

Critical Evaluation of Suture Materials and Suturing Techniques in Implant Dentistry

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Abstract

The number of implant seekers is increasing with various medical adements and the 'Baby Boom' generation will soon make it to 'Geriatric Boom' Misch criteria allowed a minimum of 90% success for 5 years and 85% for 10 years. These criteria or success rate can be achieved only when each and every case/patient is properly diagnosed, planned and well-executed.

Wound closure or suturing is one of the important step for a successful implant. An extensive review of the literature that is available for various suture materials and suturing techniques does not gives a clear idea of which material and which techniques is best. This in depth review/literature critically evaluates various suture materials and techniques which can be used and advantage of one over the another.

Keywords: Suture materials, suturing techniques, wound closure.

INTRODUCTION

Loss of teeth, eventual edentulism and wearing of complete dentures and implants have been part of the expected course of aging.

There is an increasing demand for integrating oral implantology in dental practices. This demand is because of shift in population's age and health needs, to a growing public desire to preserve and restore dentition to a functional and esthetic state, and recent advances in the techniques, technologies and technicalities in the field of dentistry. This number of implant seekers is sure to increase with various contributions and the 'Baby boom' generation will soon make it to 'Geriatric boom'.

Wound closure or suturing is one of the important clinical step for a successful implant. The evaluation of various suture materials and suturing techniques is regarded particularly important for a perfect closure of wound so as no infection can affect the prognosis of implant.

Suturing (according to Glossary of Prosthodontic Terms-7) is defined as the process of uniting the tissues separated by either a traumatic or surgical wound in a specific manner using an appropriate material.

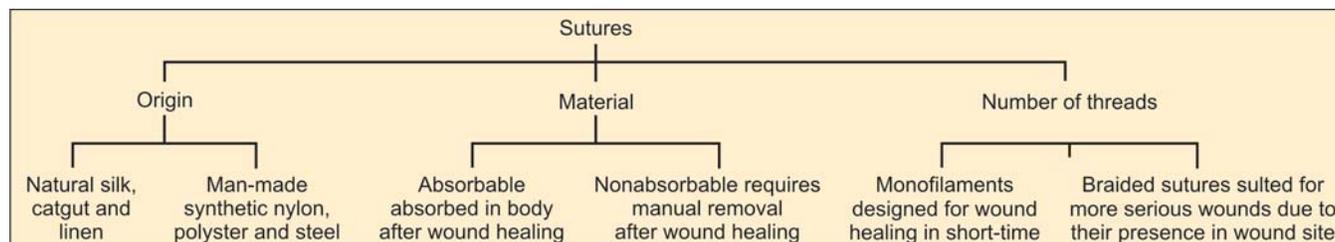
MATERIAL AND METHODS

A suture is a strand of material used to ligate blood vessels and to approximate tissues together. To suture is the act of sewing or bringing tissues together and holding them in apposition until healing has taken place.

The goals of wound closure include obliteration of dead space, even distribution of tension along deep suture lines, maintenance of tensile strength across the wound until tissue strength is adequate, and approximation and eversion of the epithelial portion.

CLASSIFICATION

Sutures can be classified in different ways:



Suture can be broadly divided into:

1. **Absorbable:** All suture materials that are digested by the body enzymes or are hydrolyzed by the fluids are absorbable.
2. **Nonabsorbable:** Sutures that cannot be digested by tissue enzymes and are encapsulated or walled are non-absorbable.

These can be further divided into monofilamentous and multifilamentous in each category.

- a. *Monofilamentous:* It is made up of single strand, resists harbouring micro-organisms and ties down smoothly.
- b. *Multifilamentous:* It consists of several filaments twisted or braided together. This gives good handling and lying characteristics. The multifilamentous sometimes produce wicks (mainly silk) that may cause retrograde infection which the monofilamentous discourage.

UNITED STATES PHARMACOPEIA CLASSIFICATION

3. *Class-I:* Silk or synthetic fibers of monofilament, twisted, or braided construction.
Class-II: Cotton or linen fibers or coated natural or synthetic fibers in which the coating contributes to suture thickness without adding strength.
Class-III: Metal wire of monofilament or multifilament construction.

REQUISITES FOR SUTURE MATERIALS

1. *Adequate strength:* Depends on the elasticity of the material. Flexible materials will have a greater ability to stretch and bear stress.
2. *Low tissue irritation and reaction:* Sutures made from inorganic material will evoke a higher tissue response than synthetic materials. Tissue reaction is also directly proportional to the size of suture material.
3. *Low caillarity:* Multifilamentous soak up tissue fluid by capillary action providing a rich medium for proliferation of microbes and increases chances of inflammation and infection.
4. Good handling and knotting properties.
5. Sterilization without deterioration in properties.
6. Good memory, Knot strength and elasticity.
7. *Thickness:* Suture materials are numbered according to their thickness from 1-0(0) to 9-0 (000000). The greater

the number of zeroes, thinner is the material. Thicker suture are used for approximating deeper layers, wounds in tension prone areas and for ligation of blood vessels. Thin ones are used for closing delicate tissues like conjunctiva and incisions of face.

SUTURE MATERIALS IN BRIEF

Plain Catgut

- Word catgut is derived from 'Kit gut' which means violin string.
- Catgut is derived from submucosa of the sheep intestines.
- Oldest suture material known.
- Plain catgut lasts for 7-10 days, hence its uses are minimal.
- It is biological, absorbable and monofilament.

Chromic Catgut

- When plain catgut is mixed with chromic salts, chromic catgut is formed.
- Strength is for 15-25 days.
- It is biological, absorbable, monofilament.
- It has good knotting property.
- It is preserved in 70% alcohol and kept soft due to 5% glycerine.

Vicryl

- It is a copolymer of glycolide and lactide.
- It is a synthetic and absorbable suture.
- Unlike catgut this is absorbed by hydrolysis.
- It has better strength and reliability.
- It is synthetic so tissue reaction is less than that of chromic catgut.
- Good knotting property.

Prolene

- It is polypropylene and nonabsorbable.
- It is monofilament, artificial and uncoated.
- It is nonabsorbable.

Sutupack

- It is monofilament or multifilament polyauide.
- Black, braided, uncoated, nonabsorbable.
- Not good knotting property so mandatory to put 4-5 knots.

Mersilk

- Nonabsorbable, braided silk, black.
- Used for ligating bleeding points.

Silk

- Nonabsorbable, biologically derived from cocoon of silkworm larva.
- Braided, coated with wax to reduce capillary action.
- Tissue reaction is more as it is a foreign protein in spite of this widely used because of easy availability and is cheap.
- Excellent knotting property.



Ambroise Paré (1520-1590)

An astute observer and brought many innovations to surgery and wound care. One of the most important concepts he introduced was that wounds should be treated gently to reduce inflammation and promote healing.

Paré became a champion of treating wounds gently. Paré said.

“I dress the wounds, God heals them.”

COMPARATIVE EVALUATION OF SUTURE TYPES

| Name | Material/characterization | Resorbable | Time to resorb | Purpose/size | Values | Problems |
|-------------|--|------------|----------------|--|--|--|
| Silk | Braided, black, natural | No | – | Mucosal closure-3.0, tongue and flap retraction –2.0 | Slides and knots easily, knot doesn't slip | Acts as a wick needs to be removed, not very strong |
| Plain gut | Monofilament, clear, animal | Yes | 5-7 days | Subcuticular and mucosal closure 3.0 | Resorbs quickly, good for noncritical wounds | May create sensitivity, doesn't hold knots well, unreliable for critical wounds, both the tongue intraorally, weak |
| Chromic gut | Monofilament, gut beige, natural | Yes | 28 days | Deep muscle closure 3.0, 4.0 | Resorbs slowly, dependable | May create sensitivity, not applicable for intraoral use, holds knots poorly, weak |
| Nylon | Monofilament, blue/black synthetic | No | – | Skin closure | Strong discourages wicking | Holds knots poorly, has plastic memory, requires removal |
| Tevdek | Braided, green, teflon coated dacron, synthetic | No | – | Skin closure | Strong knots well | Acts as wick to some extent, requires removal |
| Dexon | Braided, white or dyed polyglycolic acid, synthetic | Yes | 28-45 days | Deep suturing mucosal closure | Strong, knots well, after removal residual deep components may be left behind and will resorb eventually | Causes some wicking requires removal when used intraorally as 28 days is too long when wet neither slides nor knots as well as silk. |
| Vicryl | Braided white or dyed violet, polylactic acid, synthetic | Yes | 28 days | Deep suturing mucosal closure | | |

Principles of Suturing

1. The needle should be grasped at approximate 1/3rd the distance from the eye and 2/3rd from the point.
2. The needle should enter the tissues perpendicular to tissue surface along its curve.
3. The suture should be passed at an equal depth and distance from incision on both sides.
4. Needle always passes from movable tissue to fixed tissue.
5. Needle should pass through the thinner tissue to thicker tissue.
6. Needle passes from deeper tissue to superficial tissue.
7. Tissue should never be closed under tension.
8. Tissue should not be blanched while suturing.
9. The knot should never lie on incision line, suture knot must lie on bone.
10. Suture should be placed at a greater depth than the distance from incision, so as to evert the wound margins.
11. Intraoral sutures are generally removed after 7 days. If there is stress/tension while suturing the sutures may be kept for 10 days.

SUTURING TECHNIQUES (FIGS 1A TO 3G)

There are several methods of closure that offer advantages when employed for different incisions and at varying locations.

1. Interrupted Sutures (Figs 1A to E)

- Both the points of entry and exit are on the outer surfaces of flaps respectively.
- Most commonly used suture.
- Suture is passed through both the edges at an equal depth and distance from incision and knot is tied.

Advantages

- It is strong and can be used in areas of stress.
- Successive sutures can be placed according to individual requirement.
- Each suture is independent and loosening of suture will not produce loosening of others.
- A degree of eversion can be produced.
- If the wound becomes infected or there is hemorrhage, removal of few sutures may be of satisfactory treatment.

Disadvantage

More time is required.

2. Continuous Suture

Initially a simple interrupted suture is placed and needle is then reinserted in continuous fashion that the suture passes perpendicular to incision below and obliquely above. The suture is ended tying a knot over the untightened end of suture.

Advantages

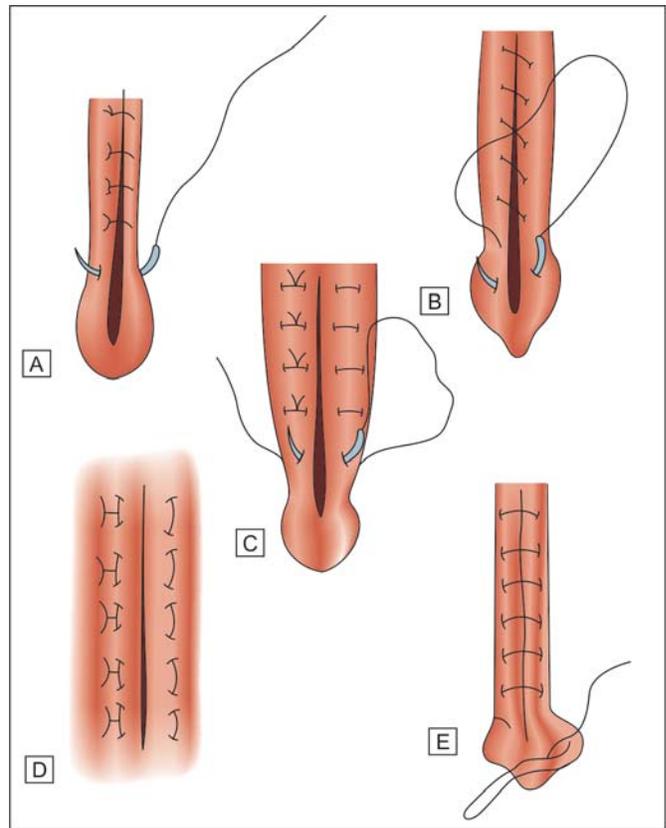
- Offer a water tight closure.
- Rapid technique.
- Distributes tension uniformly over the suture line.

3. Continuous Locking (Figs 4 and 5)

- Similar to continuous suture.
- Suture is with drawn through the loop and thus passes perpendicular to incision line.

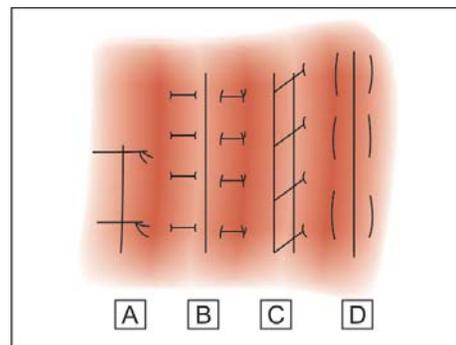
Advantage

The locking prevents excessive tightening of the suture as the wound closure progresses.



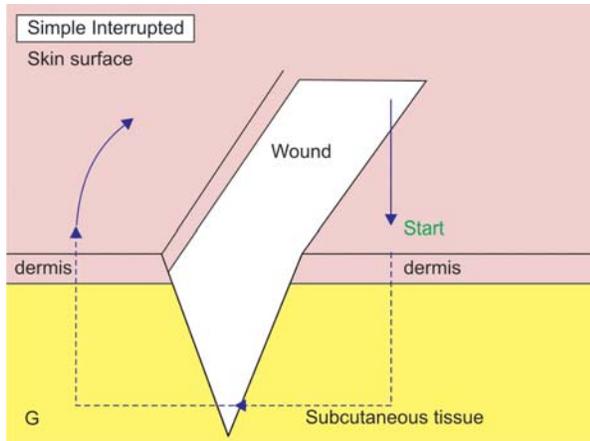
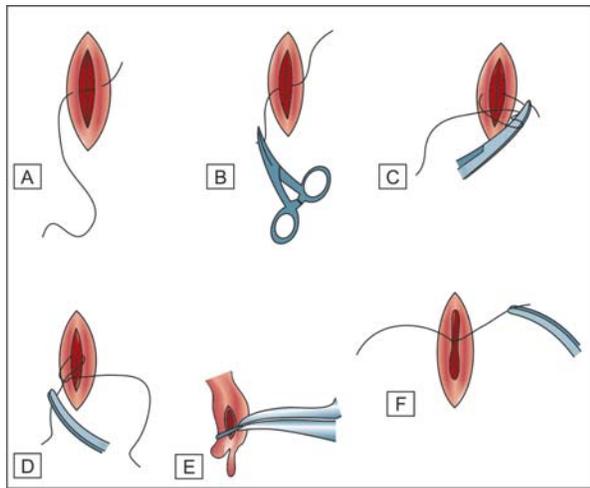
Figs 1A to E: Simple interrupted suture

(A) Interrupted sutures, (B) Continuous sutures. (C) Vertical mattress sutures. Stabilize the flaps and pass the needle through each of the flaps 1 mm from the incision. Then reverse the needle and pass it in the opposite direction 4 mm from the wound margins. The exit and entry points are both on the buccal flap. They are tied in surgical knot. (D) Interrupted horizontal mattress sutures. (E) Continuous box-lock sutures. The technique is valuable for closure of crestal incisions. Entry is made from buccal to lingual each time as for a continuous sutures. Before tightening each pass, however, lift the loop from the tissue, turn, it once clockwise, and pass the needle through it. When tightened, a locked box configuration will result



Figs 2A to D: Various types of suturing

- (A) Interrupted,
- (B) Vertical mattress,
- (C) Continuous,
- (D) Horizontal mattress



Figs 3A to G: Simple interrupted suture.

- (A) Pass the needle through both flaps.
- (B) Wrap the needle end of the suture twice around the needle holder in a clockwise direction.
- (C) Then, open the beaks and grasp the free end.
- (D) Pull the free end through the double loop and fasten it snugly along side the incision.
- (E) Now, wind the needle end counterclockwise one revolution around the needle holder and grasp the free end with the beaks.
- (F) Pull the free end through the loop and, when tightened, it creates a stable square knot. The knot should not be allowed to rest directly on the incision, but should lie alongside it. The cut ends must be left sufficiently long to permit easy access for removal.
- (G) Clinical view of closure with interrupted sutures

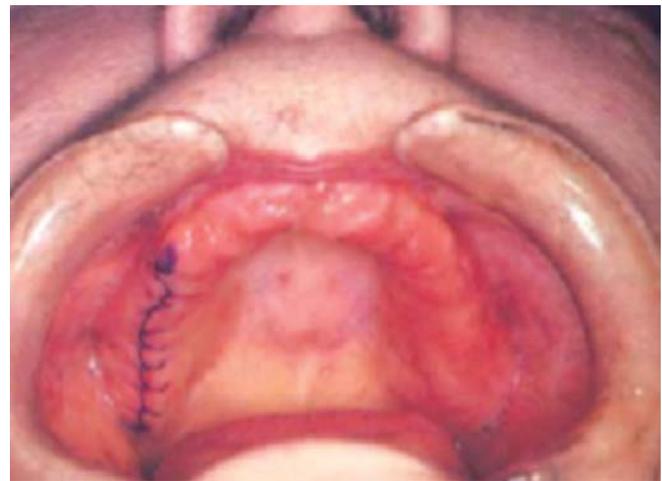


Fig. 4: Continuous box-lock suture. This technique is valuable for closure of crestal incisions. Entry is made from buccal to lingual surfaces each time, as for a continuous suture. Before tightening each pass, however, lift the loop from the tissue and turn it once clockwise and pass the needle through it. When tightened, a locked-box configuration will result

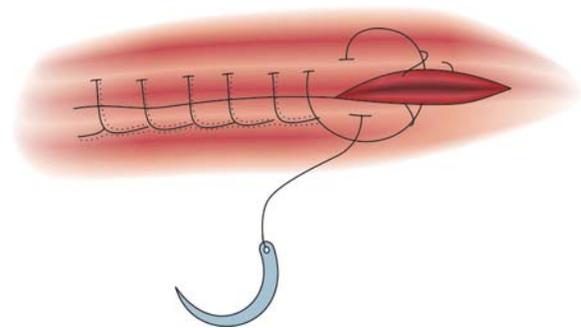


Fig. 5: Continuous locking suture

4. Subcuticular Sutures

- The subcuticular layer of tough connective tissue if sutured will hold the skin edges in close approximation when cosmetic results are desired.
- Continuous short lateral stitches are taken beneath the epithelial layer of skin.
- The ends of suture come out of each end of incision and are knotted.

5. The Mattress Sutures: Vertical, Horizontal and Corner Stitch (Figs 6A to E)

- These mattress sutures are beneficial for closure of wounds under tension and for everting skin edges.
- Less prominent scarring.



Figs 6A to E: (A) Pain, irregularity, or hyperplasia may be the reason for performing an alveoplasty. (B) After the crestal incision and soft tissue reflection, reduce the irregular undercut, or sharp bone using a sidecutting Rongeur forceps. (C) Complete smoothing with a bone file. (D) A simple but effective test is to draw a 4 × 4 gauze sponge across the bone. In this instance, some remaining spicules may cause its fibers to shred. At the sites of such irregularities, additional filling is required. (E) An effective closure may be made after trimming and coapting the flaps by using a continuous box-lock suture

a. Vertical Mattress

- Used to evert skin edges. By incorporating a large amount of tissue within the passage of suture loop, the technique permits greater closure strength and better distribution of wound tension.
- Mainly in body sites where the wound edges tend to invert.
- The vertical mattress suture uses the far-far, near-near system. When used intraorally are of great benefit when possibility of primary closure needs to be enhanced such as transosteal or staple implants.

- a. Far-far suture placement passes 4-8 mm from the wound edge, fairly deep in the wound below the dermis.
- b. Near-near placement occurs at a shallow depth within 1-2 mm of wound edge and should be in upper dermis.
 - Suture thread should be tied on one side of wound.
 - Vertical mattress suture should be tied snugly, but gently.
 - Natural process of wound inflammation and shear retraction will pull loops of suture that lie on skin surface downward. This pull results in small skin

scars that have been given variety of names including Gross Hatching.

RAIL ROAD MARKS OR FRANKEN TEN MARKS

- This limits its use to cosmetically sensitive areas such as face.
- Early removal can minimize the cross hatching.

b. Horizontal Mattress Suture (Figs 7A to H)

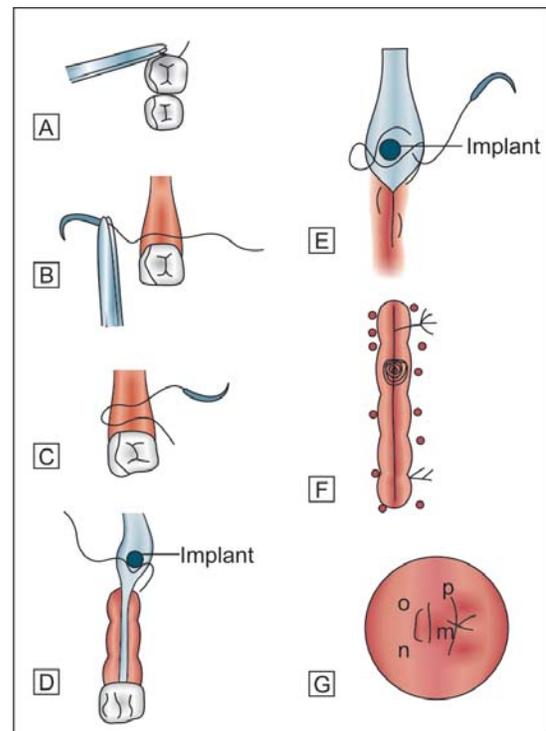
- This technique is commonly used for pulling wound edges together over a distance or as initial suture to anchor two wound edges (holding sutures).
- This suture is also effective in holding fragile skin together, such as skin of an elderly patient or a patient receiving chronic steroid therapy.

Horizontal mattress when used intraorally avoids the problem of bleeding periosteum

- Presents the greatest opportunities of primary healing.
- The suture is initiated by inserting the needle 4-8 mm from the wound edge.
- Needle passes through to the opposite wound inserted into the skin about 4-8 mm farther down that edge (the edge where the needle has just been passed through) and passed from the far side of wound back of the near side.
- The suture is tied gently on the side of the wound where the suturing began.
- If the suture is tied tightly, it can cause strangulation, necrosis and scarring of skin.
- Use of bolsters such as plastic tubing, cardboard, gauge or compressible cushions beneath the suture loops is advocated.
- Because of tissue contained within the passage of suture head, the horizontal mattress sutures are effective hemostatic sutures on vascular tissues.
- Early suture removal is especially important in cosmetically important areas.

c. Corner Stitch/Half Buried Horizontal Mattress Suture

- Used to approximate angled skin flaps without compromising blood supply to tissue tip.
- Closure of Y-shaped or X-shaped wounds is often accomplished with a corner stitch used for central corners.
- Corner suture is best initiated near an imaginary line that bisects the tissue opposite the tissue corner.



Figs 7A to H: Continuous horizontal mattress suture. (A) Use the mouse tooth forceps to stabilize the flaps. (B) Pass the needle through the buccal and lingual flaps (a to b) at the beginning of the incision. (C) Then, reverse the needle and press it from lingual to buccal (c to d). (D) Tie a knot between ends a and d, cut the loose end and pass the needle from buccal to lingual at point e. continue the pattern from lingual to buccal and buccal to lingual until the mesial surface, of the one-stage implant is encountered. Enter the buccal flap at a point distal to the abutment wrap it to its mesial surface, and exit distal to the cervix through the lingual flap. (E) Bring the needle mesially (see arrow on lingual) and pierce the lingual flap mesial to the abutment. The arrows indicate that the suture then passes distal to the cervix and exits mesially through the buccal flap, and on this fourth pass, when the suture is tightened, the tissue will be gathered, purse string fashion around the cervix. (F) Continue the suture pattern through points k, l, n, o and p and suture at point m. (G) Make the final closure by taking end n and tying it to loop pl, creating knot m. (H) Clinical view of continuous horizontal mattress suture. Rapid and reliable healing is a characteristic of this kind of closure

- This allows the pull of tissue directly into the corner and not off to one side.
- A plumb line drawn opposite the corner will help guide the start and finish of corner stitch.
- Needle enters the skin next to plumb line (1-2 mm from line) about 6-8 mm from the corner. The needle passes to the wound edge about 4-6 mm from corner.
- The corner flap is elevated with Adson forceps (pick-up) and needle is passed from one side of flap tip to the other side in deep dermis.
- The needle then passes back into the wound edge about 4-6 mm from tip and exits the skin.
- If the suture is tied too tightly, the corner tends to buckle.

6. Figure of Eight Suture

- Used for extraction socket closure as well as for adaptation of gingival papilla around the tooth.

Periodontal Sling Suture (Figs 8A to H)

Begin the technique by entering a facial papilla at the distal end of the wound. Pass the needle to the lingual through the greater embrasure, wrap it around the lingual cervix of first tooth, and then pass it through the second buccal papilla. Return the needle over this second papilla through the second embrasure, again to the lingual flap and wrap it around the second papilla through the second embrasure, again to the lingual flap, and wrap it around the second tooth.

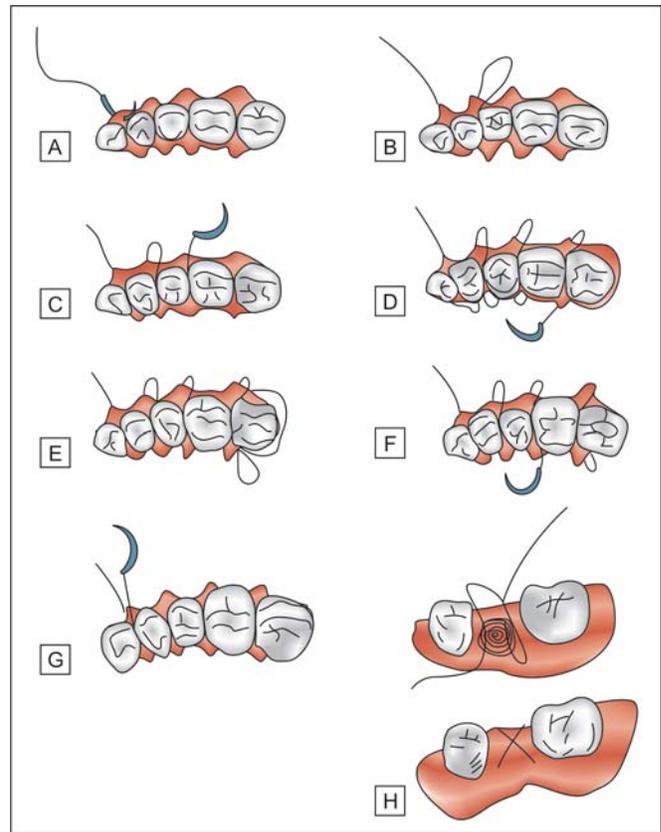
In this fashion the buccal flap is brought firmly to place. At the distal portion of the last tooth, after passing the suture through the buccal papilla, it passes to the lingual and enters this papilla. All of the papillae of the lingual flap are engaged.

Make the final pass around a tooth anterior to the incision so that the suture will come directly from lingual to buccal at the mesial surface of the first tooth. Before tying the two ends, tighten the system by tugging gently at each loop. Tie the knot at the mesiobuccal papilla of the first tooth.

SUTURE REMOVAL (FIG. 9)

Many patients are very apprehensive about suture removal, so the first step is to reassure the patient that the procedure is not painful. The skin/tissue should be cleansed. Hydrogen peroxide is a good choice for gently removing dried blood and exudate.

Then grasp one of the “ears” of the suture with a forceps to elevate the suture just enough to slip the tip of a small scissor under the suture in order to cut it. This should be done close to the skin/tissue edge in order to minimize the



Figs 8A to H: Periodontal sling suturing. (A) Entry is made through the first buccal papilla. (B) Pass the needle to the lingual through the greater embrasure, wrap it around the lingual cervix of the first tooth, and then pass it through the second buccal papilla. (C) Return the needle over this second papilla through the second embrasure again to the lingual flap and wrap it around the second papilla through the second embrasure, again to the lingual flap, and wrap it around the second tooth. (D) In this fashion the buccal flap is brought firmly to place. At the distal portion of the last tooth, after passing the suture through the buccal papilla, it passes to the lingual and enters this papilla. (E and F) In similar fashion, all of the papillae of the lingual flap are engaged. (G) Make the final pass around a tooth anterior to the incision so that the suture will come directly from lingual to buccal at the mesial surface of the first tooth. Before tying the two ends, tighten the system by tugging gently at each loop. (H) Tie the knot at the mesiobuccal papilla of the first tooth. Clinical view of a properly executed periodontal sling suture

amount of contaminated suture that will be dragged through the stitch path. The suture is then gently removed by pulling with the forceps. It is frequently a good idea to reinforce the wound with Proxi-Strips or gauze packs. Proxi-Strips are narrow adhesive strips that are placed perpendicularly across the wound at intervals.

The timing of suture removal depends on following factors:

- a. The amount of wound tension at the time of closure.
- b. Whether subcutaneous sutures have been placed.
- c. The age and medical condition of patient.

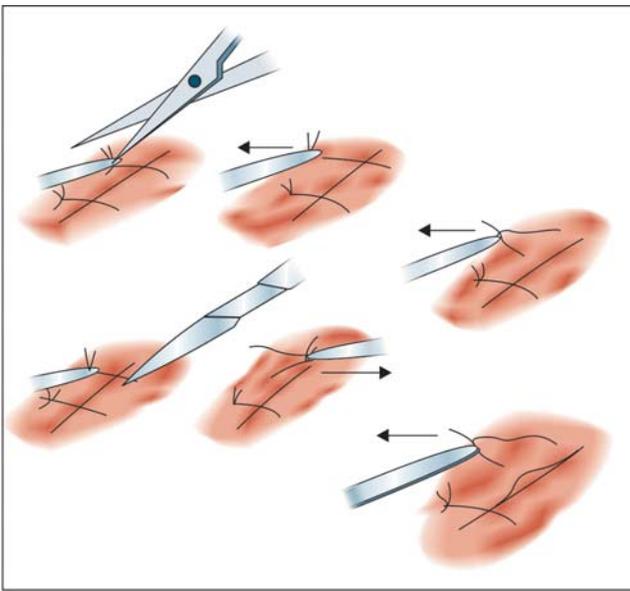


Fig 9: The technique of suture removal, showing the use of iris scissors and a no. 11 scalped blade. Correctly removed the suture is pulled towards the wound incorrect removal, pulling the suture away from wound causes added tension across the wound and is liable to result in dehiscence

- d. Location over stress sites.
- e. Patient medications.
- f. Presence of vascular disease.

These factors necessitate longer time before removal.

The suture is grasped with an instrument and lifted above the epithelial surface.

The scissors are then passed through one loop and transected close to surface. The suture is then pulled out.

- Skin sutures are usually removed after a period of 7-10 days and mucosal sutures are removed between 5-7 days.

When?

Face: 3-4 days; Scalp: 5 days; Trunk: 7 days
Arm or leg: 7-10 days; Foot: 10-14 days.

DISCUSSION

The goal of modern dentistry is to restore the patient to normal contour, comfort, function, esthetics, speech and health regardless of the atrophy, disease or injury of the stomatognathic system. In cases with multiple replacements this goal becomes more arduous with traditional dentistry. As a result of continued advancements in treatment planning, implant designs, materials and techniques the predictable

results are now a reality in challenging clinical situations. Life expectancy has increased over the last two years. In 1965 average life span was 65 years where as in 1990 it was 78 years.

Social pleasures including dining and dating continuous throughout the life. In the past geriatric dentistry meant inexpensive treatment with primarily nonsurgical approach. The best way to manage problems is to practice avoidance. In 1978 the Harvard Consensus Development Conference on Dental Implants listed several conditions for implant success including that the implant type or system should succeed at least 75% of the time for 5 years. Misch criteria allowed a minimum of 90% success for 5 years and 85% for 10 years. These criteria or success rate can be achieved only when each and every case/patient is properly diagnosed, planned and well-executed besides this all the steps, surgical protocol and all the principles of osseointegration should be strictly adhered.

For a rigid fixation i.e. for osseointegration to happen besides all other steps once an implant is placed perfect, wound closure is required. The various suture materials have been tried. Surgeons have long thought a suture material which could be used in every step of a surgical operation. Ideally, such a universal material would combine the most desirable characteristic of both absorbable and non-absorbable sutures and be devoid of most of the undesirable features of each. But such a suture material does not exist for the closure of deeper layers absorbable catgut and for closure of superficial layers black silk is popular.

The various techniques for closure have been followed Interrupted sutures are the most common ones used for simple closures but they pose a problem of bringing thin mucosal edges together which have the potential of not healing primarily. These areas present the areas of ischemia, further affecting healing, collecting food debris and a source of annoyance to tongue and lips. Horizontal mattress avoids these previous problems cited. Vertical mattress has few intraoral uses continuous box lock sutures are more reliable than simple continuous or a series of interrupted sutures.

CONCLUSION

Dental implant therapy requires careful patient evaluation, surgical planning and meticulous prosthetic execution.

The healing capacity of oral tissues is excellent. Flap design should allow maintenance of optimal and sufficient

blood supply to all mobilized and immobilized portions of the soft tissues. With prolonged duration of the surgical procedure, especially when a high degree of hemostasis has been achieved, there is a risk of drying out of tissues. The surgical site must be kept moist to minimize shrinkage of the reflected tissue flap. In surgical endodontics, the marginal epithelium and connective tissue are not removed, but are left intact on the tooth surface subsequent to tissue incision, elevation and reflection.

The treatment is aimed at maintaining vitality and survival of these tissues in order to facilitate and expedite the healing process. Ideally, wound healing does not result in new attachment formation, but preferably in reattachment, or healing by primary intention. The reapproximated tissue flap should rest passively in the desired place before suturing, reducing tension on the flap margins. In general, tissue trauma, such as stretching, tearing or distortion should be avoided at all times. Gentle and careful manipulation with microsurgical instruments is helpful, as every placement of a suture poses additional injury to the wound margins

The smallest possible number of sutures should be used. Nonabsorbable suture materials in sizes 6-0 to 8-0 are preferred and absorbable materials only recommended in multilayered closure. Time required for the wound to heal is closely related to the gap between tissue wound margins. Therefore perfect adaptation will allow earlier suture removal. Wound support is only needed until the healing process has progressed to such an extent that the tissue can withstand functional forces.

ACKNOWLEDGMENTS

At this juncture it gives me great pleasure to express my deep sense of gratitude and indebtedness to Dr. Shankar Iyer course director Maxicourse India for his everlasting inspiration, incessant unwavering support through out this course.

With deep gratitude and humbleness, I take this opportune moment to express my sense of gratitude to Dr. Mahesh Verma, Dean Maulana Azad Dental College, New Delhi for his constant encouragement and help.

I express sincere gratitude to Dr. Brij Sabatwal, our course coordinator for timely advise and support during the whole course.

I am extremely grateful to my colleagues at the Maxi-course, for acting like a healthy team, and thanks to Dr Anju Gupta for the help rendered.

Last but not the least with profound feeling of gratefulness, I thank my parents, my brother, my wife Mona, my children Manav and Manya for their invigorating and unrestrained enthusiasm to energize my efforts and incessant moral boosting without which this dissertation would have remained a highly arduous task. And finally, thanks to the allmighty god.

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