The "index cutback technique": a three-dimensional guided layering approach in direct class IV composite restorations

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Abstract

One of the main difficulties encountered with conventional class IV direct composite restorations is the layering management in terms of three-dimensionality and shape control. The major concern is the predictability of the esthetic outcome, which is closely linked to the clinician's skills. This article presents a predictable approach to treat class IV direct composite restorations. The technique allows for the shape and thickness of different composite layers to be guided through transparent indexes that have been carried out previously on a planned wax-up. The final goal is to achieve a good esthetic outcome in an easy and fast way through a copy-and-paste approach. The "index cutback technique" is a complementary variant of the "index technique" for class IV direct restorations. After the casts have been generated, the technician creates a full wax-up of the tooth to be restored. A transparent silicone key of the full wax-up provides the full enamel index that is then cut with a blade along the incisal edge to achieve two enamel indexes, one palatal and one buccal. Then, the required amount of wax is removed from the full wax-up through a cutback step. The aim of this step is to remove a suitable amount of wax to leave a predetermined space for the composite enamel layers, both on the palatal and buccal surfaces. A second transparent silicone key is built on the cutback wax-up to achieve the cutback dentin index, which is then used to press the composite dentin onto the prepared tooth.
(Int J Esthet Dent 2017;12:2–18)

Introduction

In recent years, the development of composite resin materials has resulted in them having similar optical properties to natural teeth. Manufacturers have achieved composite resin materials that meet the demands of both clinicians and patients, provided they are used with specific protocols.

Different treatment options can be applied to each tooth in the anterior sextants. Depending on the severity of the enamel and dentin loss due to trauma, caries, and/or the size of preexisting restorations that must be removed, clinicians can choose between direct restorations, partial indirect restorations, or full dental prostheses. The reliability of adhesive and composite resin materials[1,2] has extended the indication range of the direct technique. Furthermore, direct composite restorations in vital and non-vital teeth are minimally invasive treatment options due to the sound tooth preservation principles involved, as well as the possibility for easy re-intervention and refurbishing. Moreover, the lower costs associated with direct composite restorations compared to indirect restorations needs to be considered.[3-5]

Nowadays, the composite market is such that clinicians performing anterior restorations can select various materials, depending on the value, chroma, hue, translucency, fluorescence, opalescence, mechanical strength, and elasticity desired. These different properties can sometimes be confusing for clinicians, especially when they need to select the right colors to achieve a good chromatic integration for the final outcome. Very often, clinicians tend to concentrate on selecting the right colors but ignore the importance of shape control and accurate planning of three-dimensional (3D) thicknesses within each layer. However, these aspects are very important to the final outcome.

Furthermore, the clinician's experience with a given material is of paramount importance, bearing in mind that the same composite mass will look opaque in thick layers and translucent in thinner ones. The thickness of the layer strictly relates to the value, which represents the most important parameter in the color characteristics perceived by the human eye.[6]

Shape and thicknesses: the key points

Many parameters need to be taken into account when approaching a class IV direct composite restoration. Apart from color, in a multilayered restoration the thickness of the various composite layers (dentin and translucent shades) and their 3D proportions greatly influence the final esthetic outcome.[7-13]

The color of the restoration is the result of an accurate selection of shades. Dentin masses should be used to provide the correct chroma in order to match the adjacent natural teeth. Enamel masses, on the other hand, are intended to be a color modifier as far as the value of the restoration is concerned. Their change in thickness from the cervical to the incisal area, especially on the buccal surface, is crucial for the final esthetic outcome.[14,15,17]

The color evaluation is based on an accurate analysis of the neighboring teeth.

Fig 1 Initial case: young patient with a fracture of tooth 21. The patient already had a direct composite restoration that broke (cohesive fracture) due to a new trauma.

Fig 2 After field isolation, minimal chamfer preparation (approximately 1 mm) is performed on the buccal surface with a 1.8-mm diameter round diamond bur.

It can be enhanced by photographs taken at different exposures (deep shade analysis) and eventually converted into a gray scale (value). In the same way, much information about shape can be obtained from the direct observation of natural teeth, as well as photographs taken under different conditions of artificial light (such as changing flash position, and with and without bouncers). Photography is a useful tool for a careful evaluation of macro- and microanatomic details. The stone cast evaluation is also useful for this purpose in order to cover more anatomical aspects.

Only after an accurate analysis is it possible to plan a multilayered restoration that can mimic the optical behavior of the natural tooth. As pointed out previously, the key to success is the control of the thickness of every single layer. Many clinicians use sagittal silicone guides or dedicated instruments to control this.[3] However, these layering strategies are always supplementary to the clinician's knowledge of the restorative material employed, which is crucial.

What is apparent is that there is a lack of standardization in the optical behavior of enamel-like and dentin-like composites of different brands. It is therefore very important for the clinician to have sufficient confidence with a composite system to be able to predict the necessary thickness of a certain composite layer in order to achieve the desired esthetic outcome. When this early assumption is fulfilled, the goal is to manage and control the planned dentin and enamel thicknesses three-dimensionally.[7-13] The index cutback technique described in this article is a modified and improved approach to the management of layers and shape. It allows a more predictable and operator-independent restorative strategy with respect to the conventional approach to class IV restorations.

Tooth preparation

Most class IV restorations are re-dentistry, or are performed due to traumas (Fig 1). The first aim of tooth prepar-

Fig 3 A full wax-up is performed by the technician.

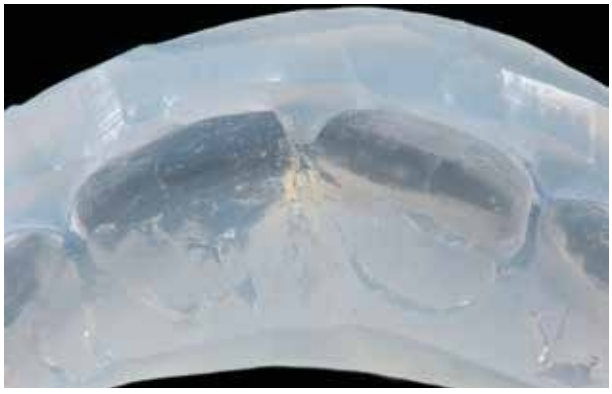

Fig 4 The full enamel index is achieved on the full wax-up.

ation is to remove all traces of decay or previous restorations. Furthermore, unsupported enamel and the removal of discolored dentin (if present) have to be taken into account. A short and definite bevel can be performed with a round diamond bur. Also, a small chamfer can be carried out in the buccal area to achieve a smoother transition between composite and natural enamel (Fig 2). Indeed, the index cutback technique can be used for any tooth preparation. A flat (butt) margin (see Fig 16) is carried out on the palatal and interproximal surfaces. Finally, fine diamond burs and aluminum oxide finishing disks are used to take care of delicate and frail enamel prisms that could break off during light curing and lead to marginal gap formation and, potentially, to discoloration or infiltration of the restoration.[9-11]

Conventional silicone index approach

One of the main difficulties in approaching a class IV direct composite restoration is the management of composite layers three-dimensionally. Two different composite materials have to be handled: 1) the dentin is the inner body mass; 2) the enamel is placed to create palatal, buccal, and interproximal surfaces. The lack of guided layering management can lead to color matching failure due, for example, to a dentin under-application, and therefore a thicker enamel layer, which can cause a final grayish effect. This is what happens with many enamel composite masses when the layer thickness increases.[3,9-11]

When no palatal guides or references are used to build up the palatal wall (ie, when the freehand layering technique is employed), important static and dynamic occlusal adjustments can occur when the restoration is complete. This may lead to esthetic failure due to excessive composite removal in the palatal and incisal areas. A rough trimming of the restoration to create proper occlusal contacts with the antagonist teeth can modify the relative proportion of the composite enamel and dentin layers and, finally, the optical behavior of the restoration itself. Apart from this, the

procedure is time consuming. It is for all these reasons that the freehand layering technique is not recommended.

To better manage the abovementioned issues, some authors[14-17] have proposed the use of a rigid silicone matrix as a stable guide for creating the palatal surface and the incisal edge. This layering guide can be achieved in three different ways:

1. From an intraoral silicone impression of the preexisting restoration, provided it has a good shape and the clinician simply wants to copy it.
2. From a wax-up previously performed on a cast by the technician (Fig 3).[3]
3. From an intraoral silicone impression of a freehand composite build-up, made without adhesion and dental dam.

The interproximal surfaces are usually managed with wooden wedges and acetate matrices to create a natural emergence profile and a good contact area. The dentinal body and the buccal enamel in the incisal third, together with opalescence and stains, then have to be layered into a virtual "box" (palatal surface, interproximal walls, and incisal edge). Three options are available:

1. A freehand solution based on the clinician's skills, where the evaluation of all the thicknesses is managed by eye, and mistakes may occur that could lead to esthetic failure.
2. Through several sagittal silicone matrices that allow the clinician to control the relative thickness of the various composite layers in a more predictable way (similar to what is done in prosthodontics during abutment preparation).

Fig 5 Buccal view of the cutback wax-up.

Fig 6 Incisal view of the cutback wax-up. The amount of wax that has been removed creates the space required for the composite enamel in the future restoration.

3. Through managing and controlling the thicknesses with the dedicated instruments currently available on the market.

Index cutback technique protocol

The aim of this protocol is to provide the clinician with a guided copy-and-paste approach in order to achieve control of enamel thickness and shape in a predictable and fast manner.

Fig 7 In the incisal third, the amount of wax removed should be approximately 0.8 mm.

Fig 8 In the middle third, the amount of wax removed should be approximately 0.5 mm (slightly less than that removed in the incisal third).

Fig 9 In the incisal third, 1 mm is left for stains and opalescent effects.

After the casts have been generated through impressions of both arches, a full wax-up of the teeth to be restored is performed by the technician (Fig 3). A transparent silicone key (ie, Memosil 2, Kulzer; Temp silic, Micerium) (Shore A hardness 72) of the full wax-up is built in the second sextant, achieving the full enamel index (Fig 4). Then, through a cutback step, the technician removes a specific amount of wax from the full wax-up, which provides the clinician with the ideal space for the composite enamel layer on both the palatal and buccal surfaces (Figs 5 and 6).[9] The approximate amount of wax to be cut away from the full wax-up should have a thickness of 0.2 mm in the cervical third, 0.5 mm in the middle third, and 0.8 mm in the incisal third (Figs 7 to 9, and 17). These values may vary between different composite brands due to differences in optical properties, as translucency and opacity are related to the material thickness needed over the different tooth areas.

A second transparent silicone key is then built on the cutback wax-up to achieve the cutback dentin index

Fig 10 The cutback dentin index is carried out on the cutback wax-up.

Fig 11 The full enamel index is cut with a blade to achieve a palatal enamel index.

Fig 12 The full enamel index is cut with a blade to achieve a buccal enamel index.

Fig 13 Final result after 1 week.

(Fig 10). The full enamel index is then cut with a blade along the incisal edge to achieve palatal and buccal enamel indexes (Figs 11 and 12), which will be used as guides for the palatal and buccal walls of the composite enamel restorations (Figs 13 to 15).

All the above procedures for the preparation of the indexes can be carried out before the patient attends the clinic. After the selection of dentinal/enamel composite masses, the field is isolated and the tooth prepared, as discussed previously. All three indexes – palatal enamel, buccal enamel, and cutback dentin (Figs 10 to 12, and 18), after having been trimmed on the cast, are checked in the mouth and eventually modified to set the landmarks for a perfect seating.

An adhesive technique protocol followed by curing can be performed.[2,18] A very thin flowable composite, as an option, can be layered and cured. Following this, the composite dentin is selected, which can also be preheated in order to have a higher conversion in the deepest part of the layer.[19] This is applied extraorally in the cutback dentin in-

Fig 14 Final result after 3 years.

Fig 15 Final result after 4 years.

dex, and then pressed onto the tooth to be restored. This step has to be carried out under control, checking previously set landmarks. A small chute can be made with a bur on the transparent index to allow the flow of the excess composite during the molding process. Light curing for 60 s is then required (Fig 19).

Applying a composite monolayer in these kinds of situations, where the C-factor is one of the most favorable due to the cavity design, is not considered

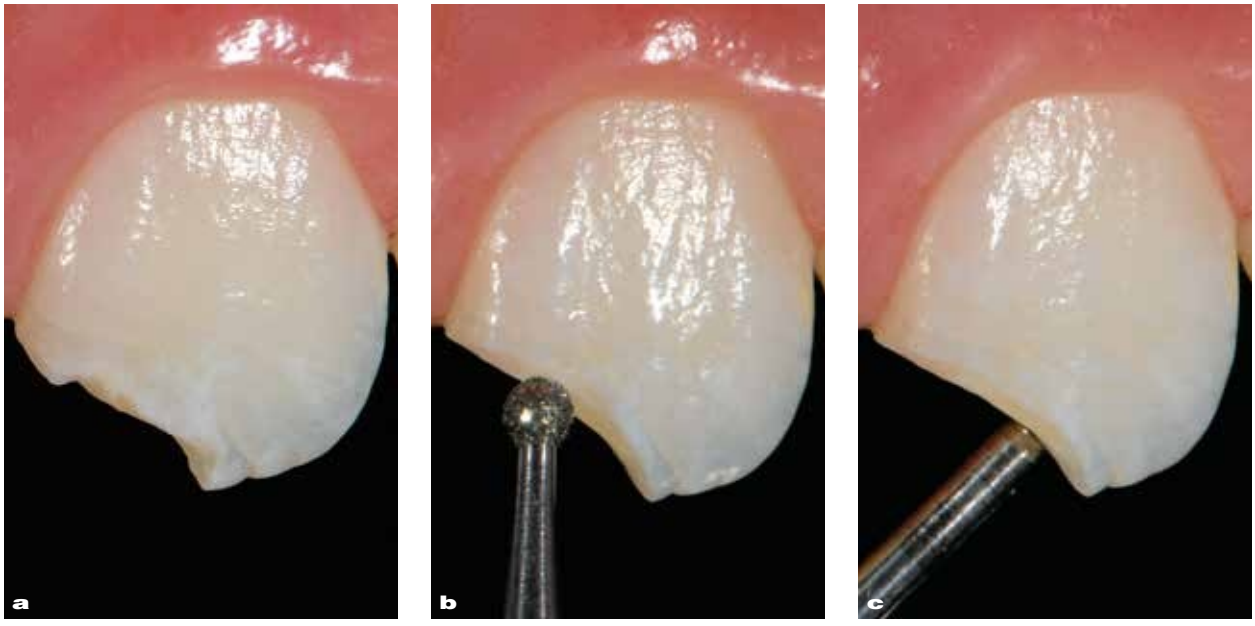

Fig 16 **(a)** Fracture of tooth 21 in an 8-year-old patient. **(b)** Minimal chamfer preparation (approximately 1 mm) is performed with a 1.8-mm diameter round diamond bur on the buccal surface. **(c)** Butt joint preparation of the palatal finishing line with a specific bur, which is working only on the head part.

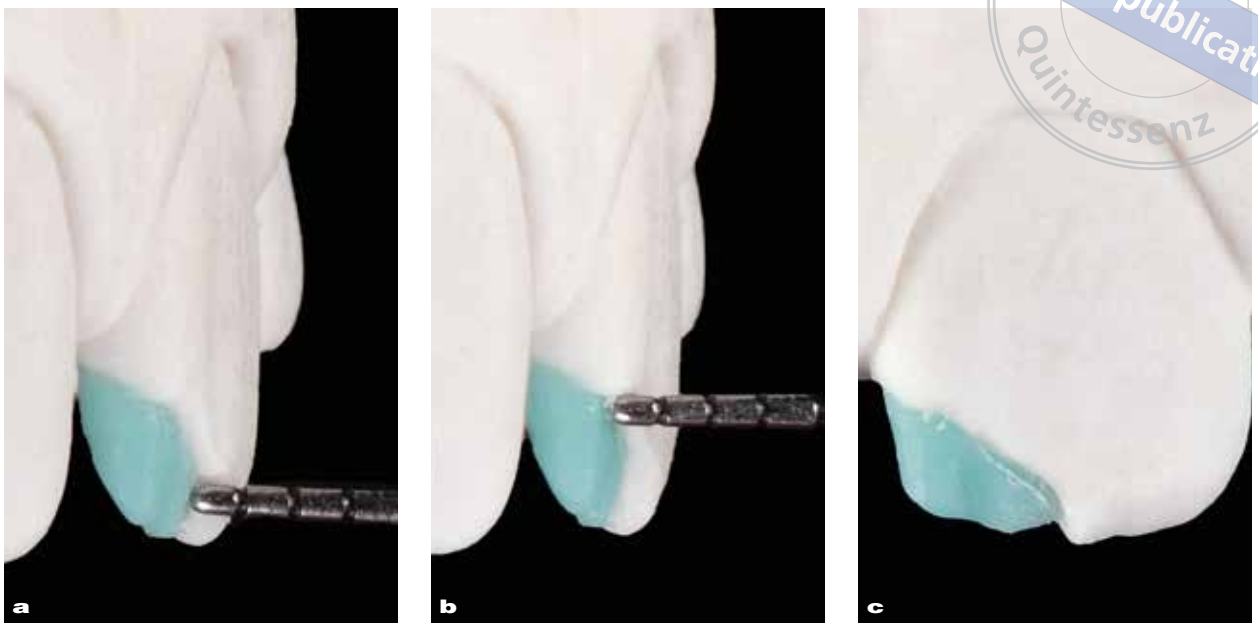

Fig 17 **(a)** Wax-up after the cutback of the enamel layer, the thickness of which is around 0.8 mm in the incisal third. **(b)** Wax-up after the cutback of the enamel layer, the thickness of which is around 0.5 mm in the middle third. **(c)** Buccal view of the cutback wax-up.

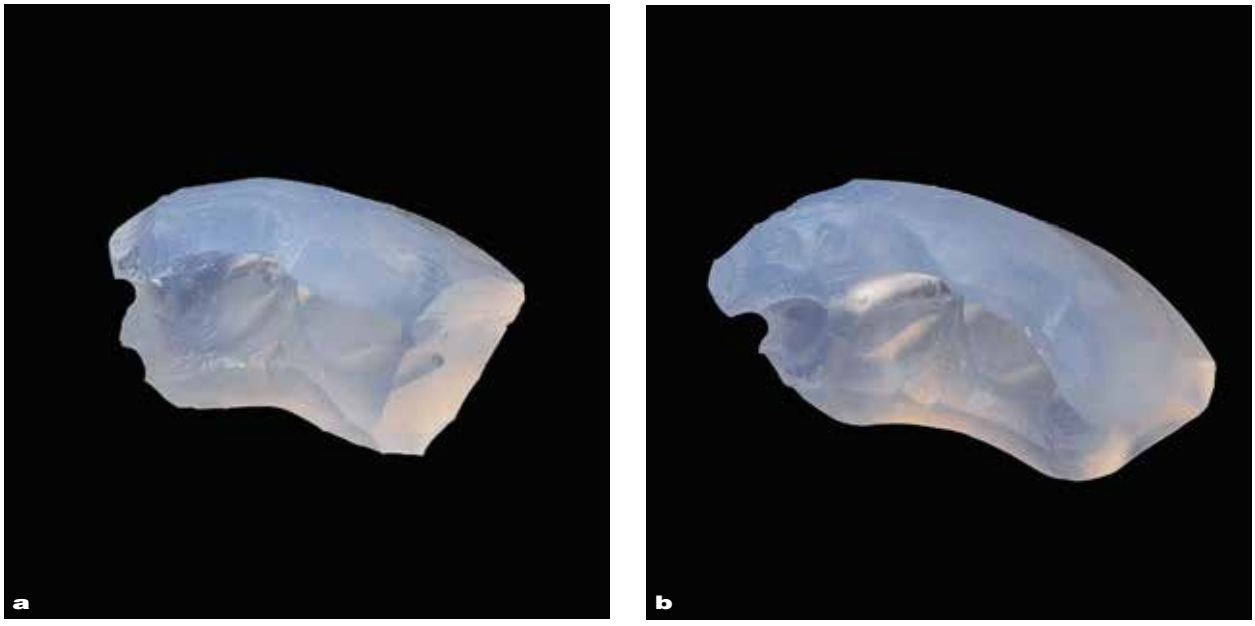

Fig 18 **(a)** Full enamel index achieved with a transparent silicone index. **(b)** Cutback dentin index achieved with a transparent silicone index on the cutback wax-up.

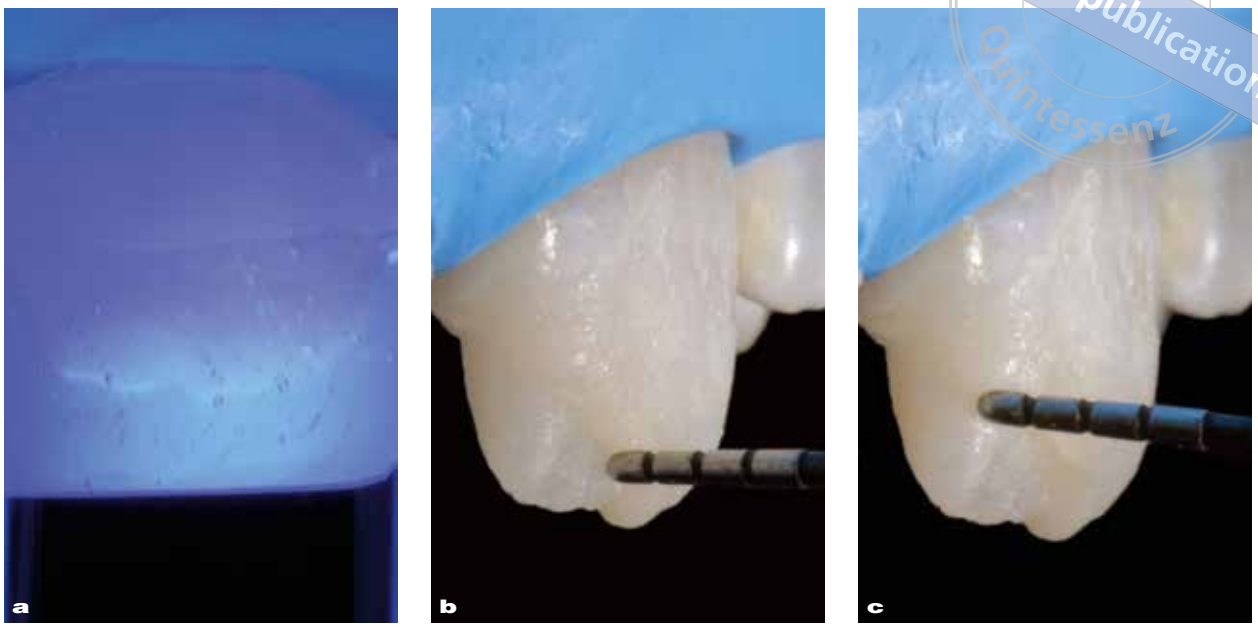

Fig 19 **(a)** Light curing of the dentinal body through the transparent cutback dentin index. **(b)** Composite thickness checked after luting the dentinal body cutback phase. Around 0.8-mm thickness is left for the next buccal composite enamel layer in the incisal third. **(c)** Composite thickness checked after luting the dentinal body cutback phase. Around 0.5-mm thickness is left for the next buccal composite enamel layer in the middle third.

Fig 20 The palatal shell composite enamel cured, applied with the full enamel index.

Fig 21 Additional stains and translucent effects are applied freehand near the incisal edge before pressing the last buccal enamel layer.

stressful for the residual healthy hard tissue.[20]

Afterwards, the palatal wall is restored with composite enamel by means of the full enamel palatal index. In this situation, the composite can be applied on the index extraorally and then placed on the tooth, checking for the appropriate landmarks (Figs 11 and 20). The interproximal walls are built in one layer, each with a sectional transparent matrix kept in place by wooden wedges. In each of these steps, extended curing time is required (60 s). Then, stains and opalescent effects can be applied near the incisal edge using a freehand approach and flowable materials or packable composite resins (Fig 21).

The last layering step is performed with composite enamel through the full enamel buccal index, which is filled with the material extraorally (Figs 12 and 22), and then placed on the tooth in the correct position. Again, light curing for at least 60 s is advisable (Fig 23). Also in this step, a small chute can be made with a bur on the transparent index to allow for the flow of excess composite during the

Fig 22 Buccal composite enamel positioned on the full enamel index.

Fig 23 Full enamel index positioned on the central incisor for the light curing phase.

Fig 24 Final result after finishing and polishing. The diffused light of the photograph highlights the surface details.

Fig 25 Initial clinical situation. The patient complained about the esthetics of her central incisors and was not satisfied with the color of her teeth.

Fig 26 Initial radiograph.

Fig 27 A complete wax-up of teeth 11 and 21 is performed by the technician.

Fig 28 The cutback of the wax-up is performed to predetermine the dentinal body and the space for the composite enamel of the restorations. The amount of wax removed from the buccal and palatal surfaces is related to the optical behavior of the composite system chosen for the restorations and must be communicated to the technician.

molding process. The full buccal index is then removed, and another 60 s light curing is performed under glycerine to achieve a better composite surface conversion, which improves surface resistance and allows for better finishing and polishing procedures.

Finishing is carried out initially with a low-grain bur at a slow speed without water to reproduce the macroanatomy. A silicone point on a handpiece is then used very gently on the composite surface. Before polishing, if required, a high-grain bur can be used at a low speed without water to scratch the composite surface, reproducing the microanatomy.[11-14] Polishing can then be carried out with various felts using diamond and aluminum oxide pastes, in sequence[11-14] (Fig 24).

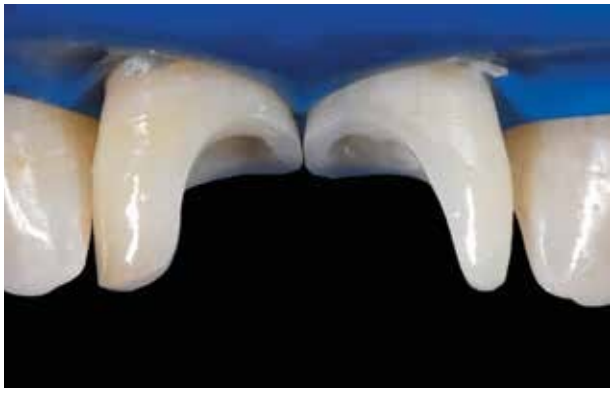

Fig 29 The cavity prepared for the restorative sequence.

Fig 30 Two glass fiber posts are cemented in the root canals of teeth 11 and 21. Their position and axis is checked by means of the palatal silicone index.

Fig 31 The cutback dentin index: The dentinal body is built up with composite resin pressed onto the teeth using the silicone index obtained from the cutback wax-up.

Fig 32 The palatal walls are performed in the same way as the dentin anatomy with the palatal index. This step requires some adjustments in the interproximal space between teeth 11 and 21 in order to ensure correct proportions and proper contact surfaces. Intensive and incisal effects are applied.

When the indications are present, the index cutback technique can be employed using the same protocol as described above on non-vital teeth (Figs 25 to 35).

Fig 33 The restorations of teeth 11 and 21 after finishing and polishing.

Fig 34 Final clinical result.

Fig 35 Final radiograph.

Conclusion

The index cutback technique, which is a complementary approach to the index technique[21] for class IV direct restorations, is a procedure that allows the clinician to previsualize – through a double wax-up (full and cutback) – composite dentin and enamel thicknesses, as well as the shape, for a class IV restoration. From the full and the cutback wax-up, two different transparent indexes are obtained.

This procedure allows for the control of the correct amount of dentin and enamel, as planned preoperatively by the clinician according to the diagnostic data, as well as the material employed. Along with the predetermination of the different composite material thicknesses that have to be managed, another interesting aspect associated with this approach is that the shape can also be predetermined and is easily achievable.

The driving force behind this technique is an easier management of the restoration, which is made possible by the transparent guiding indexes. This leads to a more predictable final result, independent of the clinician's skills.

While they do not propose that this technique replace the traditional restorative techniques, the authors point out that – despite it having more steps – this approach ensures an exact and repeatable reproduction of dentin and coronal anatomy. Above all, it once again demonstrates the versatility of modern composite systems when applied to innovative clinical protocols.

Today, composite materials enable us to perform very conservative restorations due to minimally invasive preparation that results in less structure removal.[22] At the same time, these direct composite restorations are cost effective and offer good esthetics. Also, they allow for easy repairing and refurbishing, which improves their longevity. They are, therefore, a viable option for the anterior region compared to other more invasive and expensive solutions. Finally, in addition to all the above-mentioned benefits, the easy handling involved enables the clinician to develop new techniques and widen the range of applications without performing more invasive treatment.[23-29]

Acknowledgments

The authors thank Maximiliano Valle CDT, Renato Alcidi CDT, and Cristian Marchini CDT for all the technical work carried out. A special thanks to Accademia Italiana di Odontoiatria Conservativa e Restaurativa (AIC), through which the authors gained knowledge.

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