Review paper
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VARIOUS SUTURING MATERIAL AND WOUND HEALING PROCESS AFTER ORAL SURGERY PROCEDURE - A REVIEW PAPER

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Abstract

The most oral surgical interventions require primary wound closure with stitches after previously raised mucoperiosteal flap. Different suture materials are used for this purpose which are classified upon their origin (organic and synthetic) or according to their durability in host tissues (absorbable and non-absorbable). The aim of the review paper was to emphasize the all-important properties of suture material include knot safety, stretch capacity, tissue reactivity, and wound safety.

MEDLINE and PubMed databases were explored from the 1970 up to 2018 using the keywords in different combinations: oral surgery, suture material, flap, dental implants, nylon, periodontal, polyglecaprone, polytetrafluoroethylene, polyglycolic acid, polylactic acid, silk. Normal wound healing after oral surgery procedures requires multiple finely tuned processes that occur in a specific sequence as well as proliferation, regeneration and organization (differentiation). The final stage of the wound healing process is named the contraction phase, which begins following sufficient collagen formation in the granular tissue. Traditionally, silk has been the mostly used as suture material for oral surgical procedures, with rarely including others as: nylon, polyester, cat gut, polytetrafluoroethylene (ePTFE), polyglycolic acid (PGA) etc. Surgery with silk sutures increases the risk of infections because they react with the connective tissue, causing adhesion of dental plaque and bacteria adherence around the stitch. On the other hand, a specific form of wound healing occurs around placed dental implants. Usually the implants are placed directly under or at the same level as the bone surface at biphasic dental implant procedures.

In conclusion, besides the carefully used surgical and suturing technique, and properly oral hygiene in the postoperative period, the choice of suture material may also influence the healing of the incised soft tissues. Thus the selection of the suture material should be brought under consideration during treatment planning for oral surgical interventions, periodontal surgery and dental implantation.

***Key words**: Oral, Surgery, Periodontal, Implants, Flap, Suture, Silk, Nylon.*

1. Introduction

The main goal of soft tissue surgery is primary closure of wound flaps, without flaps tension, which will support optimal wound healing. Oral surgical procedures that require flap such as those used with traditional oral surgical procedures, surgical periodontal therapy, dental implantation, hard and soft tissue regeneration, and the excision of pathologic tissue, require

excellence in manipulation, thorough understanding and implementation of the various surgery techniques, as well as suturing and the currently available materials to ensure the desired clinical results. The most oral surgical interventions require primary wound closure with stitches after previously raised mucoperiosteal flap. Different suture materials are used for this purpose which are classified upon their origin (organic and synthetic) or according to their durability in host tissues (absorbable and nonabsorbable) [1].

The aim of the review paper was to emphasize the all-important properties of suture material include knot safety, stretch capacity, tissue reactivity, and wound safety. MEDLINE and PubMed databases were explored the from 1970 up to 2018 using the keywords in different combinations: oral surgery, suture material, flap, dental implants, nylon, periodontal, polyglecaprone, polytetrafluoroethylene, polyglycolic acid (PGA), polylactic acid, silk.

2. Suturing material and wound healing process

2.1 Historical aspects

In everyday clinical practice the most oral surgical interventions require primary wound closure using a previously raised mucoperiosteal flap. Several suture materials are available for dental and medical surgical procedures; however, it is essential for surgeons to be aware of the nature of the suture material, the biologic processes of healing, and the interaction of the suture material with the surrounding tissues.

The technique of closing wounds by means of needle and thread is several thousand years old. History of surgical sutures can be traced back to ancient Egypt, and the literature of the classical period contains a number of descriptions of surgical techniques involving sutures. Before catgut became the standard surgical suture material towards the end of the 19th century, many different paths had been followed to find a suitable material for sutures and ligatures. Materials that had been tried included: gold, silver and steel wire, silk, linen, hemp, flax, tree bark, animal and human hair, bowstrings, and gut strings from sheep and goats. At the beginning of the 19th century metal threads were tested as suture material. At that time inertness of a material with respect to body tissues was considered an advantage. Nevertheless, metal threads had major disadvantages: their stiffness rendered knottying more difficult and could easily result in knot breakage; in addition, suppuration of the wound edges occurred frequently. These negative experiences with metal contributed to the establishment of silk as the number one suture material. A fundamental change in the assessment of suture materials followed the publication in 1867 of Lister's research on the prevention of wound suppuration. On the basis of work by Koch and Pasteur, Lister concluded that wound suppuration could be prevented by disinfecting sutures, dressings, and instruments with carbolic acid [2].

2.2 Suture material in oral surgery procedures

There are several different suture materials and needles that provide an accurate and secure approximation of the wound edges. Ideally, the choice of the suture material should be based on the biological interaction of the materials employed, the tissue configuration, and the biomechanical properties of the wound. The tissue should be held in apposition until the tensile strength of the wound is sufficient to withstand stress. A common theme of the many reportable investigations is that all biomaterials placed within the tissue damage the host defenses and invite infection. Because surgical needles have a proven role in spreading deadly blood borne viral infection, the surgeon must select surgical gloves that reduce the risk of accidental injuries during surgery [3,4].

Important considerations in wound closure are the type of suture, the tying technique, and the configuration of the suture loops. Selection of a surgical suture material is based on its biologic interaction with the wound and its mechanical performance *in vivo* and *in vitro*. Measurements of the in vivo degradation of sutures separate them into two general classes [5]. Sutures that undergo rapid degradation in tissues, losing their tensile strength within 60 days, are considered absorbable sutures. Those that maintain their tensile strength for longer than 60 days are nonabsorbable sutures.

This terminology is somewhat misleading because even some nonabsorbable sutures (i.e., silk, cotton and nylon) lose some tensile strength during this 60-day interval [7-9]. Traditionally, silk has been the mostly used suture material for dental and several other surgical procedures. Even though silk is inexpensive and easy to handle as compared to other nonabsorbable suture materials [3, 4], the authors believe that it should not be considered as a "material of choice" for oral surgical interventions. Studies on oral tissue reactions to sutures have revealed constant inflammatory reactions, which are most prominent with silk and cotton and minimal with others including: nylon, polyester, expanded tetrafluoroethylene (ePTFE), polyglecaprone 25 and polyglycolic acid (PGA) [3 - 7]. A histological study [8 - 10] compared the oral tissue reactions to various suturematerials. The results showed the presence of a large number of neutrophilic polymorphonuclear leukocytes in the premises of silk sutures which were less intense in oral tissues farther from silk sutures [9].

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. General guidelines for suturing, according to Krttzman *et al.*, [11], included these recommendations:

1. Sutures are usually placed distal to the last tooth, in each interproximal space, and suturing continued in a mesial direction.
2. Sutures should always be inserted through the more mobile tissue flap first.
3. When space is restricted use a ½ circle needle.
4. Only needle holders should grasp suture needles and the suture needle should be inserted and pulled through the issue in line with the circle.
5. Grab the suture needle in the centre of the needle, never at its tip or near where the thread is swag to the needle.
6. The needle should be placed a few millimetres from the tip of the needle holder when grasped.
7. The goal during suturing multiple tissue levels is to suture periosteum to periosteum and gingival tissue to gingival tissue.
8. The needle should enter at right angles to the tissue when penetrating through tissues.
9. Sutures should be placed no closer than 2mm to 3mm from the flap edges to prevent tearing through the flap during post-operative swelling.
10. The flaps should be approximated without blanching when sutured.
11. Pull the suture just tight enough to secure the flap in place without restricting the flap's blood supply.

Krttzman *et al.*, [11], emphasize that when suture is 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. Furthermore, 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.

2.3 Periodontal sutures

Many factors contribute to healthy and adequate post-operative healing after periodontal surgical interventions. The adequate choice of suture material is one of the decisive factors in determining the successful of the overall surgical treatment. Surgical improvements and progress in periodontology have been achieved because of advances in basic and contemporary science, animal and clinical research, and the presented knowledge from known and recognized specialists and clinicians. Medical and pharmaceuticals industry companies continue to develop new surgical materials, improving the quality of sutures and needles and in turn, supporting advances in all surgical specialties.

Closure of periodontal flap post-surgically for the establishment of primary union between flap margins is of utmost importance. That is why, a proper choice of surgical suture materials and techniques are most important for this process of healing. As a basic principle in periodontal surgery, atraumatic suture materials are used.

In contrast to other surgical fields in dental medicine, periodontal surgical procedures are characterised by one distinctive feature caused by the length of the interdental spaces. This condition is dominant present between the posterior teeth, when long, large-radius needles are required which can easily be grasped again after being introduced into the interdental space on the opposite side [10]. Most commonly used in periodontal surgery are non-absorbable materials for sutures. They are subdivided in three groups: polymers, silks and Teflon (expanded polytetrafluoroethylene). All of these materials are used for suturing in periodontal surgical interventions.

Tendencies in contemporary dentistry and periodontology are directed towards the use of adsorptive suture materials. The advantage of absorbable materials is that they are glycolyzed or dissolved, and they are broken down with almost no residues by natural metabolic processes. If the molecules are hydrophobic, their hydrolysis is delayed, and their absorption time is lengthened [11]. Absorbable sutures should become unavoidable in periodontal and implant surgical interventions because they reduce postoperative inflammation, there is more patient's comfort and they are available in two forms as natural or synthetic. Back in 1978 it was discovered that braided silk has a phenomenon of "wicking," making it ideal site for secondary infection. Furthermore, this type of suture material can cause the maximum amount of inflammatory tissue response [3].

From the result from one study [12], it can be noted that the healing after 1 week was better in the site where isoamyl 2-cyanoacrylate is applied compared to the sutured site. Similarly, isoamyl 2-cyanoacrylate was found to be better when plaque index was considered as compared to sutured site after 1 week [12]. The absence of dental plaque is of exceptional importance in the process of healing surgical wounds and in the very process of initiation and progression of periodontal disease. The antibacterial sutures can be used to reduce or inhibit plaque formation. The antibacterial coated sutures have a promising potential in preventing the colonization of periodontal pathogens around it thereby inhibiting biofilm formation. Among coated sutures, chlorhexidine-coated sutures showed better results [13].

The study made by Khiste *et al.*, [14], demonstrated that the 4-0 sutures were stronger and had greater tensile strength than the 5-0 sutures for all of the three materials. Among the 4-0 sutures, PGA showed the highest tensile strength at the end of day 10 and is a desirable suture if tensile strength is required after 10 days. All of the sutures lost their tensile strength by day 14. According to Kulkarni *et al.*, [15], periodontal flaps healed by primary union when closed with sutures and with N-butyl cyanoacrylate and clinically and histologically, the cyanoacrylate sites appeared less inflamed as compared to the just sutured sites at 7 days.

Manimegalai, [16], published a study in which he analyzed the efficacy of a commercial fibrin adhesive (Tisseel®) vis-à-vis silk suture on a wound closure following periodontal surgical procedures. According to the same research fibrin adhesive material has ideal bio-adhesive qualities for fixing of flaps and is easier and quicker to use. Fibrin adhesive suture materials lessens the surgical time considerably and provides early hemostasis. Hence, this type of suture materials according to Manimegalai, [16], could be considered as a predictable technique for periodontal regeneration.

Suturing, as final procedure of a periodontal surgery, is used to reattach the removed tissue, and also to control bleeding and to allow adequate primary healing. But it must be noted that sutures can cause inflammation around themselves and also accumulate food and plaque. The use of synthetic absorbable sutures, suture selection in periodontology should be predicated upon the demands of the repair process and the surgeon's preference, knowledge and experience.

2.4 Sutures in dental implantology

Non-tensional primary closure is essential for implant success, both for the implant and for any site requiring a bone graft, but several flap designs can facilitate surgical wound healing with minimal complications, which is very important. In order to obtain optimal securing and positioning of implant-surgical flaps to provide ideal conditions for wound healing, practitioners must understand three areas of suturing: types of sutures, suturing techniques, and surgical knotting techniques [17]. According to Silverstein, it is most important that the clinician select the specific suture thread and diameter of them based on the thickness of the tissues to be sutured and whether tension-free mobile tissues are present or absent [18].

In dental implantology, atraumatic wound handling avoids tension and pressure to the flap that may lead to impaired blood flow and interrupted lymph drainage. When graft materials or membranes are used, it is sensible to place relieving incisions at least at one tooth, proximal to the area of augmentation [19]. Non-resorbable suture materials are elastic, which helps in securing knotting. But more important is that draws fluids and bacteria to the wound site. Braided strands of polyester fibers can be coated with a lubricant to facilitate passage through tissue, although this certainly diminishes the capacity of the knot to stay tied [20].

Silk no-resorbable sutures are the most widely used in dental implantology in our country. Silk is strong, workable and not irritating to the tissues, and it has a great tensile strength. The raw material is obtained from the silkworm cocoon and is manufactured into braided and twisted ligatures. The braided type is the stronger and more popular material, especially by the clinician. Silk ligature material is supplied in spools of 25 or 100 yards and in precut lengths in paper envelopes. It comes in sizes 000000 through 5 [21]. But it must be noted that resorbable suture materials are also widely used in dental implantology. Primary, because resorbable suture materials tend to reduce postoperative inflammation. Also, patients prefer them because they do not require a return visit for suture removal [18].

In one study design by Pons-Vincente *et al.*, [22] a comparison of the usage of two different suture materials, silk vs. Teflon-coated, multi-filament braided polyester threads suture is done. The results showed a more pronounced plaque accumulation for silk sutures. The intraoperative handling of the silk sutures was less comfortable, and the patient comfort was worse than Teflon-coated polyester suture. According to Ivanoff and Widmark, [23], sutures may influence early peri-implant healing if filaments are left near the bone-implant interface. Further investigations are required to determine the influence of a broader number of sutures materials on peri-implant bone healing.

Numerous studies showed that absorbable sutures, because of their metabolism that includes enzymatic digestion and phagocytosis, may cause a greater degree of inflammation in contrast to non-absorbable materials that produce only a blind inflammatory response [24, 25]. But in one study published by Selvi *et al.*, [26], no significant difference was observed between the absorbable and non-absorbable materials.

2.5 Suturing material and prosthodontics

Wound closure or suturing is one of the most important clinical steps for successful implantation. In order to ensure a perfect closure of the wound and to prevent the penetration of the infection, which will have bad prognosis on the final prosthodontic rehabilitation, it is of crucial importance to evaluate the various suture materials and techniques.

Numerous factors have an impact on the early peri-implant osseous healing prior finalizing the prosthetic procedures. Peri-implant tissue complications can occur as a result of the presence of foreign materials residues, such as cement or suture materials.

Determining the influence of the suture material on the peri-implant tissue healing is critical to ensure minimal treatment delays and adequate continuity of care while allowing for adequate healing to produce optimal functional and esthetic results from prosthodontic rehabilitation.

The selection of the suture material has an impact on the final outcome of implant procedures [23]. The perfect suture material should secure uncomplicated primary wound closure without having any negative consequences on the outcome. Taking into consideration that the oral cavity is a site rich in bacteria, it is necessary that the materials we choose cause minimal inflammatory reactions [27]. Sometimes, suture material can provide accumulation and bacteria transport to the depth of the wound which will negatively effect on the host defense mechanism. The result from this interaction could be local infection followed by acute inflammatory reaction [8]. Suture materials are either resorbable or no resorbable. According to their physical characteristics suture materials are mono- and multifilamentous or braided [28]. Braided sutures possess some advantages over monofilament, such as easier manipulation and greater stability of the knot, but they still have a much greater potential for transmitting infections [29]. The most commonly used no resorbable suture material is nylon. Nylon sutures can be both monofilamentous and braided. Nylon sutures are synthetic polyamide polymer fibers that are biocompatible and present low inflammatory response in infected wounds [30].

The most commonly used resorbable suture material is chitosan which is obtained by deacetylation of chitin (a poly-N-acetyl glucosamine). Chitosan sutures are usually monofilamentous and possess antibacterial and anti-inflammatory characteristics, also improve wound healing and bone formation [31].

There are few data in the literature for the suture material influence on the preimplant osseous healing. Some studies suggest that bone resorption and inflammation can be modify by suture materials and that various materials may have different effects on these processes. In the same study is concluded that no resorbable suture materials decrease implant retention more than resorbable suture materials, which is a result of increased bone resorption [32].

3. Conclusions

- This article should provide some aspects for understanding of suturing materials in different surgical fields in dentistry.

- 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.

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