Suturing for Surgical Success

Gregori M Kurtzman, Lee H Silverstein, Peter C Shatz and David Kurtzman discuss several of the suture materials available and the rationale of specific suturing techniques to aid the clinician in obtaining optimal wound closure.

The paramount goal of soft tissue surgery is closure of wound flaps, in the absence of tension on the flaps, which will lead to optimal wound healing. Surgical procedures that require flap manipulation such as those used with traditional periodontal therapy, periodontal plastic cosmetic surgery, hard and soft tissue regeneration, and the excision of pathologic tissue require excellence in execution and a thorough understanding of the various techniques of surgery, suturing, and the materials currently available to ensure the desired clinical results. This article will discuss several of the suture materials available and the rationale of specific suturing techniques to aid the clinician in obtaining optimal wound closure.

Meeting the objectives

Dental surgery involves the creation of a wound and necessitates closure of this wound to allow healing and to achieve the surgical objective. The primary objective of wound closure is to position and secure surgical flaps through suturing to promote optimal healing (Table 1).

When done properly, surgical sutures should hold flap edges in apposition until the wound has healed enough to withstand normal functional stresses and to resist wound reopening. When the proper suturing technique is used along with the appropriate thread type and diameter, wound margins should be tension-free to allow healing by primary intention (Silverstein LH, 2005a). Accurate apposition of surgical flaps is important for patient comfort, haemostasis, reduction of the wound size to be repaired and prevention of unnecessary bone resorption. If, however, the surgical wound edges are not properly approximated, haemostasis can be compromised and blood/serum may accumulate under the flap, delaying the healing process by separating the flap from the underlying bone (Silverstein LH, 2005b). Healing thus occurs by secondary intention and can lead to irregular soft tissue contours and the formation of scar tissue.

Conventional intra-oral surgical therapy concludes with closure of the soft tissue. The art of suturing allows for the precise positioning of the mucosal and/or mucoperiosteal flaps. For example, certain surgical procedures, such as an excisional new attachment procedure (ENAP) and modified Widman flap procedure, dictate that the surgical flap margins be positioned to their original location. Conversely, other periodontal procedures may require that the surgical flaps be placed apically, coronally or laterally, depending on the specific surgical objectives of the procedure being performed (Cohen ES, 1994).

In periodontal plastic, cosmetic and reconstructive procedures, choosing the appropriate suturing technique, thread type, thread diameter, surgical needle and use of the proper surgical knot for each respective thread material chosen are all critical in obtaining optimal wound healing. When suturing tissues over hard and/or soft tissue, autologous or allograft material, and/or over regenerative membranes, the wound closure variables are different and thus suture and needle selection will change. In addition, the art and precise skill of suturing is paramount to the success of all surgical procedures.

TABLE 1: General guidelines for suturing

| Sutures should be placed no closer than 2mm to 3mm from the flap edges to prevent tearing through the flap during post-operative swelling. |
| The flaps should be approximated without blanching when sutured. |
| The goal during suturing multiple tissue levels is to suture periosteum to periosteum and gingival tissue to gingival tissue. |
| The needle should enter at right angles to the tissue when penetrating through tissues. |
| The needle should be placed a few millimetres from the tip of the needle holder when grasped. |
| Pull the suture just tight enough to secure the flap in place without restricting the flap’s blood supply. |

Needles

The surgical needle comprises three parts: the needle point, the needle body and the swaged (press-fit) end. Suture needles are usually classified according to their curvature, radius and shape. The most commonly used suture needles in dentistry are the 3/8 and ½ circle needles (Cohen ES, Silverstein LH, 2000) (Figure 1).

The 3/8 needle allows the clinician to pass from the buccal surface to the lingual surface in one motion by rotating the needle on a central axis. In contrast, the ½ circle needle is traditionally used in more restricted areas, for example in the buccal of the maxillary molars and the facial aspect of the maxillary and mandibular incisors. In addition, the ½ circle needle is routinely used for periosteal and mucogingival surgery (Silverstein LH, 2005a, 2005b; Cohen ES, Silverstein LH, 2000).

Suture needles are classified as either conventional cutting or reverse cutting (Somerville NJ, 1985) (Figure 2). In dentistry, the clinician should always use reverse cutting sutures to prevent the suture material tearing through the papillae or surgical flap edges, which is referred to as ‘cut out’. A cut out is usually caused by a conventional suture needle because it has an inside concave curvature that is sharpened, whereas a reverse cutting needle has a smooth inner curvature and its third cutting edge is located on its convex (outer) edge (Silverstein LH, 2000). Generally in dentistry, the 3/8 reverse cutting needle with a 3:4 or 4:4 thread diameter and the ½ reverse cutting needle with the thinner and more delicate 5:0 or 6:0 thread diameter are the most commonly used needle and thread combinations, according to the authors’ private communications with suture manufacturers.

Suture materials

Suture thread

Tensile strength is an important quality when selecting which thread is appropriate for the intended use. Tissue biocompatibility, ease of tying and a thread type that permits minimal knot slippage also influence selection. It is important that the clinician select...
the specific suture thread and diameter based on the thickness of the tissue to be sutured and whether or not there will be flap tension or freely mobile tissues (Silverstein LH, 2000).

Therefore, it seems to the authors that suture technique and material selection should be based on a knowledge of the desired goals of the respective surgical procedures and the physical/biologic characteristics of the suture thread in relationship to the healing process. The practitioner has an armamentarium of suture materials from which to select for use both intra- and extra-orally. Adequate strength of the suture material will prevent suture breakage, and proper suture knots for the material used will prevent untimely untying or knot slippage. The clinician must also understand the nature of the suture material, the biologic processes of healing, the biologic forces exerted on the healing wound (e.g. muscle pull and swelling) and the interaction of the suture and tissues. This is vital because we must ensure that a suture will retain its strength until the tissues of the surgical flaps regain sufficient strength to keep the wound edges together. In those circumstances in which the intra-oral tissues most likely will never regain their pre-operative strength, or if the surgical flaps are not tension-free, the clinician should consider using a suture material that retains long-term strength for up to 14 days and resorbs in 21 to 28 days, such as conventional polyglycolic acid (PGA) sutures (Silverstein LH, 2000, 2005b).

Conversely, if a suture is to be placed in a tissue that heals rapidly (e.g. intra-oral tissue), the clinician should select a resorbable suture that will lose its tensile strength at about the same rate that the tissue gains its strength. The suture will be absorbed by the tissue so that no foreign material remains in the wound once the tissue has healed, such as surgical gut or the new, rapidly resorbable PGA suture material (PGA-FA) (Silverstein LH, 2005a).

Absorbable sutures resorb due to two mechanisms of absorption resulting in the degradation of the sutures. First, sutures of biological origin, such as surgical gut (e.g. plain and chromic gut), are gradually digested by intra-oral enzymes (Silverstein LH, 2005a). Surgical gut suture material is made from an animal protein and can induce an antigenic reaction. When used intra-orally, this material loses most of its tensile strength in 24 to 48 hours, unless it is coated with a chondrom compound that extends absorption up to seven to 10 days and extends loss of tensile strength for up to five days (Somerville NJ, 1985).

An additional consideration with regard to surgical gut sutures is that breakage may occur too rapidly to maintain flap apposition, particularly if used in patients with a very low intra-oral pH. A decrease in intra-oral pH may be caused by a plethora of physiologic events, such as metabolic disorders (e.g. epigastric reflux, hiatal hernia, bulimia). Autoimmunity caused by Sjögren’s syndrome, chemotherapy, radiation therapy and some medications (e.g. maximum acid output inhibitors and angiotensin-converting inhibitors, antipsychotics, diuretics, anti-hypertensive agents, anti-epilepsia medications and steroid inhalers) can also result in dry mouth and low intra-oral pH (Silverstein LH, 2005b; Lilly CE et al, 1969).

The minimum coaptation time for tissue flaps is approximately five days (Somerville NJ, 1985). Selection of a fast-absorbing PGA suture is indicated in clinical situations where there is a low intra-oral pH, when surgical gut sutures are contraindicated. The PGA-FA suture material is manufactured from synthetic polymers, is principally broken down by hydrolysis in tissue fluids in approximately seven to 10 days and is not affected by a low intra-oral pH (Silverstein LH, 2005b). The PGA-FA suture also has a higher tensile strength than surgical gut suture material, yet it absorbs at a rate comparable to that of surgical gut sutures under normal intra-oral physiologic conditions (Silverstein LH, 2005b, 2005a).

Non-resorbable surgical threads are fabricated either from natural or synthetic materials. Classically, silk has been the most universally used material in dentistry and many other surgical disciplines (Macht SD, Krizek TJ, 1978). Silk is easy to handle, ties with a slip knot and is relatively inexpensive compared with other non-resorbable suture materials currently available. There are distinct disadvantages, however, when using silk. First, it is non-resorbable and thus must be removed, usually a week or so following surgery when the patient is not numb. Second, silk is a multi-filament thread that ‘wicks’ or pulls bacteria and fluids into the wound site (Manor A, Kaffe I, 1981). Therefore, in the authors’ opinion, silk is not the suture material of choice when any foreign materials are placed under a mucoperiosteal flap (e.g. dental implant, bone graft or regenerative barrier) or when there is clinical evidence of an infection at the surgical site. Instead of silk, there are other non-resorbable sutures that can be used in these situations, such as nylon, polyester, polyethylene, polypropylene or expanded polytetrafluoroethylene (e-PTFE).

Polyester sutures consist of multiple filaments that are braided into a single strand. This suture is made of a polyester polymer, does not weaken when moistened and has a lot of tensile strength. The polyester sutures are usually coated with a biologically inert non-resorbable compound, which aids the suture in passing more easily through tissues. This coating, however, does present a problem in that it also makes knot security an issue and the material will easily untie if not secured with a surgeon’s knot (Silverstein LH, 2000).

The e-PTFE suture material is a non-resorbable monofilament that has high tensile strength, good handling properties and good knot security, but is expensive when compared with all the other non-resorbable suture materials (Silverstein LH, 2005a). Surgical threads, aside from being classified by the material they are comprised of, also are classified by thread diameter. Thread materials range in diameter from 1 to 10 with the higher number corresponding to the thinner, more delicate thread (Meyer RB, Antonin CJ, 1989). In implant dentistry, a 3-0 thread diameter is usually used to secure flaps when a mattress suturing technique is placed and then a 4-0 thread is used closer to the flap edges to coat tension-free flap edges. A 4-0 thread is also used to secure implant surgical flaps when interrupted, for some mattress sutures and more continuous subperiosteal techniques. With periodontal plastic surgery, a 5-0 thread diameter is most often used to secure soft tissue grafts to transpositional/sliding pedicle flaps, whereas a 4-0 thread is used to secure most other periodontal mucoperiosteal flaps (Table 2).

<table>
<thead>
<tr>
<th>Table 2: Suture thread types used in dentistry</th>
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<tr>
<td>A: Non-resorbable Type</td>
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<tr>
<td>Silk</td>
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<td>Nylon</td>
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<td>Polypropylene</td>
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<td>e-PTFE</td>
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<td>B: Resorbable Type</td>
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<td>Gut</td>
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<td>Chronic gut</td>
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<td>PGA</td>
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<td>PGA-dyed</td>
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- **Figure 4:** Surgeon’s knot being tied
- **Figure 5:** A simple loop suture used to coat flap margins
- **Figure 6:** The simple loop suture being tied to coat the edges of the incision
- **Figure 7:** A criss-cross suture placed at an extraction site to close the margins and aid in retention of the socket graft
Knots

Surgical knot tying is an important component of the art of suturing. It is essential for knot security and to prevent untimely knot untangling that the appropriate surgical knot be used for the specific suture material being secured. For instance, when using silk, e-PTFE, chromic gut or plain gut suture material, a slip (granny) surgical knot could be used. However, with the synthetic resorbable and other non-resorbable synthetic suture materials, a surgeon’s knot must be used to prevent untimely knot untangling (Silverstein LH, 2000) (Figure 4). The type of knot that is used for each material is determined by the mode in which each type of thread is manufactured (Somerville NJ, 1985). 

User-friendly periodontal Suturing techniques

The interrupted suture encompasses two suturing techniques: the simple loop and the figure-8. The simple loop (Figure 5) is the most commonly used technique in dentistry and is routinely used to coapt tension-free, mobile surgical flaps (Silverstein LH, 2000). For example, the simple loop is useful in edentulous ridge areas, to coapt vertical releasing incisions, for periosteal suturing, to coapt flaps in ENAP, modified Widman flap, some periodontal regeneration and some exploratory flap procedures. A simple loop is tied by entering the buccal flap (position 1) and crossing under the periostium to exit the lingual flap (position 2), and a knot is tied towards the buccal flap (Figure 6).

The criss-cross technique is placed similarly to the simple loop on the buccal aspect. However, on the lingual aspect the needle penetrates through the outer, not inner, surface of the lingual flap. This results in suture thread being interposed between the surgical flaps. Both of the interrupted suture techniques achieve similar results when used for wound closure with tension-free flaps. The criss-cross is useful when suturing on the lingual aspect of the lower molars, especially in a patient with an active gag reflex or a large, cumbersome tongue (Silverstein LH, 2000). A criss-cross suture is tied by entering the mesial buccal (position 1) and exiting the distal buccal (position 2). The suture is then crossed over the socket and enters the mesial lingual (position 3) and exits the distal lingual (position 4). The suture at the distal lingual (position 4) is tied to the free end at the mesial buccal (position 1) and the knot is positioned towards the buccal.

The mattress technique, a variation of the interrupted suture, is routinely used in areas where tension-free suture closure cannot be accomplished (Silverstein LH, 2000). Mattress suturing techniques are generally used to resist muscle pull, evert the wound edges (this keeps epithelium away from underlying structures) and to adapt the tissue flaps tightly to the underlying structures (e.g. bone graft, tissue graft, alveolar ridge, regenerative membrane or dental implant). When using a mattress suture, usually a 3/8 reverse cutting needle is used with a thicker (3-0 or 4-0) thread diameter (Silverstein LH, 2005a). Traditionally, mattress sutures are left in place for 14 to 21 days before dissolution or removal (Mejias JE, Griffin TJ, 1983).

There are variations of the mattress suture technique, referred to as the horizontal (Figure 6) and the apically or coronally repositioned vertical mattress.

Unlike the mattress suture technique, interrupted sutures should be used only with tension-free mobile flaps and should have needle penetration approximately 3mm from the wound edges or at the base of an interdental papilla. In contrast, when performing a mattress suture, the needle penetration through the surgical flap should be approximately 8mm away from the flap edge or just above the mucogingival junction in keratinised tissue (Figure 8).

A horizontal mattress suture is tied by penetration of the needle at the mesial buccal (position 1) apical to the mucogingival junction and crossed under the flap to exit at the mesial lingual (position 2). The suture then penetrates the tissue at the distal lingual (position 3) and again crosses under the flap to exit at the distal lingual (position 4) apical to the mucogingival junction. The suture at the distal buccal (position 4) is tied to the free end at the mesial buccal (position 1) (Figure 9).

The interrupted suspensory suture, commonly referred to as the sling suture, is used when only one side or one more papillae of a flap is independently repositioned to its original position or coronally repositioned. In the authors’ opinion, the sling suture technique is especially useful when performing coronally repositioned sliding flaps. When tying a sling suture, the needle enters the buccal flap’s papilla distally (position 1) and is carried lingually around the neck of the tooth or implant to penetrate the papilla mesially (position 2) through the periosteum, exiting buccally. The suture is then looped back around the same tooth or implant lingually and is tied with the free end, positioning the knot buccally (Figures 10 and 11). With this technique, each suture involves a papilla on the mesial and distal of every other tooth using separate ties.

Another variation of the interrupted suture technique is called a continuous suture. Continuous sutures can be used to attach two surgical flap edges or to secure multiple interproximal papillae of one flap independently of the other flap. Although there is a distinct advantage of the continuous suture in that there are fewer individual suture ties, the disadvantages, in the authors’ opinion, of using any continuous suture far outweigh the advantages of its use. This is due to the likelihood that if one knot or loop breaks, the integrity of the entire surgical site will become compromised (Hutcheson LH, 1995). The authors believe that most clinicians would have more control using individually placed interrupted, sling, criss-cross or mattress sutures in lieu of placing one large continuous suture (Silverstein LH, Kurtzman GM, 2005).

Conclusion

The evolution and recent innovations in suturing material have eliminated some of the difficulties previously encountered during surgical closure, and have presented dentists with advancements in sutures designed for specific surgical procedures. With the sophisticated surgical procedures used daily, there is a greater need for knowledge with regard to the various types of suturing armamentarium available to assist in obtaining optimal wound closure. The success of technique-sensitive procedures such as conventional periodontal therapy, dental implant therapy, mucogingival microsurgery, periodontal cosmetic plastic surgery, regeneration of hard and/or soft tissues, and excisional treatment of pathologic tissue depends on the clinician’s knowledge and skill of executing proper suturing for optimal wound closure.

References


Acknowledgement

Illustrations drawn by David Kurtzman DDS.

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