot is tied using the two-hand technique. On some occasion it will be necessary to use one hand, either the left or right, to tie a square knot. These illustrations employ the left-handed technique.

The sequence of throws illustrated is most commonly used for tying single suture strands. The sequence may be reversed should the surgeon be holding a reel of suture material in the right hand and placing a series of ligatures. In either case, it cannot be too strongly emphasized that the directions the hands travel must be reversed proceeding from one throw to the next to ensure that the knot formed lands flat and square. Half hitches result if this precaution is not taken.

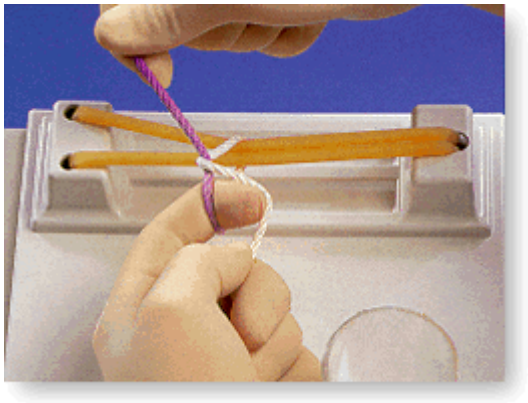
1. **White strand held between thumb and index finger of left hand with loop over extended index finger. Purple strand held between thumb and index finger of right hand.**



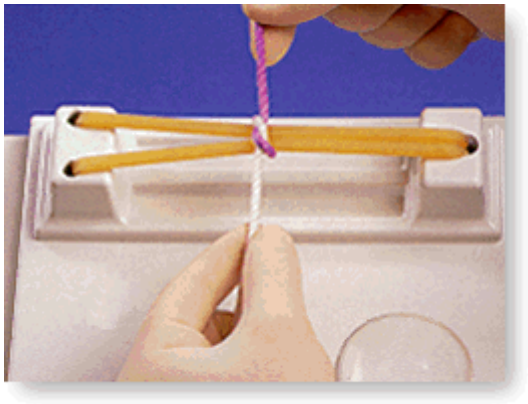
2. **Purple strand brought over white strand on left index finger by moving right hand away from operator.**



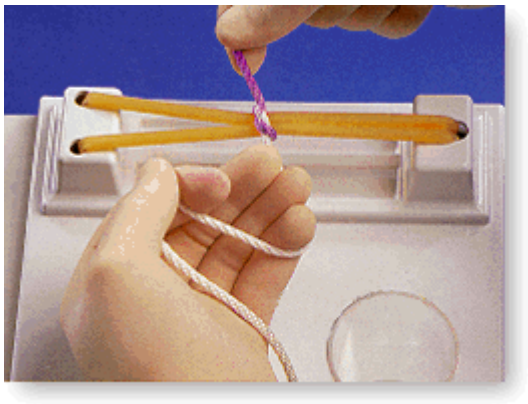
3. **With purple strand supported in right hand, the distal phalanx of left index finger passes under the white strand to place it over tip of left index finger. Then the white strand is pulled through loop in preparation for applying tension.**



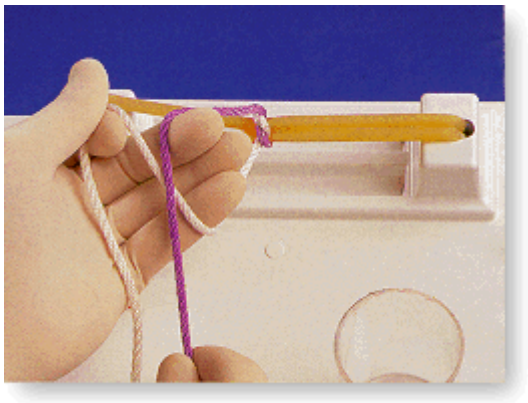
4. **The first half hitch is completed by advancing tension in the horizontal plane with ht left hand drawn toward and right hand away from the operator.**



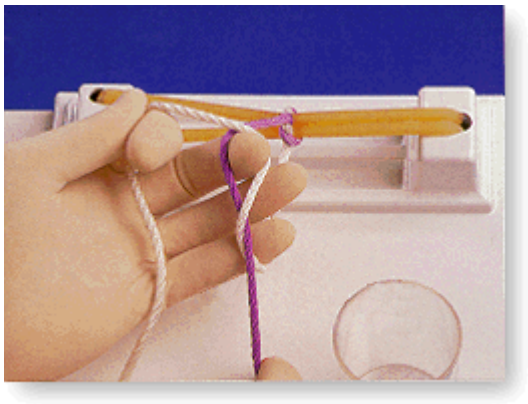
5. **White strand looped around three fingers of left hand with distal end held between thumb and index finger.**



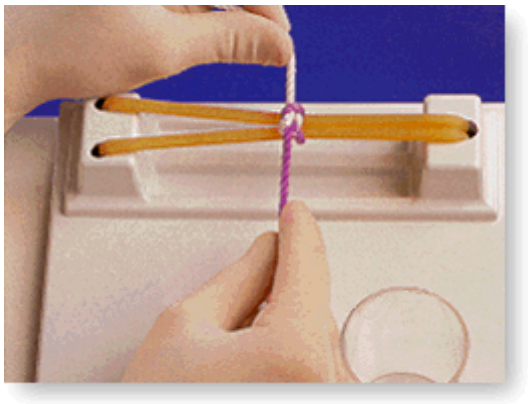
6. **Purple strand held in right hand brought toward the operator to cross over the white strand. Continue hand motion by flexing distal phalanx of left middle finger to bring it beneath white strand.**



7. **As the middle finger is extended and the left hand pronated, the white strand is brought beneath the purple strand.**



8. **Horizontal tension applied with the left hand away and right hand toward the operator. This completes the second half hitch of the square knot. Final tension should be as nearly horizontal as possible.**



Instrumental Knot (surgeon's traditional knot) :

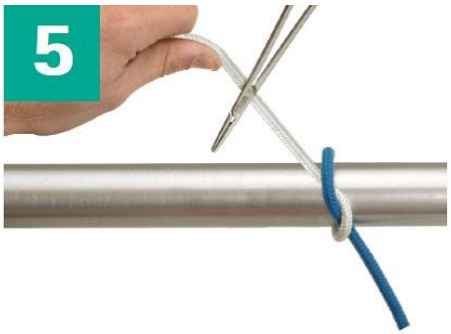
1. Place instrument over the inner surface of extended white strand.

2. Encircle instrument with white strand.

3. Grasp blue strand with instrument.

4. **Pull both threads in opposite directions so that white strand pulls away and instrument pulls towards operator.**

5. **Place instrument again over the inner surface of extended white strand.**



6. **Encircle instrument with white strand.**

7. **Grasp blue strand with instrument.**

8. **Pass blue strand through the loop formed by white strand.**

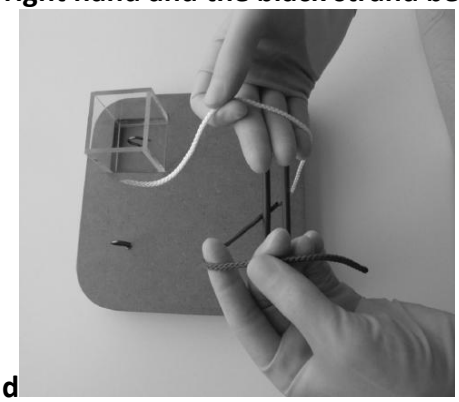
9. **Pull blue strand away and white strand towards operator. A square knot should be obtained.**

Surgical Knot : The ambidextrous surgeon's knot: an alternate way to tie the surgeon's knot

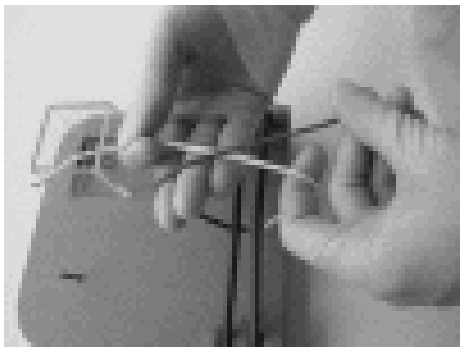
The surgeon's knot is a well-established knot in surgical practice, known to provide unsurpassed grip and security for the tissue tied. We describe a 2-handed single-throw technique, which produces the 2 loops of each throw simultaneously. In tying an ambidextrous surgeon's knot, the surgeon must be able to perform an "index finger" and "middle finger" throw with both the right and left hands independently, thus resulting in a much simpler and elegant set of movements.

The surgeon's knot is a secure way to tie sutures or ligate critical vessels. It is particularly useful when using nonabsorbable monofilament sutures. Another advantage of this knot is to use the double first throw to keep it from slipping when approximating tissues under tension. It is extremely useful in tying drains whose surfaces are slippery and can lead to slippage and thus loosening of traditional knots.

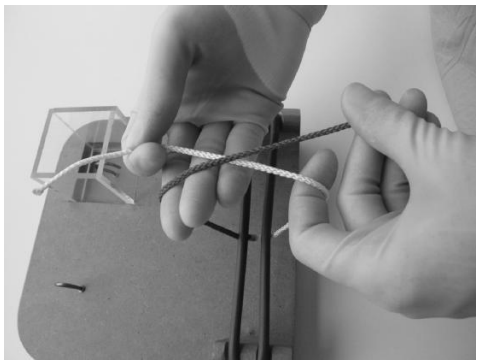
1. **Start the knot by holding the white strand between the thumb and the index finger of the right hand and the black strand between the thumb and middle finger of the left hand**



2. **Bring the black strand over the 3 fingers of the right hand; at the same time, pass the index finger of the left hand through this loop**

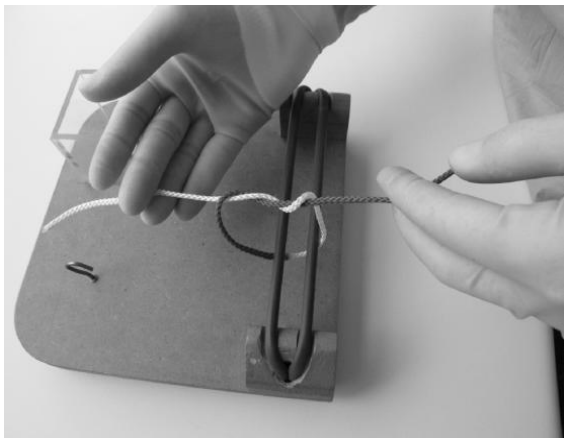


3. **Flex the middle finger of the right hand to bring it between the black and white strands; simultaneously supinate the left hand and flex the index finger of the left hand to bring it between the black and white strands, as shown. End this step by extending the right middle finger and the left index finger in their new positions**

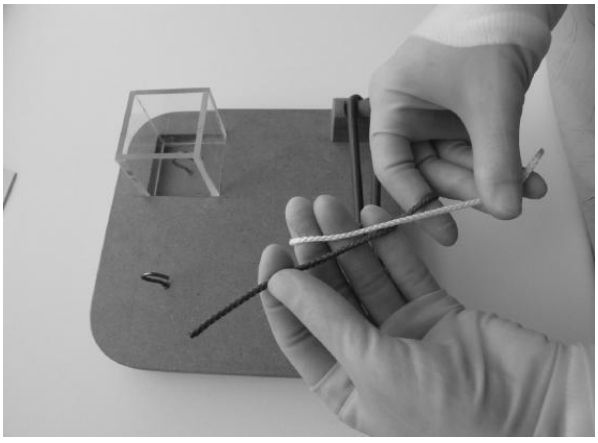


4. **Grasp the white strand between the right middle and ring fingers and the black strand between the left index and middle fingers, releasing the strands from their original grips involving the thumbs**

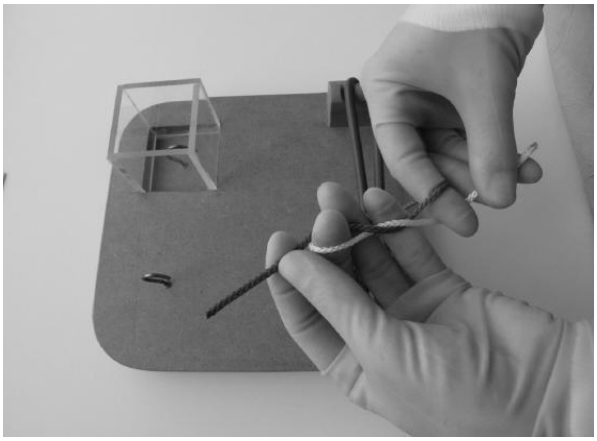
5. **Pull the strands in opposite directions in a smooth movement to form the first set of double loops of the surgeon's knot. The strands may be regripped with the thumbs while doing this, to provide extra leverage. Push the knot down securely by applying as much horizontal tension as possible**



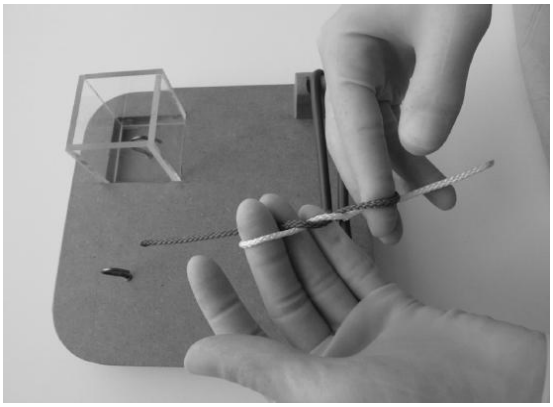
6. **To place the second throw, the actions preformed by each hand are reversed. The black strand is now held between the thumb and the index finger of the left hand and is looped around the 3 fingers of this hand (Fig. 6); the white strand is held between the thumb and the middle finger of the right hand and is brought toward the operator over the 3 fingers of the left hand. The index finger of the right hand is placed under the black strand, as shown**



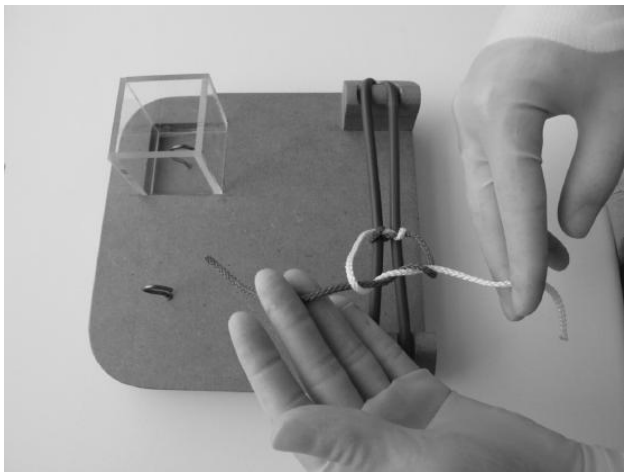
7. **The index finger of the right hand is flexed so that it lies between the black and white strands; at the same time, the middle finger of the left hand is flexed to bring it between the white and black strands**



8. **Extend the above-mentioned index and middle fingers and grip the white strand with the right index and middle fingers and the black strand with the left middle and ring fingers, releasing the strands from their original grips, using the thumbs**



9. **Pull the strands in opposite directions in a smooth movement to form the second set of double loops of the surgeon's knot. The strands may be regripped with the thumbs while doing this, to provide extra leverage. Secure the knot by applying as much horizontal tension as possible, completing the knot**



Deep Tie Knot :

Sometimes, the tissues to be sutured are not on the surface and therefore, they are quite difficult to access and to perform a knot with comfortability using the previously described techniques.
In these cases, the knot will have to be done on the surface and then slipped down to the desired position.

1. Tissue to be sutures lies at deep. Strands to be knotted come to the surface.

2. Make a simple knot on the surface (left over right strand).

3. **Use your index finger to push the knot to its final position.**

4. **Make sure that the knot is tight by further pushing down your index finger.**

5. **Make a second simple knot on the surface (right over left strand).**

6. **Push this second knot down in the same manner as before.**

7. **Further push down with your index finger to complete a deep square knot.**

Arthroscopic Knot tying: Slipping knot

This one is fairly easy and is called a bunting hitch by sailors, or the Tennessee slider by Steve Snyder.

1. The left is called the post

2. Throw one half hitch over

3. **Throw a second under both**

4. **Pull on the post**

5. **The knot slides down to the anchor**

6. **Tighten the knot with the right strand**

7. **Tighten the knot**

8. **Throw more half hitches**

9. **Tighten the half hitches**

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- **Basic suturing techniques, University of Pennsylvania Medicine**
- **Surgical Techniques: Ambidextrous surgeons knot: an alternate way to the surgeon's knot. Pankaj K Jha, Anthony A Barabas, Hemant Sharma**