CHAPTER 11

Suturing in Maxillofacial Surgery

INTRODUCTION

At the end of every surgical procedure meticulous wound closure is mandatory. This is vital to the healing of the wound. Careful suturing of traumatic wounds also helps in esthetic healing of the wound. Various techniques and suture materials are available commercially and for each type of wound it is important to choose the correct type of suturing needle and material.

Surgical Wound Healing

Wound healing is the process by which there is a repair of a tissue defect. It is a complex process that takes place in various phases. It is a dynamic process which helps restore cellular continuity and finally tissue continuity.

Phases of Wound Healing

1. ***Phase of hemostasis (0–6 days)***
   - Injury to the tissues causes bleeding; this is followed by vasoconstriction. Next platelet adhesion and thrombocyte aggregation takes place in an attempt to decrease the hemorrhage.
   - Platelets release a large amount of cytokines, platelet derived growth factor (PDGF), transforming growth factor–beta (TGF-beta).
   - Thrombocytes release histamine and serotonin.
   - PDGF attracts fibroblasts into the area. TGF-b also modulates fibroblastic mitosis. All of this helps to form a thick fibrin network which then goes into the next inflammatory phase paving a way for the inflammatory constituents.
2. ***Phase of inflammation***
   - Starts almost simultaneously with the first phase within 6–8 hours of injury. There is a release of large number of polymorphonuclear leucocytes (PMN's). TGF-b released in the initial phase also attracts more PMNs from the surrounding blood vessels.
   - These help in phagocyting all the debris in the wound
   - Other chemotactic agents such as fibroblastic growth factor (FGF), TGF-b, PDGF and anaphylactic toxins are also released.
   - Macrophages (monocytes) are then released into the wound from surrounding blood vessels which further help in "cleaning up" the debris.
   - Macrophages have an important role in endothelial cell multiplication- new blood vessel formation
   - Production of smooth muscle cells enhances the process of wound healing.
3. ***Phase of granulation (up to 4 weeks)***
   - In this phase neoangiogenesis takes place. Fibroblasts lay down new collagen.
   - Reepithelisation takes place with the division of peripheral cells. This new epithelial layer bridges the wound edges.
4. ***Phase of remodeling***
   - This is a dynamic process which can last for years after the injury has occurred.
   - Collagen that was deposited earlier undergoes alternately degradation and deposition on specialized fibroblasts called myofibroblasts which are similar to smooth muscles and tends to cause wound contraction.
   - The wound achieves maximum strength by the 12th week. Even after complete wound healing, the strength of the scar is only 80% of that of the original skin in that region.

Box. 11.1 Phases of wound healing

Phase of hemostasis.
Phase of inflammation.
Phase of granulation.
Phase of remodeling.

Types of Wound Healing

1. Primary healing or first intention healing
2. Delayed primary healing
3. Secondary intention healing

Primary Healing or First Intention Healing

- This occurs in case of surgical wounds which have been neatly approximated. The surgical insult causes minimal injury to the cellular components.

Delayed Primary Healing

- If the wound edges are not approximated immediately, delayed primary healing takes place. E.g.: in case of an infected wound, it is not closed immediately.
- By the 4th day, phagocytosis of contaminated tissues, epithelisation, collagen deposition etc are taking place.
- Any foreign body in the wound is encircled by the macrophages forming granuloma.
- Usually at this stage, the wound is cleaned and sutured.

Secondary Intention Healing

- A full thickness wound is not closed surgically but left to heal unaided.
- Inflammatory reaction is much more than in primary intention.
- More amount of granulation tissue is produced.
- More intense wound contraction takes place.

Things to be Done Prior to Suturing

- Check for completion of procedure.
- Remove any sharp bony spicules and smoothen bone margins.
- Remove any loose tissue tags or non-vital tissue as it may be a further source of infection.
- Ensure complete hemostasis.
- Check if the wound can be approximated without any tension. If not, undermine the tissue to ensure tension-free closure.
- For large wounds, and possible dead space place a temporary drain prior to suturing.

Wounds should be closed in layers:

- When the incision passes through multiple layers of tissue, e.g.: in a submandibular (Risdon's) incision, it is started on the skin, proceeds through subcutaneous tissue, fascia, platysma, muscle, periosteum and then reaches bone.
- It is essential to close such a surgical wound in layers, otherwise the deeper layers remain unapproximated and open, thus allowing dead space for the collection of hematoma. The periosteum is approximated first, followed by masseter muscle, platysma, subcutaneous tissue and lastly skin.
- Wound closure in deeper layers is done with resorbable suture materials such as catgut, vicryl etc. Skin closure is done with non-resorbable suture materials such as silk, ethylon, prolene etc.
- Subcutaneous layer suturing is to be done meticulously. Usually subcutaneous and subcuticular layer (this is a tough connective tissue layer present just beneath the skin) suturing is done by placing inverted or buried knots.
- It is important that the knots and suture materials are not exposed to the exterior on the skin. This is because it will lead to bacterial contamination and tracking of infection into the deeper layers of the wound.

How to Place a Buried Knot

- Generally while placing an interrupted suture, after placing the knot it lies on the visible or outer surface of the tissue. This makes the knot visible.
- The technique for placing a buried knot is a little different from the usual procedure.
- The needle is first passed through the flap that is closer to the operator. It is passed from the inside to the outside.
- The needle is then passed through the flap away from the operator from outside to inside. In this way both the free ends of the suture material are facing inwards.
- The knot is then placed in the usual manner. The suture material is cut as close to the knot as possible. Once the suture tags are snipped, the knot rests on the inner surface of the tissue.

Advantages of Layered Suturing

- Approximation of the wound in such a way that the tension is not taken up only by the outermost layer but is equally distributed over the various layers. This munimises the chances of wound dehiscence.
- Decreased dead space due to good approximation of tissues and thereby less chances of accumulation of tissue fluids and blood in the areas opened up by the surgery. This further minimises the chances of wound infection.
- In cases of fractures where bone plates or wires are placed, closure of the periosteum over the hardware minimizes the risk of dead space, infection and plate exposure.
- In areas where cosmetic closure is preferred, uniform distribution of tension along the wound and subcutaneous closure helps in minimizing the scar.

Intraoral wounds in the maxilla need not be closed in layers. Only deep mucosal sutures are sufficient.

In the mandible, incisions in the region of the chin are given for procedures such as genioplasty, anterior subapical osteotomy, fixation of fractures in the symphysis region, etc. After these surgical procedures, in this particular region layered wound closure is advisable; first, the periosteum, then the mentalis muscle and lastly the mucosa. This is because this forms a potential dead space under the mentalis muscle. Due to gravity there is a tendency for a downward pull on the reflected mentalis muscle leading to an unsightly feature called "chin ptosis".

Incisions in the posterior region of the mandible may be closed in a single mucosal layer alone as the buccinator muscle tends to naturally approximate and collapse the wound.

SUTURING ARMAMENTARIUM

Suturing either extraoral or intraoral wounds requires the following equipment:

1. Needle holder: These are available in different types and sizes based on the region where it is used and also based on the thickness of the suture material being used for suturing.

   The most commonly used needle holder in the head and neck region is the Mayo Hegar needle holder. A needle holder is an instrument that has 2 short and stout beaks. The beaks have blunted tips and criss-cross serrations on the inner aspect and a deep vertical groove. This instrument has a ratchet for locking the needle in position. Suturing for finer procedures such as cleft lip repair, eyelid repair etc where very fine suture material is used, a Castroviejo design of needle holder may be used.
2. Suture materials: Will be discussed in detail later in this chapter
3. Suturing needles
4. Tissue holding forceps: This is also available in different types:
   - Toothed
   - Non-toothed

   Usually the toothed Adson's forceps is used for suturing in the maxillofacial region. A non-toothed forceps may be used for suturing fragile mucosa.
5. Suture cutting scissors.

SUTURING NEEDLES

Suturing needles are made of either *stainless steel* or *carbon steel*.

Classification of Suturing Needles

1. **Based on the needle design.** They are classified as:
   - Straight needles
   - Curved needles

   Straight needles: These can be either round bodied (tapered) or cutting needles.

   Use: These are generally used for suturing in the abdominal region. In the maxillofacial region, its use is limited. In the absence of an awl, it may be used for circummandibular wiring. It can also be used for placing a cheek stitch for the stabilization of a cheek retractor for intraoral surgical procedures.

   Curved needles: Most commonly used in the maxillofacial region. These can further be classified based on the curvature into 1/4th circle, 3/8th circle, ½ circle (most commonly used in oral surgery), 3/4th circle.

   Use: This type of needle may be used for suturing extraoral incisions on the skin and intraoral mucosal incisions/lacerations.
2. **Based on the cross-section of the needle.** It may be classified into:
   - Round body (tapering)
   - Cutting needle

   Round-bodied needle: The cross-section of this type of needle is round. It slowly tapers to a point and so it is called a tapered needle.

   Use: A round body needle is generally preferred for the closure of all intraoral mucosal wounds as it is gentle on thin and fragile mucosal tissues. It is also used for the suturing of fascia and muscle which may tear through if a cutting needle is used.

   Disadvantage: due to its design, it is more difficult to pass through tough tissues like skin and more pressure will be required to do this.

   Cutting needle: This type of needle has a triangular cross section. Based on the position of the apex of the triangle, it is further classified into:
   - Conventional cutting
   - Reverse cutting needle

   Conventional cutting needle: This type of needle has the apex facing towards the inner aspect of the curvature of the needle

   Disadvantage: It may cut through if used on fragile tissue such as mucosa.

   Reverse cutting needle: In this type of needle, the apex is towards the outer aspect of the curvature with the inner part of the needle being flat **(Fig 11.1–11.3)**.

   Uses of cutting needle: It is used in the suturing of skin wounds, subcuticular suturing.
3. **Based on how the suture material connects to the needle:**
   - Eyed needle
   - Swaged needle

   Eye needle: Also called a traumatic needle. It has a hole (eye) which may be round, oval or square at the broader end of the needle. The suture material is threaded into this hole of the needle. Such needles can be sterilized and reused a few times till they lose their sharpness. They are thus a cheaper alternative.

   Disadvantage: multiple uses make it blunt and traumatic to the tissues.

   Chances of infection if not adequately sterilized.

   Traumatic entry through the tissues as two strands of thread have to go through it.

   Chances of slipping out of the thread from the needle during suturing

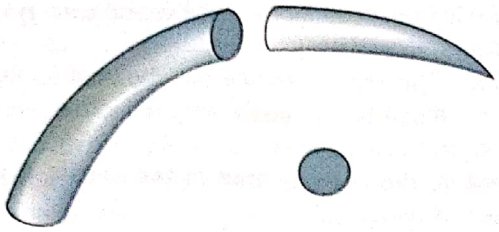

Fig. 11.1 Round-bodied needle

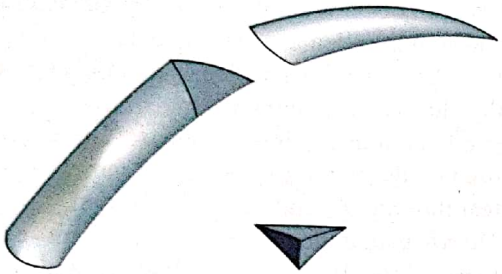

Fig. 11.2 Conventional cutting needle

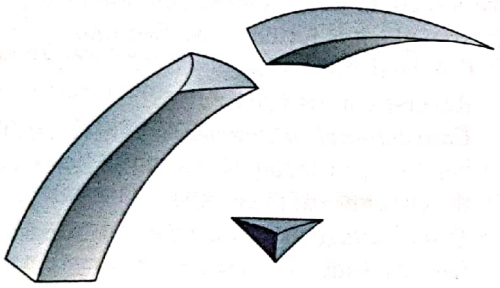

Fig. 11.3 Reverse cutting needle

Swaged needle: Also called atraumatic needle. These are available in ready-made sterile pack swhere the manufacturer attaches the suture material into the hollow of the needle body. This type of needle has no eye.

Advantages: atraumatic
Sterile needle for each procedure
Single use sharp needle for each procedure

Disadvantage:
Needle and material to be discarded after each use
Expensive **(Fig 11.4)**

SUTURE MATERIALS

Properties of an Ideal Suture Material

- The suture material should produce least tissue reaction. Synthetic suture materials have less tissue reaction when compared to natural materials. Once the suture material is placed within the tissues, the reaction to this material should be minimal to enable good wound healing.

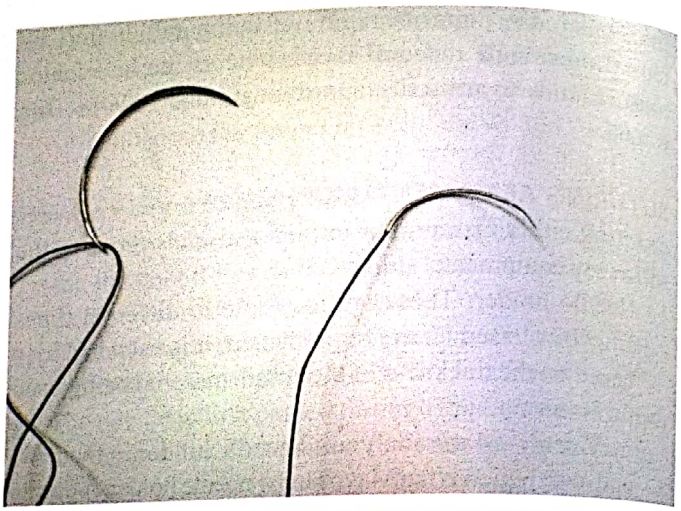

Fig. 11.4 Eye needle, swaged needle

Box. 11.2 Classification of suturing needles

- Tensile strength: Adequate strength of the suture material to withstand stress and not give way. The material should hold the wound edges together till the wound healing is complete.
- The suture material should be easily sterilisable.
- It should be easy to handle within the tissues.
- It should have good knot tying properties.
- It should have less capillary action. This means that it absorbs less fluids when it is within the tissues and so its strength remains for a longer period of time.

Box. 11.3 Properties of ideal suture material

Based on design
Straight
Curved
Based on cross-section
Round body (tapering)
Cutting
Conventional cutting
Reverse cutting
Based on how material connects to needle
Eyed needle
Swaged needle
Least tissue reaction
Good tensile strength
Sterilisable
Easy to handle
Good knot tying properties
Less capillary action

Classification of Suture Materials

1. **Based on the degradation of the material within the tissues:**
   - Absorbable
   - Non-absorbable

Absorbable materials: Loses its strength within the tissues and usually degrades within 60 days. This usually coincides with the approximate time taken for complete wound maturation. Examples are: catgut, polyglycolic acid (Dexon) etc. It undergoes enzymatic degradation by natural enzymes present within the body.

Uses: Deeper layer suturing, suturing of wounds in patients who are unable to come for suture removal.

Non-absorbable suture materials: These materials are usually not degraded by the body. Suture removal is required at the end of the healig phase.

Example: Silk, nylon etc.

2. **Based on the source of the materials**
   - Natural, e.g.: silk
   - Synthetic, e.g.: polyglycolic acid
   - Metallic, e.g.: stainless steel

   Both absorbable and non-absorbable materials may be derived from natural or synthetic sources.
3. **Based on the number of filaments in the suture material**
   - Monofilament
   - Multifilament
   - Pseudomonofilament

Monofilament suture material

- These materials are made of a single strand.
- These materials have the advantage of least capillary effect thereby they do not absorb tissue fluids and thus do not swell. This decreases the chances of infection.
- E.g.: *Absorbable*: monocryl
  Non-absorbable: polyamide, polyester etc.
- Disadvantages of this material: Main disadvantage is its "memory effect" due to which the material tends to come back to its original position. This property tends to loosen the knot. Multiple throws may be required to stabilize the knot.

Multifilament

- This is made of multiple thin strands of the suture material which are either rolled, twisted or braided together to form a uniform strand of thread.
- These materials are usually easier to handle and have good knot tying properties.
- The knot once placed, usually does not slip.
- It is preferred for use in those areas where good strength is required to hold the wound edges together.
- As the material is multifilamentous, it has more capillary action, whereby tissue fluids and inflammatory exudates seep through these multiple filaments harbouring more microorganisms and forming a source of infection.
- Example: black braided silk.

Pseudomonofilament

An example of this material is catgut. It is microscopically made of numerous strands of fibre which have been processed by twisting, grinding and finally polishing to give it a monofilamentous appearance.

4. **Based on the diameter of the thread in cross section**
   Suture materials are labeled from 1-0 to 10-0. With an increase in the number of zeros, the diameter of the material reduces. Therefore the diameter of an 8-0 material is less than the diameter of a 3-0 material.
   10-0: is generally used for microsurgery repair
   5-0,6-0: suturing of skin on the face.
   4-0. 5-0: used for suturing in the extremities
   3-0: scalp sutures
   3-0, 4-0: most commonly used in most oral surgical procedures
5. **Based on the coating applied on the material**
   - Teflon coated
   - Chromic coated etc

Box. 11.4 Classification of suture materials

Based on degradation
Absorbable
Non-absorbable
Based on source
Natural
Synthetic
Metallic
Based on number of filaments
Monofilament
Multifilament
Pseudomonofilament
Based on diameter in cross-section
1-0 to 10-0
Based on coating applied
Teflon coated.
Chromic coated

Catgut

- This was the first absorbable suture material available.
- It is derived from a natural source which may be purified connective tissue (mostly collagen) derived from either serosal layer of cow's intestine (bovine source) or submucosal fibrous layer of sheep intestines.
- It is pseudomonofilamentous in nature which means that microscopically it is made up of multiple filaments which are processed in such a way that they are twisted and ground together and polished to give the appearance of a monofilament suture material.
- Since it is mostly composed of collagen fibres, there are chances of degradation, so the material must be kept

moist. It is commercially supplied as a package soaked in isopropyl alcohol which acts as a preservative.
- Resorption is by enzymatic degradation by proteolytic enzymes and phagocytosis.
- When placed inside the tissues, it loses most of its tensile strength within 10–15 days and is resorbed by 2–3 months.
- It is available in three forms which are:
  - Plain gut
  - Chromic gut
  - Fast-absorbing surgical gut

Disadvantages of Plain Surgical Gut Suture
- If it is allowed to dry during suturing, it becomes stiff and difficult to handle.
- It also tends to have weak areas along its length as a result of manufacturing process which makes it break easily.
- Since it is degraded by enzymatic action, there is an intense inflammatory reaction during this process.
- It also allows more bacterial adhesion when compared to nylon or polypropylene.
- It has poor tensile strength and rapidly looses strength when placed in the tissues.

Chromic Gut
- Plain surgical gut is tanned with chromic salts.
- This is basically done to decrease its tissue reactivity and increase tensile strength.
- Chromic gut also has better knot security when compared to plain gut sutures.
- Coating with chromic salts also increases its resistance to absorption. While plain gut loses most of its strength by 10–15 days, chromic gut takes about double the time around 3–4 weeks.
- It is usually completely resorbed after about 90 days.
- Resorption mechanism is similar to that of plain gut.
- The tissue reaction produced by chromic gut is less than plain gut.

Fast Absorbing Gut
- This plain surgical gut treated with heat to allow rapid resorption. It has been basically designed for use on skin. It loses most of its tensile strength by 5–7 days and gets resorbed by 2–4 weeks.

Absorbable Synthetic Material
Dexon: Polyglycolic Acid (PGA)
- Introduced in 1970 as the first synthetic absorbable suture material.
- Synthetic absorbable suture materials are synthetic polymers.
- Resorption of these suture materials is by hydrolysis of the ester bond.
- They are broken down by hydrolysis into H_2O and CO_2.
- This is the reason for minimal tissue reaction when compared to natural absorbable materials like catgut.
- Hydroxyacetic acid is subjected to heat in the presence of a catalyst. This procedure converts it into a high molecular weight polymer.
- These monofilament thin strands are then stretched and braided together making it a multifilament suture material.
- It may then be coated with polycaprolate (commercially available as Dexon Plus) or may be sold in an uncoated form (Dexon S).
- Braiding and coating of the suture material makes its strength and durability much improved when compared to gut sutures.
- Orally the suture is lost in 16–20 days while in tissues it remains for 56–70 days.
- Fast-absorbing PGA is also available. This is completely hydrolysed in 40 days.

Polyglactin 910 (Vicryl) (Fig 11.5)
- This material was first introduced in 1974.
- This is a copolymer of glycolic acid and lactic acid in the ratio of 9:1.
- This was the second synthetic absorbable suture material available commercially.
- It is a multifilament braided material.
- May be coated with polyglactin 370 to improve its knot tying characteristics.
- Coating with polyglactin 370 decreases knot security.
- Once it is placed in the tissues, it retains only about 8% of its strength after 28 days.
- It is resorbed by hydrolysis by around 60–90 days.
- Tissue reaction is less than that of polyglycolic acid.

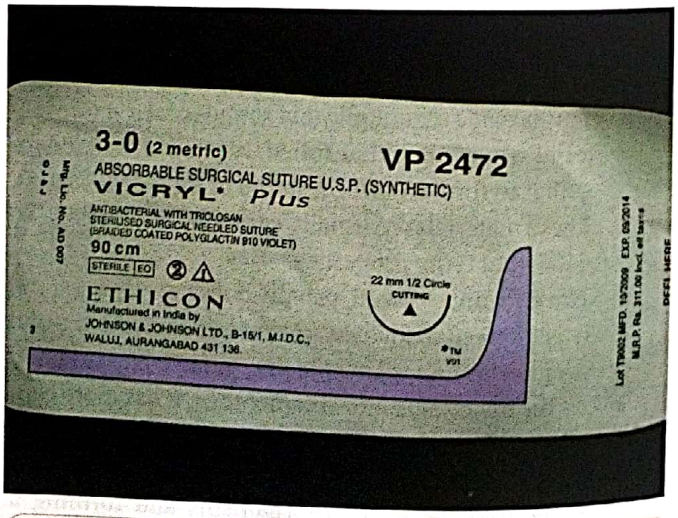

Fig. 11.5 Vicryl suture material

- Available as clear or violet coloured sutures. two types of polyglactin 910 are available recently:
- ***Vicryl Rapide***: this is polyglactin 910 which has been ionized with gamma rays. This speeds up the rate of absorption.
- Initial strength is comparable to that of nylon and catgut.
- It gets completely absorbed in 35 days. It is the fastest absorbing synthetic suture.
- Use: It is used in deeper layers in wounds that requires short-term wound support (about 7–10 days).
- A newer antibacterial-coated material (***Vicryl plus***).
- This is coated with Triclosan. It has been found to be noncytotoxic and non-irritating as well as biocompatible with the surrounding tissues.
- Studies have been done to prove that antibacterial-coated polyglactin 910 inhibits bacterial colonization of MRSA (Methicillin resistant *Staphylococcus aureus*) and methicillin sensitive SA.
- Probably its use may be in wounds which are at a risk of infection.

Polydiaxanone

- First available commercially in 1982.
- Synthetic absorbable monofilament suture material.
- Disadvantage: knot handling characteristics are poor as the material is stiff and knot security is also poor.
- It is also expensive when compared to PGA and 910.

Advantages Over PGA and 910

- Initial tensile strength is low but it retains its strength for much longer.
- Resorption is by hydrolysis after 180–210 days.
- Monofilament, therefore lesser tissue reaction.
- More useful in those areas which are at a risk for infection.
- It is available as clear or violet coloured suture material.

Polyglecaprone (Monocryl-Ethicon)

- Introduced in 1993.
- Synthetic absorbable suture material.
- It is a monofilament material but very easy to handle and flexible.
- Knot handling and strength are good.
- Absorbed by hydrolysis in 90–120 days.
- Since it is a monofilament suture, capillarity, tissue reaction are minimal.
- Used for putting buried sutures in deeper layers.
- Specially used in those areas where prolonged dermal support is not required.
- Available as a clear material.
- Also available as an antibacterial-coated material coated with triclosan (Monocryl plus).

Polytrimethylene Carbonate

- Introduced in 1983.
- Synthetic absorbable monofilament suture.
- Hydrolysed by 180–210 days
- Knot handling and knot security better than PDS.
- Available as clear or green suture.

Other materials available are:

Glycomer 631: Monofilament Synthetic, Polyester, Absorbable

Absorbed in 90–110 days.
Available as undyed or violet form.

Polyglytone 6211

- Newest synthetic absorbable suture material
- Rapidly degradable monofilament polyester
- Completely hydrolysed by 50–55 days
- Available as undyed or violet colours

Non-absorbable Suture Materials

- These are materials that are not degraded in living tissues
- Non-absorbable materials are mostly used for cutaneous (skin) closure
- Also classified into natural or synthetic materials.

Non-absorbable Natural Suture Material

Silk

- This has been used since 1890's.
- Available from protein fibres produced by silkworm larvae.
- Although it is considered non-absorbable, it is slowly degraded over a period of 2 years.
- It is available as a black, multifilament, braided form.
- It is easy to handle with good knot tying properties and also good knot security.
- Tissue reactivity is high as it is multifilament and has high capillary action.
- Uses: Can be used to ligate blood vessels.
- Mucosal closure intraorally, Skin sutures.
- Usually silk sutures are to be removed within 5–7 days. **(Fig 11.6).**

Nylon (Ethilon- Ethicon)

- First introduced in 1940.
- It was the first synthetic suture material available commercially.
- Available as monofilament and multifilament sutures.
- Available as black, green or clear varieties. Black and green are generally preferred as their visibility is enhanced in the tissues and makes suturing and removal easier.

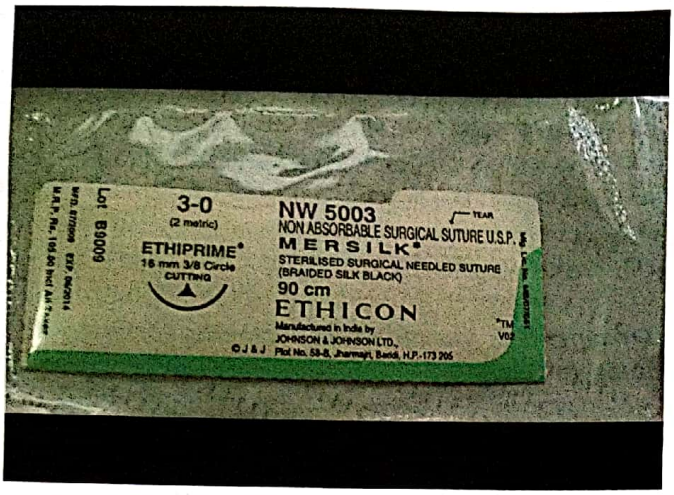

Fig. 11.6 Silk suture material

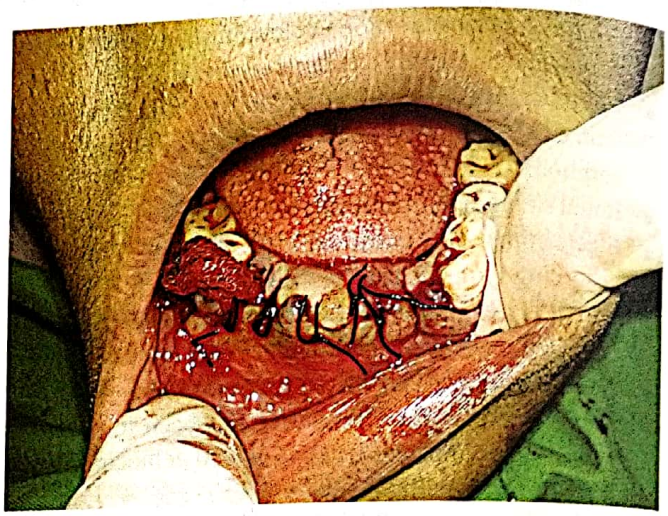

Fig. 11.7 Intraoral interrupted suturing

- Multifilament forms are easy to handle but have high tissue reactivity.
- Monofilament nylon is stiff and difficult to handle. It also has poor knot security and slippage of knots may take place. Since it is stiff it sometimes cuts through delicate skin.
- It is classified as non-absorbable but it slowly loses strength when buried within the tissues.
- Uses: Skin sutures.

Polyester

- Non-absorbable synthetic suture.
- Multifilamentous braided suture.
- Also available in coated form. This coating makes it more softer, pliable and easy to handle.
- Advantage: it has high tensile strength, easy suture handling,good knot security, low tissue reaction.
- Disadvantage: expensive.
- Uses: suturing of skin and mucosa.

TECHNIQUES OF SUTURING

Interrupted Sutures

- This is the most common, universally used type of suturing technique.

Indications

- Closure of oral mucosal incisions/lacerations
- Closure of skin wounds (Fig 11.7)

Technique

- The needle is held at 2/3rd the distance from the tip of the needle with a needle holder.
- The needle is passed through one side of the flap perpendicular to the tissues and brought out along the curvature of the needle.
- It is than passed through the other flap at the same distance from the edge of the flap and also at the same depth.
- It is brought out of the flap along with the suture material till about 3–4 cm of the free end of the suture material is left. The needle-end of the material is kept longer than the free end.
- The needle is held in the left hand and wound around the needle holder once or twice depending on the type of knot.
- The free end of the suture material is grasped with the beaks of the needle holder.
- The material that is wound around the needle holder is made to slip over the beaks by slowly pulling on the needle end of the suture material. The free end of the suture material is pulled minimally as it will result in wastage of the suture material.
- The knot is stabilized such that it comes to one side of the flap. It should not rest along the edges of the wound. Aim for a slight eversion of the wound edges.
- To complete the knot, hold the needle in the left hand and roll the suture material around the beaks of the needle holder in the opposite direction. Again grasp the free end of the suture material and slide the suture material over this free end to stabilize the knot. This may be done one more time to get a stable knot.
- Hold both the free end and needle end of the suture material taut for the assistant to trim them with a scissors leaving about 3–4 mm (Fig 11.8–11.15).

Advantages of Interrupted Sutures

- Allows equal distribution of tension along the wound.
- If one of the sutures gets loose it does not affect the remaining sutures. It can be replaced separately.
- In case of edema or hematoma after a surgical procedure,

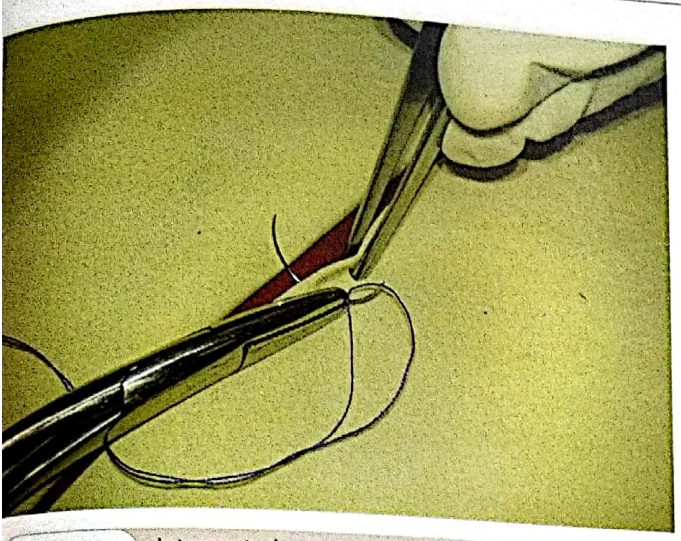

Fig. 11.8 Interrupted suturing step 1: pass needle through one flap

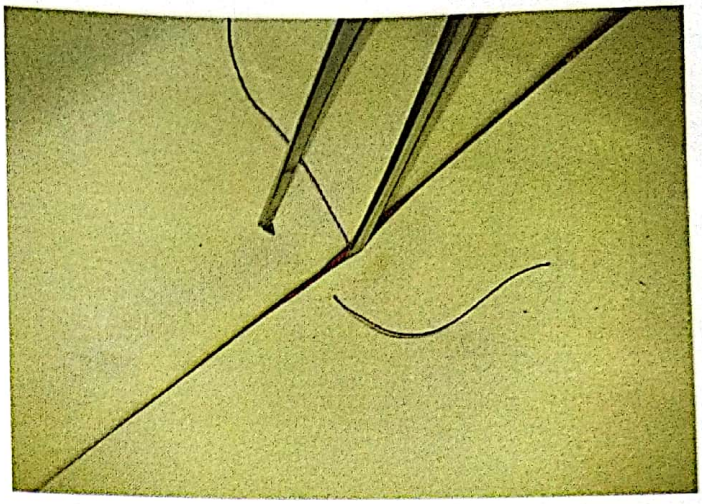

Fig. 11.9 Step 2: pull the thread through one flap

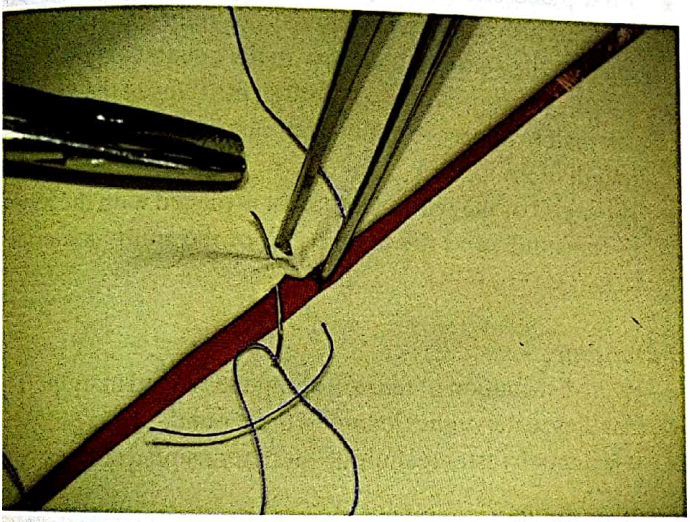

Fig. 11.10 Step 3: pass needle through the next flap

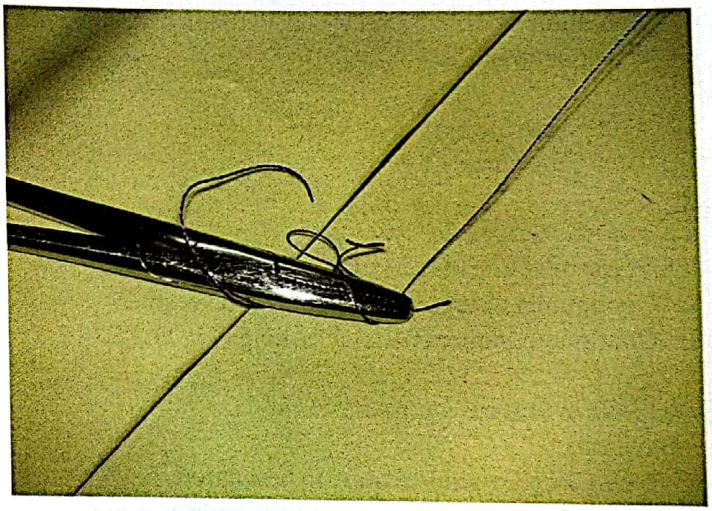

Fig. 11.11 Step 4: place a knot

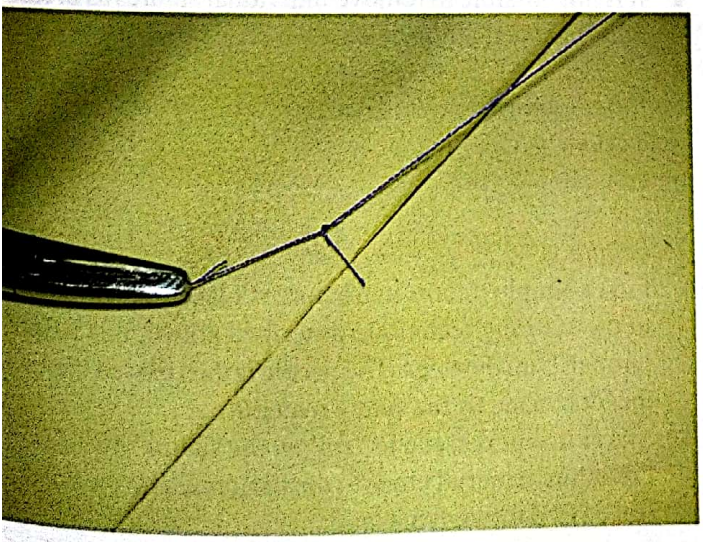

Fig. 11.12 Step 5: stabilise the knot on one side

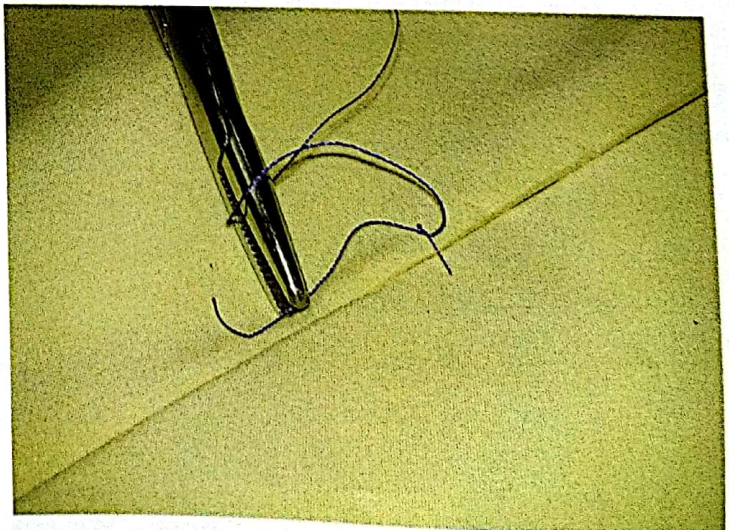

Fig. 11.13 Step 6: place the second knot

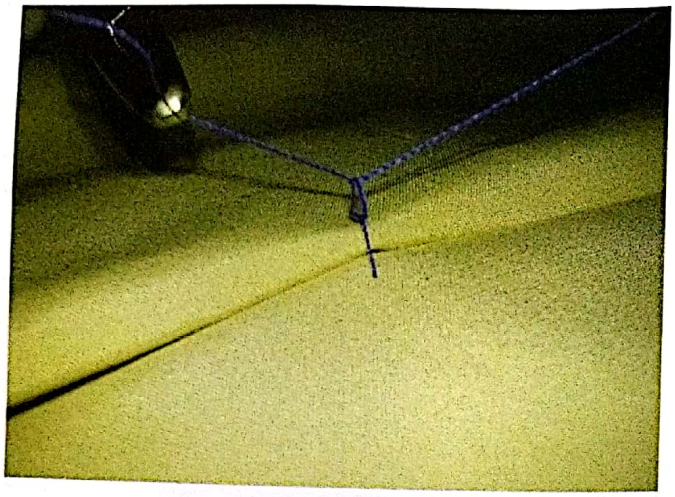

Fig. 11.14 Step 7: stabilise the knot

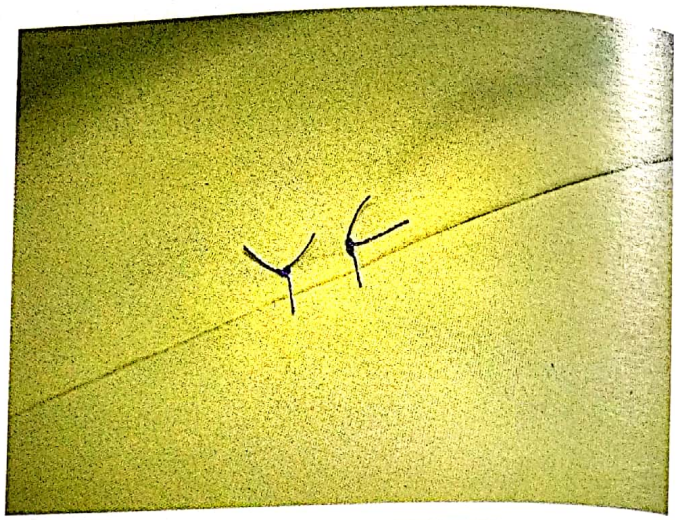

Fig. 11.15 Completed interrupted sutures

if the tension on the wound edges is too much, one or two sutures may be removed without disturbing the other sutures.

Disadvantage

- Time consuming

Continuous Suture

This type of suture may be of two types:

- Continuous sutures with locking (blanket stitch)
- Continuous sutures without locking **(Fig 11.16)**

Continuous Sutures without locking

Indications

- Where large wounds require to be sutured
- Intraorally when full-quadrant alveoloplasty is done

Technique

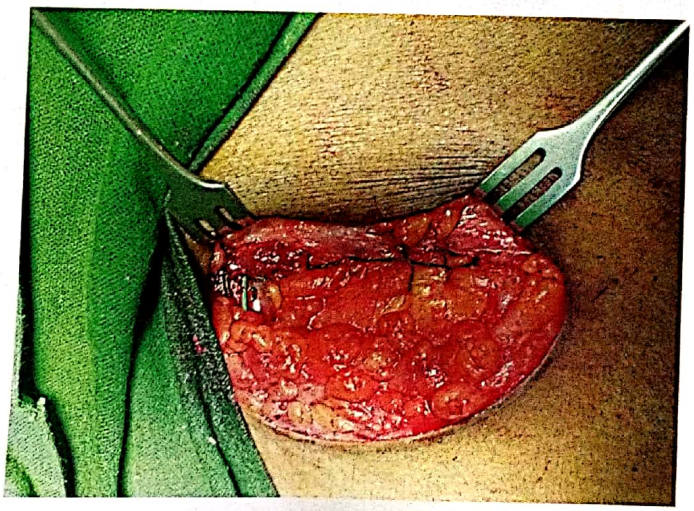

Fig. 11.16 Continuous sutures with locking

- First place one interrupted suture.
- While cutting the suture ends, cut only the free ends leaving the suture material with the needle behind.
- The needle is then passed through the flaps of the wound alternately to get continuous oblique sutures all along the length of the wound.
- A the end of the wound, the knot is placed with the loop of the suture and the needle end of the suture material **(Fig 11.17–11.24)**.

Advantages

- Even distribution of tension along the wound margin.
- Enables water-tight closure of the wound.
- It is a much faster technique than interrupted sutures.

Disadvantages

- If one suture gets loose, all the other sutures also get loose.
- It is not possible to remove individual sutures as in case of edema/ hematoma release.

Continuous Sutures with Locking

Indications

Same as above

Technique

- First a simple interrupted suture is placed. Then similar to the suturing technique described above, it is passed through both the flaps. The needle is then passed through the loop made by the suture material.
- The assistant is made to "follow the suture" by holding the suture material close to the tissues where the needle last passed through the loop.
- Each time the needle is made to pass through the flaps

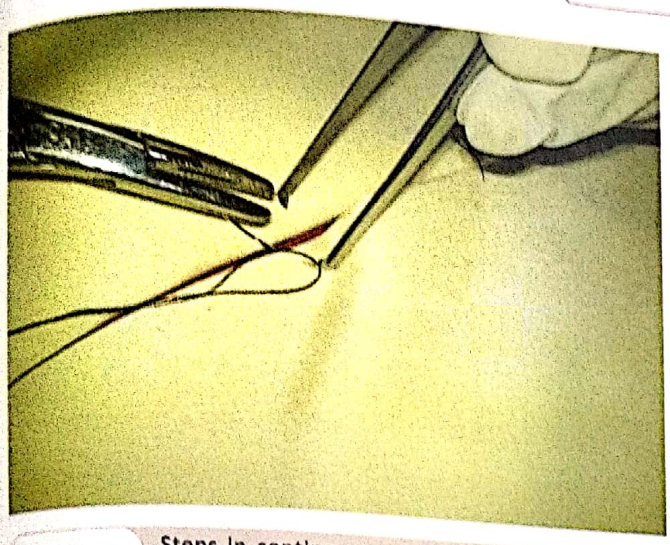

Fig. 11.17 Steps In continous sutures—Step 1: Needle is passed through one flap

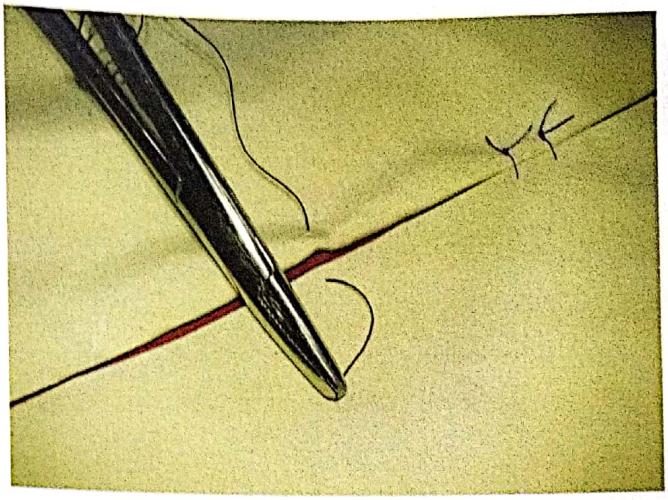

Fig. 11.18 Step 2: pass the needle through the other flap

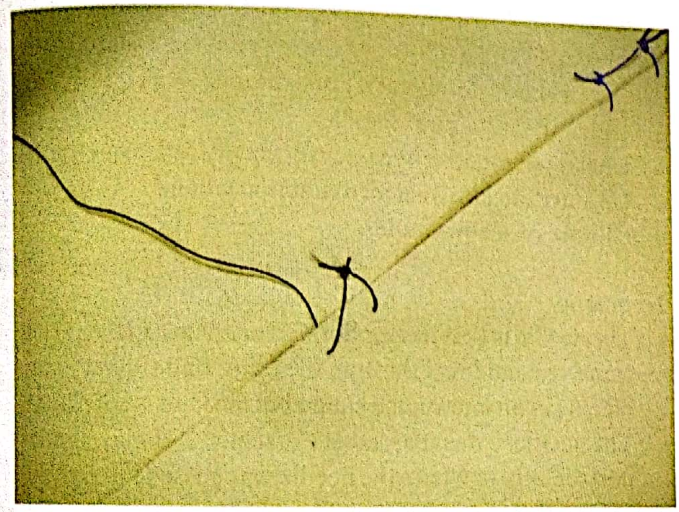

Fig. 11.19 Step 3

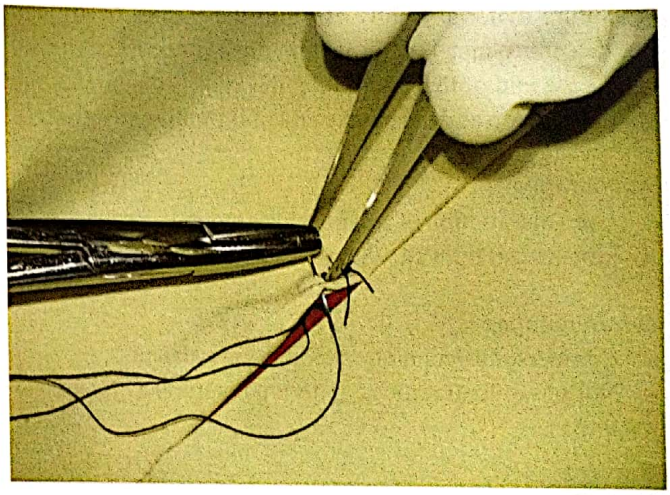

Fig. 11.20 Step 4

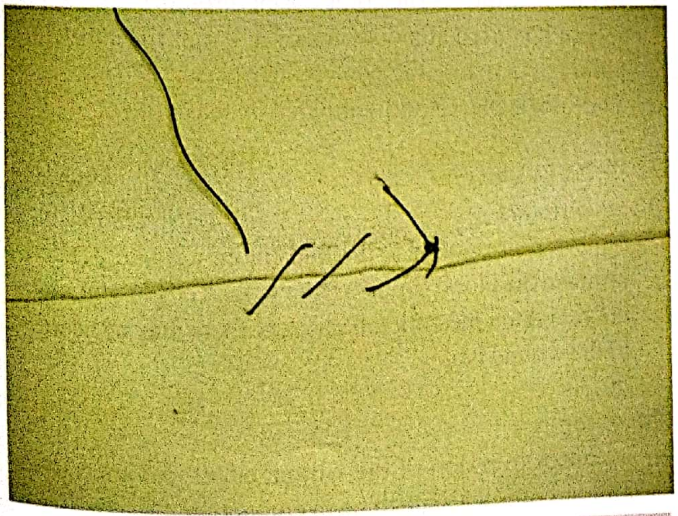

Fig. 11.21 Step 5

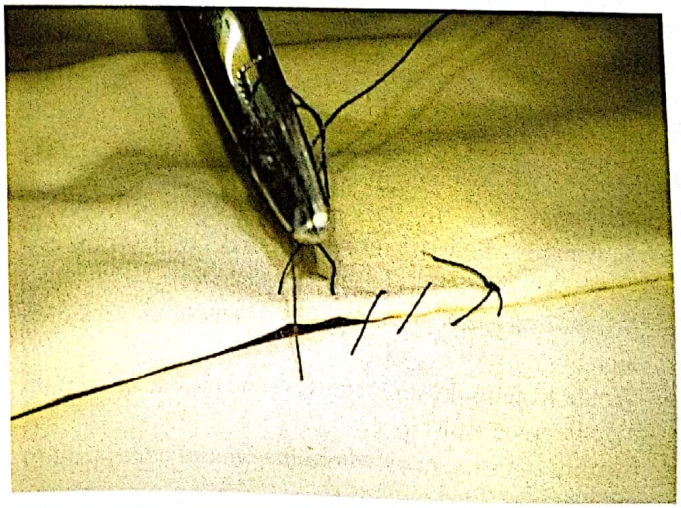

Fig. 11.22 Step 6•4

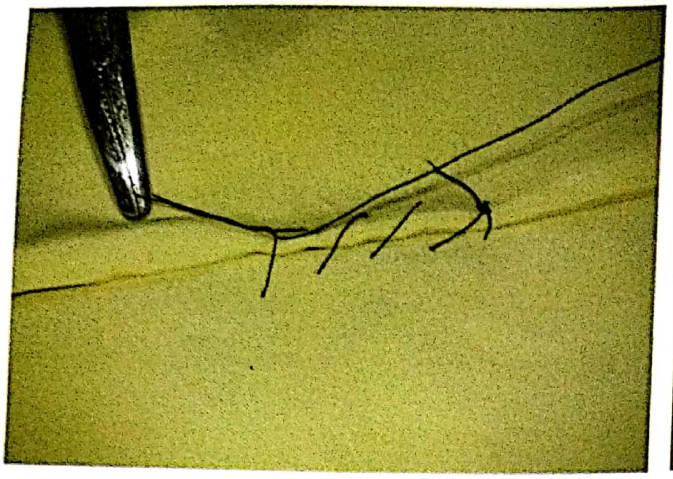

Fig. 11.23 Step 7

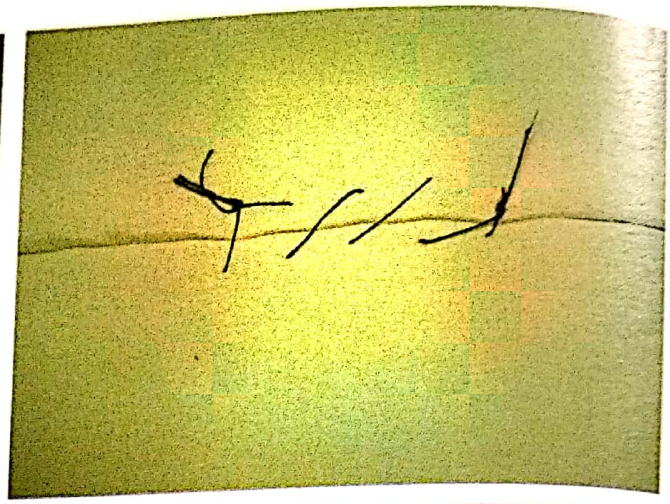

Fig. 11.24 Step 8

and under the suture loop, the assistant should hold the suture material tightly close to the tissues to prevent the suture material from slipping and becoming loose.
- At the end of the suture line, the knot is made with the suture loop and the needle end of the suture material.

Advantages
- Even distribution of tension along wound margins
- Good water tight closure especially for intraoral wounds

Disadvantages
- Cumbersome technique. Requires assistance
- Not possible to remove individual sutures **(Fig 11.25–11.31)**.

Mattress Sutures
- This type of suturing technique provides wound edge eversion. It is observed that wounds tend to contract as they heal, so if the edges are everted during closure,they approximate with less prominent scarring.
- These are of two types:
- Horizontal mattress
- Vertical mattress

Indications
- In wounds where wound eversion is desirable during closure
- Wounds on the abdomen, hip and sometimes neck incisions
- Where wounds are under tension and need to be brought together over a distance
- Closure in those areas where the wound edges tend to roll inwards.

Horizontal Mattress Sutures

Indications

Used specifically in those areas where there is an underlying bony defect of a deficiency. For example:
- Closure of oroantral fistula
- Closure of mucosa over a cystic cavity after enucleation
- Used for closure over an extraction wound
- Closure of scalp wounds

Technique
- The needle is first passed through one flap and then at the same vertical level through the other flap similar to the placing of an interrupted suture but the knot is not placed.
- The needle is then passed at a distance 3–4 mm parallel horizontally to where the needle was passed through the second flap.
- It is then passed through the first flap at the same vertical level as the last bite.
- In this way the needle comes back through the same flap where it started at a distance of 3–4 mm from the entry point.
- The knot is placed and stabilized on that side **(Fig 11.32–11.39)**.

Disadvantages
- Since it runs parallel to the flap edges, it is likely to compromise the blood supply of the wound edges. Be careful not to tighten the knot too much or there may be necrosis of the wound edges.

Advantages
- It causes eversion of the wound edges, it allows more amount of raw tissue to be in contact.
- Causes even distribution of tension along the wound.

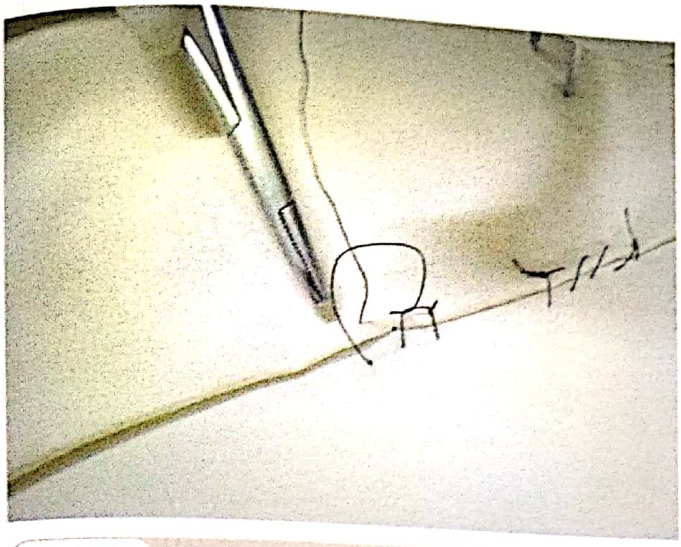

Fig. 11.25 Continuous sutures with locking

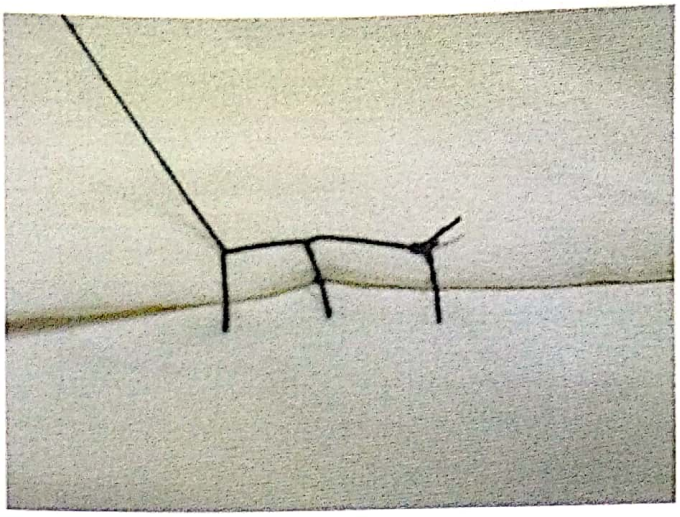

Fig. 11.26 Continuous sutures with locking

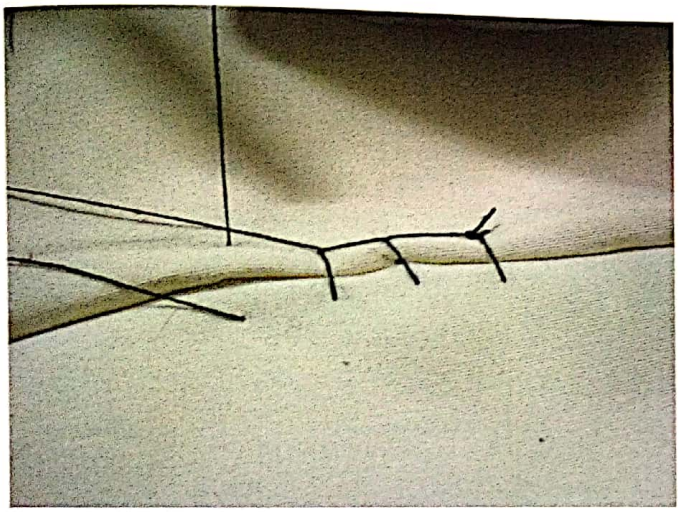

Fig. 11.27 Continuous sutures with locking

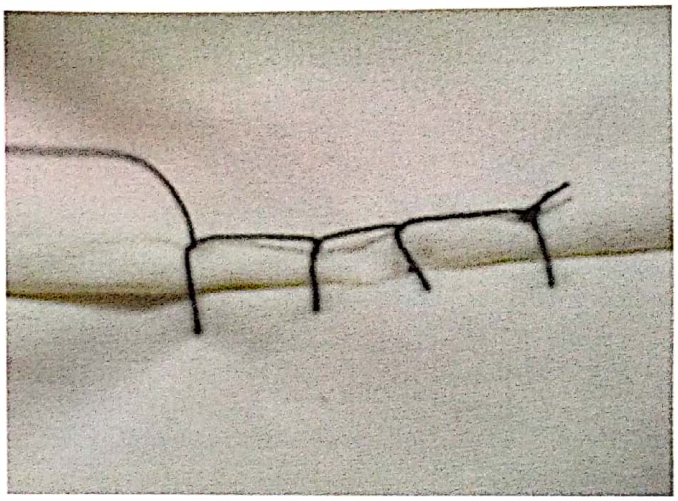

Fig. 11.28 Continuous sutures

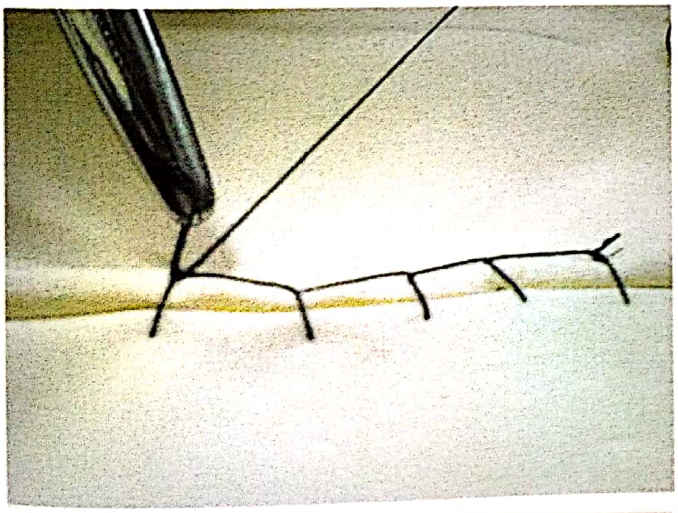

Fig. 11.29 Continuous sutures

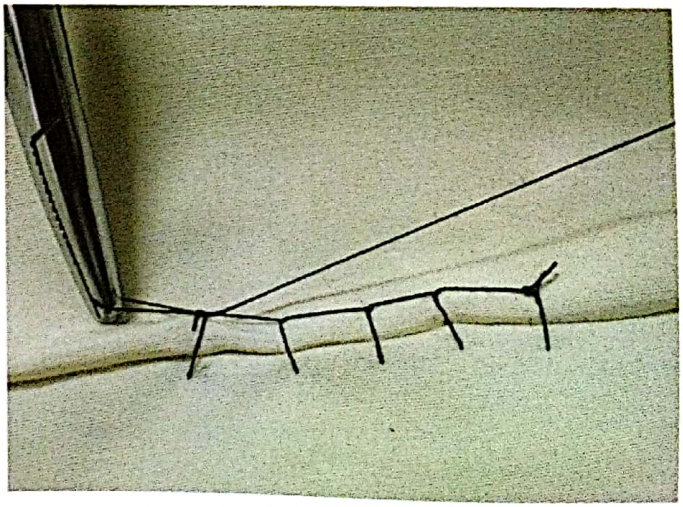

Fig. 11.30 Continuous sutures

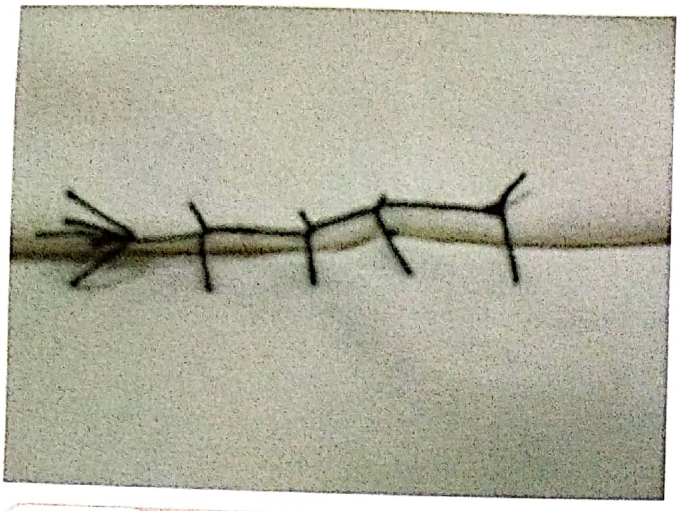

Fig. 11.31 Continuous sutures

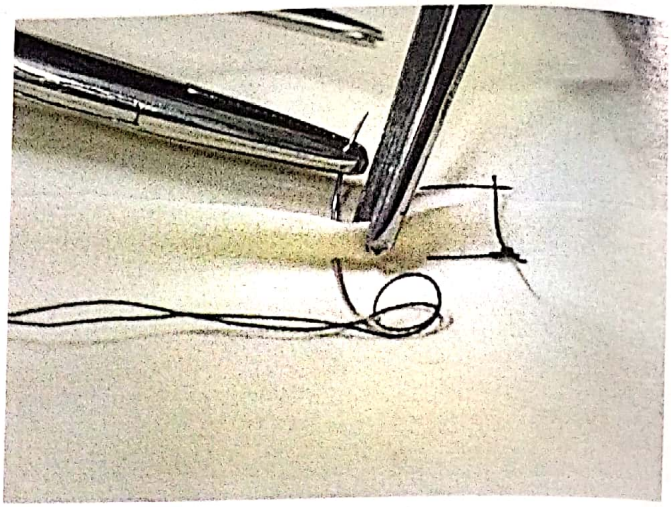

Fig. 11.32 Horizontal mattress sutures—Step 1

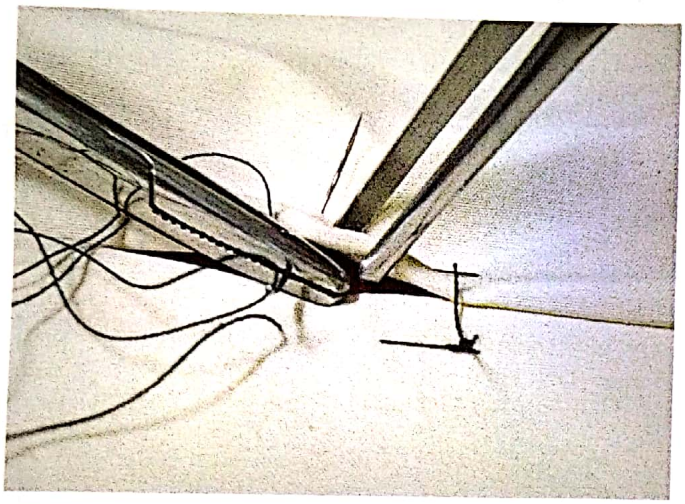

Fig. 11.33 Step 2

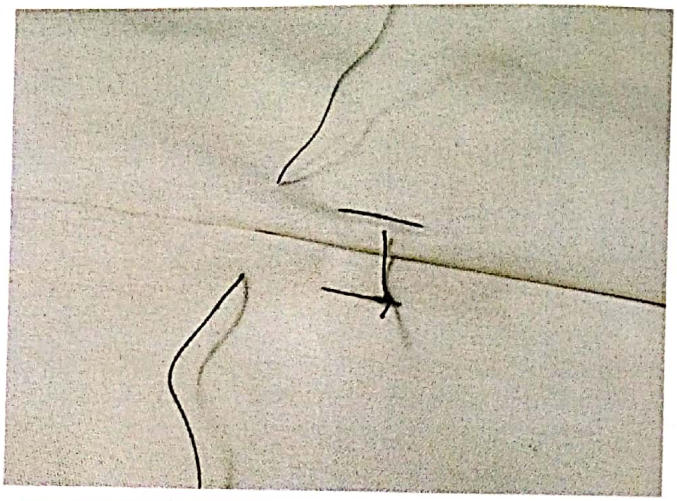

Fig. 11.34 Step 3

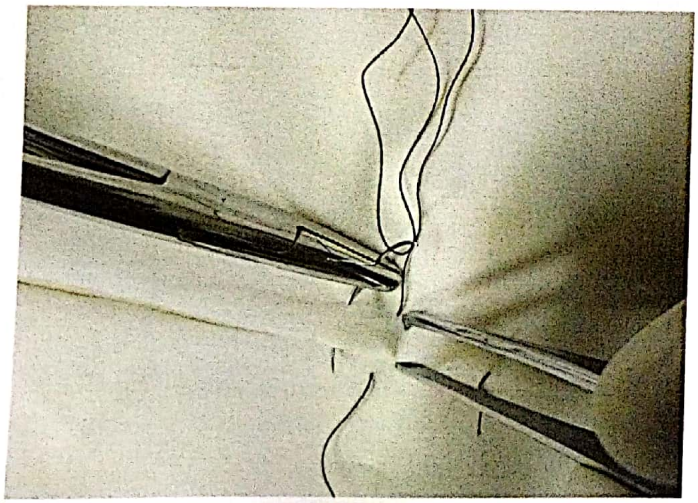

Fig. 11.35 Step 4

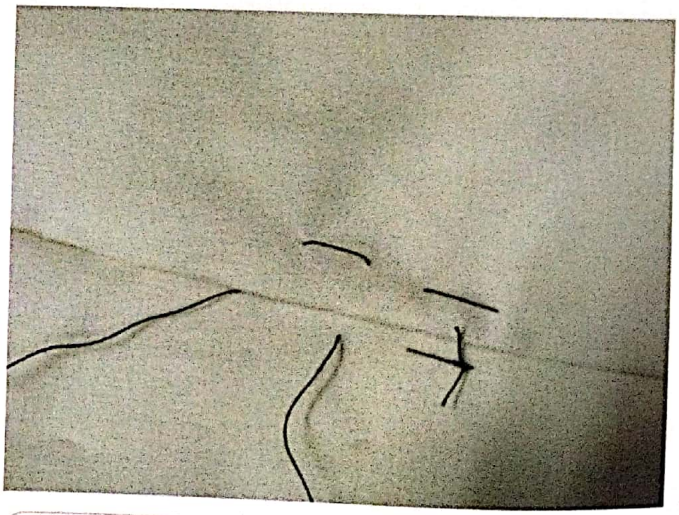

Fig. 11.36 Step 5

Fig. 11.37 Step 6

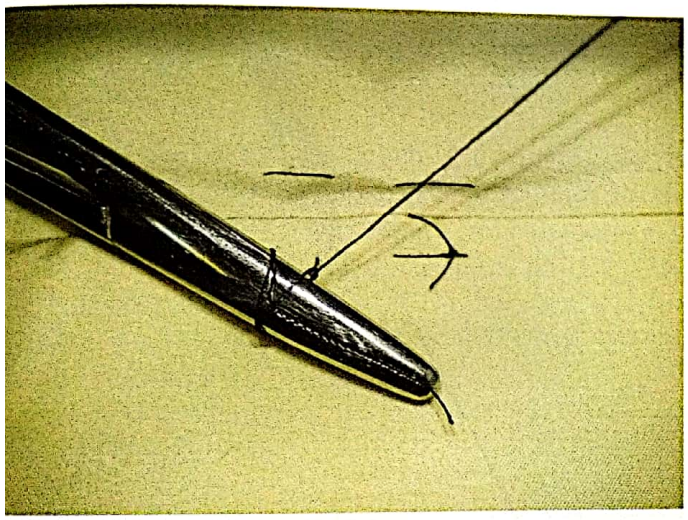

Fig. 11.38 Step 7

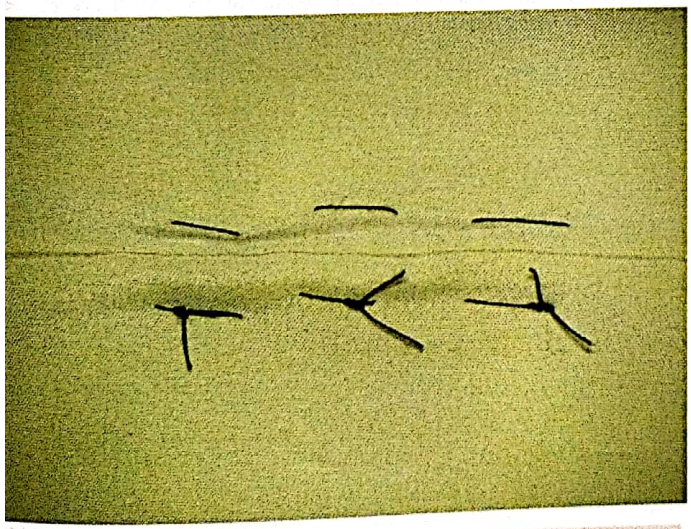

Fig. 11.39 Step 8

Vertical Mattress Suture

Indications

- Used for the closure of skin wounds.
- In those areas where the skin edges tend to invert.

Technique

- It is used by the "far-far, near-near" system where the needle is first passed far away from the wound edges and then nearer or at a more superficial level.
- The needle is passed through one wound edge taking a deep bite of tissue almost 4–8 mm from the wound edge.
- This type of suturing requires that the wound edges are well undermined prior to suturing.
- It is then passed through to the other edge at the same depth and brought out. A knot is not placed as yet.
- The needle is then turned around and passed backward through the second flap at a level more superficial, i.e., closer to the wound edges (1–2 mm away).
- The needle is then passed through the first flap at the same superficial level and brought out. In this way both edges suture material are on the same side.
- The knot is then placed and stabilized on the side where the suturing first began **(Fig. 11.40–11.45)**.

Advantages

- It causes good eversion of the wound margins bringing greater amount of raw tissue surface into approximation.
- Since it passes at 2 levels, one superficial and one deep,it provides good wound support, draws the wound edges with good eversion.
- Since it runs vertical to the blood supply of the wound edges, suturing in this manner is not likely to compromise the vascularity of the wound edges.

Corner Stitch

It is a type of modified horizontal mattress suture. Also called a 3-point suture. This is a type of half-buried horizontal mattress suture.

Indications

- To approximate angled skin flaps or corners where 3 points meet.
- To place a triangular flap in position without compromising the delicate vascularity of the tip of the flap.
- To close X or Y shaped wounds.
- Usually, to place a triangular tip into its position, multiple sutures near the small tip tends to compromise the vascularity of the tip, leading to necrosis.
- This suture is placed such that the suture material does not pass through the full thickness of the dermis at the

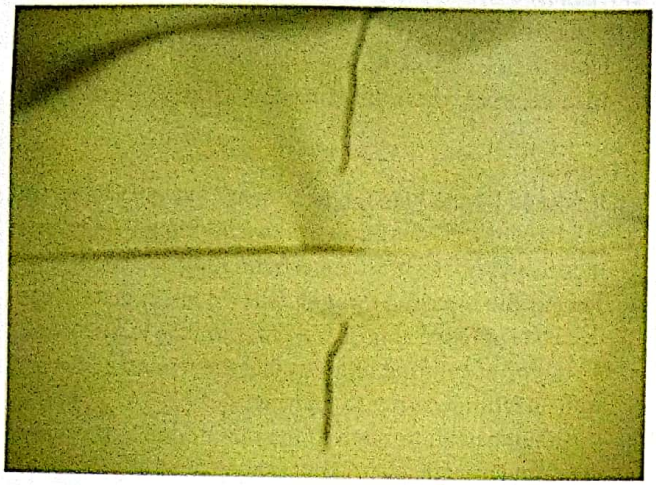

Fig. 11.40 Vertical mattress sutures—Step 1

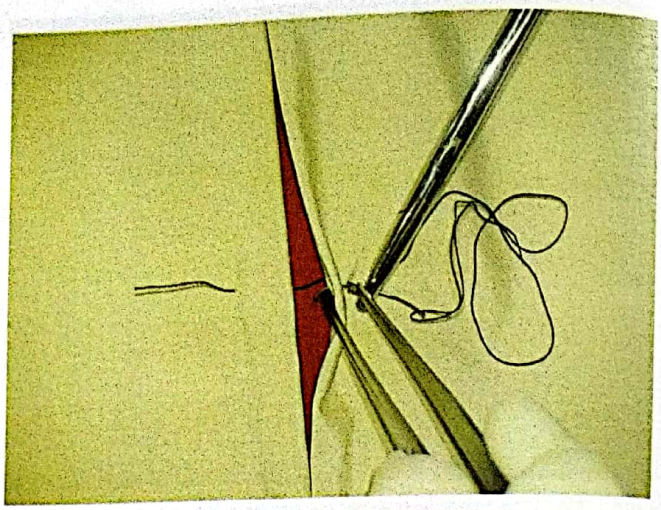

Fig. 11.41 Step 2

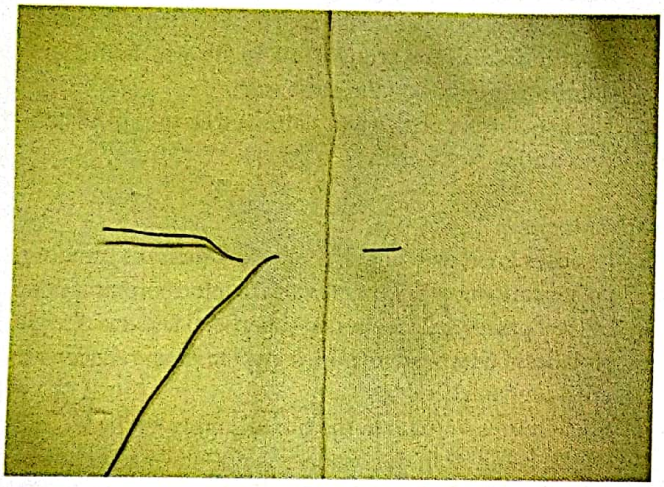

Fig. 11.42 Step 3

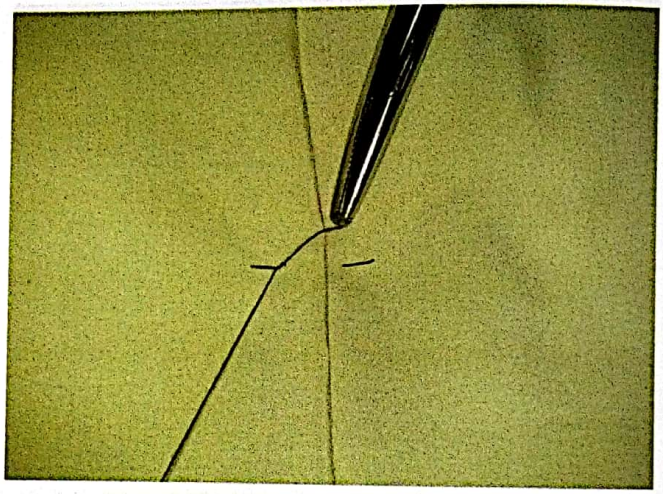

Fig. 11.43 Step 4

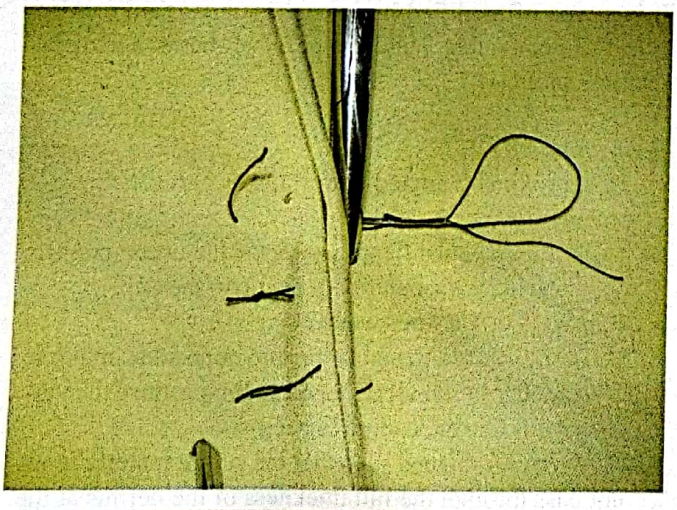

Fig. 11.44 Step 5

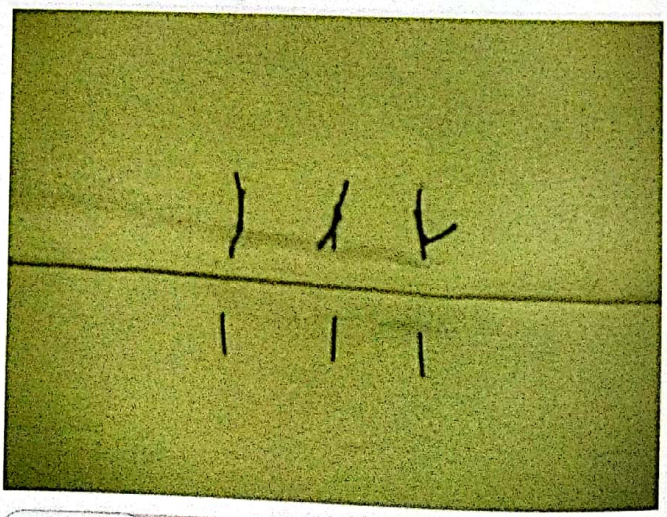

Fig. 11.45 Step 6

tip, thus maintaining its vascularity and also approximating it accurately.

- An imaginary equilateral triangle is drawn with the apex at the region of the triangular tip of the flap.
- The needle is then passed through one corner of the base of the triangle 6–8 mm from the edge of the wound and at a distance of 4–6 mm from the corner (triangular tip). The needle is then passed through the full thickness of the dermis.
- Now the needle has to pass through the triangular tip (or apex of the imaginary triangle).
- The needle is not passed through the entire thickness of the skin. Lift up the tip of the flap with an Adson's tissue holding forceps and pass the needle through the subdermal tissue without coming out through the skin.
- Now the needle is passed out through the opposite end of the base of the imaginary triangle through the entire thickness of the skin.
- The knot is then placed on the site where the needle first went through the flap and the corner tip snugly fits into the flap.
- The key to a neat corner stitch is to pass the needle through at the same distance on both sides of the imaginary triangle.

Advantages

It helps in the insetting of a triangular flap without causing necrosis of the tip of the flap **(Fig 11.46,11.47).**

Subcuticular Sutures

Indications

- For the cosmetic closure of wounds

Technique

- A good deeper-layered closure is essential with a good passive approximation of the wound edges of the skin before considering subcuticular suturing.

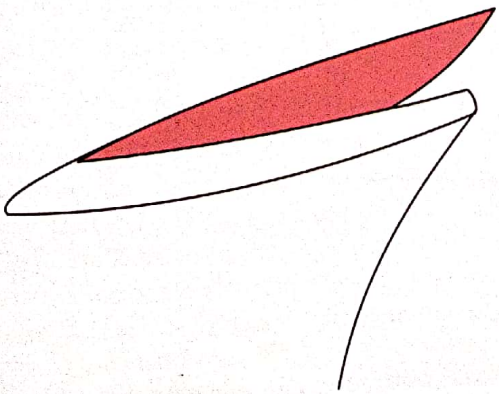

Fig. 11.46 Suturing of triangular flap

- A non-absorbable monofilament suture material such as prolene may be used.
- It is first passed through skin in one end of the wound such that the needle is brought into the wound.
- The needle is then passed alternately through opposite wound edges completely in the subcuticular layer without piercing the skin and also without placing any knots anywhere along the length of the wound.
- In the end the needle is brought out again through the edge of the wound through the skin.
- The suture material is pulled slightly to get a good approximation of the wound edges without any bunching.
- The suture material is trimmed to leave long ends and taped on both ends to secure it from slipping.
- Suture removal is done after 5–7 days by removing the tape on both sides, cutting one end of the material close to the skin and then gently pulling the other end of the suture material out of the wound **(Fig 11.48–11.55).**

Box. 11.5 Different suturing techniques

Interrupted sutures
Continuous sutures
- Without locking
- With locking

Mattress sutures
- Horizontal mattress
- Vertical mattress

Corner stitch (modified horizontal mattress)
Subcuticular sutures.

PRINCIPLES OF SUTURING

For a good suture to be placed, selecting the correct armamentarium, the appropriate suture material, the required needle and also the type of suturing technique are all essential. It is also important to follow certain principles.

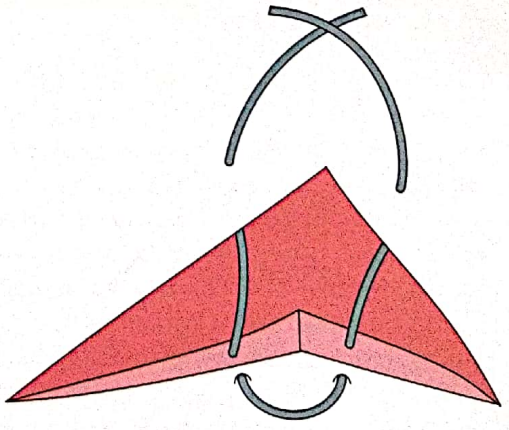

Fig. 11.47 Buried horizontal mattress suture for triangular flap

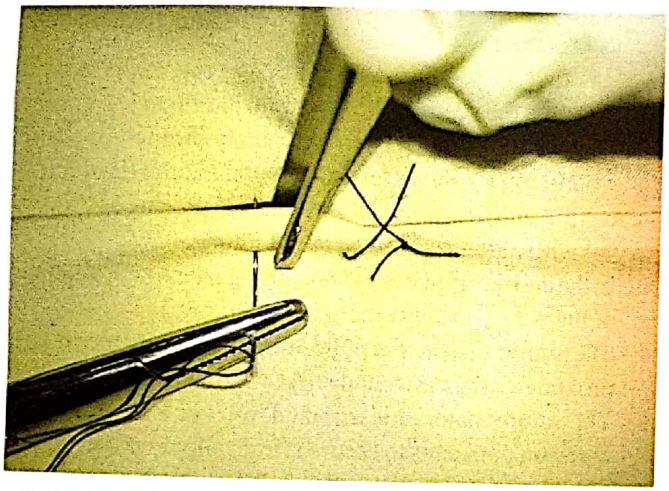

Fig. 11.48 Figure-of-8 suturing—Step 1

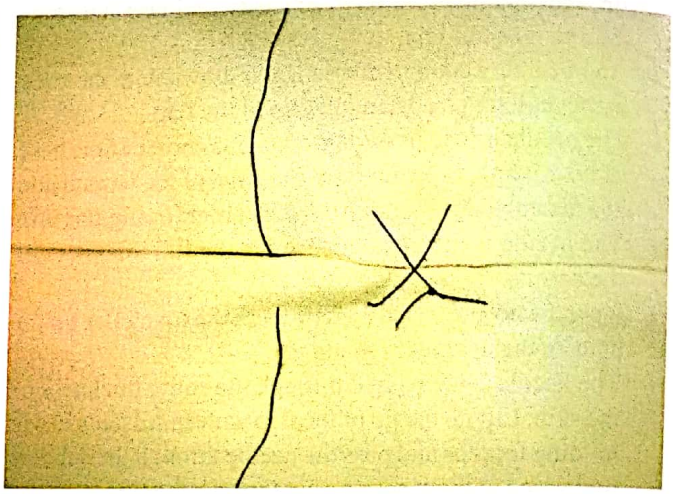

Fig. 11.49 Step 2

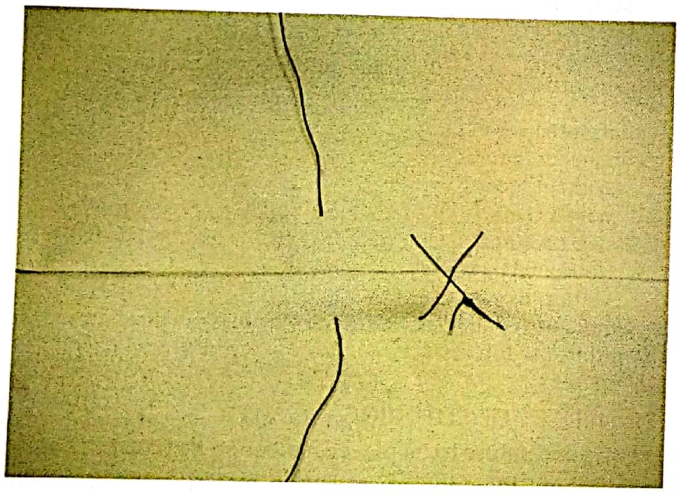

Fig. 11.50 Step 3

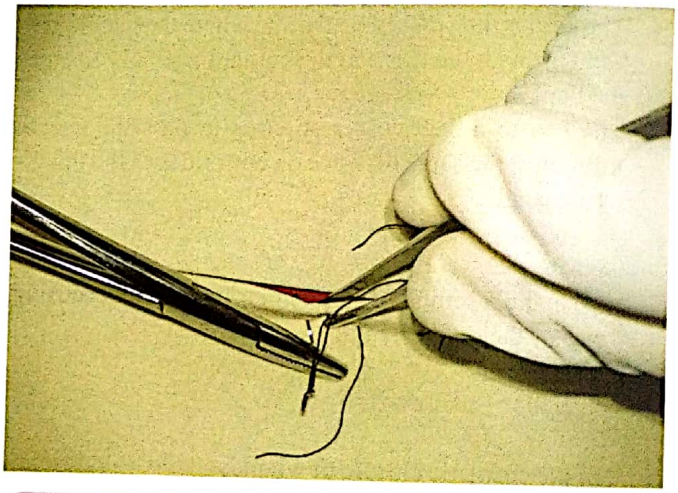

Fig. 11.51 Step 4

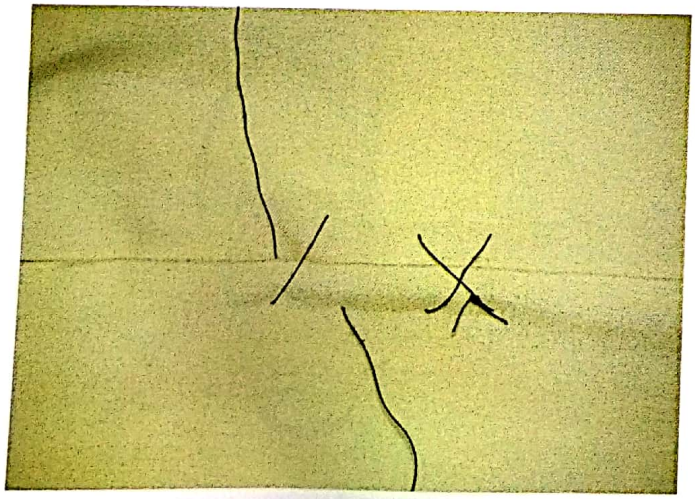

Fig. 11.52 Step 5

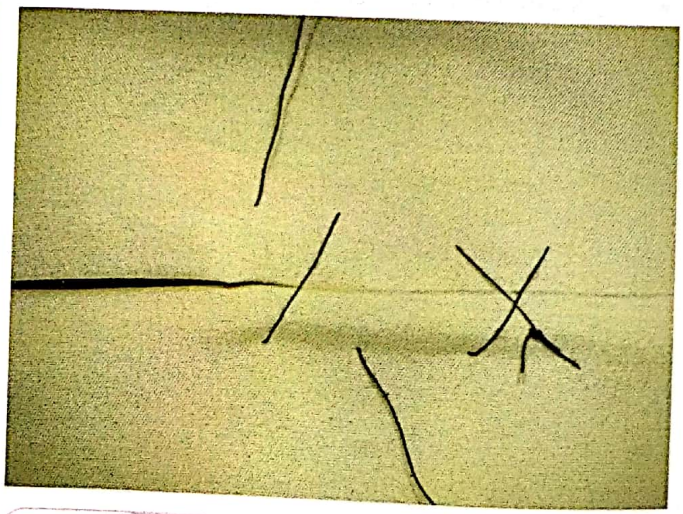

Fig. 11.53 Step 6

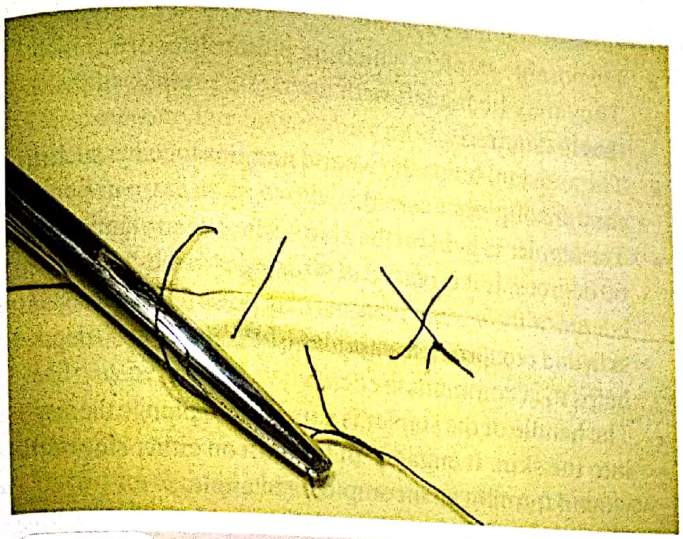

Fig. 11.54 Step 7

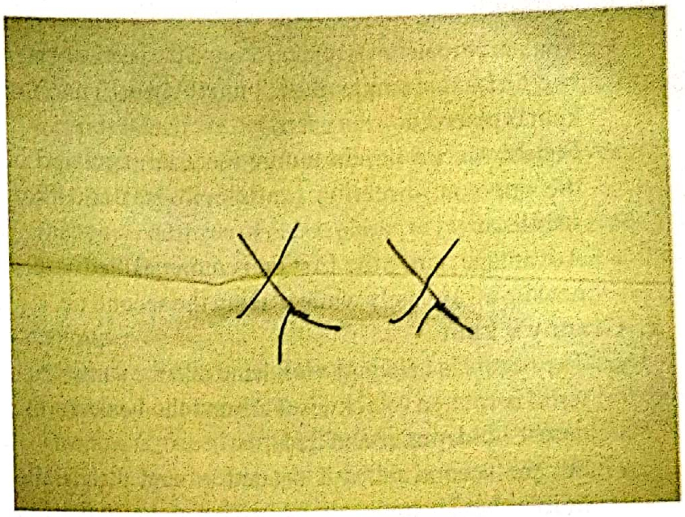

Fig. 11.55 Step 8

1. The beaks of the needle holder should grasp the needle at the junction of 2/3rd of the needle from the tip. Grasping the needle further away will result in bending of the needle when inserting through the tissues. It may also result in breakage of the needle especially a swaged needle as it is weak in that region.
2. When the needle is introduced into the tissues it should enter perpendicular to the tissue surface. Change in this angulation may tear the tissues.
3. After inserting the needle, pull the needle along its curvature to prevent undue damage to the tissues.
4. The needle should pass at a distance of about 2–3 mm from the edges of the flap. This distance should be the same on both wound edges. This principle may be modified in certain instances where the wound edges are at uneven levels. In such cases to approximate the wound edges to the same level, two techniques may be followed:
   a) Described by Pick in 1941: The needle is passed through the lower flap at a distance closer to the edge and through the flap which is at a higher level at a distance further from the edge. On tying the knot, the wound margins come into the same level of approximation.
   b) Described by May in 1971: The needle is passed in such a way that it takes a deeper bite on the flap that is inferior and a more superficial bite on the flap that is superiorly placed. The distance from the wound edges remains the same. On placing the knot, both the flaps approximate at the same level.
5. The needle is passed through the free side of the flap first and then through the fixed side.
6. In wound edges of uneven thickness, the needle is first passed through the thinner flap and then through the thicker flap.
7. The needle is to be passed from the deeper flap to the superficial flap.
8. When the needle is passed through the tissues, the depth of penetration should be more than the distance from the wound edges. This brings about wound edge eversion which is required for wound closure.
9. Make sure suturing is not done under tension. The wound edge will necrose or tear under tension. Undermine adequately prior to closure to ensure tension-free wound approximation.
10. Do not strangulate the tissues by unnecessary tightening of the knot as it will result in necrosis and loss of tissue.
11. The knot should be stabilized over one side of the wound and not rest along the edges of the wound as infection may track into the wound.
12. Distance between 2 sutures is approximately 3–4 mm. It may be placed closer in areas of high muscular activity where movement is likely to cause dislodgement of sutures.

TYPES OF KNOTS

1. **Square knot**
   - After the needle is passed through both wound edges, the needle end is held in the left hand and rotated around the beaks of the needle holder one time (clockwise direction), the free end of the suture material is held and the knot stabilized on the tissues.
   - The suture material is then rotated around the needle holder once in the opposite direction (anticlockwise direction) and then tightened.
   - A third tie is also recommended in the same direction as the first time and then stabilized. This ensures complete stability of the knot.

2. **Surgeon's knot**
   - The suture material is rotated around the needle holder two times in a single direction (clockwise) and the knot is placed.
   - For the second tie, the suture material is rotated in the opposite direction (anticlockwise) and then stabilised.
   - Advantage: since the first tie is more stable, it does not slip away easily while placing the second tie.
3. **Granny's knot**
   - The needle is held in the left hand and the suture material is rotated (clockwise) around the beaks of the needle holder once and tied.
   - For the second tie, it is rotated around the needle holder beaks once again in the same direction (clockwise) as the first time and stabilized.
   - A third tie in the opposite direction (anticlockwise) is recommended for complete stability.

Box. 11.6 Types of knots

Square knot
Surgeon's knot
Granny's knot

ALTERNATIVES TO SUTURING

Staples

- This is an alternative method of closure of wound where staples are used for wound approximation.
- Staples are made of high quality stainless steel.
- They are available in a variety of sizes for use on different types of wounds.

Parts of the Staple

- Cross member that lies on the skin surface placed perpendicular to the wound.
- two legs that are vertically placed in the skin
- Tips that secure the staple in the soft tissues and which come parallel to the cross member.

Indications

- Lengthy wounds in the extremities which are closed under tension.
- Wounds on the trunk and scalp
- May be used to stabilize skin grafts

Contraindications

- Not used in soft tissue or mucosal closure or intraoral wounds.
- Not used for the closure of wounds in mobile areas such as joints or bony prominences.

Technique

- Disposable staplers which are presterilised are available. They may be loaded with up to 5–35 staples of the size that is required.
- The assistant holds the wound margins together such that they are slightly everted.
- The stapler is held on the skin surface at an angulation of 60 degrees. If it is placed at 90 degrees to the skin surface, edema of the wound margins may press the staple against skin and compromise vascularity. Placing it at 60 degrees helps to accommodate edema.
- The handle of the stapler is squeezed to plunge the staple into the skin. It engages in the skin on either side of the wound forming an incomplete rectangle.
- The depth of penetration of the staple depends on the pressure with which the stapler is placed on the skin.
- After healing of the wound, the staples may be removed with a pair of staple extractors.

Advantages

- Much faster method of closure.
- Lesser chances of infection.
- The staples do not cause much tissue reaction.
- Better wound margin eversion.

Disadvantages

- Wound closure may not be precise.
- Does not cause cosmetic wound closure.
- Chances of cross hatching are more.
- Requires an assistant to constantly hold the tissues everted during procedure.
- Expensive alternative to suturing.

Tissue Adhesives

Also called tissue glue. "Cyanoacrylate" available as octylcyanoacrylate and N-butyl-2 cyanoacrylate are used to close simple wounds and lacerations.

Indications

Lacerations in patients who do not cooperate for suturing e.g.: in uncooperative children. Closure of wounds in patients where follow-up may not be possible.

Contraindications

- Mobile areas of skin such as on bony prominences and joints.

Technique

- Deeper layer closure is done prior to application on skin or mucosa.
- Clean the skin with acetone or alcohol.

- N-butyl-2-cyanoacrylate is available as a single use droplet vial.
- It is applied along the wound margin.
- Octacyanoacrylate may require multiple applications as thin layers once the previous layer dries.
- It polymerises as an exothermic reaction once it comes in contact with tissue fluids. It forms a 3-dimensional strong but flexible bond on the skin.
- It takes about 30 seconds for this reaction. In about 7–14 days if left untouched, it sloughs off with the epidermis and may be cleaned away with soap and water.

Advantages

- Useful for wound closure in uncooperative patients as the procedure is very fast.
- It is quick and easy to apply.
- It provides a water-tight closure and also forms an antimicrobial coating.
- Does not require any suture removal.
- The cosmetic result is acceptable.

Disadvantages

- Exothermic reaction may be felt by the patient.
- repeated washing and wound care may remove the adhesive. This may hamper the healing.

Tapes

- These may be used as additional support for wounds that have been approximated with surgical adhesive (cyanoacrylate).
- May also be used as wound support after suture or staple removal.
- It may be used alone for small non-exudative type of wounds which are not in the tension zones.
- Tapes are made of microporous material which have an adhesive on one side.
- Tapes may be made of paper, plastic or rayon and are available in different widths.

Technique

- After deeper layer closure is done, wound is cleansed with alcohol or acetone.
- The tape is placed perpendicularly across the wound such that the edges are brought together without any overlap.
- Additional tapes may be placed parallel to this as reinforcement.

Advantages

- Easy to use, no infection
- No suture marks, removal or follow up reqired

Disadvantages

- Limited wound eversion, approximation may not be precise
- Cannot be used in hair bearing regions, adhesive may be washed away if the wound is washed