Supracrestal tissue esthetic management (STEM) technique and current approaches in restorative and surgical treatment of deep margins

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Abstract

Carious lesions with deep margins represent a challenge in daily clinical practice. The following key points are discussed in this article: how to manage a deep margin from a restorative point of view; when and how to perform a surgical procedure; and when it is favorable to carry out definitive restoration work after surgery. The restorative materials and adhesive procedures available today allow minimally invasive techniques to be used on dental tissue with a high preservation of tooth structure. These materials and techniques help to avoid adverse periodontal tissue reactions. Depending on the clinical situation, three treatment options are available when dealing with a subgingival margin. If the depth of the cavity margin is at a maximum distance of 1.5 mm below the gingival margin, isolation with rubber dam allows the performance of interproximal margin relocation, thereby facilitating optimal restoration and periodontal tissue integration. If the margin is located deeper than 1.5 mm below the gingival margin, surgery is necessary before any restorative work can take place. When the margin is within 2 mm above the bone crest, a supracrestal tissue esthetic management (STEM) procedure is undertaken, which means that no ostectomy is required and only osteoplasty is necessary to reshape the preexisting supracrestal attachment, thereby allowing the restorative work to proceed. When the margin is less than 2 mm above the bone crest, crown lengthening with minimal ostectomy and subsequent osteoplasty becomes necessary.

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Introduction

In day-to-day clinical practice, the clinician frequently encounters deep carious lesions with margins that invade the periodontal tissue.[1] The correct choice of treatment plan is crucial to success in such cases; however, this choice is often difficult due to the scarcity of clinical protocols and the lack of consensus regarding the optimal method of restoration.[2] In fact, such clinical situations present a great challenge, and very often it is necessary to substitute previous restorations, with their incongruous margins and secondary carious lesions. Consequently, it is important to choose the right treatment plan to restore these cavity margins perfectly and avoid tooth loss.[3] In such clinical situations, it is important to manage two different problems: one of a biologic nature and the other of a technical one.

Biologic problems are linked to the risk of invading the periodontal tissue with the restoration work, while technical ones are concerned with the difficulty of managing very deep cavity margins located below the gingival margin, both from the point of view of perfect isolation and in terms of the adhesive procedure, reconstruction and, in the case of indirect work, impression taking and cementation. These critical issues are mainly related to the difficulty of obtaining perfect isolation to avoid potential contamination by saliva and crevicular fluid. In fact, isolation and accessibility of the cavity are key points in any restorative protocol. Among the different isolation options, many authors[4-8] recommend the use of rubber dam to obtain perfect moisture control, especially when applying adhesive procedures, and even more so in the presence of deep margins, where the risk of contamination is higher.

When it is impossible to obtain perfect rubber dam isolation, it is necessary to carry out a combined surgical–restorative approach to lengthen the clinical crown. In this way, it will be possible to execute each single restorative phase under isolation as well as the adhesive procedure and reconstruction of the deep cervical margin, while at the same time safeguarding the periodontal tissue.

Owing to the development and availability of materials today and the deeper knowledge of the behavior of the periodontal tissue, it is possible to treat complex restorative cases with techniques that are minimally invasive from both a surgical and restorative point of view.

Supracrestal attachment system

According to the latest (2017) world workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions,[9] the biologic width – a commonly used clinical term to describe the variable apicocoronal dimensions of the supracrestal attachment tissue – should be replaced by supracrestal tissue attachment. The supracrestal tissue attachment is histologically composed of the junctional epithelium and supracrestal connective tissue attachment, with tissue that extends from the bone crest to the gingival margin. According to Schimdt et al,[10] these tissue dimensions may vary between individuals.

The junctional epithelium adheres to the root surface through the hemidesmosomes; however, its adhesion capacity is non-specific in that it allows the connection of the epithelium to any smooth and polished surface[11] and has a variability range of 1 to 9 mm.[12]

In healthy periodontium, the periodontal probe penetrates the coronal part of the junctional epithelium, stopping at the most apical portion where the density and layers of epithelial cells are greater, and without penetrating the connective tissue.

The supracrestal connective tissue attachment is made up of collagen fibers that connect solely to the root surface on one side and the connective tissue on the other. The dimensions of this tissue have an extremely narrow range of variability, from 0.29 to 1.84 mm.[12]

It is widely recognized that the connective tissue attachment must be respected when performing restorative procedures, otherwise there may be an inflammatory response of the periodontium owing to a potential accumulation of microbial biofilm on the subgingival restoration margin.[13] Clinically, this reaction leads to gingivitis or periodontitis, resulting in loss of attachment, periodontal pockets, bleeding, edema, and gingival recessions.[14]

A number of questions therefore arise. How does periodontal tissue behave in contact with the material used for the reconstruction of the deep cervical restoration? In light of current knowledge and available materials, how does one choose between margin relocation procedures and clinical crown lengthening surgery? What is the best surgical procedure?

Behavior of composite restoration materials in subgingival areas

There is relatively little scientific data available regarding the reaction of periodontal tissue to different materials, and many studies that have been conducted discuss materials that are no longer in use. In the past, studies have shown a higher Plaque Index around margins reconstructed with composite materials as opposed to a healthy enamel surface as well as more pronounced gingival inflammation. There were no differences found between conventional, hybrid or microfilled composites.[15]

Recently, several experimental studies have shown no significant differences in terms of plaque accumulation between healthy enamel, glass ionomer, and composite.[16-19] Interestingly, most of the composites used in these studies are no longer available, and the materials used today are undoubtedly superior in terms of their adhesion, polishability, and mechanical properties.

In a study by Martins et al[20] conducted on dogs, a flap was raised. A cavity was then created that was restored with composite and glass ionomer, upon which the flap was then sutured. A comparison was then undertaken with zero-cavity control cases. It is important to note that, in most of these samples, epithelium was formed along the entire restoration, and during healing the bone crest grew back in a coronal direction up to 0.37 mm from the apical margin of the restoration, thereby demonstrating evident biocompatibility of the composite resins that were used. These materials appear to have been tolerated in the subgingival area, given their good adaptation to the cavity walls, the careful finishing and polishing of the restorations before flap closure, and the attention paid to bacterial plaque control during the experiment.

In 2014, Comuzzi et al[21] demonstrated similar results in humans. These authors treated a recession associated with a non-carious cervical lesion with a compomer restoration, then a subsequent connective tissue graft (CTG) and a coronally advanced flap. Histologic examination after a block biopsy showed a long epithelial attachment on most of the restoration. The most apical portion of the restoration was covered with parallel fibers of connective tissue, which suggested connective adhesion on the restorative material. These histologic results seem to confirm the conclusions of previous studies.

In 2007, Santos et al[16] performed coronally advanced flaps on roots restored with glass ionomer or microfilled composite,

and on healthy roots in the control group. At 6 months, there was no difference regarding the pocket depth between the test and control groups.

In 2009, Santamaria et al[22] conducted a randomized controlled clinical trial and made the same comparison with a nanofilled composite on canines and premolars, with a follow-up of 12 months. The results showed a comparable percentage of root coverage. The composite restorative group showed a slightly greater pocket depth than the CTG (alone) group, while all other periodontal parameters showed no significant difference. Likewise, similar results were obtained by Konradsson and van Dijken[18] in a study inducing experimental gingivitis in humans: concentrations of the inflammatory marker Interleuken-1 were analyzed in crevicular fluid around composite or calcium aluminate cement restorations on Class V cavities, compared with healthy enamel. Again, no difference was noted between the two materials in healthy gums or under experimental conditions of gingivitis. Therefore, even in the presence of gingivitis, these materials do not appear to be a factor affecting increased crevicular fluid production or peripheral inflammation.

Consequently, in all situations in which very deep cervical margins might be reconstructed, the interaction of the periodontal tissue with the restorations could lead to another type of biologic width. In fact, compared with periodontal tissue on a healthy tooth, a longer junctional epithelium on the restorative margin could be obtained as well as a smaller connective attachment on the root cement below the restoration margin.[23]

It should be emphasized that no true periodontal attachment can be obtained on the restorative material other than the junctional epithelium.

Restorative or surgical approach?

The reconstruction of interproximal cavities on posterior teeth presents many clinical complexities, including limited access, the challenge of isolation, management of the adaptation of the material, and the difficulty of obtaining an adequate interproximal morphology. All of these are risk factors for secondary carious lesions and the onset of periodontal problems.[24] There are several treatment options in these situations: interproximal margin relocation (IMR), surgical crown lengthening, orthodontic extrusion,[25] and surgical extrusion.[26] These options must then be adapted to each clinical situation.

Orthodontic and surgical extrusion are used in those situations where a severe loss of cervical dental tissue has taken place around the tooth and a sufficient ferrule is necessary[27] to ensure the longevity of the restoration in terms of fracture resistance.[28]

In clinical situations in which any margins to be reconstructed involve only the interproximal area or limited areas of the tooth, the treatment options to be considered are either a restorative approach with margin relocation, or a surgical approach that allows restorative work. In fact, the presence of an adequate amount of healthy residual dental structure allows a partial restoration, which is more conservative and advantageous in terms of biomechanical reinforcement of the tooth over time.[2,29,30]

Figure 1 shows a decision-making process to assist in the choice of procedure.

Interproximal margin relocation (IMR)

The objective in restoration is to obtain a correct emergence profile and contact point in every clinical situation, whereas surgical work aims at reestablishing the supracrestal attachment system, even more so in cavities with deep subgingival

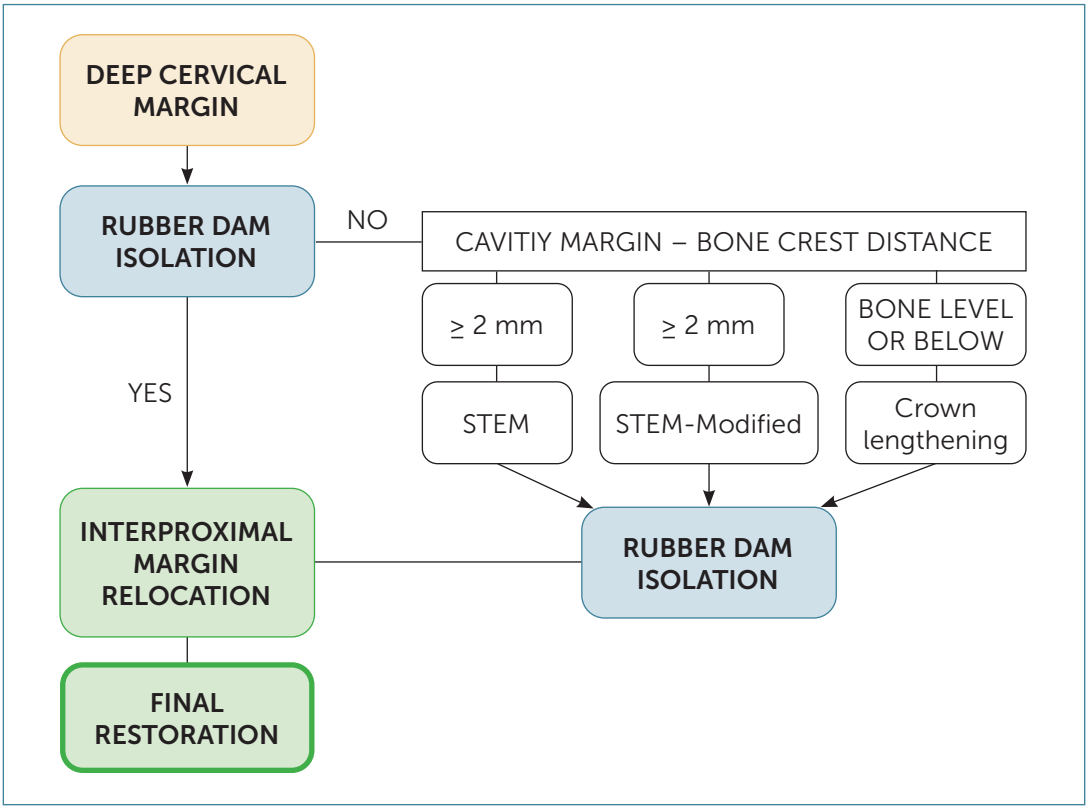

Fig 1 Decision tree: How to choose the best approach.

margins.[24] This is one of the key points to consider when choosing between an exclusively restorative approach with margin relocation or a surgical approach, because the clinician needs to be able to apply all of the procedures to be discussed effectively in order to allow accurate interproximal morphology.

Isolation is possible if the margin is located at a maximum of 1.5 mm below the free gingival margin; therefore, in the junctional epithelium area (Fig 2). This consideration is merely technical/operative in nature; in fact, in the present authors' experience, the correct isolation of the margin to be reconstructed would be less reliable on a more apical margin.

When faced with carious lesions with deep margins (Figs 3 and 4), total rubber dam isolation (Fig 5) determines whether or not surgery should be performed before the restorative treatment, with the confidence

Fig 2 Deep cervical margin in the junctional epithelium area, 1.5 mm below the gingival margin.

Fig 3 Two large carious lesions on teeth 14 and 15: occlusal view.

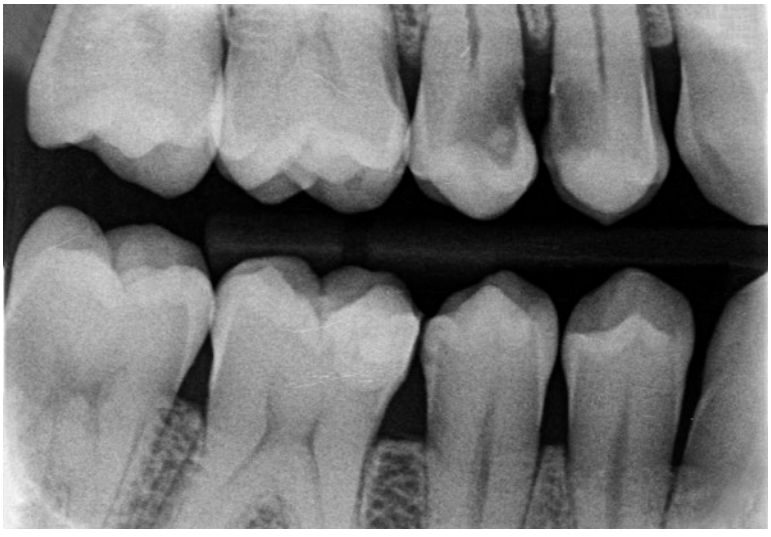

Fig 4 Radiograph showing the two large carious lesions on teeth 14 and 15, affecting the pulp tissue.

Fig 5 Deep margins isolated with rubber dam.

that periodontal tissue health will not be undermined.[31]

Once it is completely certain that surgery is not necessary, the clinician may proceed with IMR. This technique, first described by Dietschi and Spreafico,[32] is used for managing cavities with deep cervical margins. It involves reconstructing the subgingival cavity margins coronally, thereby making the restorative procedure easier. The procedure was first termed cervical margin repositioning (CMR) and was subsequently renamed deep margin elevation (DME) by Magne and Spreafico.[33] It involves rubber dam isolation and the positioning of a circular matrix on the deep cervical margin to reconstruct the cervical margin so as to reposition it juxta- or extragingivally.

Over the past two decades, this technique has been utilized and analyzed by a number of authors.[23,34-38] Its main clinical aims are to facilitate adhesive restorations in difficult access areas, encompassing the benefits of immediate dentin sealing (IDS), and facilitate direct or indirect adhesive restorations of cavities with margins located beneath the gingival tissue. A systematic review by Kielbassa and Philipp[37] on proximal box elevation showed that the DME technique was successful at maintaining clinically acceptable margins.

Another recent study[39] demonstrated that CAD/CAM-cemented restorations on cementum margins, with large occlusogingival ceramic inlay heights, were significantly less resistant than cemented restorations on the composite relocated margins. This finding demonstrates a potential additional benefit of IMR beneath ceramic indirect restorations, being that the coronal reconstruction of the deep cervical margin with a direct composite reconstruction inherently shortens the occlusogingival height of the proximal portion of the indirect restoration. Moreover, in 2020, Grubbs et al[40] showed that composite resin on deep margins has

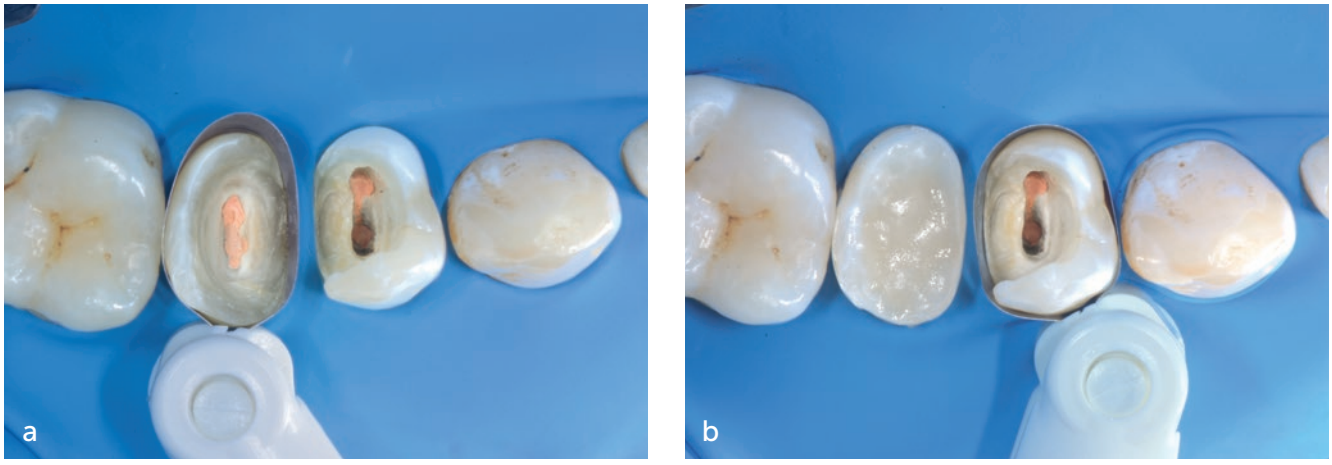

Fig 6 A circular matrix adheres closely around the cervical margins of tooth 15 (a) and 14 (b) without the use of an interdental wedge so as to relocate the margins with a direct reconstruction by applying flowable composite. The buildup is completed with packable composite.

the ability to absorb and transfer energy more effectively than ceramic, resulting in less stress at the tooth–restoration margins. In addition, the IMR technique allows the increase of the marginal adaptation of Class II restorations, reducing the incidence of secondary caries.[41]

When deep margins have to be treated, perfect rubber dam isolation is crucial (see Fig 5), thereby allowing the treatment plan to be confirmed, and exclusively restorative therapy to proceed without the need for any surgical intervention.

In order to facilitate subsequent work (impressions and isolation for cementing) and to better manage the deep margins from an adhesive, restorative, and finishing point of view, the most coronal cavity margin is relocated to a juxta- or extragingival position. This involves the use of a circular matrix (Omni-Matrix; Ultradent) that isolates the cervical margin without using an interdental wedge (Fig 6). It should be taken into account that, in these situations, the positioning of an interdental wedge would be very difficult if not impossible, given the position of the margins and the interdental space, and would create the risk of an incongruous emergence profile morphology. Also important and fundamental is the correct choice of adhesive protocol: either an etch-and-rinse or a self-etch adhesive system, of which an etch-and-rinse three-step adhesion system is to be preferred, thereby allowing highly beneficial and preferable IDS after the cavity preparation, as described by numerous authors.[32,33,36,42,43] However, when the enamel is thin, selective enamel etching is difficult to achieve without the risk of inadvertently over-etching the adjacent dentin;[44,45] a suggested clinical 'compromise' is to condition such thin enamel, together with the dentinal tissue, for no more than 15 s. Alternatively, a two-component self-etch system can be used without prior selective enamel acid etching.[46]

Which composite materials should be chosen?

In 2020, Julosky et al[47] and Grubbs et al[40] showed that both flowable and traditional packable restorative composites could be selected for the IMR technique. Another study examining the performance of flowable and conventional packable composite reported no significant difference between the two different viscosity composites in terms of microleakage.[48] The use of flowable composite resins has been advocated to improve the marginal adaptation of IMR restorations (with decreased microleakage and fewer gaps).[49,50] Therefore, highly filled flowable composites are recommended in IMR procedures owing to their consistency and ease of use.[36,51]

Following the present authors' protocol, the relocation of the cervical margins to a supragingival level is carried out with a direct reconstruction by applying a 1.5-mm layer of flowable composite material. The thickness of the composite is limited to the minimum needed to position the preparation supragingivally (usually about 1.5 mm), to control polymerization stresses and optimize marginal adaptations while creating an ideal restoration emergence profile. Immediately thereafter, the buildup can be completed with packable composite layered at 2 mm. Analyzing the residual dental structure, it is important to create an optimal preparation design[52] (Figs 7 and 8) so as to strengthen the tooth from a biomechanical point of view.

Relocation offers a number of advantages, including allowing accurate impression taking (Fig 9) to easily achieve isolation for the cementation (Fig 10) and for the possibility of checking the accuracy of the margin, as well as finishing and polishing, all of which are essential for periodontal health (Figs 11 and 12).

From a periodontal perspective, subgingival restorations are demonstrably compatible with gingival health, provided that the biologic width has been respected, along with rigorous follow-up care (Figs 13 and 14). In particular, in 2020, Bertoldi et al[31] carried out a clinical and histologic study on 29 patients, each of whom had a tooth that needed subgingival restoration. A margin relocation procedure with composite resin was applied. The full-mouth plaque score, full-mouth bleeding score, and periodontal probing depth were measured at baseline, immediately before margin relocation, and after 3 months. At 3 months, the tip of the periodontal probe stopped at a more coronal point than the most apical margin of the reconstruction, thus suggesting the formation of an epithelial junction on the restorative margin, together with an improvement in the periodontal indices, thereby leading to the conclusion that subgingival restorations were more compatible with gingival health and presented periodontal conditions similar to those of untreated root surfaces. The authors of that study[31] emphasize the absolute necessity of rubber dam isolation when performing this restorative procedure.

Supracrestal tissue esthetic management (STEM) technique

In restorative treatments of deep cervical margins located close to the connective attachment area (Fig 15) in which correct rubber dam isolation cannot be achieved, a surgical approach that allows restoration of the tooth is necessary (Figs 16 and 17). In fact, the positioning of a restorative margin in the area of the junctional epithelium will allow the latter to adhere, as previously mentioned, to the perfectly polished and finished composite and ceramic restorative materials. Accordingly, it is to be deduced that the only area that must not be compromised is that of the connective attachment,

Fig 7 Preparations are finished and polished to provide an ideal taper.

Fig 8 Interproximal margin relocation and final preparation on tooth 14 and 15: buccal view.

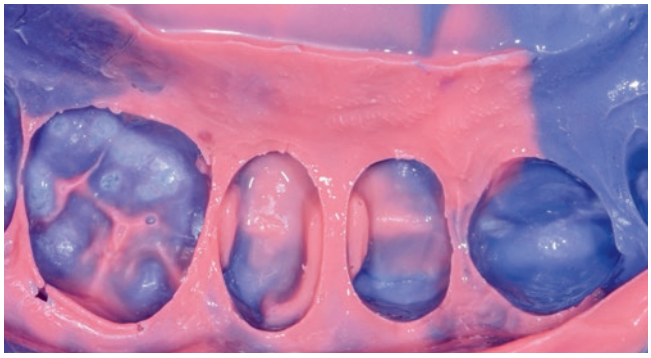

Fig 9 Final polyether impression.

Fig 10 Overlay cementation with heated composite.

Fig 11 Indirect restoration immediately after cementation: occlusal view.

Fig 12 Radiograph after 2 years.

Fig 13 Two-year follow-up: occlusal view.

Fig 14 Vestibular view at baseline (a) and after 2 years (b). After 2 years, good stability can be seen as well as good integration between the periodontal tissue and the restoration, with the development of the interproximal papilla, in comparison with baseline.

which is specific and can only connect to the root cement.

When a restoration invades the connective attachment space, an inflammatory reaction occurs involving the production of prostaglandins and inflammatory cytokines, the activation of osteoclasts that reabsorb the bone, and the release of free cement for the formation of fibers that are inserted more apically; hence, the apical migration of the entire supracrestal attachment apparatus.[13,53,54] The inflammatory reaction occupies an area of about 1.5 mm in diameter.[55] If the thickness of the bone is less than 1.5 mm, an even horizontal bone reabsorption will be expected; however, if it is more than 1.5 mm, resorption will only occur for that width (1.5 mm) and, consequently, a pocket with a vertical defect will be formed.[56]

In all these clinical situations, a crown lengthening procedure is used to access the subgingival cavities so as to expose the margins, reconstruct them correctly, and avoid compromising the periodontal tissue.[57] In a traditional surgical approach, ostectomy necessarily entailed compromising adjacent alveolar bone[58] and provoking problems with esthetics and root hypersensitivity after healing.[59]

Following the aforementioned biologic considerations, a more conservative approach is presented here, which allows the clinician to carry out restorative work, maintain periodontal health, and, simultaneously, ensure an excellent esthetic result, with the objective of not modifying the soft tissue level after healing. In this way, the formation of interproximal black triangles may be avoided, which compromise esthetics, promote food impaction, and make oral hygiene procedures more difficult. This approach, called supracrestal tissue esthetic management (STEM), aims at thinning the bone and soft tissue to achieve a spontaneous clinical crown lengthening without

Fig 15 Deep cervical margin more than 1.5 mm below the gingival margin.

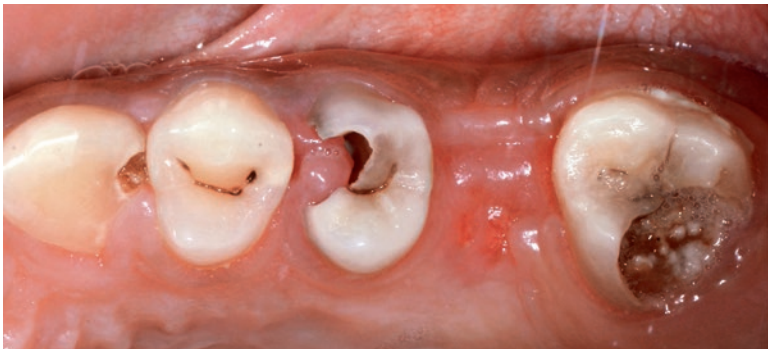

Fig 16 Deep carious lesions on teeth 15 and 17, invading both the endodontic and periodontal space.

Fig 17 Radiograph showing the deep carious lesions on teeth 15 and 17.

ostectomy in the posterior interproximal area,[60] providing ideal conditions for periodontal tissue healing in such a way as to reestablish a healthy connective space and gingival margin stability. For the STEM technique, the presence of at least 2 mm is required between the clean cavity margin and the bone crest. In fact, the reduced bone and soft tissue thickness are determining factors in crown lengthening, avoiding pocket formation. Therefore, Zucchelli et al[60] consider that the most significant surgical steps in this procedure are split thickness surgical papilla elevation, thinning of the palatal flap, and osteoplasty (reduction of the buccolingual dimension of the bone), together with root planing up to the bone crest and apical positioning of the flap in order to obtain clinical crown lengthening even without surgical ostectomy. Consequently, invasive ostectomy is avoided and osteoplasty is performed in all cases to thin

Fig 18 Vestibular flap.

Fig 19 Vestibular flap: clinical image.

the vestibular and lingual sides of the interproximal bone crest in the area in question. In this way, unnecessary loss of attachment[62] is avoided, thereby leaving the possible reabsorption of the most coronal portion of the bone crest to the natural biologic healing process in terms of the reestablishment of the connective attachment.

STEM technique: surgical procedure

The surgical technique to be described concerns the treatment of interproximal carious lesions in the posterior area.

Vestibular flap: The vestibular flap (Figs 18 and 19), without vertical releasing incisions, requires a vestibular incision of the flap extending from the mesial to the distal tooth areas. The incision is intrasulcular on adjacent teeth and paramarginal in the interproximal space. It should be stressed that this procedure depends on the presence of an adequate level of keratinized tissue (approximately 4 mm). The intrasulcular incision continues in a split-thickness flap elevation at the interdental papilla of the adjacent tooth, leaving the connective tissue of the entire papilla in place to avoid future gingival alteration. The flap is elevated full thickness in the more apical area to access the bone crest without affecting the mucogingival line.

Palatal flap: A thinned palatine flap is carried out. A paramarginal incision (Fig 20) of the same extent as the vestibular flap is performed with a mesial vertical releasing incision. A split-thickness flap elevation is performed with the blade parallel to the bone plane extending approximately 5 mm apically to thin the palatine fibro mucosa (Fig 21). A third incision with the blade perpendicular to the bone plane allows an apical incision of the thinned fibro mucosa (Fig 22). Finally, an intrasulcular incision allows the extraction of the tissue wedge (Figs 23 to 25).

Mandibular lingual flap: This requires a lingual incision of the flap extending from the mesial to the distal tooth areas. The incision is intrasulcular on adjacent teeth and paramarginal in the interproximal space affected by the carious lesion; it is a full-thickness flap without vertical incisions.

Measuring the distance between the cavity margin and the bone crest: After removing the carious lesions, the interproximal soft tissue at the cavity level is removed to expose the margin and bone crest. The

Fig 20 Thinned palatine flap: first paramarginal incision.

Fig 21 Thinned palatine flap: second incision with the blade parallel to the bone plane to thin the palatal fibro mucosa.

Fig 22 Thinned palatine flap: third apical incision with the blade perpendicular to the bone plane.

Fig 23 Thinned palatine flap: fourth intrasulcular incision.

Fig 24 Thinned palatine flap: palatal tissue wedge removal.

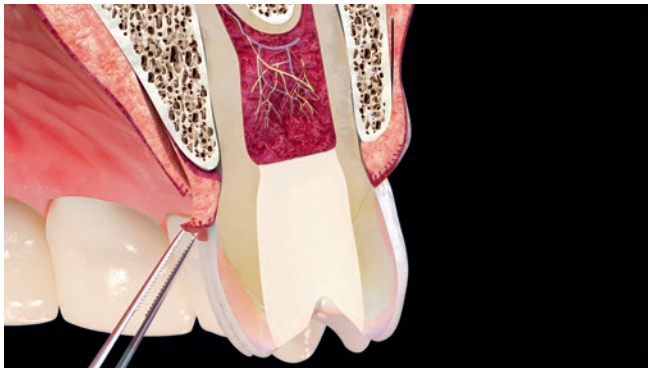

Fig 25 Thinned palatine flap: palatal tissue wedge removal, section view.

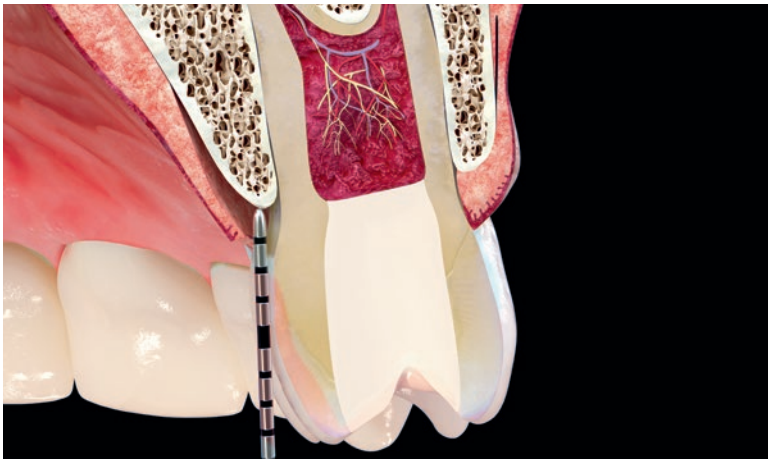

Fig 26 Distance between the clean cavity margin and the bone crest is measured, leaving 2 mm.

Fig 27 After carious lesion removal, the distance between the clean cavity margin and the bone crest is measured: clinical view.

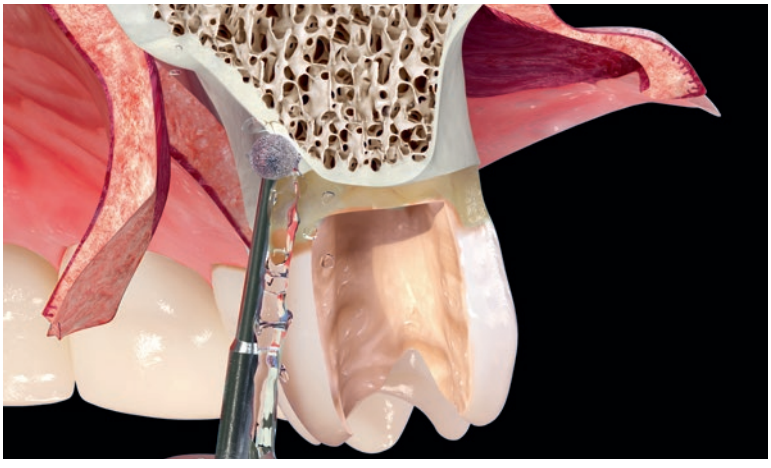

Fig 28 Palatal and vestibular osteoplasty.

distance between the cleaned cavity margin and the bone crest is measured. If the distance is 2 mm, osteoplasty is performed without ostectomy (STEM); if it is less than 2 mm, an interproximal ostectomy is performed to ensure 2 mm between the cavity margin and the bone (STEM-Modified) (Figs 26 and 27).

Palatal/lingual and vestibular osteoplasty: The osteoplasty on both the vestibular and palatal sides is limited to the interproximal space being worked on with a round diamond bur; this allows the blending of the interdental bone to the buccal and palatal side, reducing its thickness (Figs 28 and 29).

Root planing: The root is smoothed apically to the cavity margin to ensure the removal of preexisting connective attachment fibers and to avoid excessive tissue regrowth in the area (Figs 30 and 31).

Vertical mattress sutures: The flap is sutured with vertical mattress sutures (monofilament 6–0) to achieve optimal adaptation of the flap (Figs 32 to 34).

When should restorative treatment be performed?

The best time for restorative treatment is immediately after surgery.[60] Although successful techniques suggesting an open-flap restoration are described in the literature,[61] performing the restoration immediately after suturing, in the posterior sector, allows greater control over bleeding and contamination in the area to be reconstructed. In addition, rubber dam isolation is easier to achieve when the tissue is repositioned by a compressive suture. If this is not possible, the restoration should be completed within 2 weeks, at the most, to avoid tissue regrowth due to healing. This allows rubber dam positioning to isolate the exposed margin (Figs 35 and 36) and to perform the restorative treatment (Figs 37 to 39).

The approach described in this article allows a perfect reconstruction of the tooth while respecting the periodontal tissue (Figs 40 to 42).

Discussion

The developments in adhesive techniques in dentistry have resulted in progress and changes and have also allowed a reduction in the level of invasiveness of restorative treatments. From both a mechanical and functional point of view, adhesive protocols minimize dental preparation, thereby allowing greater conservation of healthy dental tissue and the optimal integration of restorative reconstruction. From a biologic point of view, it has been demonstrated that adhesive materials perform better than those used in the past in subgingival restorations.[19]

A number of histologic studies on animal and human models have shown a good level of biocompatibility between composite materials and periodontal tissue;[63] in particular, the adhesion of junctional epithelium on composites positioned in subgingival areas has been demonstrated.[20,21,31] When it is necessary to treat deep carious lesions, and rubber dam isolation is not possible, it is essential to perform a combined surgical–restorative treatment that allows the margin in question to be exposed and isolated. The surgical approach proposed to resolve such cases is based on the knowledge of periodontal tissue and the analysis of its behavior. According to the above-mentioned histologic studies, it seems possible for the epithelial component of the supracrestal attachment to adhere with a well-finished and polished restorative margin.

The connective attachment is the component that must not be violated. Individual variability exists in the size of the various components of the supracrestal attachment; however, the connective attachment,

Fig 29 Palatal and vestibular osteoplasty: clinical view.

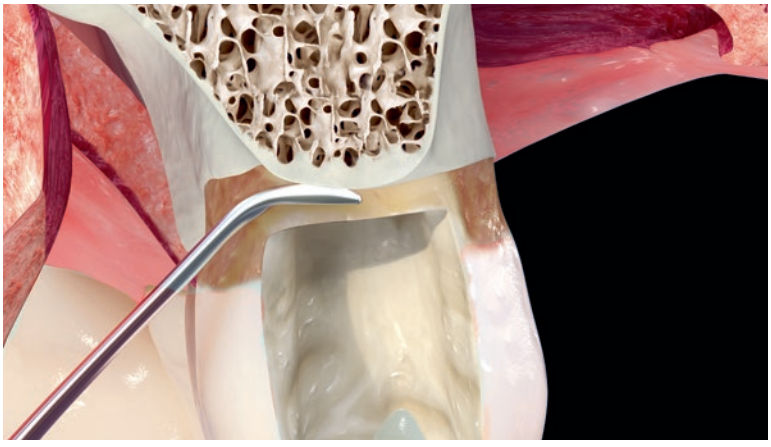

Fig 30 Root planing.

Fig 31 Root planing on tooth 15: clinical view.

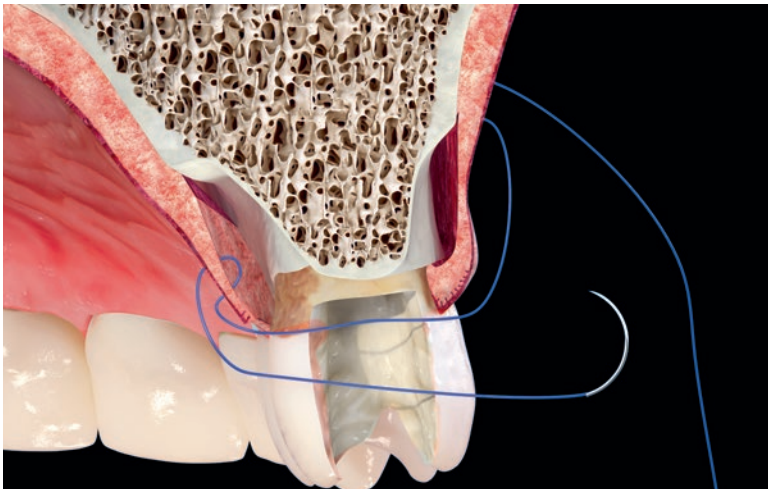

Fig 32 Vertical mattress suture.

Fig 33 Vertical mattress sutures: palatal view.

Fig 34 Vertical mattress sutures: vestibular view.

varying between 0.29 and 1.84 mm,[12] is the most consistent measurement among the supracrestal tissue components.

Similar results were obtained from another histologic study that confirms the variability of the connective attachment in a range between 0.76 to 1.60 mm.[64] Therefore, it is absolutely safe to place a restoration within 2 mm above the bone crest.

Taking these considerations into account, the STEM technique aims at ensuring 2 mm between the clean cavity margin and the bone crest to allow for the restoration and give sufficient space for the connective attachment. This surgical protocol is used with deep interproximal carious lesions when the cavity margin is more than 2 mm above the bone crest. It also allows the modification of the bone crest while maintaining an ideal anatomical morphology, leaving a space of 2 mm between the desired restoration margin and the bone, alongside the renewal of the supracrestal connective attachment.

The present authors' clinical experience shows that, at the time of surgery, there is almost always at least 2 mm between the clean cavity margin and the bone crest. This space is sufficient to avoid the connective tissue, thereby making it possible to isolate the cavity immediately after suturing at the bone crest. In fact, in the case of subgingival caries, bacterial invasion always causes an apical displacement of the entire supracrestal attachment system because the biologic response aims to maintain a constant space between the bacterial infection and the crestal margin, with a mechanism similar to that in periodontal disease. For this reason, an ostectomy is seldom necessary.

If the distance between the cavity margin and the bone is less than 2 mm, the STEM-Modified technique is used. This differs from classic crown lengthening in that it requires a minimal ostectomy in

Fig 35 Two weeks after surgery, the cavity margins are perfectly isolated with rubber dam.

Fig 36 The circular matrix in position on tooth 25 in order to relocate the margin and complete the buildup.

addition to the STEM technique in order to reach 2 mm without the need for bone remodeling on the adjacent sides.

In cases where the cavity margin to be restored is at bone level or even below bone level, as is the case with dental fractures, the correct procedure to adopt is classic crown lengthening, with ostectomy and remodeling of the supporting tissue of the adjacent teeth (Table 1).

Therefore, the STEM and STEM-Modified techniques differ from the crown lengthening technique used in the past because the former does not sacrifice the tooth-supporting tissue and the latter reduces this tissue to a minimum. Moreover, these techniques aim at remodeling the existing supracrestal attachment system, with the goal of creating a restoration that ensures both effective tooth reconstruction and healthy periodontal tissue in the long term.

Therefore, it is not a real lengthening of the clinical crown but rather a technique

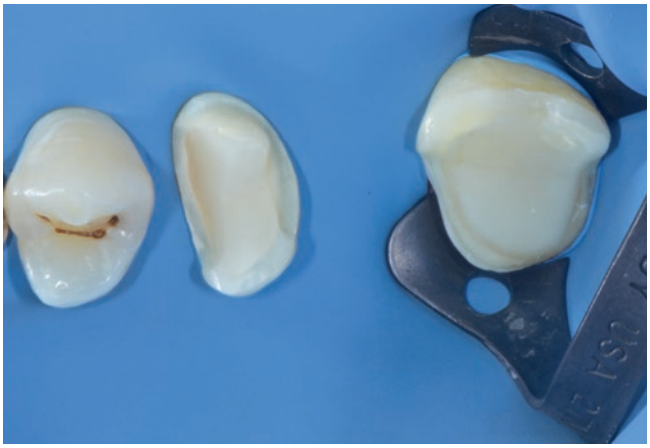

Fig 37 Tooth preparation for the indirect restoration.

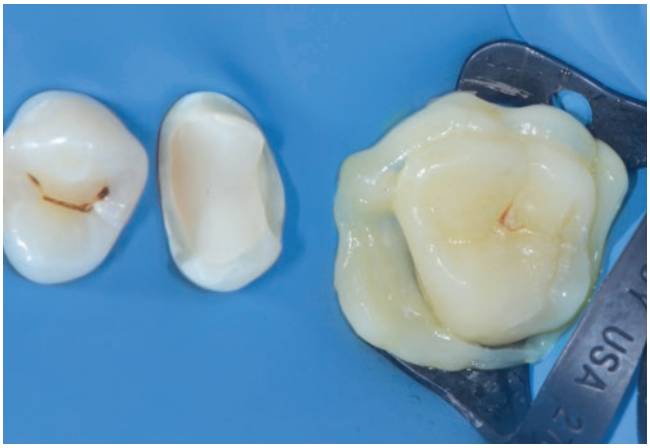

Fig 38 Cementation with heated composite.

Fig 39 Clinical situation 1 year after treatment: occlusal view.

Fig 40 Clinical situation 1 year after treatment: vestibular view. The rehabilitation will be completed with orthodontics and implants.

Fig 41 One-year follow-up radiograph.

Fig 42 One year after cementation: good integration between the restoration margins and the periodontal tissue, with physiologic probing depth and no gingival inflammation.

Table 1 Suggested procedure with reference to the position of the cavity margin

Cavity margin	Rubber dam isolation	Surgery	Technique used
Up to 1.5 mm subgingivally	Yes	No	Interproximal margin relocation
More than 1.5 mm subgingivally and 2 mm or more above the bone crest	No	Yes	STEM (osteoplasty)
More than 1.5 mm subgingivally and less than 2 mm above the bone crest	No	Yes	STEM-Modified (osteoplasty + minimal ostectomy)
At or below bone level	No	Yes	Crown lengthening with ostectomy

that allows the surgical management of the supracrestal tissue, aimed at the execution of the restoration. There is, in fact, no desire to lengthen the clinical crown; rather, the aim is to achieve, at the end of the healing process, a level of soft tissue as similar as possible to baseline, thus maintaining esthetics and allowing the patient to perform proper oral hygiene.

It is essential to finalize the restorative treatment immediately after the surgery, or after 2 weeks at the most, when a stable connective attachment has formed, yet before the development of supracrestal tissue (allowing for the benefits of apical tissue position) in order to anticipate the possible coronal regrowth of the soft tissue. In addition, a definitive restoration allows a well-polished and finished restorative margin on which tissue heals best.

Nevertheless, it is important to emphasize that long-term success is also, and inevitably, linked to patient compliance and appropriate oral hygiene in terms of the interproximal spaces. In order to safeguard the results obtained, the patient must be informed by the clinician about good oral hygiene practices and be included in a personalized dental hygiene and maintenance program.[65]

Conclusion

As evidenced by the scientific research, it is possible to place a restorative margin within the junctional epithelium without creating adverse periodontal reactions. Therefore, the answers to the initial questions posed in this article – the approach to restorative deep margin management, when and how to carry out surgical procedures, and the timing of definitive restoration work after surgery – are to be found in the protocols for carious lesion management as follows:

- If the cavity margin, positioned 1.5 mm below the gingival margin, can be isolated, a restorative approach with margin relocation is recommended; an epithelial junction will form on the restorative margin.
- If the cavity margin, positioned more than 1.5 mm below the gingival margin, cannot be isolated immediately, an initial surgical approach will be necessary, followed by isolation and subsequent restoration.

The surgical approach differs depending on the clinical situation:

- *A cavity margin within 2 mm above the bone crest:* A STEM procedure may be performed, with no ostectomy and only osteoplasty.
- *A cavity margin less than 2 mm above the bone crest:* A STEM-Modified procedure with minimal ostectomy may be performed to reach 2 mm, followed by osteoplasty.
- *A cavity margin at or below bone level:* A classic crown lengthening procedure may be performed, with necessary ostectomy.

After the STEM or STEM-Modified procedures, the best time to carry out definitive restoration work is immediately after surgery.

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