Deep margin elevation versus crown lengthening: biologic width revisited

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Abstract

This article revisits the concept of biologic width, in particular its clinical consequences for treatment options and decisions in light of modern dentistry approaches such as biomimetics and minimally invasive procedures. In the past, due to the need to respect biologic width, clinicians were used to removing periodontal tissue, bone, and gum around deep cavities so that the limits of restorations were placed far away from the epithelium and connective attachments, in order to prevent tissue loss, root exposure, opening of the proximal area (leading to black holes), and poor esthetics. Furthermore, no material was placed subgingivally in case it led to periodontal inflammation and attachment loss. Today, with the more conservative approach to restorative dentistry, former subtractive procedures are being replaced with additive ones. In view of this, one could propose deep margin elevation (DME) instead of crown lengthening as a change of paradigm for deep cavities. The intention of this study was to overview the literature in search of scientific evidence regarding the consequences of DME with different materials, particularly on the surrounding periodontium, from a clinical and histologic point of view. A novel approach is to extrapolate results obtained during root coverage procedures on restored roots to hypothesize the nature of the healing of proximal attachment tissue on a proper bonded material during a DME. Three clinical cases presented here illustrate these procedures. The hypothesis of this study was that even though crown lengthening is a valuable procedure, its indications should decrease in time, given that DME, despite being a very demanding procedure, seems to be well tolerated by the surrounding periodontium, clinically and histologically.

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Introduction

During the past decade, most dental procedures have moved toward a more conservative approach. Today, whatever the depth of the cavity, pulp capping has replaced automatic root canal treatment, partial preparation shapes are used instead of peripheral preparations, and root post-and-core treatments are less frequently indicated. However, one of the difficulties of a conservative approach is determining its limits, and knowing exactly what situations demand changing the tissue shape around a tooth to restore it, or extracting a tooth instead of restoring it. This article looks at the consequences on the surrounding periodontium of deep margin elevation (DME) for posterior teeth. The possibilities of keeping the periodontium intact and the need for crown lengthening are discussed.

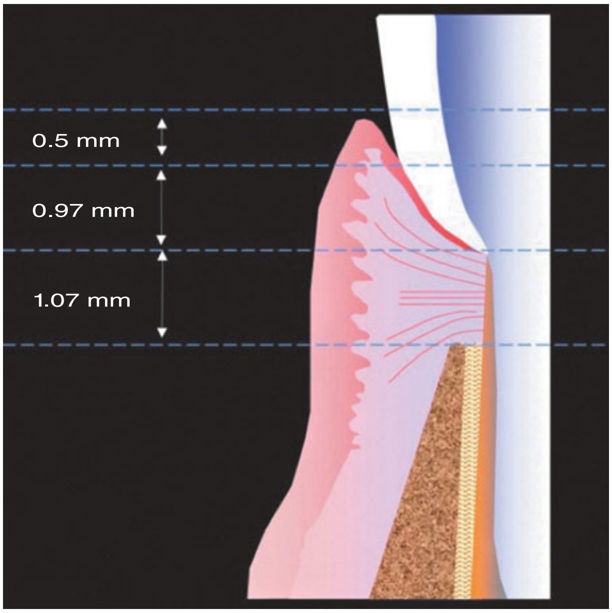

Fig 1 Schematic representation of a normal biologic width.

The biologic width

The biologic width is defined as the gingival attachment along the root surface, from the most coronal portion of the epithelium attachment to the most apical portion of the connective attachment (Fig 1). This is based on studies led by Gargiulo et al[1] on cadavers that detailed the composition of the biologic width. It is noteworthy that in these studies, the sulcus was not included in the biologic width. It was measured at a mean of 2.04 mm: 0.97 mm for the epithelium attachment, and 1.07 mm for the connective attachment below. Above, the sulcus was measured at a mean of 0.69 mm. However, there was high variability regarding the epithelial attachment, ranging from 1 to 9 mm, whereas the connective attachment height remained fairly constant. This variability was confirmed in a study by Schmidt et al,[2] which showed that a standard measurement could not be defined, given the literature and meta-analysis available, and gave the mean biologic width as 2.15 to 2.30 mm. It should be noted that the epithelium attachment is weaker than the connective tissue attachment because the former is a hemidesmosomal attachment on the root surface, whereas the latter is made of horizontal collagen fibers inserting into the cementum on one side and into the connective tissue on the other. Thus, from a histomorphometric point of view, in a healthy gum, the periodontal probe penetrates into the coronal part of the epithelium attachment and is stopped at its most apical portion, where the density and layers of epithelial cells are higher, without getting into the connective tissue. Then, in case of periodontal healing or regeneration, the more connective tissue attachment one achieves, the better.

It is widely accepted that this biologic width must be respected when restorative procedures are performed, otherwise it could lead to an inflammatory response from the periodontium due to microbial biofilm on restorations placed in deep areas. Clinically, this reaction leads to gingivitis or periodontitis, including a loss of attachment, periodontal pockets, bleeding, suppuration, swelling, and gingival recessions.[3] Given these principles, in 2010 Veneziani[4] edited a classification of proximal cavities and clinical situations (three-grade scale), where it was possible for the clinician to control the isolation in a deep area as well as the limits of the cavity compared to the position of the biologic width. These three clinical situations led to three different treatments, from a simple coronal replacement of the margin to a crown lengthening to expose the limits of the cavity, taking care to respect the biologic width without placing limits on it.

On the other hand, in case of deep cavities, there is already a destruction of the gingival attachment facing the decay. If a restoration can be performed on a deep dentin margin with proper isolation and bonding procedures, how would the periodontal attachment heal? Would it tolerate the restoration, or is crown lengthening mandatory to get a healthy periodontium around the restored tooth?

Periodontium reaction to different materials

There is very little scientific data on the reaction of the periodontium to different materials, and much that exists is based on studies conducted on materials no longer in use.[5,6] There are few studies on materials in use today. Dragoo[7,8] proposed that the ideal characteristics of a subgingival restorative material include, but are not limited to, biocompatibility, dual-cure set, adhesiveness, fluoride release, radiopacity, compactness, surface hardness, insolubility in oral fluids, absence of microleakage, a low coefficient of thermal expansion, and low-cure shrinkage. Unfortunately, none of the materials available today present all these characteristics at the same time.

Gold

In a study on dogs, Frank et al[9] performed subgingival preparations on class V cavities. In group 1, gold restorations were performed normally, and in group 2 a flap was raised so that the gold restorations could be perfectly adapted to the limits of the cavity. Histology was conducted after 3 weeks. Group 1 showed an inflammatory remodeling in the epithelium and the connective tissues, and the presence of dental plaque between the material and the sulcular epithelium. Group 2 showed no inflammatory remodeling. The authors concluded that these differences were due to the presence or absence of dental plaque on the restoration, which correlated with the operator ensuring the perfect adaptation of the restoration to the limits of the cavity. From a material surface point of view, in a study based on proximal golden inlays with a rough or smooth surface, Mörmann et al[10] showed an increase in the production of crevicular fluid compared to unrestored teeth, and a higher plaque accumulation for the rough surface inlays. The study concluded that surface texture is a major factor in the tolerance of the material by the gum.

Ceramics

There is no longer a debate about the biocompatibility of ceramics, which are very well tolerated by the gum. Ariaans et al[11] compared gum inflammation around sound teeth, teeth restored with bonded lithium disilicate restorations, and zinc phosphate cement-sealed zirconium restorations. No difference could be observed clinically in terms of plaque index, probing depth, or bleeding on probing (BOP). In the crevicular fluid, levels of inflammatory cytokines (IL-1Ra, IL-1beta, MMP-8) were comparable. These materials were used for indirect restorations with limits that were mostly supragingival or intrasulcular. The main event occurred in deeper areas, where margin elevation was performed using direct bonding of the restorative material. The two main materials, glass ionomers and composite resins, made contact with the healing gum. The discussion concerned the kind of healing that was expected on these substrates, and how they were tolerated by the gum.

Glass ionomers

From a gingival point of view, Lewis et al[12] examined the effects of components released from glass ionomer cements on the growth and metabolism of hamster oral epithelial cells. They observed that the leachable components of these materials affected the rate of progression of these cells through the cell cycle rather than cause cell death due to toxicity. In a case report, Dragoo[8] histologically analyzed hopeless teeth presenting external resorptions. A flap was raised and the cavity treated and filled with a glass ionomer. After 1 year, the teeth were extracted. Results showed that the connective tissue was joined to the material, with very few inflammatory cells. A long junctional epithelium and a shallow sulcus were found. On the contrary, in another study on dogs, Santamaria et al[13] showed bone resorption and an apical migration of the epithelium 100 days after a restoration. The test group restored with glass ionomer showed a significantly higher bone loss than the control group, and the junctional epithelium was longer. Clinically, both groups presented a significant clinical attachment loss and an increased probing depth, but differences between the groups were not statistically significant. Histologically, a significant difference between groups was observed for the length of the epithelium. Interestingly, in another study on dogs, Gomes et al[14] showed that when placing glass ionomer on a root subgingivally and supragingivally, with the restoration going through the gingival attachment, inflammation was not induced from a histologic point of view. The study demonstrated that if connective tissue is joined (not attached) to the material and a bone reparation, the material is well tolerated.

Given the paucity of data on this topic, and with all due precautions, the results of gum healing after root coverage procedures on roots restored with glass ionomer must be extrapolated. Based on two randomized clinical trials, Santamaria et al[15,16] compared connective tissue grafts on healthy roots and roots treated with glass ionomer at the 6-month and 24-month follow-ups. There were no significant differences clinically between both procedures for the percentage of root coverage, pocket depth, attachment level, and BOP. Thus, based on clinical observations, it seems that glass ionomer is very well tolerated subgingivally. These clinical outcomes were confirmed for the same patients immunologically through the analysis of the crevicular fluid composition, the subgingival plaque, and its bacteria from red complexes (such as Tannerella forsythia or Prevotella intermedia); also for Fusobacterium nucleatum and Streptococcus sanguinis, and for the presence of inflammatory markers (IL-1beta, IL-4, IL-6, IL-10) at 180 days. Polymerase chain reaction (PCR) analysis failed to show any difference between both groups for any of these factors. In their study showing that glass ionomer was well tolerated by the gum, Santos et al[17] explained these excellent clinical and microbiologic results by the good marginal adaptation, the reduced surface roughness, and the fluoride and aluminum release by the glass ionomer. These properties could interfere with the adherence of bacteria onto the material surface, thereby inhibiting bacteria metabolism and growth.

Composite resins

Given the poor mechanical properties of glass ionomer and the weakness of its long-term adhesion on tooth surface, composite resins seem to be an interesting alternative for deep subgingival bonding procedures if the clinician is able to get an adequate isolation. Then, the behavior of the gum in contact with this material must be analyzed.

Studies on this topic[18,19] have shown a higher plaque index around cavities filled with composites compared to a healthy enamel surface. The gingival index and the production of crevicular fluid were also higher, demonstrating a gingival inflammation more pronounced around restored teeth. No differences could be found between conventional, hybrid or microparticle composites. In the second study, based on an experimental gingivitis, there were no significant differences in term of plaque accumulation, gingival index or BOP between areas made of healthy enamel, glass ionomer, and composite. It is noteworthy that most of the composites used in these studies are no longer available, and the quality of the materials used today is superior in terms of bonding procedure, polishability, and mechanical properties.

Martins et al[20] conducted a study on dogs in which a flap was raised on the roots, the bone removed, and a cavity created and filled with composite or glass ionomer, or nothing in the control group. At 90 days, the histologic analysis showed the presence of an inflammatory infiltrate in the three groups. This infiltrate was more important in the cervical third, without any differences between groups. In the control group, the junctional epithelium was shorter, the connective attachment longer, and the bone resorption less important, with sometimes a bone formation into the cavity. There were no differences between the test groups with regard to the long junctional epithelium on the material, and the small connective attachment on the root that started underneath the apical limit of the material. None of them exhibited bone regeneration. According to the authors, these materials seem to have been tolerated subgingivally, given their good adaptation on the cavity walls (direct vision through raised flap in this case), the careful finishing and polishing of the restorations prior to flap closure, and the care taken with bacterial plaque control throughout the experiment.

Information on the gingival reaction to subgingival composite can be found in studies on root coverage procedures. In fact, in many clinical situations of gingival recession, the loss of gingival tissue exposing the root can also be associated with the wearing of the cervical portion of the crown. Thus, as the gum cannot be replaced higher than the cemento-enamel junction, the loss of enamel must be restored prior to the root coverage procedure.[21]

In 2007, Santos et al[17] compared coronally advanced flaps performed on such roots restored with glass ionomer or microfilled composite, and on sound roots in the control group. At 6 months, there were no differences between the groups in terms of plaque index, BOP, and pocket depth. There were also no differences in the percentages of root coverage. Among the 40 periodontal pathogens studied, 10 decreased in the control group, 5 decreased in the composite group, and all showed a tendency to decrease in the glass ionomer group. The authors thus concluded that these materials, placed subgingivally, seemed to be well tolerated by the gum. According to the authors, the reduced frequency of BOP in their study, despite the presence of visible plaque, might be explained by plaque composition, and also by the fact that the evidence showed that gingival response to biofilm may vary between individuals, with neither quantitative nor qualitative differences in plaque accumulation.[22] Even though the roughness of the material surface influences plaque accumulation, there was no evidence of biofilm composition on it. In this study, the decrease in periodontal pathogens from the red and orange complexes was more evident in the glass ionomer group after 6 months than in the composite group. The initial pellicle biofilm formation on composite resin could influence the adhesion mechanisms of some bacterial species. Although the microbiologic results with composite were not as good as those with glass ionomer, the interesting clinical finding is that the decrease of pathogens may be related to the surface aspect of the material after finishing and polishing. This capacity to obtain a very smooth surface could lead to a lower plaque adherence and soft tissue inflammation. Regarding bacterial adherence and dental plaque accumulation on these materials, Quyrinen et al[23] studied the influence of roughness and surface free energy on these parameters. Given all kinds of surfaces in the healthy mouth, there is a dynamic balance between retention forces and the removal forces of bacteria. Adhesion and stagnation are the two mechanisms in favor of dental plaque accumulation. Rough surfaces favor formation and maturation of the dental plaque, and high surface free energy attracts more plaque to link to it and to select specific bacteria. Even if these two factors are present, the surface roughness dominates the surface free energy.

In 2008, Santamaria et al[24] conducted a randomized clinical trial and made the same comparison with a nanofilled composite on canines and premolars with a 12-month follow-up. Results showed a comparable percentage of root coverage. The group treated with composite showed slightly deeper pocket depth than the group treated with a connective tissue graft only, whereas all the other periodontal parameters were not significantly different. The same biologic results were found by Konradsson et al[25] in an observational study on an experimental gingivitis in humans. They analyzed the concentrations of the inflammatory marker IL-1 in the crevicular fluid around restorations made of composite or calcium aluminate cement on class V cavities compared to healthy enamel. No difference was found between both materials in healthy gum or in experimental gingivitis conditions. Thus, even in the presence of gingivitis, these materials do not seem to be a factor affecting the increase of crevicular fluid production or peripheral inflammation. In another study[26] conducted over 2 years, the authors bonded dental fragments subgingivally after traumas with a three-step adhesive and a flowable composite. The presence of the materials at a depth and close to the bone had no effect on the clinical parameters, and seemed to be well tolerated.

One must be careful when extrapolating because in all these root coverage studies, restorations were placed on the buccal aspect of the roots, where they are easy to fill, polish, and control. More difficulty is experienced in cases of posterior DME. Also, it is more difficult for a patient to perform good interdental brushing on posterior teeth presenting a composite margin than on the buccal aspect of anterior teeth, given that these two factors have been demonstrated to have a major impact on the tolerance of these materials by the periodontium.

Given this data, it seems that glass ionomer and composite resin can be used subgingivally for DME, provided the clinician can ensure a proper isolation, sufficient adaptation of the material to the dentin limit, and that the smoothest surface is in contact with the gum. It must be emphasized that no real periodontal attachment can be obtained on the material except with the epithelium. Although we cannot comment on the biocompatibility of composites, they seem to be the main choice today, given the quality of their adhesion compared to glass ionomer. They are also reported to be well tolerated subgingivally.

In these situations, where the presence of subgingival proximal caries leads to the destruction of periodontal attachment, DME could lead to another kind of biologic width that is healthy, with a longer junctional epithelium along the material, and a smaller connective attachment along the remaining dentin height beneath the composite.

Deep cavities in posterior teeth: DME or crown lengthening?

Posterior proximal cavities present many clinical complexities such as limited access, difficulty of isolating and controlling the material adaptation, and the quality of the emergence profile in order to get an efficient interdental brush cleaning. All these factors influence the extent and severity of caries and periodontal diseases.[27-29] From an epidemiologic point of view, even when conducted on the buccal and palatal aspects of healthy or restored teeth, Yotnuengnit et al[30] showed that supra- and subgingival emergence profiles influence loss of attachment, whereas only the subgingival emergence profile correlates with pocket depth. The authors emphasize that it may not be the emergence profile itself that had this influence, but the fact that its shape makes hygiene more or less difficult, which in turn affects the periodontal parameters. Treatment must then be adapted to each clinical situation: almost straight for very tight teeth, and more flared and rounded when the proximal area is more important. Thus, the issue is the possibility of controlling these factors, since previous studies have shown that overhanging proximal restorations are statistically correlated with the extent and severity of periodontitis.[29,31] This is one of the key points to consider when choosing between DME and crown lengthening, because the clinician must be able to place the tools allowing for a proper shaping of the material.

Crown lengthening

The different crown lengthening procedures (not detailed in this article) all aim to recreate the space necessary to reestablish the biologic width when deep restorations are needed, so that the necessary margin between prosthesis and biologic tissues is respected (Figs 2 and 3). In a literature review, Pilalas et al[32] showed that crown lengthening is an efficient procedure to increase the height of the crown, but that predicting the exact position of the marginal gum after healing is complicated. Recurrence is frequent and usually occurs during the first 3 months, particularly in patients presenting a thick biotype or when the surgery comprises a gingivectomy only.[33] Moreover, recurrence would lead to restoration limits being replaced subgingivally, whereas the surgery aims to place them supragingivally. Also, the crown lengthening procedure leads to the opening of the proximal area and may complicate hygiene, especially as some authors have shown an increase of bone loss at the 6-month follow-up.[34] Dibart et al[35] conducted a study on the consequences of crown lengthening procedures on mandibular molars. It seems that the consequences of such procedures are not limited to proximal areas, even when a crown is not planned. Results showed that all treated teeth presenting a distance between the bottom of the cavity (or the temporary crown) and the zenith of the furcation inferior to 4 mm presented an opening of the furcation area at 5 years.

Fig 2 Crown lengthening surgery showing a deep cavity.

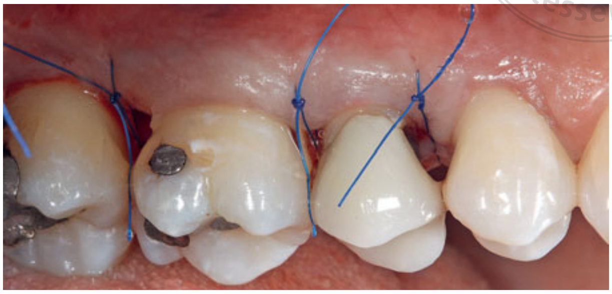

Fig 3 Sutures after crown lengthening exposing the cavity subgingivally.

Deep margin elevation (DEM)

Dietschi and Spreafico[36-38] proposed a new approach for deep cavities. Instead of relocating the margin of the periodontium according to the limits of the cavity, they relocated the margin of the restoration coronally to adapt it to the periodontium and make the restoration procedure easier. They called this cervical margin relocation (CMR), later called deep margin elevation (DEM) by Magne and Spreafico.[39] This procedure is based on the ability to get a proper isolation after carious tissue removal and the bonding of several layers of composite onto the deep margin, creating a new, more coronal restoration margin. Given previous data, it can be speculated that the gum heals along the composite. However, one must also analyze the biotype surrounding the tooth before choosing this procedure. In fact, Stetler et al[40] showed that among teeth treated with subgingival restorations, those presenting < 2 mm of keratinized tissue showed a higher gingival index.

A randomized clinical trial compared the clinical results of crown lengthening and DME in posterior teeth.[41] At 180 days, clinical attachment loss was obviously higher in the surgery group, but plaque index, pocket depth, and BOP were similar in both groups, suggesting that DME was well tolerated by the periodontium.

Case 1

A 65-year-old patient lost an old metallic inlay on her first maxillary left molar. Clinical examination revealed an important cavity on the distal aspect of the tooth,

Fig 4 Occlusal view.

Fig 5 Buccal view.

Fig 6 Radiograph showing a deep cavity close to the pulp.

extending to the middle of the palatal aspect and becoming deep close to the pulp. Old material remained on the sclerotic dentin (Figs 4 to 6). Surprisingly, the tooth was still vital. Rubber dam was placed and the teeth ligatured with dental floss containing Teflon, which gives it more elasticity. In Figure 7, the difficulty of placing the floss properly on the distal cavity area is shown. The old restoration was removed and the carious tissue removed. On the distal aspect, the cavity

Fig 7 Rubber dam isolation.

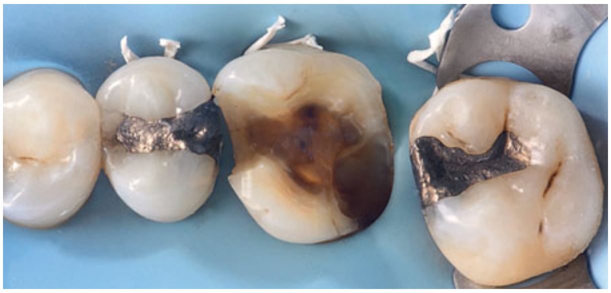

Fig 8 Carious tissue removal.

Fig 9 Teflon impaction revealing the true limits of the cavity.

Fig 10 Matrix positioning.

Fig 11 Ultrasonic tip to finish carious tissue removal.

Fig 12 Sandblasting.

Fig 13 Flowable composite input on distal aspect of the cavity.

Fig 14 Flowable composite input on palatal aspect of the cavity.

Fig 15 Flowable composite input on buccal aspect of the cavity.

Fig 16 Removal of the matrix.

Fig 17 Preparation and polishing of the edges of the cavity.

was so deep that its limits were not visible (Fig 8). A Teflon strip was rolled and placed between the cavity wall and the rubber dam to improve deep isolation and highlight the remaining carious tissue (Fig 9). At that point, the tissue was not yet removed; it was retained to help the placement of the matrix that slips

Fig 18 Radiographic control of the DME.

Fig 19 Limits of the preparation on the cast (Technicians: Asselin Bonichon and Yann Tarot, Paris).

Fig 20 Waxing the overlay.

along the wall and goes deeper into the healthy dentin area (Fig 10). Then, an ultrasonic tip with a smooth distal aspect and a rough mesial aspect was used to eliminate the remaining carious tissue (Figs 11 and 12). Immediate dentin sealing (IDS) could be performed.[42-46] Dental tissues were then sandblasted with 27-µm alumina oxide particles, and etched with orthophosphoric acid. A three-step etch-and-rinse adhesive was used, and filled flowable composite was used in several intakes to respect the C factor and decrease the polymerization stress as much as possible by placing each intake on a single dentin wall (Figs 13 to 15). Final polymerization was performed under a glycerin gel to isolate the composite from oxygen and improve the polymerization of the top layer of composite. The matrix was then removed (Fig 16), the edges of the preparation polished, and the available peripheral enamel slightly re-prepared to obtain sound tissue on which to bond the indirect restoration (Fig 17). A radiograph was taken to check the margin elevation and emergence profile (Fig 18).

Fig 21 Preparation for ceramic pressing.

Fig 22 Ceramic pressing.

A pressed lithium disilicate overlay was prepared by the technicians (Figs 19 to 24). Seven days later, rubber dam was placed again, and the remaining cavity comprising peripheral enamel and composite from the IDS procedure was sandblasted and etched (Fig 25), while the collateral teeth were protected with Teflon (Fig 26). The intaglio surface of the ceramic restoration was etched for 20 s with hydrofluoric acid (Fig 27), and for 30 s with orthophosphoric acid (Fig 28), and then placed for 3 min in ethanol and an ultrasound bath to eliminate mineral residues (Fig 29). Silane was applied for 60 s and heat activated with a lamp for 1 min (Fig 30). Adhesive was placed in the cavity and on the lower aspect of the ceramic, and solvents were eliminated by air spray. Preheated filled composite was placed in the cavity, and the indirect restoration inserted using an ultrasonic Teflon tip. Excesses were removed, contact points checked, and a brush used to improve the margins. Polymerization was performed under air spray for 30 s per face in a progressive mode, 1 min in a high-intensity mode, and then 30 s

Fig 23 Ceramic staining.

Fig 24 Final lithium disilicate overlay.

Fig 25 Rubber dam placement prior to bonding, sandblasting, and etching.

Fig 26 Collateral teeth protection.

Fig 27 Hydrofluoric acid etching.

Fig 28 Orthophosphoric acid etching.

Fig 29 Ultrasound bath and ethanol.

Fig 30 Silanization.

Fig 31 Final bonding.

Fig 32 Palatal view showing the composite of the DME and ceramic overlay.

in a high-intensity mode under glycerin gel. Margins were then polished and a radiographic control performed before checking the occlusion (Figs 31 to 33).

Case 2

The same procedure was performed. At the 1-year control, the healthy gum against the mesial composite was observed, with no swelling or BOP, no pocket depth higher than 3 mm, and no clinical attachment (Figs 34 to 43).

Fig 33 Radiographic control.

Fig 34 Clinical view of old composites.

Fig 35 Radiograph showing cavity under the composite.

Fig 36 Deep cavities.

Fig 37 IDS and DME with filled flowable composite.

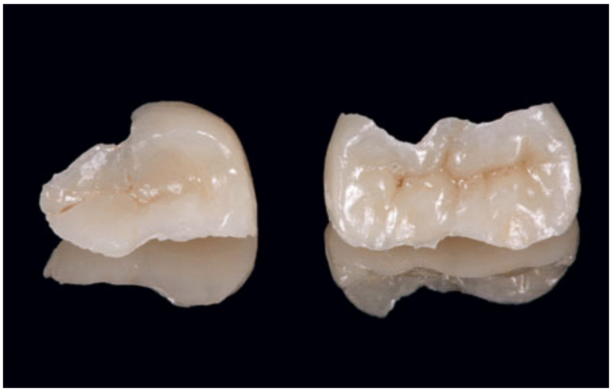

Fig 38 Lithium disilicate inlay.

Fig 39 Preparation for bonding.

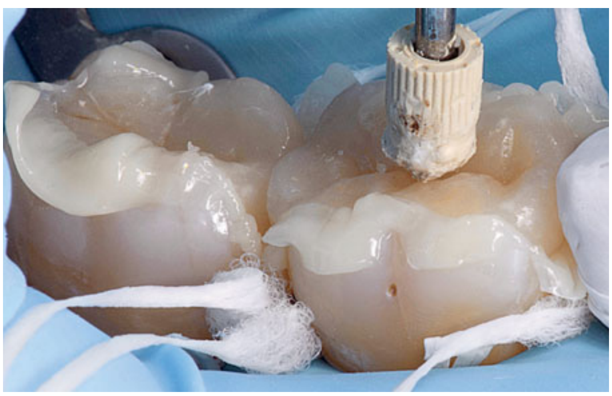

Fig 40 Preheated composite bonding.

Fig 41 Final view.

Fig 42 Radiographic control.

Fig 43 1-year control showing a healthy gum around the restorations.

Case 3

The same procedure was performed. At 1.5-year control, no bone loss was seen even though the composite limit was close to the bone crest. Importance must be given to the emergence profile provided by the composite of the margin elevation, which facilitates the ceramic being in continuity with the composite, and allows for the proper shape of a proximal restoration, which in turn allows for proper proximal cleaning, with the avoidance of food accumulation and the benefit of healthy gums (Figs 44 to 51).

Fig 44 Cavity under old composite.

Fig 45 Radiograph showing distal deep cavity.

Fig 46 Carious tissue removal.

Fig 47 IDS and DME with filled flowable composite.

Fig 48 Final restoration.

Fig 49 Immediate radiographic control.

Fig 50 1.5-year clinical control.

Fig 51 1.5-year radiographic control showing no bone loss around the composite.

Fig 52 Deep cavities under old restorations.

Case 4

The same procedure was performed. In this case, the decay was very deep, so that the rubber dam was pierced during its removal. Teflon was used not only to improve the isolation but also to visualize the exact limits of the carious lesion. Two-year control showed an ideal periodontal integration of the restoration (Figs 52 to 61).

Fig 53 Radiographic view prior to treatment.

Fig 54 Carious tissue removal and rubber dam piercing.

Fig 55 Isolation improvement with Teflon and cavity limits visualization.

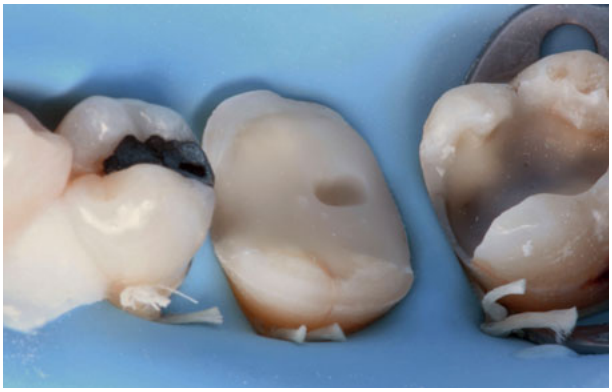

Fig 56 IDS and DME with filled flowable composite.

Fig 57 Preheated composite bonding.

Fig 58 Final view.

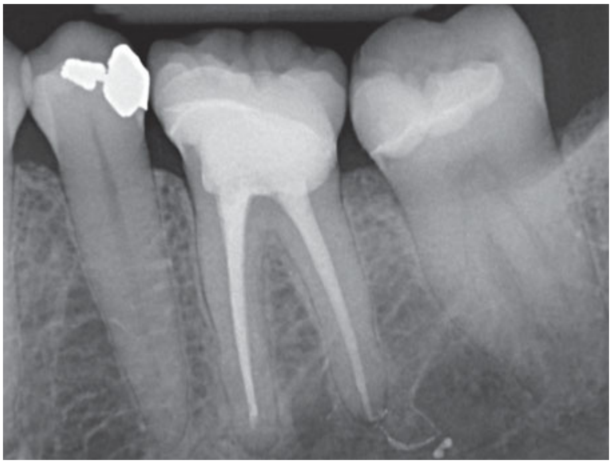

Fig 59 Immediate radiographic control.

Fig 60 2-year clinical control showing a 3-mm pocket depth probing in a healthy sulcus.

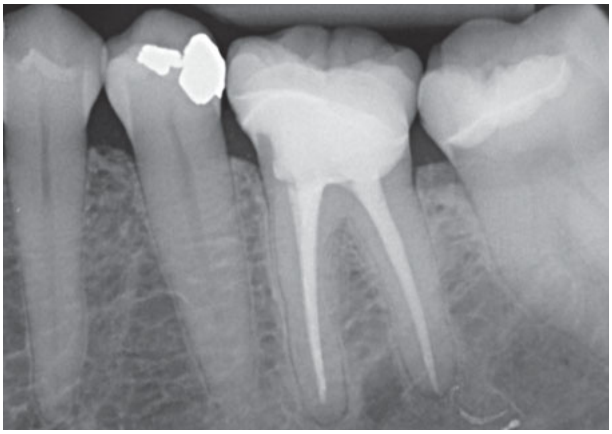

Fig 61 2-year radiographic control showing no bone loss around the composite.

Conclusion

From a clinical point of view, DME seems to be well tolerated by the periodontium when a good bonding with a proper isolation is performed, leading to very few or no signs of clinical inflammation. From a histologic point of view, it is clear that no connective attachment could be obtained on the material, and that DME did not lead to the recreation of a normal periodontal attachment, but rather to a different biologic width, mainly composed of a long junctional epithelium and a slight connective attachment on the dentin below the material. Even though it is far from the ultimate goal of a regeneration of a normal attachment apparatus, this situation seems healthy and well tolerated by the organisms. Further clinical and histologic studies are needed to confirm this conclusion.

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