Gingival Displacements Options in Prosthodontics: A Critical Review on Recent Advances

Abstract

A plethora of innovations have taken place in impression-making for fixed prosthesis, all with a singular objective to record the finish margins of tooth preparation and the gingival tissues. The gingival displacement temporarily dislocates the tissues laterally to adequately record the sub-gingival margins. The purpose of this review is to make an appraisal of the latest advancements in the field of tissue-displacement and analyze their merits and demerits. A conscientious dentist is one with lucid comprehension of concepts, a keen discerning eye on recent developments, well-informed choice of treatment plan, and impeccable execution of the chosen plan.

Keywords: Gingiva, Margin, Retraction, Sub-gingival.

Introduction

Gingival displacement is reversible lateral and vertical deflection of the marginal gingiva away from the tooth. Gingival displacement has been suggested to be an important and mandatory procedure in fabricating indirect restorations, which may frequently have cervical margins placed in the gingival sulcus (sub-gingival margins) for aesthetic and functional reasons. This must be reproduced accurately in the impression made. A failure will result in a compromised marginal integrity, recurrent caries and/or gingival inflammation and periodontal breakdown. Gingival displacement’s three-pronged goals are to have adequate bulk flow of material into the sulcus, to accurately record margin details, and to prevent impression material tear upon retrieval from the gingival sulcus. The minimum lateral displacement so desired is about 0.2 mm. It is also imperative that a small amount of impression material flows beyond the prepared margin. This will permit accurate trimming of the recovered die.

Occasionally, gingival retraction is required in order to permit the completion of tooth preparation or to allow cementation of laboratory-manufactured restorations.

Gingival Displacement Techniques

The techniques used for gingival displacement are broadly classified into mechanical, chemico-mechanical, and surgical. According to Benson et al., gingival displacement measures fall into one of four major categories: (1) simple mechanical methods, (2) chemo-mechanical methods, (3) rotary gingival curettage, and (4) electrosurgical methods. Of these four categories, the chemo-mechanical method of gingival displacement is the most widely used.

Mechanical Technique

The most commonly used methods are:

1. Copper band
2. Rubber dam
3. Displacement cords
Displacement cords are supplied in three basic designs, namely, twisted cords, braided cords, and knitted cords. Selection of the cord is determined by the operator preference. The largest cord that can be atraumatically placed in the sulcus should be used. Cords are usually pressure-packed into the sulcus using special instruments like the Fischer cord packing instrument or plastic-filling instrument.

**Chemico-Mechanical Technique**

This probably is the most commonly used method of gingival displacement. In this method, a cord soaked in a medicament (reduces bleeding and sulcular fluid seeping from the sulcus) is placed in the gingival sulcus to bring about reversible gingival displacement (Fig. 1(a,b)).

Some of the commonly employed medicaments include:

1. 8% racemic epinephrine
2. Aluminum chloride
3. Alum (aluminum potassium sulfate)
4. Aluminum sulfate
5. Ferric sulfate

The displacement cord soaked in the chemical agent of choice is packed into the sulcus using a Fischer cord packing instrument and left in place for a period of 4-8 min and then removed. This usually brings about the desired gingival displacement. Harrison$^{10}$ compared plain cord, cord impregnated with two concentrations of epinephrine plus zinc chloride, and cord impregnated with 100% alum. Cords that contained zinc chloride at 8 and 40% concentrations caused severe tissue destruction, while the other materials brought about reversible injury. Both 8% epinephrine and 100% alum were effective in the control of moderate bleeding. Ramadan studied the length of time the sulcus remained open and the width of the sulcus with plain cord, 1/1000 epinephrine, 100% alum, and hemodent. He concluded that the treated cords were effective as compared to the plain cord.$^{11}$ However, de Gennaro et al.$^{12}$ studied the histological responses among humans to plain cord and cord impregnated with potassium sulfate, hemodent, and 8% racemic epinephrine and concluded that there was no practical difference between the cords. Aluminum sulfate causes hemostasis by a weak vasoconstrictor effect in addition to precipitation of tissue proteins with tissue contraction, inhibited trans-capillary movements of plasma proteins, and subsequent arrest of capillary bleeding. The medicament is regarded as safe and devoid of systemic effects when used appropriately.$^{12}$

A material available for quite some time for clinical usage is Expasyl (Kaolin incorporated into an organic binder with aluminum chloride). It aids in soft-tissue control in two ways. First, the consistency of the “putty-like material” when injected into the sulcus aids to mechanically displace the gingival tissues horizontally and vertically to open the sulcular space, effectively providing the space that mechanical cords provide. The Expasyl paste is injected in the sulcus, exerting a stable, non-damaging pressure of only 0.1N/mm. When Expasyl is left in place for 1 min, the pressure is sufficient to obtain sulcus opening of 0.5 mm for 2 min. Second, aluminum chloride incorporated in the product is an effective hemostatic agent (Fig. 2). It has been reported to have advantages like effective hemostasis, little pressure, i.e., atraumatic, less time-consuming, easy removal, and easy to dispense with the gun. Prominent disadvantages being expensive, thickness of the paste makes it difficult to express into the sulcus and metal tips too big for interproximal areas.$^{13}$ Yet another system on the docks is matrix impression system, which is a new system that requires a series of three-impression procedure, using three viscosities of impression technique. It attempts to overcome the deficiencies of the older systems and at the same time incorporate their best features.$^{14}$ A matrix of occlusal-
registration elastomeric material is made over the tooth preparations. Depending on the distribution and complexity of the preparations, the matrix may be made in one piece or in two or more sections. The retraction cord is removed and a definitive impression is made in the matrix of the preparations with a high-viscosity elastomeric-impression material. After the matrix impression is seated, a stock tray filled with a medium-viscosity elastomeric impression material is seated over the matrix and remaining teeth to create impression of the entire arch. This system effectively controls the four forces that are relapsing, retraction, displacement, and collapsing that impact on the gingiva during the critical phases of impression making. The design of the matrix also forces the high-viscosity impression material along the preparations and into the sulcus where it cleanses the sulcus of debris and fills it. The matrix facilitates the formation of the optimum flange. Chances of tearing are virtually eliminated because of improved configuration of the sulcular flange, decreased amount of voids or contaminant in the sulcus. The system eliminates chances of tearing of the sulcular flange by developing the optimal configuration, cleaning blood and debris from the sulcus area at critical moments, delivering impression material in the sulcus gently but with increased accuracy and speed, and holding the sulcus open for an increased time (Fig. 3).14

Gingitrac15 is a gingival-retraction paste system that uses a preloaded syringe to apply the paste around the margins. The paste contains aluminum sulfate as astringent, and if necessary, a hemostatic agent can be applied prior to its use. For single tooth use, a cap is used to apply pressure for up to 5 min after application of paste. The cap is first filled with the paste, and then placed over the tooth and paste is syringed around the margins. For multiple tooth preparations, a plastic tray is first used with a firm-paste matrix over which the Gingitrac paste is syringed before the tray is placed over the arch and held in position for 3-5 min. For both single and multiple tooth preparations, gingival retraction is achieved through the application of pressure. The paste is removed prior to impression-taking.

Magic foam cord16 is a new non-hemostatic gingival-retraction system. It is the first expanding vinyl polysiloxane material designed for retraction of the gingival sulcus without the potential traumatic and time-consuming packing of retraction cord. The material is syringed around the crown preparation margins and a
cap (Com-precap) is placed to maintain pressure. After 5 min, the cap and foam are removed and the tooth is ready for final impression. The material claims to have an expansion of 160% after 5 min.

Figure 5. Magic Foam Cord

Mercocel\textsuperscript{17} is a new retraction material to displace gingival tissues without tissue damage before impression making. Mercocel retraction strips are synthetic material that is specifically chemically extracted from a polymer hydroxylate polyvinyl acetate that creates a net-like strip without debris or free fragments. Placement of Mercocel retraction technique does not require use of local anesthesia, resulting in careful management of the delicate gingival tissues with improved management of the treatment. Also, mercocel retraction device ensures sufficient gingival retraction to permit measurement of the sub-gingival finish line and gingival surfaces of unprepared teeth. The porous and sponge-like microstructure of mercocel retraction strips ensures a dry environment, allowing impression material to record precise tooth preparations. Scanning electron microscopy reveals absence of fibers thus, decreasing the risk of post-operative complications. It is chemically pure and can be easily shaped. It effectively absorbs intraoral fluids such as saliva, blood and gingival fluids. It is free of any fragments without presence of any debris.

Figure 6. Mercocel Strip Reveals Absence of Filaments and Spongy Microstructure

Racegel\textsuperscript{18} is a new hemostatic agent that controls bleeding and absorbs crevicular fluid prior to and during impression-taking and crown placement. Due to its thermodynamic characteristics, the material’s viscosity increases upon contact with the tissue, providing access to the gingival margin. The gel contains 25% aluminum chloride, oxyguinol and excipients. The aluminum chloride is clinically proven for its astringent properties. The bright orange color makes it easy to dispense, place and rinse. The gel helps to prepare the sulcus prior to impression-taking and can be used with or without gingival retraction cords. It facilitates the opening of the gingival crevice and reduces bleeding and oozing. Due to its consistency, it rinses away quickly, leaving no residual material, discoloration or irritation of the surrounding tissue.
Figure 7. Racegel Kit

Stay Put combines the advantages of an impregnated braided retraction cord with the adaptability of a fine metal filament. Both impregnated and unimpregnated options are available for clinical use. Hemostatic agent, aluminum Chloride is employed for impregnated Stay Put. Non-impregnated stay put cord may be impregnated with a suitable hemostatic agent as desired. Main advantages are quick hemostasis, can be pre-shaped, adaptable and pliable, good contrast to gingiva, and no risk of cardiovascular problem.

Figure 8. Stay Put

Surgical Technique

1. Rotary curettage\(^7\) is performed on healthy tissue wherein portion of sulcular epithelium is excised. The criteria to be met are-no bleeding on probing, less than 3 mm sulcular depth with presence of appropriate keratinised gingival tissue. The choice of bur is torpedo-shaped diamond point. Bleeding is checked by utilizing a hemostatic agent-soaked cord.

2. Electrosurgical method: With the assistance of an electrode, surgical excision is affected. Sometimes, it is also termed “surgical diathermy.” This method is suggested in clinical situations having inflamed, proliferated gingiva around finish margins of tooth preparation, not indicated in patients on cardiac pacemakers. Advantages offered by this technique is minimal or no bleeding; the major disadvantage is that it has a learning curve and is technique-sensitive. There are chances of damage to soft tissue in the hands of a novice or careless user.

3. LASER: Lasers may also be employed as they cause tissue-coagulation facilitating hemostasis tissue removal via vaporization, and sulcular epithelium is removed. Commonly used soft-tissue lasers for gingival displacement include CO\(_2\) lasers, diode lasers, Nd:YAG lasers, erbium lasers, etc.\(^{20}\)(Fig. 9) Recently, erbium lasers have been added to this list. These minimally penetrate the soft tissues, so they are fairly safe to use. Some of the advantages with lasers include a dry bloodless field of surgery, sterile working area, less mechanical trauma, minimal pain and less postoperative swelling and scarring. However, cost factor is a drawback and it is technique-sensitive. Er: YAG laser is not good in hemostasis as CO\(_2\) laser. However, CO\(_2\) laser provides no tactile feedback, leading to risk of damage to junctional epithelium.
Azzi and colleagues\textsuperscript{21} studied the effect of retraction cords, electrosurgery and rotary ginvial curettage on gingival recession and loss of attachment in dogs. They found that cords had the smallest effect on the gingival and rotary curettage had the largest effect (Fig. 10(a,b)).

Gingival Displacement in Digital Impressions

A major restraint of direct optical impressions is their limitation to line of sight. A clean sulcus is a requirement of paramount importance while making digital computer-aided design/computer-added manufacturing (CAD/CAM) impressions. Retraction cord fibers that remain in the sulcus may affect the accuracy of gingival retraction and may result in artifact-generated errors. Fifteen percent aluminum chloride in an injectable matrix reduces these artifacts by leaving a clean sulcus on removal. Indirect capture of digitalized information is considered more accurate by clinicians.\textsuperscript{22} On the other hand, the method of data collection is influenced by thickness of impression material in the sulcus area. This can result in significant errors in cases of thin impression margins with radius less than the contacting-probe tip.\textsuperscript{23}

Gingival Displacement in Implants

The peri-implant tissue is different from that around the teeth. The difference between the two is listed in the chart (Fig. 11 and Table 1). Mechanical retraction techniques are contraindicated around implants, except in situations in which the patient’s gingival sulcus depths are shallow, their mucosal health is impeccable and a robust, thick gingival biotype is present.\textsuperscript{24} This is due to the inherent potential of damaging the gingival epithelial structures. Serrated packing instruments, if not handled appropriately, may increase the probability of damaging the implant collar and may create microscopic scratches on the surface.
Increase in surface free energy and surface roughness will further facilitate biofilm formation on dental implant and abutment surfaces. The atraumatic application of an injectable matrix certainly faces a few limitations. Injectable matrix provides limited success with peri-implant tissue retraction. Rotary curettage, electrosurgery and all types of lasers except CO₂ laser are not advisable for use with peri-implant soft tissues. Their use in anterior applications, where esthetics plays a critical role, is also questionable. Although injectable matrix technique sounds promising for implant situations, further development is needed. As compared to the research linked to implant fixture designs, there is relatively little research to guide clinicians about the appropriate use of various gingival retraction techniques around implant abutments. As implants become mainstream treatments for tooth loss, this topic certainly deserves further research.

Table 1. Difference between peri-implant and peridental tissues

<table>
<thead>
<tr>
<th>Peridental Tissue</th>
<th>Peri-Implant Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free gingival margin with buccal keratinized epithelium</td>
<td>Free gingival margin with buccal keratinized epithelium</td>
</tr>
<tr>
<td>Gingival sulcus apically limited by the junctional epithelium</td>
<td>Gingival sulcus apically limited by the junctional epithelium</td>
</tr>
<tr>
<td>Keratinized epithelium at the base of gingival sulcus</td>
<td>No keratinized epithelium at the base of gingival sulcus</td>
</tr>
<tr>
<td>Junctional epithelium adherent, less permeable, high regenerative capacity</td>
<td>Junctional epithelium poorly adherent, more permeable, low regenerative capacity</td>
</tr>
<tr>
<td>Cementum</td>
<td>No cementum</td>
</tr>
<tr>
<td>Gingival fibers inserting perpendicularly in the cementum</td>
<td>Gingival fibers running parallel to the implant collar</td>
</tr>
<tr>
<td>Biological width of at least 2.04 millimeters</td>
<td>Biological width of 2.5 mm±0.5 mm</td>
</tr>
<tr>
<td>Periodontal ligament</td>
<td>No periodontal ligament</td>
</tr>
<tr>
<td>No direct contact between tooth and bone</td>
<td>Direct contact of implant to bone</td>
</tr>
<tr>
<td>Peridental Tissue</td>
<td>Peri-implant Tissue</td>
</tr>
<tr>
<td>Free gingival margin with buccal keratinized epithelium</td>
<td>Free gingival margin with buccal keratinized epithelium</td>
</tr>
<tr>
<td>Gingival sulcus apically limited by the junctional epithelium</td>
<td>Gingival sulcus apically limited by the junctional epithelium</td>
</tr>
<tr>
<td>Keratinized epithelium at the base of gingival sulcus</td>
<td>No keratinized epithelium at the base of gingival sulcus</td>
</tr>
<tr>
<td>Junctional epithelium adherent, less permeable, high regenerative capacity</td>
<td>Junctional epithelium poorly adherent, more permeable, low regenerative capacity</td>
</tr>
<tr>
<td>Cementum</td>
<td>No cementum</td>
</tr>
<tr>
<td>Gingival fibers inserting perpendicularly in the cementum</td>
<td>Gingival fibers running parallel to the implant collar</td>
</tr>
<tr>
<td>Biological width of at least 2.04 millimeters</td>
<td>Biological width of 2.5 mm±0.5 mm</td>
</tr>
<tr>
<td>Periodontal ligament</td>
<td>No periodontal ligament</td>
</tr>
<tr>
<td>No direct contact between tooth and bone</td>
<td>Direct contact of implant to bone</td>
</tr>
</tbody>
</table>
Discussion

While using chemico-mechanical means of gingival retraction, absorption of chemicals, like epinephrine, at the sulcus interface is dependent on patient’s gingival health. Healthy gingiva acts, to some extent, as a barrier to the absorption of epinephrine. This may be a reason why the theoretical overdose levels are not observed clinically.

Absorption varies with the degree of vascular bed exposure, the length of cord used, the concentration of cord impregnation and the length of application time. Clinicians should avoid applying high concentrations of epinephrine to large areas of lacerated or abraded gingival tissues as its absorption increases substantially due to large vascular-bed exposure. Surgical retraction procedures are rapid but at the same time destructive and involve excision of tissue. On the other hand, few authors advocate the use of electrosurgery, rotary curettage and lasers around natural teeth. Clinicians can make a good use of an injectable matrix for gingival retraction as it offers the opportunity to perform an atraumatic procedure. The materials such as 15% aluminum chloride in a Kaolin matrix can be introduced into the sulcus surrounding natural teeth with no risk of laceration. With no damage to the junctional epithelium at the base of the sulcus or to the sulcus walls, the risk of inflammation caused by chemicals delivered in the matrix is reduced significantly. In addition to this, it is as effective as epinephrine-soaked cord in reducing the flow of sulcular exudate. Inflammation results from the use of chemical agents, but the aluminum chloride in the injectable matrix offers the best outcome of the chemical choices to date.

Conclusion

Gingival retraction holds the merit of being an indispensable clinical procedure for predictable soft-tissue management and impression-making. The myriad clinical complications arising out of inadequate marginal adaptation can be clearly avoided, provided apt attention is paid to impression-making after due exposure of finish margins with any of the mentioned methods of gingival retraction. The choice of technique and material employed for gingival retraction rests upon considerations of cost-efficacy and availability. With rapid-paced development in materials available for gingival retraction for tooth or dental implant situation, an alert and conscientious clinician will choose judiciously and remain abreast with the new knowledge.

Conflict of Interest: Nil

References


Date of Submission: 11th Feb. 2016
Date of Acceptance: 26th Feb. 2016