# Current concepts in gingival displacement

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Indirect restorations, including cast gold inlays, onlays, partial veneer restorations and complete crowns, metal-ceramic and all-ceramic crowns, and bonded ceramic inlays and onlays are routinely used to restore defective teeth. These restorations frequently have cervical margins that are intentionally placed in the gingival sulcus for esthetic or functional reasons. In these situations, the clinician must make impressions that accurately capture the prepared cervical finish lines and permit the fabrication of accurate dies on which the restorations are fabricated.

There is evidence that inadequate impressions are frequently forwarded to commercial laboratories, and the chief deficiency seen in such impressions is inadequate recording of the cervical finish lines [1,2]. The primary reason for not adequately capturing marginal detail is deficient gingival displacement technique.

The procedure used to facilitate effective impression making with intra-crevicular margins is gingival "displacement" as opposed to gingival "retraction" [3]. The goal of the procedure is to reversibly displace the gingival tissues in a lateral direction so that a bulk of low-viscosity impression material can be introduced into the widened sulcus and capture the marginal detail (Fig. 1) [4,5].

A bulk of impression material is required to obtain maximum accuracy and to improve the tear strength of the material so that it can be removed from the mouth intact with no tearing [6,7]. The critical sulcular width in this regard seems to be approximately 0.2 mm. A width of less than 0.2 mm results in impressions that have a higher incidence of voids in the marginal area, an increase in tearing of the impression material, and a reduction in marginal accuracy [8]. It is imperative that a small amount of impression material flows beyond the prepared margin (Fig. 2). This permits accurate trimming of the recovered die (Fig. 3).

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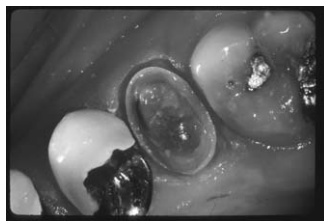  *E-mail address:* tdonovan@usc.edu (T.E. Donovan).

Fig. 1. The gingival tissues need to be displaced laterally to permit injection of a bulk of low-viscosity impression material into the sulcus.

Many clinicians have difficulty with gingival displacement procedures primarily because they have not mastered effective soft tissue management procedures [9,10]. One critical factor in this regard is to ensure that the gingival tissues are in an optimum state of health before making the impression [11]. Making impressions with inflamed marginal gingival tissues can be difficult and requires aggressive procedures that may result in gingival recession.

Quality provisional restorations are essential to establish an improved environment to facilitate oral hygiene procedures to improve and maintain gingival health [12,13]. The location of the prepared cervical margin within the sulcus is critical to long-term gingival health and to impression making. The optimum position of the margin is 0.5 mm from the healthy free gingival margin or 3.0 to 4.0 mm from the crest of the alveolar bone and must follow the natural scalloped form of the attachment and alveolar housing [14,15].

If the gingival tissues are healthy and the cervical margin is placed in the appropriate position, gingival displacement is a relatively simple, atraumatic procedure. Most of the difficulties with gingival displacement result from attempting to make impressions when the tissues are clinically inflamed, when clinically there is inadequate attached gingiva, or when prepared margins are placed too deep in the sulcus.

Techniques for gingival displacement have been classified as mechanical, chemical, surgical, and combinations of the three [16,17]. The method of gingival displacement used by the majority of practitioners is a combination of mechanical-chemical displacement using gingival retraction cords along with specific hemostatic medicaments [18]. A small number of dentists use



Fig. 2. A definite amount of impression material must flow beyond the prepared margin to facilitate trimming of the gypsum die.

Fig. 3. Trimming of gypsum die is a simple procedure when effective gingival displacement procedures result in excellent impressions.

surgical methods, including rotary gingival curettage and electro-surgery, but these are generally used as ancillary procedures in conjunction with mechanical-chemical techniques.

There are three main variations of the mechanical-chemical technique for gingival displacement. They include the single cord technique, the double cord technique, and the infusion method of gingival displacement [19–21]. Each of these techniques can be used effectively and are described in detail below. Before describing these techniques, a discussion of differences in retraction cords and medicaments may be useful.

Retraction cords are supplied in three basic designs, including twisted cords, knitted cords, and braided cords. There is little scientific evidence to differentiate one type of cord from another; thus, the selection of which design of cord to use is determined by operator preference. The authors prefer to use braided or knitted cords [22].

One key to effective displacement is to use a cord of sufficient diameter to provide adequate displacement so that adequate bulk of impression material can be introduced into the sulcus. The largest cord that can be atraumatically placed in the sulcus should be used (Fig. 4) [5,16]. The primary error made by inexperienced dentists is to use a cord that is too small in diameter. These small-diameter cords are placed with minimal trauma; however, they do not provide adequate lateral displacement of the gingival tissues.

There are numerous hemostatic medicaments that have been advocated for use with gingival retraction cords, and some of these medicaments have been extensively studied [23–33]. A review of the literature demonstrates that four medicaments seem to provide adequate displacement and fluid control and seem to be "safe" in that they do not produce iatrogenic soft tissue damage when used appropriately [18]. These medicaments include aluminum potassium sulfate, aluminum sulfate, aluminum chloride, and epinephrine.

The local use of epinephrine as a gingival displacement medicament has the potential to cause significant systemic side effects. The systemic effects of epinephrine have been studied extensively, and most researchers have concluded that epinephrine should not be used for routine gingival displacement [34–47].
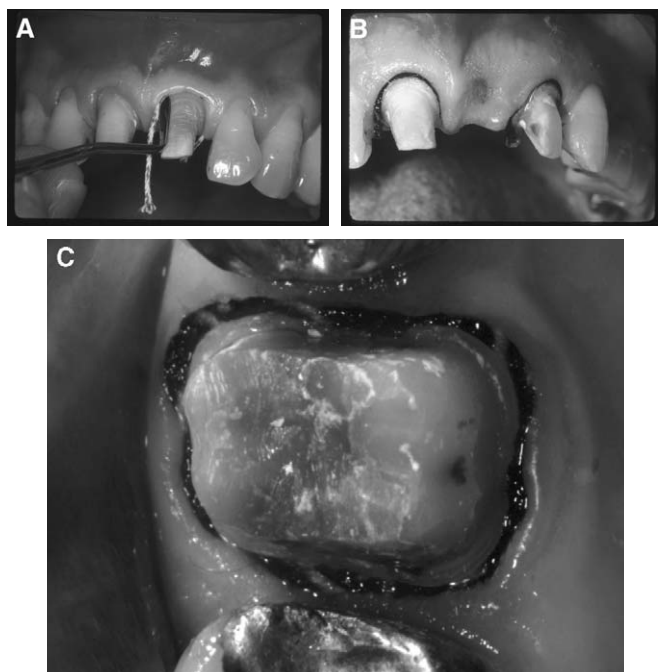
Fig. 4. The largest diameter cord that readily fits into the gingival sulcus should be used.

The literature on the absorption and effects of epinephrine from gingival retraction cords is somewhat contradictory. In correlating data from various studies, it is safe to conclude that under certain conditions epinephrine from retraction cords is absorbed systemically. Conditions that limit absorption are not clear, but increased absorption seems to occur with increased exposure of the vascular bed and with an increase in the total amount of epinephrine used. Increased doses may occur with the use of stronger concentrations of the medicament or with the use of multiple cords when making impressions of multiple prepared teeth.

Other factors related to the total dose of epinephrine received by a patient include the epinephrine administered in the local anesthetic solution and any endogenous epinephrine that may be secreted by the patient in reaction to stress or discomfort associated with the dental procedures. Epinephrine is contraindicated in patients with hyperthyroidism and in patients taking monoamine oxidase inhibitors or tricyclic antidepressants for depression, β-blockers, or cocaine. It also is contraindicated in diabetics and cardiovascular patients.

Determining which patients may be classified as cardiovascular patients can be difficult. Although many patients are clearly identified as a result of taking a careful medical history, many patients are unaware of incipient problems. Even though the majority of dentists routinely take blood pressure

and pulse records, resting pulse rates, resting blood pressure records, and resting electrocardiograph records miss approximately 45% of latent cardiovascular problems [48].

Clinicians should avoid using epinephrine for gingival displacement because of the significant number of contraindications for the use of epinephrine and the uncertainty of any given patient's cardiovascular status. Other equally effective medicaments have no systemic manifestations and are preferred. Fortunately, the use of epinephrine for routine gingival displacement has decreased over the years. In 1985, 79% of dentists routinely used epinephrine for retraction [18]. A recent article indicated that routine use had declined to 25% of respondents [49].

## Techniques for gingival displacement

Gingival displacement can be accomplished using several different techniques. Common to all of them is the use of a retraction cord along with a chemical medicament. No clinical study has demonstrated the superiority of one technique over another, so the choice of which procedure to use depends upon the presenting clinical situation and operator preference.

### The single cord technique

The single cord technique is indicated when making impressions of one to three prepared teeth with healthy gingival tissues. It is relatively simple and efficient and is probably the most commonly used method of achieving gingival displacement.

1. Tooth preparation is accomplished and cervical margins are dropped carefully to their pre-determined intra-crevicular position.
2. A length of gingival retraction cord is selected to specifically match the anatomy of each individual gingival sulcus. The largest-diameter braided (First String; Clinician's Choice Dental Products, London, Ontario) or knit cord (Ultrapack Cord; Ultradent Dental Products, Salt Lake City, Utah) that fits in the sulcus should be used.
3. The cord is soaked in the medicament of choice (eg, Hemodent; Premier Dental Products, Norristown, Pennsylvania).
4. Excess medicament is blotted from the soaked cord with a sterile cotton sponge. The cord is carefully packed into the sulcus in a counterclockwise direction.
5. After the cord is in place, the tooth preparation is carefully inspected to ascertain that the entire cervical margin can clearly be visualized and that there is no soft tissue impediment to easy injection of the impression material to capture all of the cervical margin detail (Fig. 5). If there is excess soft tissue blocking easy access, it can be displaced with an additional small section of cord or excised with an electro-surgery unit or soft tissue laser (Fig. 6).
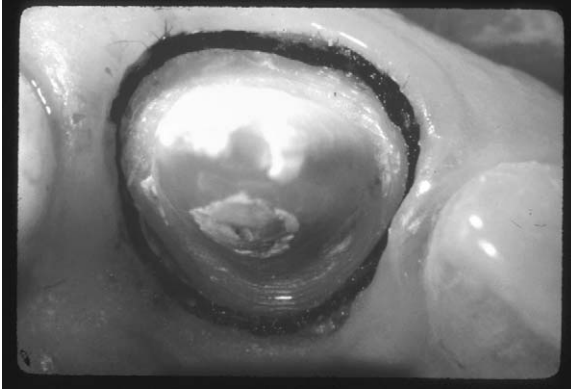
Fig. 5. After the cord is in place, the prepared tooth should be carefully examined to determine that the entire cervical margin can be visualized.

6. At this point it is critical to wait 8 to 10 minutes before removing the cord and making the impression. The cord needs time to effect adequate lateral displacement, and the medicament needs time to create hemostasis and crevicular fluid control.
7. Before removing the cord, the cord should be soaked in water to allow it to be easily removed from the sulcus. Removal of the cord when dry is traumatic and tears the inner epithelial lining and initiates hemorrhage [50].
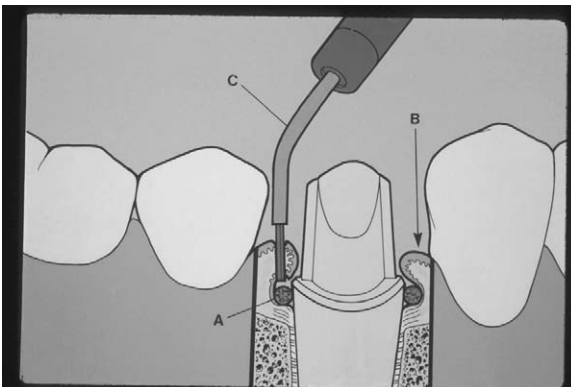8. The tooth preparation(s) should be gently dried and the impression made.



Fig. 6. If excess soft tissue obscures the prepared cervical margin, it should be removed using electro-surgery or a soft tissue laser.

*The double cord technique*

The double cord technique is routinely used when making impressions of multiple prepared teeth and when making impressions when tissue health is compromised and it is impossible to delay the procedure [20]. Some clinicians use this technique routinely for all impressions (Fig. 7).

1. A small-diameter cord (Deknatal 2/0 Surgical Silk Suture Material; J. Deknatal, Queens Village, New York) is placed in the sulcus. The ends of this cord should be cut so that they exactly abut against one another in the sulcus. This cord is left in the sulcus during impression making, and if the cord is too short (creating a space between the ends) or too long (creating overlapping ends), it may become impregnated into the
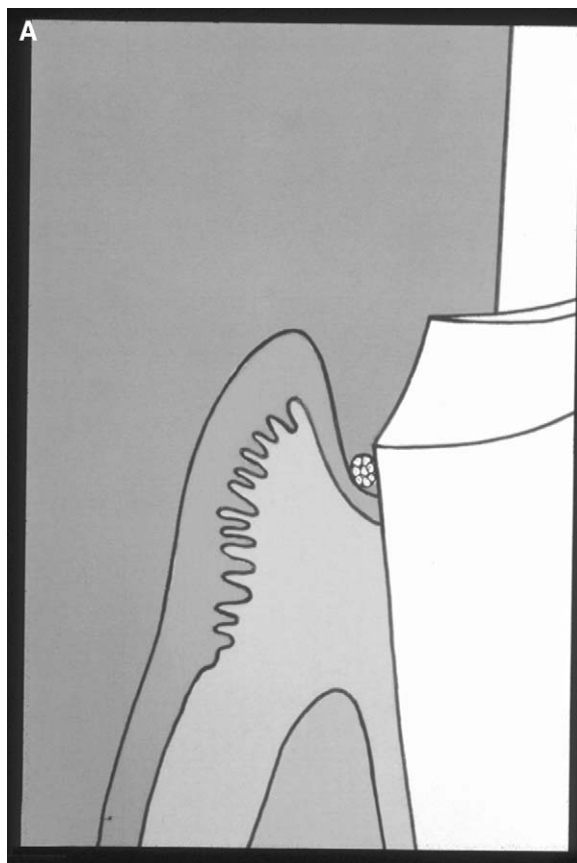


Fig. 7. With the double cord technique: (*A*) A small-diameter cord with no medicament is first placed in the depth of the sulcus. (*B*) A larger-diameter cord with the medicament is placed above the small-diameter cord. After waiting 8 to 10 minutes, the large-diameter cord is soaked in water and removed. The small-diameter cord is left in the sulcus during impression making.
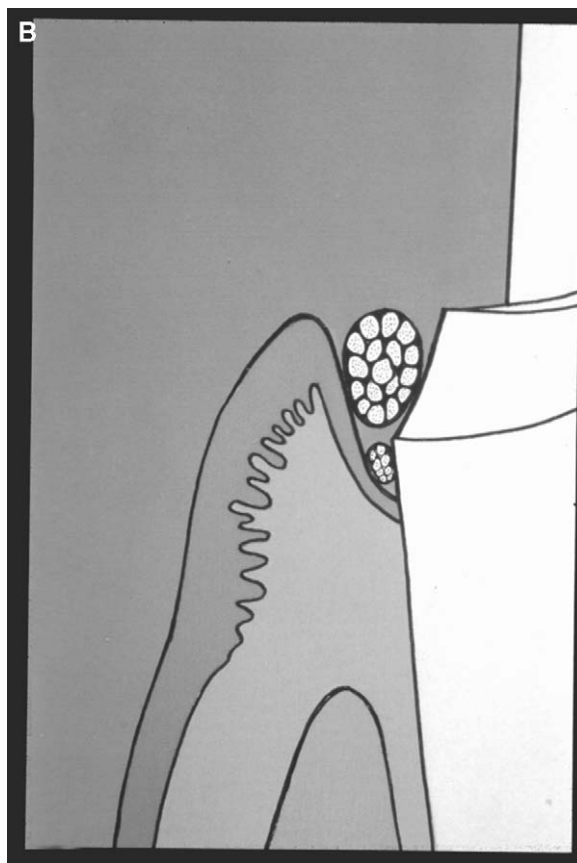
Fig. 7 (*continued*)

impression. This can create difficulties later in pouring the impression and trimming the dies.

2. A second cord, soaked in the hemostatic agent of choice, is placed in the sulcus above the small-diameter cord. The diameter of the second cord should be the largest diameter that can readily be placed in the sulcus.
3. After waiting 8 to 10 minutes after placement of the large cord, the second cord is soaked in water and removed. The preparation(s) are dried, and the impression is made with the primary cord in place.
4. After successfully making the impression, the small-diameter cord is soaked in water and removed from the sulcus.

This technique can be used with single or multiple preparations. It is especially useful with multiple preparations where gingival fluid exudate can seep over the prepared cervical margins of the last teeth to be impressed after cord removal.

*The infusion technique of gingival displacement*

The infusion technique for gingival displacement uses a significantly different approach from the single or double cord techniques [21].

1. After careful preparation of the cervical margins in an intra-crevicular position, hemorrhage is controlled using a specifically designed dento-infusor with a ferric sulfate medicament. Two concentrations of ferric sulfate, 15% (Astringedent; Ultradent Dental Products, Salt Lake City, Utah) and 20% (Viscostat; Ultradent Dental Products, Salt Lake City, Utah), are available. The 20% material is preferred because it is less acidic than the 15% solution and does not remove the smeared layer of dentin from the prepared tooth.
2. The infusor is used with a burnishing motion in the sulcus and is carried circumferentially 360° around the sulcus. The medicament is extruded from the syringe/infusor as the instrument is manipulated around the gingival sulcus.
3. When hemostasis is verified, a knitted retraction cord (Ultrapack Retraction Cords; Ultradent Dental Products) is soaked in the ferric sulfate solution and packed into the sulcus.
4. Advocates of this technique recommend leaving the cord in place 1 to 3 minutes.
5. The cord is removed, the sulcus is rinsed with water, and the impression is made.

In the opinion of the authors, this technique is effective in achieving hemostasis, but, because the cord is left in place for only 1 to 3 minutes, it may not provide adequate lateral displacement to permit an adequate bulk of impression material into the sulcus. It is not recommended that the cord be left in the sulcus for longer times because histologic data are not available to demonstrate that it is safe to do so.

The dento-infusor and the 20% ferric sulfate have proven to be an effective ancillary technique for control of hemorrhage when using the single cord technique. Occasionally, even with careful technique, isolated areas of bleeding may occur when the cord is removed from the sulcus. In such situations, the infusor and medicament can be used in the sulcus with firm burnishing pressure for approximately 15 seconds. This predictably controls hemorrhage.

When using ferric sulfate materials, patients should be forewarned that the tissues may be temporarily darkened. The tissues take on a blue-black appearance that usually disappears in a few days.

*The "every other tooth" technique*

When making impressions of anterior tooth preparations, it is critical that no damage is done to the gingival tissues that may result in recession. With teeth with root proximity, placing retraction cord simultaneously

around all prepared teeth may result in strangulation of the gingival papillae and eventual loss of the papilla. This creates unesthetic black triangles in the gingival embrasures.

This undesirable outcome can be prevented with the "every other tooth" technique. This can be used with the single or double cord technique. Retraction cord is placed around the most distal prepared tooth. No cord is placed around the prepared tooth mesial to this tooth. Retraction procedures are completed on alternate teeth. If, for example, teeth #5 through #12 are prepared, cords would be placed around teeth #5, #7, #9, and #11. The impression is made; gingival displacement is accomplished on teeth #6, #8, #10, and #12; and a second impression made. A subsequent pick-up impression allows fabrication of a master cast with dies for all eight prepared teeth.

## New materials

As with other procedures in restorative dentistry, a few relatively new products and techniques have been introduced. These include strips of a sponge-like synthetic polymer that expands after insertion into the sulcus. This material can theoretically be placed in the sulcus with no local anesthetic and thus results in minimal trauma [51,52]. Another material is supplied in a syringe and is designed be injected into the unretracted sulcus (Expasyl; Kerr Dental Products, Romulus, Michigan). Once in the sulcus it theoretically expands and provides displacement and hemostasis. The predictability and efficacy of these materials has yet to be established.

## Summary

Gingival displacement is an important procedure with fabricating indirect restorations. Gingival displacement is relatively simple and effective when dealing with healthy gingival tissues and when margins are properly placed a short distance into the sulcus.

The most common technique used with gingival displacement is use of gingival retraction cords with a hemostatic medicament. Retraction cords of sufficient diameter should be used to provide adequate lateral displacement to create a mean sulcular width of 0.2 mm. Epinephrine containing retraction cords should be avoided.

Several techniques have proven to be relatively predictable, safe, and efficacious. No scientific evidence has established the superiority of one technique over the others, so the choice of technique depends on the presenting clinical situation and operator preference.

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