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Gingival Retraction Techniques for Implants Versus Teeth: Current Status

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Current status

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ABSTRACT

JADA CONTINUING EDUCATION ARTICLE 3

Background. The authors reviewed and compared gingival retraction techniques used for implants and teeth.

Types of Studies Reviewed. The authors searched the literature using article databases Ovid MEDLINE up to May 2008, PubMED and Google Scholar (advanced search) and the following search terms: gingival retraction, implant abutment, impressions, cement-retained implant restoration, impression coping, peri-implant tissue, emergence profile and tissue conditioning.

Results. The authors found insufficient evidence relating to gingival displacement techniques for impression making for implant dentistry. Gingival retraction techniques and materials are designed primarily for peridental applications; the authors considered their relevance to peri-implant applications and determined that further research and new product development are needed.

Clinical Implications. The use of injectable materials that form an expanding matrix to provide gingival retraction offers effective exposure of preparation finish lines and is suitable for conventional impression-making methods or computer-aided design/computer-aided manufacturing digital impressions in many situations. There are, however, limitations with any retraction technique, including injectable matrices, for situations in which clinicians place deep implants.

Key Words. Gingival retraction; implant impressions; peri-implant tissue; tissue conditioning.
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Implant dentistry has seen rapid progress in recent years. Its increased use in the treatment of partially edentulous patients has led to two restorative techniques: screw-retained implant restorations, in which the fastening screw provides a solid joint between the restoration and the implant abutment or between the restoration and the implant; and cement-retained restorations, in which clinicians do not use screws but instead cement the restoration on a machined or customized abutment.

Cement-retained prostheses are the restoration of choice for many patients who receive implants for several reasons, including esthetics, occlusal stability, overcoming angulation problems and the fabrication of a passively fitting restoration.[1,2] Some investigators have suggested that the intervening cement layer can act as a shock absorber and enhance the transfer of load throughout the prosthesis-implant-bone system.[3,4]

There is, however, limited scientific documentation of the cement-retained technique compared with that for screw-retained technique.[5,6] The quest for predictable long-term results has raised questions about the materials used and the techniques followed in clinical practice. One question concerns gingival retraction techniques and their outcomes in implant treatment.

Several impression techniques are used in implant dentistry, and some require gingival displacement while making impressions. Others, such as the pickup impression technique, do not require any gingival retraction. For screw-retained implant restorations, most systems use mechanical components (impression copings) that can be adapted accurately and directly to the fixture head on the abutment shoulder. With cement-retained prostheses that use customized abutments, the pickup impression technique cannot be used owing to the unique contour of the abutments. Therefore, clinicians must use another technique such as the conventional crown and bridge impression or optical impression.

To ensure accuracy with polyvinyl siloxane impression materials, clinicians must maintain a minimum bulk of 0.2-millimeter thickness in the sulcus area,[7,8] which they can achieve by retracting the gingiva for at least four minutes before making the impression.[9,10] Rapid reclosure of the sulcus requires that clinicians make the impression immediately after removing the retraction material.[7,10]

Larger sulcus spaces than necessary for conventional crown and bridge impression techniques are needed when making digital computer-aided design/computer-aided manufacturing (CAD/CAM) impressions to ensure accurate recording of finishing lines.

Direct optical impressions are limited to line of sight, which is facilitated by performing gingival retraction to expose finish lines. Artifacts caused by retraction cord fibers that remain in the sulcus may affect the accuracy of optical impressions. Fifteen percent aluminum chloride in an injectable kaolin matrix leaves a clean sulcus, reducing the influence of artifact-generated errors.[11] However, the powders used when making optical impressions to reduce reflectivity and make tooth surfaces measurable can influence impression accuracy by increasing tooth surface thickness.[12]

Clinicians regard the indirect capture of digitized information as being potentially more accurate; however, the way in which clinicians can acquire data is influenced by the thickness of the impression material in the sulcus area.[11,12] Significant errors can result from thin impression margins with a radius less than the contacting probe tip.[12]

Donovan and Chee[13] described a variety of gingival displacement techniques, but we found no articles that specifically reviewed gingival retraction techniques in implant dentistry. Since the architecture of the gingival crevice surrounding natural teeth is different biologically from that around implants, we wanted to know if conventional retraction techniques could be applied safely to peri-implant tissue. In this article, we review the advantages and disadvantages of different gingival retraction techniques on peri-implant and peridental tissues.

METHODS

We conducted a literature search for articles about gingival retraction techniques used when making impressions of implant restorations. We noted that there was no literature on this subject, so we widened our search to include soft-tissue retraction techniques applicable to natural teeth.

We conducted the search using Ovid MEDLINE up to May 2008. The key words we used and the number of articles they generated were as follows: "gingival retraction" (130), "implant abutment" (237), "impressions" (7,242), "cement-retained implant restoration" (one), "impression coping" (22), "peri-implant tissue" (141), "emergence profile" (76) and "tissue conditioning" (326). Combinations of key words that yielded zero articles were "impressions" plus "cement retained implant restoration" and "peri-implant tissue" plus "emergence profile" plus "tissue conditioning." We searched further for relevant articles by using PubMED and Google Scholar (advanced search).

Considering the relative paucity of information on this subject, we considered all references to be a relevant contribution. If we had implemented a more rigorous selection protocol with tighter study inclusion criteria, we would have had few results.

COMPARISON OF PERIDENTAL AND PERI-IMPLANT TISSUE

There are substantial differences between the connective tissue structures surrounding teeth

ABBREVIATION KEY. CAD/CAM: Computer-aided design/computer-aided manufacturing. **CO_2:** Carbon dioxide. **Er:YAG:** Erbium:yttrium-aluminum-garnet. **Nd:YAG:** Neodymium:yttrium-aluminum-garnet.

TABLE 1

Comparison of peridental and peri-implant tissues.

PERIDENTAL TISSUE	PERI-IMPLANT TISSUE
Free gingival margin with buccal keratinized epithelium	Free gingival margin with buccal keratinized epithelium
Gingival sulcus apically limited by the junctional epithelium	Gingival sulcus apically limited by the junctional epithelium
Keratinized epithelium at the base of gingival sulcus	No keratinized epithelium at the base of gingival sulcus
Junctional epithelium adherent, less permeable, high regenerative capacity	Junctional epithelium poorly adherent, more permeable, low regenerative capacity
Cementum	No cementum
Gingival fibers inserting perpendicularly in the cementum	Gingival fibers running parallel to the implant collar
Biological width of at least 2.04 millimeters	Biological width of 2.5 mm ± 0.5 mm*
Periodontal ligament	No periodontal ligament
No direct contact between tooth and bone	Direct contact of implant to bone

* As shown in Ericsson and Lindhe.[14]

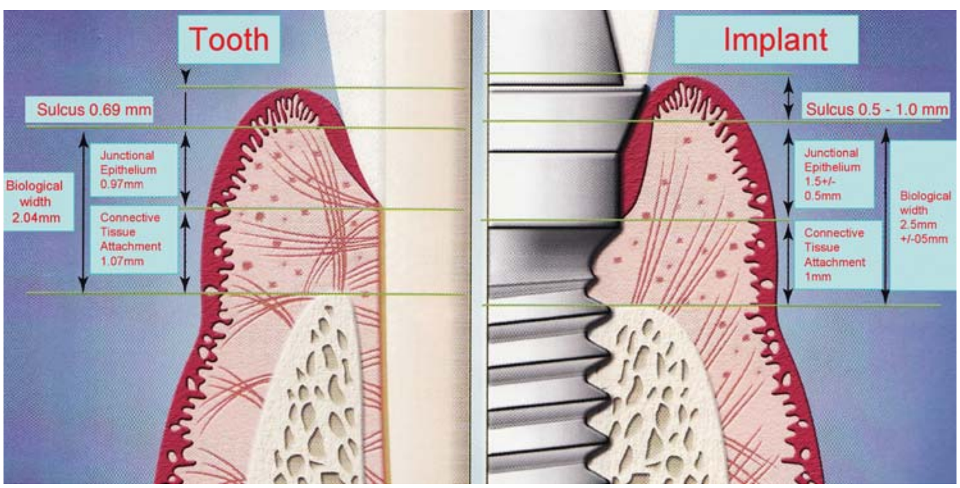

Figure 1. Comparison of peridental biological width and peri-implant biological width. mm: Millimeters.

and implants that affect the robustness of gingival tissues (Table 1[14] and Figure 1).

Peri-implant mucosa lacks keratinized epithelium at the base of the sulcus, which forms the junctional epithelium and has a hemidesmosomal attachment and internal basal lamina in the lower regions of the interface.[15,16] It adheres poorly to implant surfaces, is more permeable and has a lower capacity for proliferation and regeneration than does the junctional epithelium around teeth.[17]

Peri-implant mucosa consists of circumferentially running fiber bundles and fibers that run longitudinally to the implant surface. Most connective tissue fibers that surround smooth implants run parallel to the implant surface. The use of rougher implant surfaces encourages the attachment of fibrils to the implant surface, affecting the orientation of fibers adjacent to implants at varying angles.[15,16] The junctional epithelium is longer adjacent to machined implant surfaces (a mean of 2.9 mm) than it is to acid etch–conditioned implant surfaces (a mean of 1.4 mm) or oxidized surfaces (a mean of 1.6 mm).[15]

The junctional epithelium associated with natural teeth has a high rate of cell turnover, which occurs rapidly during the wound healing that takes place after penetration by a dental probe or while recovering from infection.[17] The rate of junctional epithelium cell turnover is twice that of oral gingival epithelium. At the base of the sulcus, the rate of exfoliation is as much as 50 times that of oral gingival epithelium, which, in effect, hinders bacterial colonization of the sulcus.

When the junctional epithelium that surrounds implants is exposed to trauma (such as during gingival retraction procedures), it is at greater risk of experiencing penetration damage than is the more robust sulcus of natural teeth. Pressure that is applied when clinicians apply retraction materials into the sulcus may cause considerable discomfort in patients; this is particularly true for patients with more vulnerable implant situations.

Another consideration that has a bearing on the ability of epithelial tissues to withstand chemomechanical manipulative procedures is the influence of the natural soft tissue biotype. In tissue hierarchy, teeth act as protagonists followed by soft tissue and bone topography. Clinicians associate a thin periodontal biotype with fragility that requires delicate management to avoid recession owing to tissue damage. Thick fibrotic biotypes are more resilient, and they have a tendency to form pockets rather than recede. Thus, a thick biotype is more conducive for implant placement.[14,18]

GINGIVAL RETRACTION TECHNIQUE

When making impressions for fixed prostheses, clinicians need to expose, access and isolate the abutment margins. Clinicians can record good impressions only if they meet these requirements. The precise reproduction of the abutment provides clinicians with crucial clinical information that allows them to fabricate exact-fitting, biointegrated restorations.[19] The aim of gingival retraction is to atraumatically allow access for the impression material beyond the abutment margins and to create space so that the impression material is sufficiently thick so as to be tear-resistant.[20] In peridental tissue, the fiber-rich, highly organized periodontal complex surrounding natural teeth provides support for gingival tissues when they are retracted, mitigating the collapse of the tissues when the retraction agents are removed before making the impression. The peri-implant fiber structure, however, does not provide the same level of support and is not able to prevent the collapse of retracted tissues to the same extent, which complicates attempts to successfully make impressions. This is particularly true in situations in which the depth of sulcus is greater than average, such as when an implant has been placed deeply.

Clinicians prefer that patients have a greater degree of soft-tissue support than that found around natural teeth when they retract soft tissues surrounding implants. Yet at the same time, clinicians need to ensure that the retraction forces are gentle since patients' peri-implant junctional epithelium is more fragile.

Deformation of gingival tissues during retraction and impression procedures involves four forces: retraction, relapse, displacement and collapse[21] (Figure 2).

Retraction is the downward and outward movement of the free gingival margin that is caused by the retraction material and the technique used.

Relapse is the tendency of the gingival cuff to go back to its original position. It is influenced by the elasticity or memory of the gingival cuff and by the rebound forces of adjacent attached gingiva that was compressed during retraction. When clinicians removed plain mechanical retraction cords, an inspection of the sulci using a miniature video camera determined that the sulci closed

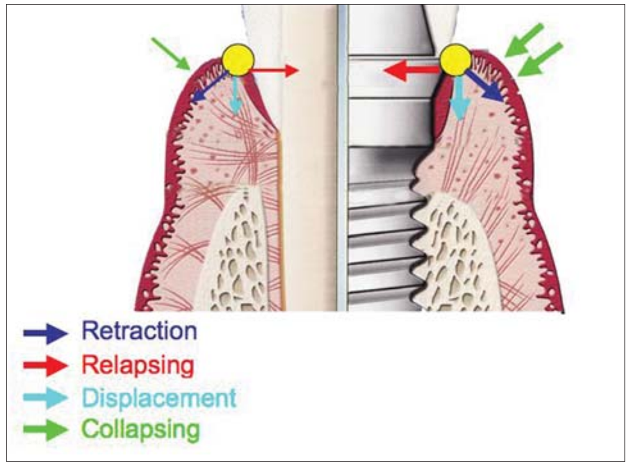

Figure 2. Force involved with retraction of peridental and peri-implant tissues.

within one minute of removal.[10] Sulci that have been retracted with medicated cords tend to remain open longer. A 0.2-mm sulcular width is necessary for there to be sufficient thickness of material at the margins of impressions so they can withstand tearing or distortion on removal of the impression.[7] The results of another miniature camera study showed that to achieve 0.2-mm crevicular width, the retraction cords needed to be in place for four minutes before making the impression.[9] Placing retraction cords for longer than this amount of time gained no further advantage, but placing the retraction cords for less time caused a significant effect. For example, if the clinician placed the cord for only two minutes, the sulcus width closed to 0.1 mm within 20 seconds after it was removed. Low-viscosity impression materials such as light-bodied "wash" type materials do not provide sufficient support to prevent this relapse.[22]

Displacement is a downward movement of the gingival cuff that is caused by heavy-consistency impression material bearing down on unsupported retracted gingival tissues.

Collapse is the tendency of the gingival cuff to flatten under forces associated with the use of closely adapted customized impression trays.[22]

Depending on the amount and duration of these forces, the gingival tissue may or may not rebound to its original position. The gingival tissue responds viscoelastically, and recovery time is much longer than the duration of the deforming force application. If too much trauma occurs and if the gingival tissue is too thin, irreversible alteration will take place.

Clinicians have adopted techniques that originally were designed for natural teeth for use in implant restoration situations despite significant differences between the tooth biosystem and the implant biosystem. Techniques that clinicians have refined to work well for teeth may not address the challenges faced by clinicians in implant dentistry. The following sections review the available retraction techniques for natural teeth and their potential application for implant restorations (Table 2).

Mechanical retraction. *Cord.* Clinicians place retraction cords by using cord-packing instruments; however, many commonly used hand instruments (such as the Hollenbach carver tip) were not designed for this application. The forces generated by pointed or wedge-shaped instrument tips may be traumatic to the relatively fragile junctional epithelium around implants, whereas gingival tissues may be more forgiving of this type of force. Some manufacturers make purpose-designed packing devices that have smooth, nonserrated circular heads that can be used to place and compress twisted cord with a sliding motion. Other manufacturers make devices with 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. There is no literature describing the use of cord-packing instruments, and the forces involved with cord placement remain undetermined.

Single-cord versus dual-cord technique. Retraction cords were developed for use with natural teeth. They provide more effective control of gingival hemorrhage and exudate when used in conjunction with medicaments than when used with no medicaments. The use of a single retraction cord often provides inadequate gingival retraction. The dual-cord technique in which the first cord remains in the sulcus reduces the tendency for the gingival cuff to recoil and partially displace the setting impression material.[23] Results from one survey showed that 98 percent of prosthodontists use cords, with 48 percent using a dual-cord technique and 44 percent using a single-cord technique.[24]

Placement of retraction cords can cause injury to the sulcular epithelium and underlying connective tissues,[25] as shown by the results of experiments involving dogs' teeth.[26] The filaments or fibers of conventional cords also may cause residual contamination of sulcal wounds, creating foreign body reactions and exacerbating inflammation.[27] Healing of the sulcus can take seven to 10 days.[26,28] Use of minimal force is necessary when packing cords to protect Sharpey fibers,[29] and application of excessive force is inappropriate because it may cause crevicular bleeding, gingival inflammation[30] and shrinkage of marginal tissues.[31]

Clinicians may place untreated plain cord safely in the sulcus for periods of five to 30 minutes,[26] but the pressure of cords alone will not control sulcular hemorrhage.[25] On removal, plain cords are associated with bleeding in more than 50 percent of situations, although wetting the cords before removal may help control the bleeding.[32]

Clinicians should question the use of cords around implants since the junctional epithelium is not as adherent, is more permeable and has a lower regenerative capacity than the junctional epithelium around teeth.

Chemomechanical retraction. *Chemicals with cord.* Epinephrine commonly is used to medicate retraction cords since it provides effective vasoconstriction and hemostasis during retraction.[33] It is, however, associated with significant local and systemic side effects, which investigators have reported occurring during 33 percent of applications.[24] Absorption at the sulcus interface is dependent on patients' gingival health.[34] Healthy gingiva acts, to some extent, as a barrier to absorption of epinephrine.[35] This may be 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.[36] Clinicians should avoid applying high concentrations of epinephrine to large areas of lacerated or abraded gingival tissues.[37] Patients who are susceptible to the effects of epinephrine may develop "epinephrine syndrome," which includes tachycardia, rapid respiration, increased blood pressure, anxiety and postoperative depression.[34,36]

A number of alternatives to epinephrine are used clinically, with varying benefits and drawbacks. Synthetic sympathomimetic agents that mimic the actions of epinephrine are more effective and safer than epinphrine.[38]

Aluminum sulfate and aluminum potassium sulphate act by precipitating tissue proteins with tissue contraction, inhibiting transcapillary movement of plasma proteins and arresting capillary

TABLE 2

Gingival retraction techniques and their application to implant dentistry.

RETRACTION METHODS	ADVANTAGES	DISADVANTAGES	USE IN IMPLANT DENTISTRY
Mechanical			
Cord (may be twisted, knitted or braided) Single-cord technique Dual-cord technique	Inexpensive Achieves varying degrees of retraction Can be used with chemical adjuncts	Painful Rapid collapse of sulcus after removal Risk of traumatizing epithelial attachment No hemostasis Placement is time-consuming Risk of sulcus contamination	Yes/No*
Chemomechanical			
Chemicals with cord			
Epinephrine	Hemostatic Vasoconstrictive	Systemic effects "epinephrine syndrome" Risk of inflammation of gingival cuff Rebound hyperemia Risk of tissue necrosis	No
Synthetic sympathomimetic agents	Hemostatic Vasoconstrictive More effective than epinephrine with the absence of systemic effects	Rebound hyperemia Risk of inflammation of gingival cuff Risk of tissue necrosis	No
Aluminum sulphate and aluminum potassium sulphate	Hemostasis Least inflammation of all agents used with cords Little sulcus collapse after cord removal	Offensive taste Risk of sulcus contamination Risk of necrosis if in high concentration	Yes/No
Aluminum chloride	No systemic effects Least irritating of all chemicals Hemostasis Little sulcus collapse after cord removal	Less vasoconstriction than epinephrine Risk of sulcus contamination Modifies surface detail reproduction Inhibits set of polyvinyl siloxane and polyether impressions	Yes/No
Ferric sulphate	Hemostasis	Tissue discoloration Acidic taste Risk of sulcus contamination Inhibits set of polyvinyl siloxane and polyether impressions	Yes/No
Chemicals in an injectable matrix			
Aluminum chloride with kaolin	Reduced risk of inflammation (injectable form) Nontraumatizing to junctional epithelium Hydrophilic Ease of placement Painless No adverse effects	Inhibits set of polyvinyl siloxane and polyether impressions More expensive Less effective with very subgingival margins	Yes
Inert matrix			
Polyvinyl siloxane	No risk of inflammation or irritation Nontraumatizing Ease of placement Painless No adverse effects	Limited capacity for hemostasis (no active chemistry) Less effective with subgingival margins	Yes
Surgical			
Laser	Excellent hemostasis—carbon dioxide (CO_2) laser safe for implants as reflected by metal Reduced tissue shrinkage Relatively painless Sterilizes sulcus	Neodymium:yttrium-aluminum-garnet laser contraindicated with implants Erbium:yttrium-aluminum-garnet laser reflected by metal but not as good at hemostasis as CO_2 laser CO_2 laser provides no tactile feedback, leading to risk of damage to junctional epithelium	Yes/No
Electrosurgery	Efficient precise hemostasis	Contraindicated with implant (risk of arcing) Gingival sulcus too small for two electrodes, impractical in implant dentistry	No
Rotary curettage	Fast Ability to reduce excessive tissue Ability to recontour gingival outline	Causes considerable hemorrhage Contraindicated with implants High risk of the bur damaging the implant surface Risk of tissue retraction exposing implant threads High risk of traumatizing the epithelial attachment	No

* Yes/No: Method could be used but is not recommended.

bleeding.[39] Both are hemostatic and retractive, which causes minimal postoperative inflammation at therapeutic concentrations,[33] although concentrated aluminum potassium sulphate solutions can cause severe inflammation and tissue necrosis.[40]

The action of aluminum chloride is similar to that of aluminum sulfate, which is an astringent that causes precipitation of tissue proteins[29] but less vasoconstriction than epinephrine.[35] Aluminum chloride is the least irritating of the medicaments used for impregnating retraction cords,[41] but it disturbs the setting of polyvinyl siloxane impression materials.[42]

Aluminum potassium sulphate– and aluminum chloride–medicated cords are more effective in keeping the sulcus open after clinicians remove the cord (10-20 percent of original opening eight minutes after the cord is removed) than are epinephrine-medicated cords (50 percent closure of sulcus observed over a similar time).[10] After 12 minutes, only sulci packed with aluminum chloride remained open at 80 percent of the original space created.[10]

Owing to its iron content, ferric sulfate stains gingival tissues a yellow-brown to black color for several days after a clinician has used it as a retraction agent.[20] The accuracy of surface detail reproduction during impressions can be modified by ferric sulfate, as it disturbs the setting reaction of polyvinyl siloxanes. Thus, it is important for clinicians to remove all traces of medicament from the tissues carefully before recording the impressions.[42]

The two main drawbacks of using chemicals with retraction cords are the occurrence of rebound hyperemia that often occurs after cord removal, which affects how effectively clinicians can make impressions,[43,44] and inflammatory reactions induced by these chemicals, which can affect the subepithelial connective tissue.[45] When clinicians consider all of these factors, they may question whether retraction cords are appropriate for use around implants, given the vulnerability of the junctional epithelium.

Chemicals in an injectable matrix. Injecting 15 percent aluminum chloride in a kaolin matrix opens the sulcus, providing significant mechanical retraction.[46,47] When compared with having a cord packed into the sulcus, an injection of 15 percent aluminum chloride in a kaolin matrix resulted in less pain for patients and was easier and quicker to administer.[48] Furthermore, its effectiveness in reducing the flow of sulcular exudate is similar to that of epinephrine-soaked cords.[49]

The use of 15 percent aluminum chloride in an injectable kaolin matrix is effective.[50] It also is safe, with the results of one study showing no reports of adverse effects.[51] Gingival recession associated with an injection of aluminum chloride into the gingival sulcus is almost undetectable.[52] The injectable matrix is hydrophilic and can be flushed away relatively easily from the gingival crevice.[46] As with any foreign materials introduced into the oral cavity, there remains a small risk of residues' persisting in the gingival crevice. The viscosity of the injectable matrix may not be enough to provide sufficient retraction for deeper subgingival preparations,[53] and aluminum chloride can inhibit the set of polyether and polyvinyl siloxane materials if clinicians do not rinse it away properly before making impressions.

The delivery of chemicals via an injectable matrix shows promise for peri-implant tissue retraction, because it preserves the gingival tissues with no risk of lacerating or inflaming the junctional epithelium. In patients who have deeply placed implants with subgingival margins, however, its value may be somewhat limited by the extent to which such matrices are able to retract effectively.

An inert matrix. A polyvinyl siloxane material for gingival retraction was introduced in 2005. It works by generating hydrogen, causing expansion of the material against the sulcus walls during setting. The manufacturer has reported advantages including gentle placement without need for local anesthetic, visibility in the sulcus due to its bright color, ease of removal and absence of the need for hemostatic medicaments. Potential drawbacks are that it may not improve the speed or quality of retraction obtained and that it likely is less effective with subgingival margins. Clinicians place deep implants with subgingival margins relatively frequently since implant placement is dictated largely by the location of available bone.

Surgical retraction. *Lasers.* Compared with other retraction techniques, diode lasers with a wavelength of 980 nanometers and neodymium: yttrium-aluminum-garnet (Nd:YAG) lasers with a wavelength of 1,064 nm are less aggressive, cause less bleeding and result in less recession around natural teeth (2.2 percent versus 10.0 percent).[54]

Lasers' properties largely depend on their wavelength and waveform characteristics. The use of Nd:YAG lasers is contraindicated near implant surfaces, because they tend to absorb energy, which causes them to heat up and transmit the heat to bone, owing to the effects of this laser's wavelength on metal.[55] There is also a tendency for Nd:YAG lasers to damage the fragile subjunctional epithelium at the sulcus base around implants.

Erbium:yttrium-aluminum-garnet (Er:YAG) lasers with a wavelength of 2,940 nm are reflected by metal implant surfaces and minimally penetrate the soft tissues, so they are relatively safe to use. The hemostasis achieved with the Er:YAG laser, however, is not as effective as that achieved with the carbon dioxide (CO_2) laser.[55]

The prime chromophore of the CO_2 laser, which has a wavelength of 10,600 nm, is water, and it reflects off metal surfaces. When used near metal implant surfaces, CO_2 lasers absorb little energy, with only small temperature increases (< 3°C) and minimal collateral damage. CO_2 lasers do not alter the structure of the implant surface.[55]

Surgical wounds created by lasers heal by secondary intention, and incision lines show disorganized fibroblast alignment. This reduces tissue shrinkage through scarring, which helps preserve gingival margin heights.[31]

Visualizing the action of laser beams is difficult, owing to the plume of coolant water. So, there is the potential for attached gingiva to be obliterated when lasers are used for retraction purposes, since clinicians receive virtually no tactile feedback. Although there is a hemidesmosomal attachment around implants that creates a biological seal, the attached gingiva serves as a barrier that prevents exposure of the implant body over time through recession.

There are many advantages to using CO_2 lasers, but their method of exposing implant margins is to create a trough by excision rather than by displacing soft tissue. Therefore, their use may not be practical around deeply placed implant fixtures where a large defect could result. In addition, in anterior applications in which esthetics is critical, it may not be desirable to create a trough around the margins, as it may have a detrimental effect on patients' appearances.

Although CO_2 lasers may be significantly useful in some implant impression situations, they are invasive, thus failing to meet the ideal objective of a truly conservative technique.

Electrosurgery. Clinicians can use electrosurgery effectively to widen the gingival sulcus around natural teeth before placing the cord and to provide hemostasis by coagulation. However, electrosurgery is not recommended around implants because there is significant risk that the contacting electrode may arc by conducting electric current though the metal implant structure to the bone rather than via the more dispersive gingival tissue pathway. The concentrated electrical current at the tip of electrodes can generate heat, which may cause osseous or mucosal necrosis.[56]

Rotary curettage. Rotary curettage involves the use of a high-speed turbine to excise the gingival tissue quickly and create a trough around the margins. For healthy, disease-free tissue around natural teeth, rotary curettage has little effect on gingival margin heights if adequate keratinized gingiva is present,[57] although slight deepening of the sulcus may result.[58] However, rotary curettage is inappropriate for use around implant restorations because of poor tactile control when cutting soft tissue, which could lead to bur contact damage to the implant surface and overinstrumentation. The absence of keratinized gingiva at the base of the gingival sulcus surrounding the implant could lead to an exaggerated response to rotary curettage, including deepening of the sulcus and gross recession.

DISCUSSION

The mechanical retraction of gingival tissues by using cords around implant restorations can lead to ulceration of the junctional epithelium. Retraction cords were developed for application around natural teeth where the junctional epithelium is robust. The forces used in cord placement are likely to exceed peri-implant tissues' capacity to resist them. The resulting laceration of the sulcal epithelium will break down, causing ulcerations with delayed healing. Once patients' gingival epithelial structure is damaged, there is significant risk of permanent recession and loss of attachment developing. Thus, the use of mechanical retraction with cords may be contraindicated around implants, except in situations in which patients' sulcus depths are shallow, their mucosal health is impeccable and a robust, thick periodontal biotype is present.

The addition of chemical adjuncts to retraction cords further complicates the situation and may lead to increased inflammation of the subsulcular tissues. If the delicate junctional epithelium around the implant restoration becomes damaged during cord placement, the lacerated sulcus provides reduced protection against the penetration of chemicals into deeper subepithelial cell layers and against systemic dissemination when the vascular bed is exposed. All chemical agents used for gingival retraction are irritants, and study results demonstrate their adverse effects on peridental tissues.[26,32,36,37,40,51] Little is known about the effects of these same chemicals when they are placed into peri-implant tissues.

Clinicians often choose to perform surgical procedures because they are able to, the procedure can be performed rapidly and hemostasis is achievable. Surgical retraction procedures, however, are destructive and involve excision of tissue. This may be acceptable around natural teeth, as the results of studies have supported using electrosurgery, lasers and rotary curettage.[54,56-58] Evidence does not support the use of such destructive procedures in the implant situation.[31,55] Peri-implant mucosa does not have the same capacity for regeneration as peridental mucosa. The correct use of lasers with appropriate wavelengths may be applicable in some, but not all, implant situations during retraction and when making impressions.

Using an injectable matrix for gingival retraction offers clinicians the opportunity to perform an atraumatic procedure. There is no risk of laceration when clinicians introduce materials such as 15 percent aluminum chloride in a kaolin matrix into the sulcus surrounding natural teeth. 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. 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.[48,52]

The atraumatic application of an injectable matrix is not without its limitations. The viscosity of the injectable matrix limits the force of retraction offered, and, while this protects the implant sulcus from the trauma of overpacking, it may not offer sufficient retraction for situations that are unique to implant dentistry in which the relapsing and collapsing forces are important. Deeply placed implants often are associated with an increased sulcus depth compared with that found around natural teeth; this is reflected by the greater "biologic width" that is observed. It is not always possible to avoid deep placement of implants as this is dictated by patients' bone morphology.

Although injectable matrices are promising as a gingival retraction technique for implant situations, further development is needed. Compared with research on implant fixtures, there is relatively little research to guide clinicians regarding how to restore implants[59] and about which gingival retraction techniques to use around implant abutments.

In the meantime, the use of techniques developed by clinicians for natural teeth will continue. Further research exploring the uniqueness of the implant restoration situation and investigating the effect of these conventional techniques on the peri-implant tissue is needed.

CONCLUSION

The literature concerning gingival retraction for impressions in fixed prosthodontics is extensive. By contrast, little has been published about the challenges presented by the unique anatomy surrounding implants. As implants become mainstream treatments for tooth loss, this topic will warrant further research. ■

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