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Suture Materials in Dentistry

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Abstract:- Soft tissue appearance after periradicular surgery plays a major role in the aesthetics. The suture material used also influence the wound closure, hemostasis and healing of wound along with the surgical and suturing technique used. It is essential for professional to be aware of the properties of the suture material and its interaction with the surrounding tissues. This article gives an overview regarding current and new advances in Suture materials and alternatives to sutures in dentistry.

Keywords:- *Periradicular Surgery; Soft Tissue Healing; Sutures.*

I. INTRODUCTION

An endodontically-treated tooth with persistent periapical lesion is managed by apical surgery. The primary goal of apical surgery is elimination of bacteria and its by-products from the periapical region with subsequent healing of existent apical periodontitis. The prognosis of apical surgery is based on the systemic condition of the patient, tooth condition, and soft tissue handling during surgery [1].

Oral wound healing varies with general wound healing in two ways. Primarily, wound in the oral cavity cannot be immobilized due to the functional movements of oral tissues. Secondly, oral cavity is colonized by different bacteria which causes wound infection [2]. Endodontic microsurgery alone may not accelerate healing, but through accurate preoperative treatment planning, proper flap design and soft tissue handling during procedure, perfect tissue adaptation of edges, suturing technique, and choosing proper suture material. Depending on the type of suture material used, wound healing differs based on their tissue response, bacterial colonization, and physical properties [3].

Literature review was performed by searching in the databases Pubmed, Web of Science and Scopus on the topic, using the following keywords: sutures materials, absorbable sutures, non-absorbable sutures and biocompatible materials. The present review helps the clinicians in understanding the availability of different suture materials, alternatives to sutures and their role in soft tissue healing of periapical surgery.

➢ *The Ideal properties of Suture are [4]:*

- It can be utilized in any operation.
- It can be handled easily and comfortably.
- Minimal tissue reaction.
- High breaking strength.
- High knot security.
- It does not cut, tear or shrink the tissue.
- It is non-allergenic, non-carcinogenic
- It is absorbed predictably with no tissue reaction

Sutures can be classified according to several parameters like source material (natural or synthetic), structure (Monofilament or Multifilament), degradation (absorbable or non-absorbable), tissue reaction (Reactive or Not reactive), and coating (Coated or Uncoated). The decision of using which type of suture material depends of a series of factors. They are the time needed for the wound to heal, the issue of temporary or permanent need of the suture to ensure mechanical support, the condition of the wound and tissue response to the material [5]. Sizes of the suture are given by a number representing their diameter. They range from 1-0 to 12-0, the higher the first number (Ex: ‘12’ in ‘12-0’), the finer is the suture material. The selected size of suture material should match the tissue into which it is implanted [6].

➢ *Types of Suture materials [6]:*

- *Natural absorbable monofilament sutures:* Catgut, Collagen
- *Synthetic absorbable monofilament sutures:* Polydioxanone (PDS), Polyglyconate (Maxon), Polyglecaprone (Monocril)
- *Synthetic absorbable monofilament/multifilament sutures:* Polyglycolic acid, Polyglactin 910
- *Natural non-absorbable multifilament sutures:* Linen, Silk, Cotton
- *Synthetic non-absorbable monofilament/multifilament sutures:* Polyester (Dacron, Mersilene), Polyamide (Nylon), Stainless steel

- *Synthetic non-absorbable monofilament sutures:* Polypropylene (Surgilene, Prolene), Polybutester (Novafil), Polyethylene (Polytetrafluoroethylene)

Suture material selection should be considered during treatment planning of oral surgery. Absorbable natural yarns (*catgut*) are responsible for the most intense inflammatory reaction among all suture, besides presenting a time very short and unpredictable absorption. The tensile strength is retained for less than 60 days in case of absorbable sutures whereas it is retained for more than 60 days in case of non-absorbable sutures. The emergence of the synthetic absorbable was very promising for several reasons [5]:

- inflammatory reactions significantly less than natural absorbable
- keep much of the resistance until the absorption process begins
- available with different times of absorption - short, medium and long, giving opportunity to the clinician choose the suitable material for each case.

In general, the monofilaments are appointed as more advantageous, because the multifilamentary provide conditions for the development of infection, since bacterial colonies are formed in spaces between filaments [5]. Multifilament sutures have large surface area in contact with tissues and inflammatory cells can penetrate into the interstitial space within the suture causing more tissue reaction.

Monofilament suture show less knot tie-down resistance, lower tissue drag and easily forms a stable knot due to its lower bending stiffness. Polytetrafluoroethylene is the biocompatible monofilament suture that shows minimal memory, low surface friction, resistance to in vivo degradation and superior handling characteristics. But chemical inertness and low static coefficient of friction makes the knot less secure [7].

Suture characteristics are divided into Biological and Mechanical/Physical aspects [8].
Biological Characteristics include Biodegradation, Sterility, & Tissue tolerability.
Physical Characteristics include Resistance to traction strength, Capillarity, Flexibility, Plasticity, Elasticity, & Manoeuvrability.
Knot efficiency is the mechanical property of suture which depends on the extrinsic and intrinsic factors of a suture material [9].
Extrinsic factors: Suture size, Throws in a knot, knot type and tension applied.
Intrinsic factors: physical structure, surface treatment and coefficient of friction of sutures.

Mass loss & strength loss profiles and biocompatibility of degradation products play a major role in biodegradation and absorption of sutures. Degradation occurs by hydrolysis and phagocytosis and the rate of degradation is depending on the temperature and pH of the surrounding tissues of the suture [7]. For an ideal absorbable suture, mass loss and strength loss profiles should be matched. Presently, there is no such absorbable suture with ideal degradation properties.

As the oral cavity contains different microorganisms, the sutures get contaminated when they come in contact with oral tissues. To reduce the complications like stitch abscesses, the sutures should be opened just before suturing [10]. bacterial adherence to sutures and inflammatory reactions of oral tissues are more common with braided silk and cotton when compared with nylon, Polytetrafluoroethylene, polyester and polyglecaprone [11,12]. In a histological study of human gingival tissue, presence of neutrophils is more near silk sutures. Fibroblasts & new capillaries formation occurred at a slow rate near silk sutures compared to tissues away from the silk sutures indicating the delayed healing and severe tissue reactions associated with silk sutures [13].

The coating on braided suture reduces friction that occurs during sliding and helps in stitching [10]. Knot tie-down is better with monofilament or coated multifilament suture than rough uncoated multifilament suture. Coated sutures have high bending stiffness that is attributable to the loss of mobility of suture under bending force. The stiffness also increases with increase in suture size and its chemical constituent [9].

➢ *Clinical disadvantages of suturing:*

- Braided suture trap plaque and soak up bacteria causing infection and delaying healing. This is called "wick effect."
- Breakdown products of absorbable suture materials cause inflammatory reactions in the tissues.
- Length of the surgery increases with suturing which can be increase the postoperative pain.

➢ *Recent Advances and Emerging Trends:*

Absorbable sutures are used as a vehicle to deliver of a variety of biochemicals like antibiotics, growth factors etc., to improve wound healing. Recent advances in suture materials are Absorbable staples, Tissue adhesives, Surgical zippers, Drug eluting sutures, Antibacterial sutures, Stem cell seeded sutures, Smart sutures, Electronic sutures [14].

❖ *Surgical Staples*

Humer Hultl in 1908 developed surgical staples. As the surgical staples are made of inert steel, they can be left in the tissues for weeks. Specially designed extractors are used for the removal of staples. Surgical staples are recently modified as absorbable staples (Lactomer). Advantages are less time for suturing, rapid wound closure & can be used in contaminated wounds [14].

❖ *Tissue Adhesives*

Naturally or artificially derived tissue adhesives are currently used for local hemostasis & wound closure. When the adhesive is applied to a clean and dry wound, it rapidly polymerizes and forms a firm bond approximating the wound edges.

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Ideal properties of tissue adhesives [15]:

- It should have adhesive property that bonds glue with adjacent tissue.
- It should have cohesive property that bonds the glue molecules with one another.
- It should have biodegradable property.
- It should be biocompatible with minimal cytotoxicity.
- It should be hydrophilic so that at body temperature it readily spreads on wet wound surfaces.
- It should be flexible and strong with the elastic modulus same as that of tissue being glued.
- It should generate minimal heat during polymerization.

➢ *Gingival bandage tape:* Miller suggested sutureless gingival grafting where a bandage tape is applied to the attached gingiva on both sides of the graft. As the moisture prevents adhesion of tape to gingiva, complete hemostasis is necessary. Otherwise wound edges do not effectively evert and gets loosened. Advantages with the gingival bandage tape are they have greater tensile strength, good biocompatibility with lesser tissue reaction and give good aesthetic results than sutured wounds or stapled wounds [14].

➢ *Autologous fibrin glue:* It is Fibrin Fibronectin Sealing System (FFSS)". This biologic adhesive contains fibrinogen, fibronectin, factor XIII, thrombin, calcium chloride and aprotinin. These are good hemostatic agents that are completely biodegradable with poor adhesive properties. [14,15].

➢ *Cyanoacrylate:* The usage of cyanoacrylate to repair wounds or as hemostatic agents is extended recently to dental procedures. Exothermic heat produced during polymerisation is avoided by applying drop by drop of cyanoacrylate and protecting the surrounding tissues [14,15,16].

➢ *Collagen- and Protein-based Sealants:* An air and fluid tight seal is formed with these collagen and protein-based sealant when collagen crosslinks with glutaraldehyde.

As Protein-based adhesives are derived from bovine serum albumin, the foreign protein present causes hypersensitization. Glutaraldehyde in collagen based adhesives is a neurotoxin. These sealants show strong inflammatory response and degradation is also very slow. [15].

➢ *Polyurethane Adhesives:* Polyurethane adhesives are formed by the reaction of polyether-or polyester-polyols with polyfunctional isocyanates. These adhesives form a strong bond with the surface by reacting with hydroxyls and amines found in tissue. This resorbable adhesive is more biocompatible and improves tissue healing [15].

❖ *Surgical Zipper*

This non-invasive suture material is used for skin closures which need to be opened for inspection. This zipper can't be used in wet conditions, high tension areas and in wounds with more than 20 degrees curvature [17].

❖ *Antibacterial sutures:*

These antibacterial sutures reduce the postoperative infections and complications. Diacetyl chitin based sutures are absorbable and used in cases of epithelial and connective tissues with short term wound healing. The bacterial attachment over the sutures can be prevented by oxidative plasma treatment though controlled etching resulting in a cost-effective antibacterial sutures without compromising the desirable features [18,19,20].

❖ *Drug-eluting sutures*

Different anti-microbial, pain management & anti-inflammatory drugs, cytokines and extracellular matrix proteins are made available at the wound site by these drug eluting sutures. Coating the suture surface with Tetracycline, levofloxacin, etc., by dip method or by electrospinning method is done without compromising their mechanical properties for the drug-eluting braided multifilament silk sutures [21,22].

❖ *Stem cells seeded sutures*

To increase the cell count and accelerate healing at the wound site, stem cells seeded sutures are preferred. The stem cells are transplanted into the soft tissues using this type of sutures, but the main problem is their physical properties are been compromised. Adipose derived stem cell seeded sutures showed equally distributed viable cells with increased metabolic activity at the wound healing area. Also the mesenchymal stem cells seeded sutures showed rapid wound healing by depositing collagen at the healing site [18,23].

❖ *Smart sutures*

Shape memory polymers are used for developing the smart sutures which helps in self-tightening of knots in deep wounds. These are available in a pre-stretched condition made by cooling the filaments below their critical temperature. The sutures are loosely adapted at controlled stress to the wounds and on stimulating them above the critical temperature using external source, they regain their original shape with defined tension across the tissues and forms a self-tightening knot [18,24].

❖ *Electronic sutures*

An ultrathin electronic suture of 1mm wide and 3mm thickness was developed with flexible silicon sensors impregnated on silk strips or polymers. These sutures are used for checking the wound condition by measuring the pH & bacterial count at the site. They improve wound healing by accurately monitoring the oxygen, temperature and enzymes at healing sites [18].

II. CONCLUSION

By following the basic rules, a good soft tissue healing can occur after dental surgery. Esthetics play a major role along with minimizing postoperative infections & complications after oral surgery. To reach this goal, proper treatment planning considering the tissue condition of wound, hemostasis & reapproximating the wound edges without tension by choosing correct suture material is necessary. With the advancement in suture technology clinician can reach the ultimate goal of pink esthetics in modern dentistry.

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