Learning Objectives

- enumerate the various methods of gingival tissue displacement
- list the advantages and disadvantages of various nonsurgical gingival displacement methods
- choose the appropriate method of gingival tissue displacement as the clinical situation demands

Abstract

Gingival displacement is critical for obtaining accurate impressions for the fabrication of fixed restorations, especially when the finish line is at or just within the gingival sulcus. Displacement of the gingival tissue is also important when dealing with the restoration of cervical lesions due to their proximity to the periodontal tissue. The methods of gingival tissue displacement can be broadly classified as nonsurgical and surgical techniques, with nonsurgical being the more commonly practiced method. Dentists must alter their armamentarium and gingival displacement techniques to meet specific demands and obtain predictable results. Hence, the purpose of this article is to describe the different means by which nonsurgical gingival displacement can be achieved effectively under a variety of clinical situations.
Harmony between a restoration and the periodontium that surrounds the teeth is crucial to the success of a restorative procedure. Key to achieving such a relationship is an accurately made impression for indirect restorations or a properly placed direct restoration into the prepared cavity. Displacement of the gingival tissue is essential for obtaining accurate impressions for the fabrication of fixed restorations, particularly when the finish line is at, or just within, the gingival sulcus. This is also true when dealing with the restoration of cervical lesions due to their proximity to the periodontal tissue.

Gingival displacement is defined as the deflection of marginal gingiva away from the tooth. This is performed to create sufficient lateral and vertical space between the preparation finish line and the gingival tissue to allow the injection of adequate bulk of the impression material into the expanded crevice. Impression along the subgingival margin is critical to the marginal fit and emergence profile of the prosthesis. A bulk of the impression material is required to obtain maximum accuracy and to improve the tear strength of the impression material so it can be removed from the mouth intact with no tearing. The critical sulcular width in this regard seems to be approximately 0.2 mm at the level of the finish line. Control of moisture in the sulcus, particularly when a hydrophobic impression material is used, is also necessary because moisture can cause an incomplete impression of the critical finish line. The displacement of the gingiva is also required during the preparation of the tooth cervically and even while placing and finishing the restoration located cervically. This is done to avoid trauma to the periodontal tissue.

The techniques of gingival tissue displacement can be broadly classified as nonsurgical and surgical methods (Table 1). Since surgical methods are usually effective in skilled hands, these techniques are used only by a minority of clinicians in their profession, and even then they are used only as adjuncts to mechanical or mechano-chemical means of gingival displacement. Therefore, the purpose of this article is to describe the different means by which nonsurgical gingival displacement can be achieved effectively under a variety of clinical situations (Table 2).

### Nonsurgical Methods

#### Retraction Crown/Sleeve

- **Temporary crown filled with thermoplastic stopping material or bulky temporary cement:** In order to displace the gingiva a temporary crown can be adapted to the finish line of the tooth and lined with an excess of temporary stopping material. The crown is then placed on the prepared tooth, and any excess stopping material protruding into the gingival crevice is rounded and smoothed with a hot instrument. In a different method, a custom temporary restoration is placed in which the gingival ends are blunted and covered with bulky temporary cements such as zinc oxide eugenol or non-eugenol-containing periodontal pack. The temporary crown thus fabricated is left in place until the next appointment, at which time the final impression is made.

These methods are no longer practiced since a temporary crown filled with thermoplastic stopping material or temporary cement can cause prolonged or lasting recession if left in place for more than 12 hours. The resulting uncovered neck of the tooth may be sensitive and susceptible to caries. Also, impressions cannot be made the same day as the tooth preparation.

- **Anatomic compression caps:** Anatomically formed compression caps with semicircle spaces on two opposite sides can be easily placed on adjacent teeth. After placement of the adjusted anatomic cap, the patient bites on it and maintains pressure. The cap stops bleeding naturally by compression, opens the sulcus wide, and ensures a dry, clean area with well-defined gingival margin.

### Modified Impression Techniques for Gingival Retraction

#### Copper band impression technique:

A copper band can serve as a means of carrying the impression material as well as a mechanism for displacing the gingiva to ensure that the gingival finish line is captured in the impression. One end of the tube is festooned, trimmed, to follow the contours of the free gingival margin. The tube with the impression material is mechanically carried to the finish line of the preparation and displaces the gingiva to produce an adequate impression. This technique can be used with impression compound and elastomeric impression. If utilized with an elastomeric material, the copper band must be filled with acrylic, fitted to the preparation, and subsequently relieved and vented. An adhesive must also be applied prior to taking the impression. Without the acrylic reinforcement, the band might get distorted during removal. Copper bands are especially useful when multiple preparations are recorded in an elastomeric impression and a localized impression defect has occurred.

The use of a copper band could negate the need to remake an entire full-arch impression just to capture one or two preparations. On the basis of wound healing and gingival recession, the metal band with impression material is shown to be better than either surgery or retraction cord. Disadvantages of this technique include the amount of time required to fit and adapt the band, the difficulty in removing the modeling compound-filled band from undercuts, and the trauma to tissue caused by the band itself.

- **Temporary acrylic coping:** In another technique, a temporary acrylic resin coping is constructed. The inside of this coping is relieved by approximately 1 mm, and a tray adhesive is applied. The temporary coping is then filled with elastomeric impression material and reseated. The tissue is displaced mechanically when...
the impression material is mechanically forced into the sulcus. A complete arch impression is subsequently made over the coping, and the coping becomes an integral part of the complete arch impression. This is a cumbersome technique that is not very popular.

**Matrix impression system:** A technique called the matrix impression system (MIS) has been described by Livaditis. The MIS is done in three steps: 1) a suitable elastomeric semi-rigid material is used initially to form the matrix; 2) a high-viscosity elastomeric impression material that will preferably bond to the matrix-forming material and which is required to make an impression of the preparations in the matrix is used to facilitate displacement of the gingival tissue and effectively flush debris out of the sulcus; and 3) a stock tray with a medium-viscosity elastomeric impression material is used to pick up the matrix impression and the remaining arch not covered by the matrix.

**Modified custom tray technique:** In another method, a custom tray is modified by intraoral relining with autopolymerizing resin that is polymerized at 100°C for 5 minutes. Relined areas are refined by trimming excess resin with burs of a known diameter to create a 2-mm clearance for the elastomeric impression material. For areas with subgingival finish lines, only 0.5 mm of resin is removed to direct the elastomer into the gingival sulcus. The procedure is said to be time-saving because it reduces the need for a retraction cord and minimizes inaccuracies that would necessitate another impression.

**Mechanical Retractor**

**Gingival protector:** A gingival protector can be used to displace soft tissue to protect gingiva from rotary instruments during tooth preparation and finishing (Figure 1). A unit is available that features a crescent-shaped tip on an adjustable ball-joint attached to a metal handle. The tip can be rotated to an angle that precisely matches the tooth’s facial surface, thereby achieving gingival fit. Such protectors can be used for veneer preparations, finishing porcelain or resin veneer margins, cervical (facial) subgingival caries, and removal and checking

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**TABLE 1**

**Classification of the Methods of Gingival Tissue Displacement**

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>METHODS OF TISSUE DISPLACEMENT</th>
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<tbody>
<tr>
<td>Nonsurgical</td>
<td>Mechanical</td>
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<td>Retraction crown/sleeve</td>
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<td></td>
<td>• Modified temporary crown</td>
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<td>• Anatomic compression caps</td>
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<td>Modified impression techniques</td>
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<td>• Copper band impression technique</td>
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<td>• Matrix impression system</td>
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<td>• Modified custom tray technique</td>
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<td>Mechanical retractor</td>
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<td>• Gingival protectors</td>
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<td>• Matrices and wedges</td>
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<td>• Rubber dam</td>
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<tr>
<td>Plain retraction cord (twisted/knitted/braided)</td>
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<td>Retraction strips</td>
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<td>Retraction paste without a hemostatic agent</td>
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<tr>
<td>• Hydrogen-generating syringed PVS</td>
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<tr>
<td>• Injected, no aluminum chloride</td>
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<tr>
<td>Mechano-chemical</td>
<td>Retraction cord with hemostatic</td>
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<td>• Vasoconstrictor</td>
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<td>• Astringent</td>
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<td>Retraction paste with hemostatic</td>
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<td>• Injectable viscous</td>
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<td>• Syringed into sulcus</td>
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<td>• Utilizes patient’s bite pressure</td>
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<tr>
<td>Surgical</td>
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<td>• Rotary gingival curettage/gingettage</td>
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<td>• Conventional surgery (gingivoplasty/gingivectomy/periodontal flap procedures)</td>
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<td>• Electrosurgery</td>
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<td>• Laser (CO2/diode/Nd:YAG, argon laser)</td>
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<td>PROCEDURE</td>
<td>FACTOR</td>
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<td>Tooth preparation</td>
<td>Location of the margin</td>
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<td>Impression taking</td>
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<td>Type of prosthesis</td>
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<td>Implant prosthesis (cement-retained prosthesis)</td>
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There is some debate regarding the use of epinephrine for gingival retraction. The local use of epinephrine as a gingival displacement medicament can be absorbed into the systemic circulation and, consequently, affect the cardiovascular system. Epinephrine-impregnated retraction cords contain 0.2 mg to 1 mg of racemic epinephrine per inch of cord depending on the diameter and the brand. One inch of the retraction cord with 0.2 mg of racemic epinephrine is capable of exposing the patient to the maximum dose of 0.2 mg (200 μg) for a healthy adult and nearly five times the recommended amount of 0.04 mg (40 μg) for a cardiac patient. The amount absorbed depends on its concentration in the cord, length of cord used, amount of vascular bed exposed, and duration of the cord application. The possible cumulative effect of epinephrine from cord combined with epinephrine from other sources (epinephrine administered in the local anesthetic and endogenous epinephrine that may be secreted by the patient in reaction to stress associated with dental procedures) must also be considered.

For patients with cardiovascular disease, hypertension, diabetes, hyperthyroidism, or known hypersensitivity to epinephrine, a cord impregnated with some other agent must be substituted. Epinephrine should also not be used on patients taking monoamine oxidase or tricyclic antidepressants, rauwolfia compounds, ganglionic blockers, or cocaine. Patients without the aforementioned contraindications can also exhibit "epinephrine syndrome" (tachycardia, rapid respiration, elevated blood pressure, anxiety, and postoperative depression). Clinicians should avoid using epinephrine for gingival displacement because of the significant number of contraindications for its use.

**RETRACTION CORDS**

Plain retraction cords can be gently forced into the gingival sulcus to displace the gingiva laterally from the tooth. Cords can be fabricated from cotton yarn or purchased commercially in a variety of forms. Retraction cords are supplied as twisted/braided/knitted cord. Desirable qualities of a cord are that it is:  
- dark in color, to maximize contrast with the tissues, tooth, and cord;  
- absorbent, to allow the uptake of the liquid medicaments; and  
- available in different diameters to accommodate the varying morphologies of the gingival sulcus. Unfortunately, their effectiveness is limited because the use of pressure alone often will not control sulcular hemorrhage. Pre-impregnating and/or soaking a cord with a hemostatic agent can control the sulcular hemorrhage and improve its tissue retraction qualities. The chemicals used along with retraction cords (gingival displacement medicaments) can be broadly classified into vasoconstrictors and astringents.

**Vasoconstrictors**

*Epinephrine:* The vasoconstrictor used is typically epinephrine in the racemic form. Endogenous epinephrine is the l-form, whereas the racemic form contains equal amounts of d- and l-form. The overall activity of the racemic epinephrine is about one-half of that of endogenous epinephrine. The epinephrine is used in the concentration of 0.1% and 8%. There is some debate regarding the use of epinephrine for gingival retraction. The local use of epinephrine as a gingival displacement medicament can be absorbed into the systemic circulation and, consequently, affect the cardiovascular system. Epinephrine-impregnated retraction cords contain 0.2 mg to 1 mg of racemic epinephrine per inch of cord depending on the diameter and the brand. One inch of the retraction cord with 0.2 mg of racemic epinephrine is capable of exposing the patient to the maximum dose of 0.2 mg (200 μg) for a healthy adult and nearly five times the recommended amount of 0.04 mg (40 μg) for a cardiac patient. The amount absorbed depends on its concentration in the cord, length of cord used, amount of vascular bed exposed, and duration of the cord application. The possible cumulative effect of epinephrine from cord combined with epinephrine from other sources (epinephrine administered in the local anesthetic and endogenous epinephrine that may be secreted by the patient in reaction to stress associated with dental procedures) must also be considered.

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**Sympathomimetic amine:** Several sympathomimetic amines capable of producing local vasoconstriction with minimal systemic side effects are available as nonprescription nasal and ophthalmic decongestants. These include tetrahydrozoline HCl, 0.05%; oxymetazoline, 0.05%; and phenylephrine HCl, 0.25%. Retraction cord can be dipped in these prescriptions to assist in hemostasis. Newer hemostatic agents such as the tetrahydrozolines and oxymetazolines have a more acceptable pH and are thought to be kinder to the tooth structure and soft tissues than the conventional solutions.

**Astringents**

Astringents act primarily by precipitation of protein and inhibiting transcapillary movement of plasma proteins. They have relatively low cell permeability and act generally as irritants in moderate concentrations and as caustics in higher concentrations. The astringents used in gingival displacement are as follows:

*Aluminum sulfate compounds (aluminum potassium sulfate [Alum] and aluminum sulfate):* Alum in 100% concentration has been shown to be only slightly less effective in shrinking the gingival tissues than epinephrine, and it shows good tissue response. Alum is safer and has fewer systemic effects than epinephrine and, therefore, has been recommended for use in place of epinephrine.
Cords saturated with 100% alum can be safely left in the sulcus for as long as 20 minutes without any adverse effect.4 Aluminum sulfate, which differs from alum, has been suggested as a gingival retraction material. The available data indicate that the material is effective and biologically acceptable.15 A practical concern is that, like most sulfates, aluminum sulfate compounds can inhibit/retard the setting reaction of additional reaction impression materials.16

Aluminum chloride: Aluminum chloride is one of the most commonly used astringents.17 The actions of aluminum chloride result from its ability to precipitate protein, constrict blood vessels, and extract fluid from tissues.18 It is used in the concentration of 5% to 25%. Studies have shown that solutions stronger than 10% can cause local tissue destruction. A 10-minute application is usually sufficient.4 Aluminum chloride is the least irritating of the medicaments used for impregnating retraction cords, but it is shown to disturb the setting of PVS impression materials.19 The inhibitory effect can be greatly reduced by thoroughly rinsing the preparation with water after the treated cord is removed.

Ferric sulfate: Ferric sulfate provides good hemostasis on exposed connective tissue. This astringent is provided in solution form only, generally in the concentration of 13% to 20%. Solutions of ferric sulfate above 15% are very acidic and can cause significant tissue irritation and postoperative root sensitivity. The recommended packing time for cord dipped in ferric sulfate solution is 1 to 3 minutes. When tissues are hemorrhaging, the solution should be rubbed into the bleeding areas with an applicator (dento-infusor) or a soaked cotton pellet. Ferric sulfate can modify the accuracy of surface detail reproduction during impressions because it disturbs the setting reaction of polyvinyl...
siloxanes. Therefore, all traces of medicament should be carefully removed from the tissues before the impressions are recorded.\textsuperscript{19} Due to its iron content, ferric sulfate stains gingival tissues a yellow-brown to black color for several days after being used as a retraction agent.\textsuperscript{20} The esthetics of the anterior all-ceramic crowns may also be compromised due to the use of ferric sulfate since it has shown to produce internalized discoloration of the tooth structure.\textsuperscript{21}

The acidity of the commonly used gingival displacement medicaments are high, with pH ranging from 1 to 3.\textsuperscript{13,22,23} This could result in the removal of the smear layer and can negatively affect the bonding mechanism of the self-etch dentin bonding systems.\textsuperscript{24} The removal of smear layer could also cause the opening up of the dentinal tubules cervically and cause dentinal hypersensitivity.\textsuperscript{23}

Many different instruments are available for placing cord in the gingival sulcus. Some are purpose-designed packing devices with smooth, nonserrated circular heads that can be used to place and compress twisted cord with a sliding motion. Other devices have serrated circular heads for use with braided cords. The thin edges of these serrated circular heads sink into the braided cord, and the fine serrations keep it from slipping off and cutting the gingival attachment.\textsuperscript{20} The instrument design used is a matter of the dentist's individual preference.

**TECHNIQUES FOR RETRACTION CORD PLACEMENT**

Two procedures for placing the retraction cord are the single-cord and double-cord techniques. The technique used is based on the clinical situation.\textsuperscript{3}

The single-cord technique is indicated when making impressions of one to three prepared teeth with healthy gingival tissues, especially when the prepared margins are at or above the tissue. In this technique, a single cord is placed in the sulcus and removed before the impression is taken. This provides displacement about the width of the cord. In a deep sulcus, however, the tissue can collapse over the top of the cord, restricting access of the impression material to the retracted sulcus. This often causes the impression material to tear on removal. Even when tearing does not occur, impression material near the most critical margins will be extremely thin and easy to deform. Though commonly practiced, this technique is often unsatisfactory.

The double-cord technique can be used with single or multiple preparations. It is especially useful for making impressions when tissue health is compromised and the procedure absolutely cannot be delayed. The double-cord technique, which some clinicians use routinely for all impressions, employs two cords, one placed above the other. A thin cord such as silk suture or #000 retraction cord is first packed under the preparation margin to control gingival seepage and hemorrhage. This cord is typically left in place for the impression. The second, larger cord is impregnated with...
hemostatic agent and placed above the first cord for a minimum of 4 minutes and removed before the impression is taken (Figure 5 through Figure 9). The principal advantage of this technique is that the first cord remains in place within the sulcus, thus reducing the tendency of the gingival cuff to recoil and displace partially set impression material. This approach not only helps to control gingival hemorrhage and exudates but also overcomes the problem of the sulcus impression tearing because of inadequate bulk.25 Another advantage of the double-cord technique is that the first cord acts as a sulcus liner, preventing tearing of the epithelium and subsequent bleeding. The main disadvantage of this technique, however, is that failure to remove the first cord can cause gingival inflammation. Also, if the deeper cord is left in place the impression material may stick to it and cause the impression to tear upon removal.

Use of retraction cord, which can be laborious and time-consuming, must be done carefully as gingival bleeding may occur. It can also be uncomfortable for patients in the absence of anesthesia, and when inappropriately manipulated it can lead to direct injury and gingival recession.26 Clinicians should be cautious when using retraction cords around implants since the junctional epithelium that surrounds an implant is not as adherent, is more permeable, and has a lower regenerative capacity than the junctional epithelium around teeth.20 The artifacts caused by retraction cord fibers that may remain in the sulcus can also affect the accuracy of optical impressions used for CAD/CAM prostheses.27 To overcome these problems, new products and techniques have been introduced into the market.

Retraction Strip
New retraction strips have been proposed for use in dentistry to displace gingival tissue prior to impression-making without damaging the tissue. The synthetic retraction material is chemically extracted from a biocompatible polymer (hydroxylate polyvinyl acetate) that creates net-like strips without debris or fragments. The material, which can be easily shaped and adapted into the sulcus without local anesthesia, is highly effective for absorption of intraoral fluids such as blood, saliva, and crevicular fluid.28 Once inserted around the tooth, the sponge-like strips expand with absorption of fluids and exert pressure on gingival tissues to cause displacement.26 Though time-consuming, this technique has shown to be suitable for the displacement of gingival tissue and to provide a readable impression that is gentle to the periodontium.29

Retraction Paste
Use of cordless retraction materials has gradually made impregnated retraction cords less competitive. Available in a paste-like form and supplied with a specialized dispenser, cordless retraction materials displace the gingiva when injected into the sulcus. Because of the passive technique used to place these pastes, they are significantly less traumatic to the tissue than conventional retraction cord.30 Hence, they are preferred for gingival tissue displacement, especially around cement-retained implant prostheses.20 These materials are also preferred when taking a digital impression for CAD/CAM prostheses since the artifacts caused by retraction cord fibers can be avoided.27

The amount of retraction offered by these pastes is limited, especially with extremely subgingival margins.20 The high cost of retraction pastes, commercially available with or without hemostatic agents, has also prevented them from becoming a mainstream commodity.

Retraction Paste with Hemostatic Agent
There are a number of retraction paste products available with hemostatic agents. One such product is an injectable viscous paste that depends on the hemostatic properties of aluminum chloride and the hygroscopic expansion of kaolin upon contact with the crevicular fluid to provide mild displacement of the gingiva in about 2 minutes. Retraction paste products contain as much as 15% aluminum chloride, which may be hazardous to the gingival tissue.26 The viscosity of an injectable matrix may not be enough to provide sufficient displacement for deeper subgingival preparations, and aluminum chloride can inhibit the set of polyether and PVS materials if clinicians do not rinse it away properly before making impressions.20

Another product is dispensed from a syringe into the sulcus, displacing the soft tissue and working synergistically with the astringent it contains (15% aluminum chloride) to create retraction. Fluid is absorbed while the paste occupies the sulcus and expands to several times its natural size. After 2 minutes, it can be rinsed away to leave an open, displaced sulcus.

Yet another product is a cordless gingival displacement system that utilizes the patient’s bite pressure via a preformed matrix for single-tooth or a custom-made matrix for multiple teeth preparations. The bite pressure pushes the hydrophilic silicone retraction paste to gently retract the gingival with no tissue damage.

Retraction Paste without Hemostatic Agent
There are also various retraction paste products available without hemostatic agents. For example, one PVS material used for gingival displacement generates hydrogen to cause expansion of the material against the sulcus walls during setting. The product is syringed around the preparation margins of the abutment teeth and maintained under pressure using a compression cap for 5 minutes before impression taking. The manufacturer has reported such benefits as gentle placement without the need for local anesthetic, good product visibility in the sulcus due to its bright color, ease of removal, and minimal rinsing of residue. However, since there is no hemostatic agent, hemostasis should be achieved in all cases before using this technique. It is also less effective in cases of teeth with subgingival margins.29
Another type of product in this category is an injection-type retraction material that contains no aluminum chloride. It has shown to produce satisfactory gingival displacement without the drawbacks of pain and gingival recession.24

CONCLUSION

A healthy coexistence between restorations and their surrounding periodontal structures should be the goal of a diligent dentist. Several techniques have proven to be relatively predictable, safe, and efficacious in the management of the gingival tissue in restorative dentistry. No scientific evidence has established the superiority of one technique over the other. The selection of any one of the various methods of soft-tissue management to control the operative site depends on the clinical situation and the preference of the operator.

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REFERENCES

Nonsurgical Gingival Displacement in Restorative Dentistry

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1. The critical sulcular width in gingival displacement seems to be approximately how much at the level of the finish line?
   A. 0.2 mm
   B. 0.4 mm
   C. 0.6 mm
   D. 0.8 mm

2. A temporary crown filled with thermoplastic stopping material or temporary cement can cause prolonged or lasting recession if left in place for more than:
   A. 10 minutes
   B. 1 hour
   C. 12 hours
   D. 1 week

3. If utilized with an elastomeric material, the copper band must be:
   A. filled with acrylic
   B. fitted to the preparation
   C. subsequently relieved and vented
   D. all of the above

4. Endogenous epinephrine is:
   A. the d-form
   B. the 1-form
   C. equal amounts of d- and 1-form
   D. only found in the dorsolateral portion of the medulla

5. The maximum dose of epinephrine for a healthy adult is:
   A. 0.2 mg (200 μg)
   B. 0.5 mg (500 μg)
   C. 1.0 mg (1,000 μg)
   D. 1.8 mg (1,800 μg)

6. Astringents act primarily by:
   A. vasovagal nerve depolarization
   B. precipitation of protein and inhibiting transcapillary movement of plasma proteins
   C. vasodilation
   D. vasoconstriction

7. Cords saturated with 100% alum can be safely left in the sulcus for how long without any adverse effect?
   A. 10 minutes
   B. 20 minutes
   C. 1 hour
   D. there is no time limit as per the manufacturer’s instructions

8. Studies have shown that solutions of aluminum chloride stronger than what percentage can cause local tissue destruction?
   A. 5%
   B. 10%
   C. 17.4%
   D. 25%

9. Once inserted around the tooth, the sponge-like retraction strips:
   A. promote haematopoesis
   B. dilute the rank-ligand concentration in the sulcus
   C. expand with absorption of fluids and exert pressure on gingival tissues to cause displacement
   D. recruit sulcular macrophages and local neutrophils

10. Retraction paste products contain how much of the following, which may be hazardous to the gingival tissue?
    A. 15% aluminum chloride
    B. 37% phosphoric acid
    C. 11% kaolin by weight
    D. 12% chlorhexidine by volume

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