



The “index technique” in worn dentition: a new and conservative approach

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Abstract

The development and reliability of adhesive resin composite systems have offered clinicians a further option for the management of tooth-surface loss. Patients with minimum, moderate, and severe hard tissue wear can be treated based on the application of minimally invasive adhesive composite restorations for posterior and anterior worn dentition. This article presents the “index technique”, a new and very conservative approach to the management of worn dentition. The technique allows for a purely additive treatment without sacrificing healthy hard tooth tissue. It follows the principles of bioeconomics (maximum conservation of healthy tissue) and the reinforcing of residual dental structure. Depending on the severity of enamel

and dentin wear, the number of caries, and the size of existing restorations, different treatment options can be applied to each tooth: direct and indirect partial restorations, or full crowns. It is essential to diagnose and treat tooth-surface loss in order to properly restore biomechanics, function, and esthetics by means of adhesive restorations. This article proposes that the index technique is a fast and conservative approach for the planning and management of a full-mouth adhesive treatment in all cases of worn dentition. The technique is based on stamping composite directly on the tooth surface by means of a transparent index created from the full-mouth wax-up following an initially planned increase in occlusal vertical dimension (OVD).

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Introduction

In recent years, the increase in tooth wear has been a major concern for the dental profession. The multifactorial causes that trigger tooth erosion include behavioral changes, an unbalanced diet, and various medical conditions, including acid regurgitation and medications that influence saliva composition and flow rate.¹ Further, awake and sleep bruxism is a widespread functional disorder which also induces severe tissue attrition. All of these factors must be taken into consideration when managing worn dentition in patients.

The consequences of tooth-surface loss are biological (sensitivity and, in extreme cases, pulpal exposure), functional (loss of canine and incisor guidance), and esthetic.

Early diagnosis of tooth wear is essential in order for the clinician to possibly restore the teeth with an adhesive technique by means of direct and indirect partial restorations to recreate tooth anatomy, function, and esthetics, and to prevent further tooth loss (Fig 1). The approach presented in this article will avoid, or at least postpone, a more complex and invasive prosthetic rehabilitation, ultimately having a positive biomechanical impact on long-term maintenance.²⁻⁵ Many authors have shown the proven potentiality of adhesive techniques and the use of resin composites for the treatment of moderate cases of tooth wear.⁶⁻¹⁴ The behavior of composite resin with the opposing natural enamel should also be considered, since its wear is 4 times faster, given also that ceramic wears 3 times less when opposing natural dentition.¹⁵ Lithium disilicate

has become a valid alternative to composite restorations in recent years due to its mechanical properties.¹⁶

The aim of this article is to propose an alternative and very conservative technique in the management of moderately worn dentition, which maintains all of the existing tooth structure. The first goal of this approach is a functional one, involving the application of the principles of bioeconomics which aim to maintain as much enamel and dentin as possible and gain the space required for the restorative materials by altering the occlusal vertical dimension (OVD) prior to tooth preparation. The second (periodontal) goal is to prevent and reduce potential inflammation and recession by maintaining the restorative margins far away from the periodontal tissues. The third (esthetic) goal can be achieved by applying the adhesive techniques of state-of-the-art composite restorations.

Index technique protocol

Many authors (especially Francesca Vailati, Roberto Spreafico and Didier Dietschi) have suggested, and proven through follow-ups, that the use of adhesive systems and resin composites are reliable in all cases of worn dentition.^{6-14,17-21} We therefore propose a new and extremely conservative technique using composite to directly restore worn dental surfaces.

The index technique is a protocol that can be performed in all cases of moderate worn dentition due to abrasion or erosion. It allows the clinician to mold and restore with composite, directly and separately, one or more teeth on the pos-



terior and anterior sextants by means of a transparent silicone matrix (Memosil 2, Heraeus Kulzer). The index is created by injecting the material over the diagnostic wax-up cast that was previously made when planning the full rehabilitation. When curing has been completed (3 min, Shore A hardness 72), the index is removed from the cast and trimmed with a surgical blade, taking care to separate the single elements so as to achieve a single matrix for each tooth that needs to be restored. Each single matrix is tried on the cast to check the fit around each waxing.

The teeth involved in the rehabilitation are isolated with a rubber dam, and each index is tried in the mouth and eventually modified with a surgical blade to achieve a very precise fit to the landmarks, which on posterior and anterior segments are usually located on the equatorial region of the buccal/lingual surfaces.

Checking the landmarks is very important for the correct positioning of each single index in order to perform and achieve a predictable restoration. For teeth that only have to be lengthened, the landmarks for the index are located at the tooth equator on the buccal and lingual/palatal aspect. For teeth that have to be lengthened and increased in volume buccally and palatally, the only true landmark is at the tooth emergence level of the gingival margin. Where it is more convenient, a small hole can be made with a bur on each transparent index to allow the flow of the excess composite during the molding process.

The teeth involved in the treatment are managed individually and are often not even touched with a bur but are simply treated applying an adhesive protocol.

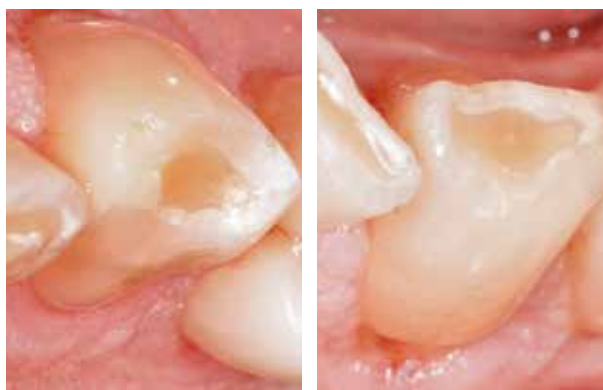


Fig 1 Initial situation showing moderate dental wear.

Two steel matrix bands (Hawe Steel Matrix Bands, Kerr) are placed previously interproximally in order to protect the adjacent teeth. Following this, the pre-heated composite is layered onto the tooth surface with a spatula and the index is placed, checking that it will seat to the landmarks described previously. The excess composite that flows out beneath the index and eventually through the hole, as previously described, is removed with a spatula or a probe, and the composite material is cured through the transparent matrix. The index is then removed following planned curing cycles, allowing for the finishing steps of excess composite removal and polishing to be carried out. Once the clinician has completed the direct restoration, the same steps can be carried out on the adjacent teeth to finalize the planned rehabilitation.

The indication for the use of this direct technique is mainly in cases where there has been a minimum or moderate loss of enamel and dentin, or to increase and/or modify volume in one or more teeth of the posterior and anterior sextants.



In the management of cases of moderate tissue wear, the main benefits of the index technique are the bioeconomics associated with minimal invasiveness, eg, in cases where an old restoration or decay requires removal. In situations where there is only sound residual tooth structure present, a total additive approach rather than a conventional subtractive–additive approach will be applied, since the increase in the OVD will allow for the achievement of the required restorative spaces, leading to a total absence of invasive techniques.

Total reversibility is another important characteristic of this technique. It allows the clinician to restore the patient's initial situation at the end of treatment (if, for any reason, this becomes necessary), although it should be borne in mind that composite removal after adhesive protocols is not as easy to perform due to bonding strength and composite chromatic integration with the tooth.

Another positive characteristic of this technique is the relative ease with which chipping or restorative failure can be managed by applying a simple adhesive protocol. This makes the overall treatment fairly simple.

A further benefit of this technique over traditional prosthetic rehabilitations is the shorter clinical time required to finalize a case, which in turn influences management costs. The only real expense for the clinician is the diagnostic wax-up carried out by the technician for the purpose of correct planning of the case and to obtain the transparent index required (Table 1).

Vertical dimension and centric relation

Increasing the interocclusal space by changing the OVD was not a commonly used treatment modality in the past because it was thought that the rest position of the mandible was fixed and not able to be altered.^{22,23} Further, at times it may not be possible to significantly alter the OVD because tooth eruption can occur at the same rate as tooth wear, in which case the OVD will remain unchanged. However, if tooth eruption does not keep pace with tooth wear, the OVD may decrease over time.²⁴ Regardless, in the presence of worn dentition, with or without signs of altered passive eruption, there is still the need to preserve as much of the remaining tooth structure as possible and to attempt to alter the OVD to create space for the restorative material prior to tooth preparation.²⁵ Therefore, in cases where there is moderate to severe worn dentition, increasing the OVD is essential to reduce tooth preparation and avoid endodontic treatment.

The OVD should be increased by the minimum amount required in order for it to be better tolerated by the patient.¹⁷⁻¹⁹ An esthetic analysis should be carried out during the diagnostic phase to achieve a predictable result and to decide the amount by which the OVD should be increased. This should be carried out with the help of the technician, and comprise photos, videos, and the patient's smile analyzed on a computer while pronouncing the letter "e". It is very important to observe the position of the incisal edges of the 2 degree sextant in relation to the distance be-

**Table 1** Index technique protocol: summary of key points

	Workflow with no TMJ and muscle problems	Workflow with TMJ and muscle problems
1	Through an esthetic analysis it is possible to evaluate the incisal edges to decide how much the teeth can be lengthened apical and/or incisal, and consequently on all posterior teeth	In cases where muscle and/or TMJ problems are detected, patients should undergo bite therapy to relieve symptoms before increasing VDO; following this, an esthetic analysis is carried out to evaluate the incisal edges to decide how much the teeth can be lengthened apical and/or incisal, and consequently on all posterior teeth
2	Wax-up is then performed and converted in a mock-up to evaluate and eventually modify esthetics, phonetics, function, and occlusal plane	Wax-up is then performed and converted in a mock-up to evaluate and eventually modify esthetics, phonetics, function, and occlusal plane
3	Each single transparent index on the anterior sextants is created from the final diagnostic wax-up; in one appointment the two sextants are restored with the index technique, without preparing the teeth, achieving simultaneous bilateral contacts on the canines	Each single transparent index on the anterior sextants is created from the final diagnostic wax-up; in one appointment the two sextants are restored with the index technique, without preparing the teeth, achieving simultaneous bilateral contacts on the canines
4	Each single transparent index on the posterior sextants is created from the final diagnostic wax-up; according to the time available, it is possible to schedule the restorations of the four sextants in one appointment or more	Each single transparent index on the posterior sextants is created from the final diagnostic wax-up; according to the time available, it is possible to schedule the restorations of the four sextants in one appointment or more

tween the upper and lower lip to decide where and by how much the teeth can be lengthened (apical and/or incisal) in this sextant and, consequently, on all the maxillary posterior teeth. Once the wax-up is converted into a mock-up, to check whether the maxillary incisors are too long, the patient should pronounce the letter “f”, during which the maxillary incisors should not sink into the lower lip. To check whether the new OVD is correct, the patient should pronounce words beginning with the letter “s”. If the OVD has been increased too much, the two arches will contact prematurely.

The final goal of such a rehabilitation is to provide efficient anterior guidance and stability in the posterior areas with a stable occlusion. Many studies dealing with full-mouth rehabilitations associated with increasing the OVD have shown how it is preferable to plan such cases in a centric relation (CR) position,^{26,27} that being the only acceptable and reproducible position.

When it has been decided to treat a case in CR and increase the OVD, the class molar occlusion should be checked because if the patient is in Class II occlusion there is a risk of losing anterior



Fig 2 The OVD must be increased according to a “reorganizational” approach.

guidance by the end of the treatment. In such situations, orthognathic surgery, orthodontics, direct and indirect restorations, or a combination of these therapies should be considered when planning the case. In re-establishing anterior guidance, care should be taken not to create oversized cingula in the maxillary anterior teeth and thick incisal edges of sextant 5.

Muscular tension and joint problems should be checked before starting treatment. Further investigations could be carried out with the aid of magnetic resonance scans to rule out degenerative articular diseases. In cases where muscular or articular symptoms are present, bite therapy based on posterior support should be carried out prior to starting the planned therapy.

Treatment guidelines

The following factors should be taken into account during the initial diagnosis: loss of periodontal support, periapical lesions, insufficient root canal treatments,

insufficient existing restorations, and any recurrent or new decay. A precise diagnosis for the cause of the dental wear should be made so as to understand whether the origin is physical (bruxism or friction), or chemical (erosion due to endogenous or exogenous substances).

Before the start of therapy, patients should begin a strict oral hygiene and maintenance protocol, including the use of fluoride and chlorhexidine, in order to reduce the risk of caries. Dietary habits needs to be examined, and acidic meals reduced.²⁸

All of the urgent or emergency treatment should be carried out prior to the planning of the index technique. The approach of the technique can be a “conforming” one, where the OVD is not altered but the main treatment is carried out on sextants 2 and 5 (since the anterior guidance has been lost due to wear, and the incisal edges need lengthening). Cases in which this approach is used need to be evaluated carefully by the clinician, who should be aware of the risk of mechanical failure due to the thin layers of composite applied on function-



Fig 3 Leaf gauge in position to increase the OVD and record a CR position, which is essential when planning a full-mouth rehabilitation.



Fig 4 A full-mouth wax-up is performed, beginning with a correct esthetic analysis.

al surfaces. Alternatively, the approach could be a “reorganizational” one, which entails a more complex therapy whereby the OVD requires altering to create the correct interocclusal space for the restorations to be carried out (Fig 2).

In order to record CR, the patient is deprogrammed by means of a leaf gauge,^{29,30} aiding the condyles in a superior/anterior position through a self-induced technique (Fig 3). Following this, the wax records are taken with a heated and folded sheet (Beauty Pink, Moyco Union Broach) or a silicone-based material (Jet Bite, Coltene) on the posterior quadrants with a leaf gauge between sextants 2 and 5 in order to register a new OVD in CR (Fig 3). There-

after, a facebow record is essential for an arbitrary esthetic plan.

The dental technician receives two impressions of the dental arches from the clinician: a facebow fork, and a wax record of the new OVD in CR. Casts are then mounted on a semi-adjustable articulator (Artex CR, Amann Girrbach) in CR at the new OVD, slight changes to which could be required at this stage. A full esthetic evaluation is carried out, with photos and a video reproducing the face and smile in a dynamic situation. This information is essential for the technician and clinician to properly evaluate the patient before being able to plan an esthetically driven diagnostic wax-up (Fig 4). Such a plan will take into

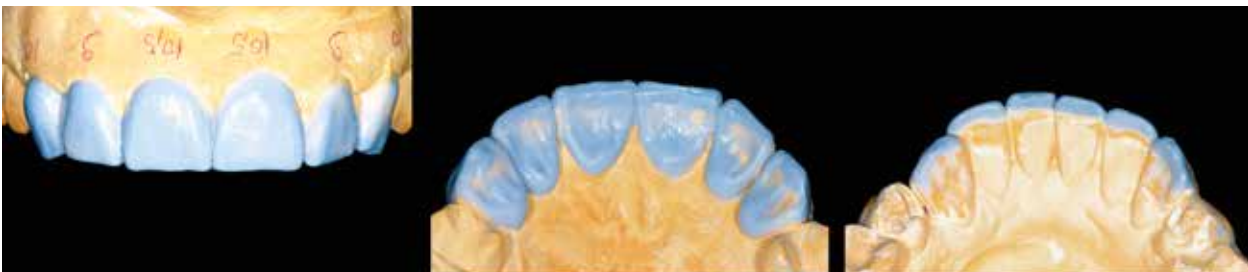





Fig 5 A mock-up is constructed from the wax-up, essential for an esthetic and functional evaluation.



Table 2 Three options for the reconstruction of the anterior sextants

1	2	3
		
<p><i>Incisal edge (IE)</i> Allows the restoration of the incisal edges on anterior sextants in all cases where OVD increase is not needed but canine and anterior guidance have been lost due to grinding/erosion</p>	<p><i>Palatal incisal (PI)</i> Allows the restoration, increasing the OVD, of both incisal edges and the volume on the palatal aspect (on sextant 2), which have been lost due to grinding/erosion</p>	<p><i>Full veneering (FV)</i> Allows the restoration, increasing the OVD, of both incisal edges and the volume on the palatal/buccal aspect (on sextant 2), which have been lost due to grinding/erosion</p>

consideration a functional evaluation of the occlusal plane, anterior guidance, canine guidance, and occlusal stability on the posterior sextants (Fig 5).

A direct composite mock-up from 15 to 25 is made from a transparent silicone key fabricated on the diagnostic wax-up models. This is an essential step in the therapy since the patient, clinician, and technician can start to visualize the planned outcome, with everything being easily reversible or altered.



Fig 6 A wax-up is performed on sextant 2 and 5 to achieve correct canine and anterior guidance.

Anterior index technique

Following the mock-up evaluations, the correct alterations can be carried out on the wax-up models prior to the index construction. The index technique always begins by restoring sextants 2 and 5. To avoid problems, the correct series of appointments with the patient should be scheduled at the start of treatment so that the entire therapy can be carried out in the shortest possible time to avoid leaving the patient in an uncomfortable occlusal situation (Table 2).

Incisal edge (IE)

The incisal edge (IE) option allows for the restoration of the incisal edges on the anterior sextants without an increase in the OVD in cases where the anterior and canine guidance have been lost due to wear. Usually, a mock-up is not required in these situations as only small changes are made. A transparent silicone index key (Memosil 2, Heraeus Kulzer) of Shore A hardness 72 is made on the di-



Fig 7 An etch-and-rinse technique is performed without preparing the tooth, followed by a restoration applying the index technique protocol.



Fig 8 The index is trimmed with a blade and a try-in is carried out to check the fit at the predetermined landmarks; heated composite is then placed on the incisal edge and light cured for 60 s (with index) and 120 s (without index).



agnostic wax-up models for sextant 2, where the incisal edges of 13, 11, 21 and 23 need to be lengthened (Fig 6).

Each silicone key is then trimmed with a surgical blade to achieve a 2 to 3 mm thickness, and tried on the cast to check for the correct fit. A rubber dam is then placed in the upper anterior sextant to treat the involved teeth, and the fit of each index is checked by placing two metal matrices (Hawe Steel Matrix Bands, Kerr) interproximally to achieve proper tooth separation. If necessary, the transparent silicone indices are trimmed until a proper fit is achieved around the tooth's equatorial area, which is the key landmark in this option. The teeth to be restored are not prepared with rotary instruments, but a three-step etch-and-rinse technique is performed,^{31,32} followed by 60 s curing. Composite shades are chosen prior to

rubber dam placement, then heated before placing the increments on each tooth (Fig 7).

The two metal matrices are bent distally towards the adjacent teeth before the composite resin is placed on 11 with a spatula. The transparent matrix is then seated accordingly, always checking for a proper fit at the landmark (equatorial area). Finger pressure is maintained buccally and palatally while the excess composite is removed with a probe or spatula. The site is then light cured through the silicone index initially for 60 s and then for a further 120 s incisally following index removal (Fig 8).

Finishing of the composite excess is performed with interproximal metal strips, paper discs, fine diamond burs, and an Eva handpiece (Fig 9). This protocol is then carried out for all the teeth involved in the therapy.

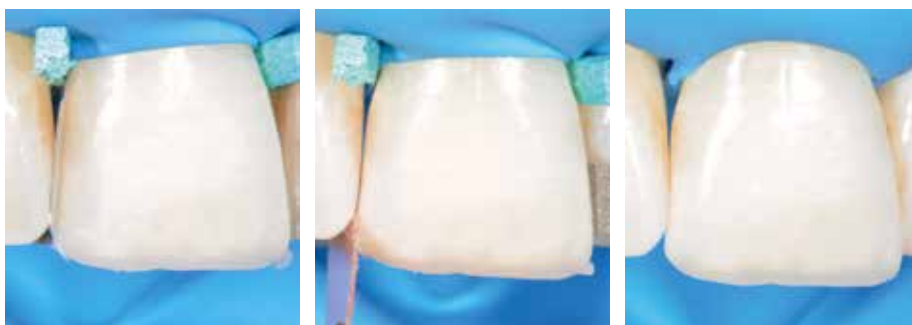


Fig 9 Following curing, finishing steps are performed.



Fig 10 The index technique has been performed on 33 and 43.

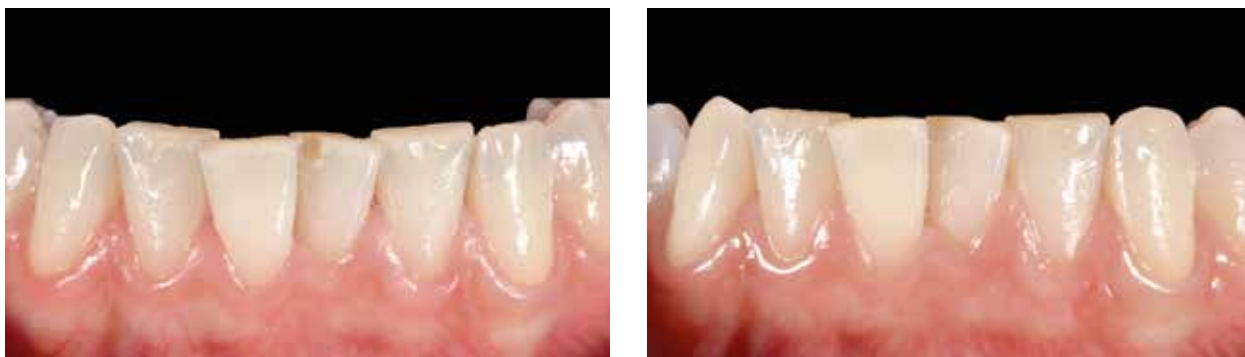


Fig 11 Pre- and post-treatment on sextant 5.

This protocol is also performed on sextant 5 in the same appointment. The teeth involved in the treatment are lengthened on the incisal edges with the index technique, based on the pre-

viously developed wax-up (Figs 10 and 11).

The final goal is to establish a correct canine and anterior guidance (Fig 12) in order to have good posterior protection



Fig 12 A good protection of posterior teeth due to a correct canine guidance.



Fig 13 Once anterior and canine guidance are established, posterior restorations can be carried out. Sextant 1 is restored with a direct composite restoration (17) and a partial indirect composite restoration (16).



Fig 14 Brux Checker is delivered to the patient at post-therapy stage. One night of wearing the device records dynamic occlusion to check the paths and behavior of the restorations. The case shows 13 and 23 working for a correct posterior disclusion.

during dynamic occlusion so as to restore these sextants with a low chipping risk (Fig 13).

Brux Checker (Scheu Dental Technology), a device made with a 0.1 mm-

thick polyvinyl chloride sheet, can be used to check occlusal patterns during sleep bruxism, where the clinician has no control and failures can occur. Patients can wear it with no interferences



Fig 15 Abraded incisal edges.



Fig 16 Erosion due to a diet rich in lemons.

for one night whilst sleeping to record real tooth-grinding conditions during sleep bruxism. Brux Checker is useful in the diagnostic stage, and may also be used in post-therapy evaluation to check the function and behavior of the restorations, especially in dynamic occlusion³² (Fig 14).

Palatal/incisal (PI)

The palatal/incisal (PI) edge option allows the restoration of the teeth in sextant 2 that have lost incisal edge length and also have inadequate volume on the palatal aspect (Fig 15). These cases require an increase in the OVD. It is therefore even more important to schedule enough appointments prior to the start of treatment so that the patient is not left in an uncomfortable position for a long time.

A clinical case is described with erosion on the posterior sextants due to a diet rich in lemons, and visible abrasion marks on the anterior teeth (Figs 15



Fig 17 Index technique, PI option. Incisal edges and palatal volume of sextant 2 require restoring.

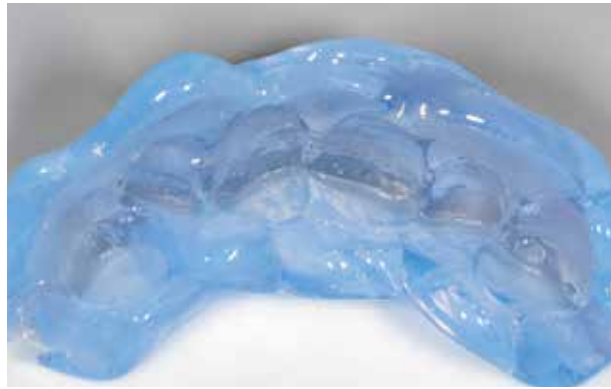


Fig 18 A transparent silicone key is made.



Fig 19 According to the index technique protocol, a rubber dam is placed to restore the incisal edges and palatal volumes of sextant 2.

and 16). The patient was advised to undergo orthodontic treatment to align and derotate the two arches prior to considering any restorative procedure, but the advice was declined. The patient's posterior teeth were sensitive to temperature and her anterior teeth were short. She wanted a very conservative treatment.

A complete esthetic analysis is carried out, as previously described. According to this second option (PI), as the incisal edges and also the volume on the palatal aspect of all of sextant 2 has to

be restored (Fig 17), a transparent silicone key (Memosil 2, Heraeus Kulzer) of Shore A hardness 72 of the final wax-up is made on sextant 2 (Fig 18). Following chemical curing, the key is cut with a surgical blade to achieve six single transparent indices. Each index is tried on the cast to check for the correct fit. A rubber dam is then placed to treat sextant 2. The teeth are not prepared with rotary instruments but only cleaned with pumice (Fig 19). For esthetic reasons only, a bevel can be performed on the buccal edge to achieve better chromatic inte-



Fig 20 Following an adhesive protocol, heated composite is placed on the tooth with a spatula. The silicone index is then placed on 12, checking the landmarks to achieve the correct position. After curing, the index is removed and the finishing/polishing protocol can take place.

gration. The fit of each index is checked by placing two metal matrices (Have Steel Matrix Bands, Kerr) interproximally to achieve proper tooth separation. If required, the transparent silicone indices are trimmed until a proper fit is achieved.

The same adhesive protocol is followed for PI as for IE. A three-step etch-and-rinse technique is performed on one tooth at a time.³¹ Each tooth is then cured for 60 s (Demi Power 1,100 to 1,330 mW/cm², Kerr). Composite shades are chosen prior to dam placement, then heated prior to placing the increments on each tooth. As described for IE, the two metal matrices that were placed to protect the adjacent teeth are bent distally towards the adjacent teeth before the composite resin is placed on the palatal surface and the incisal edge with a spatula. The index is then placed on the first tooth, usually starting from 13 or 23, taking even more care in the seating of the transparent matrix, since the palatal landmark is the emergence profile at the gingival level where the rubber dam is positioned. The landmark on the buccal aspect is the equatorial area. Finger pressure is maintained buccally

and palatally while the excess composite is removed with a probe or spatula. The site is then light cured through the silicone index, initially for 60 s and then for a further 120 s incisally following index removal (Fig 20).

Finishing of the composite excess is performed with interproximal metal strips, paper discs, fine diamond burs, and an Eva handpiece. This protocol is then carried out for all the other teeth of sextant 2.

This protocol is also performed on sextant 5 (33, 43) in the same appointment, the only difference being that only the incisal edges require lengthening with the index technique based on the previously developed wax-up (Fig 21).

The ultimate goal at the end of this appointment is to have a simultaneous bilateral contact on the canines and only a skimming contact on the incisors that can be checked with 8 μ shimstock (ShimStock, Hanel, Coltene) and 12 μ articulating paper (Occlusion Foil, Hanel, Coltene). All the restorations in the two sextants are polished and the patient is dismissed with an increased OVD and no occlusal contacts on the posterior teeth.

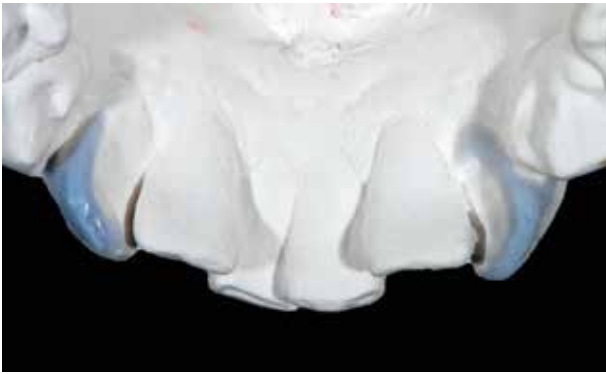


Fig 21 Restorations on 43 and 33, performed using the index technique.

It is possible at this stage, as an alternative option before dismissing the patient, to provisionally restore the posterior sextants with composite resin without performing an adhesive protocol through the transparent indices built on the wax-up of the posterior sextants, taking advantage of the undercuts at the contact areas for retention. This would allow for improved posterior occlusal stability in the interim period between appointments.

Following the initial appointment, the patient whose anterior teeth have been

restored will be recalled a few days later for an occlusal check, and slight adjustments may be performed if necessary, mainly concerning simultaneous bilateral equal contacts on the canines, which have to be present. At this stage, a new wax-bite record of the posterior areas at this OVD will be taken (Fig 22), as well as a new facebow. This will allow the technician to perform a new and more precise wax-up of the occlusal scheme of the posterior sextants, which will be the guide for direct and, if necessary, indirect restorations (depending on the in-



Fig 22 Immediately after removing the rubber dam, restorations on sextant 2 and 5 are trimmed to achieve simultaneous bilateral contact on canines, checking with shimstock. A wax-bite record on the posterior areas is then taken, being sure of achieving bilateral contact on canines.



Fig 23 Pre- and post-treatment frontal views.



Fig 24 Pre- and post-treatment occlusal views.

dications for each tooth) to complete the rehabilitation. The function and esthetics achieved in the anterior sextants are pleasing and very conservative (Figs 23 and 24).

As previously mentioned, in cases where increasing the OVD in anterior and posterior sextants is carried out with direct restorations with the index technique, Brux Checker can be used to investigate further (Figs 25 to 27).

Full veneering (FV)

The full veneering (FV) option allows the restoration of teeth that have lost volume three-dimensionally on the incisal, buccal, and palatal aspects. The OVD also requires increasing with this option, and therefore appointments should be scheduled accordingly.

A clinical case is described where the patient's main complaint was pain in the posterior teeth and a slight tension in the cheek muscles on awakening in the morning. The patient also wanted to



Fig 25 Initial situation. The two arches require restoring with direct composite restorations applying the index technique, increasing the OVD.



Fig 26 Final outcome. The two arches have been restored with direct composite restorations applying the index technique, increasing the OVD.



Fig 27 The Brux Checker is delivered before starting treatment to record tooth grinding during sleep bruxism. Once all restorations are carried out, a new Brux Checker is delivered and checked after one night. It is possible to evaluate the behavior of the restorations to ensure that correct occlusal stability and anterior guidance are achieved. Friction on sextant 5 is decreased.

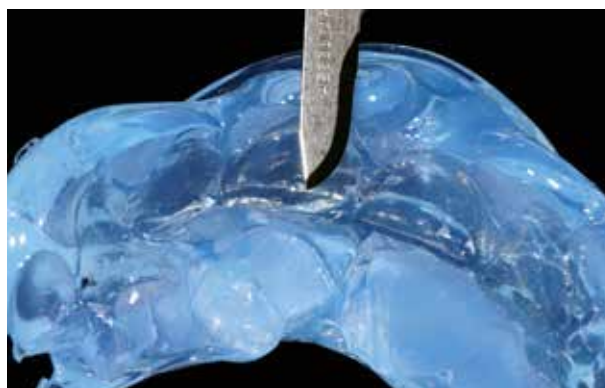


Fig 28 A transparent index is built on sextant 2 wax-up to perform the index technique. The index is cut with a surgical blade to achieve six single indices, one per tooth.



Fig 29 A three-step etch-and-rinse technique is performed on one tooth at a time, without the need for rotary instruments.



Fig 30 Heated composite is placed on each tooth. The index is then applied with a probe, and excess composite is removed in the plastic phase. 1 min curing with index in place, and 2 min without index is performed. Once the composite is cured, the finishing/polishing protocol can be carried out.



change the shape and size of the anterior teeth without them being touched.

The slight muscle tension is managed by bite therapy prior to starting treatment, as it is only possible to proceed once this tension is resolved. The clinical approach for treating this patient is the same as that described previously for the PI option. Extra care should be taken when placing the transparent silicone indices as the landmarks to check for correct fit are both palatally and buccally at

the emergence level near the gingival margin, where the rubber dam is positioned, since the whole crown requires restoring (Figs 28 to 30).

This protocol is also performed on sextant 5 in the same appointment, the only difference being that in this case the teeth only require lengthening on the incisal edges (Figs 31 and 32). The occlusal goals and the clinical steps are the same as for the PI option. Again, the importance of obtaining equal simulta-



Fig 31 Heated composite is placed on each tooth. The index is then applied with a probe, and excess composite is removed in the plastic phase. Finishing is performed with interproximal metal strips, paper discs, fine diamond burs, and an Eva handpiece.



Fig 32 Final restorations on sextant 5, on which only IE has been performed.



Fig 33 After restoring sextant 2 and 5, it is essential to achieve equal simultaneous bilateral contact on the canines, checking with shimstock, before finishing and polishing the restorations.



Fig 34 Restorations on sextant 2, at 2 years follow-up.

neous bilateral contact on the canines is essential before proceeding with the development of the new posterior occlusal scheme (Fig 33 – note the shimstock check on the canines). The initial appointment ends with an increased OVD and no occlusal contact on the posterior teeth.³⁴ Again, it is possible at this stage, as an alternative option before dismissing the patient, to provisionally restore the posterior sextants with composite resin without performing an adhesive protocol through the transparent indices built on the wax-up of the posterior sextants, taking advantage of the undercuts at the contact areas for retention. This would allow for improved posterior occlusal stability in the interim period between appointments.

Following the initial appointment, a patient whose anterior teeth have been restored will be recalled a few days later for an occlusal check, and slight adjustments may be performed, if necessary, mainly concerning equal simultaneous bilateral contact on the canines, which must be present. At this stage, a new wax-bite record of the posterior areas at this OVD will be taken. This will allow the technician to perform a new and more precise wax-up of the occlusal scheme of the posterior sextants, which will be the guide for direct, partial indirect, and full indirect restorations to complete the rehabilitation.

The final outcome of sextant 2 at 2 years follow-up is shown in Fig 34.



Curing considerations

Since the index technique is dependent on a silicone key, Giulio Marchesi, DDS (University of Trieste, Italy) carried out the following *in vitro* study, the aim of which was to establish the correct key thickness through which irradiation allows the best composite polymerization.

Correct polymerization is an important factor affecting the clinical performance of resin composites.³⁵ The use of long exposure time and high irradiances (E) on photoactivation of resin-based composites has become an axiom in restorative dentistry. In fact, several studies have demonstrated that a resin composite's degree of conversion (DC) and, consequently, its physical properties, are directly related to the total amount of light delivered to the polymer (ie, E multiplied by irradiation time),³⁶ referred to as radiant exposure (H).³⁷ During the photoactivation process, the light that passes through the resin composite is absorbed and scattered. Thus, the light intensity (E) is attenuated, and its effectiveness is reduced as the depth increases.³⁸ The depth of cure depends on the light irradiance,³⁹ exposure time, and several other factors, such as material composition,⁴⁰ resin composite shades and translucency,⁴¹ and the filler particle size.⁴² If inadequate levels of conversion are achieved in the polymerization, mechanical properties and wear performance can be compromised.⁴³ With incomplete cure, leachable residual monomer and initiator become greater biocompatibility issues, and color stability may also decline.

For all these reasons, to reach a good conversion of composite, the luting pro-

cedure with the index technique is 60 s curing through the transparent index, with a further 120 s curing on the palatal/buccal surface without the key (Table 3).

Hardness evaluation is a widely used test to examine composite curing. We present here a short study to demonstrate that the index technique, with 60 s curing with the key in place, followed by 120 s curing without the key, is an appropriate curing time with a LED curing unit (Bluephase, Ivoclar Vivadent).

In this study, the irradiance of the curing unit was 1,200 mW/cm², measured using a commercial dental radiometer (100 Optilux Radiometer, SDS Kerr). A hybrid composite resin (Filtek Z250, 3M ESPE) was used as the test material and was submitted to different polymerization times: 20 s with key, 60 s with key, 60 s without key and 60 s with key, and 120 s without key. Curing tip distances of 0, 1, and 2 mm were used, and controlled using metal rings. The resin composite was placed in a teflon matrix in 1 increment, with a 3 mm diameter and heights of 1 to 3 mm. Following curing, specimens were immediately submitted to microhardness evaluation to investigate the lower surface of the specimen. The test was performed with a Leica VMHT microhardness tester (Leica Microsystems) equipped with a Vickers indenter. Data were statistically analyzed using a three-way ANOVA and t-test.

The mean and standard deviations of the microhardness of the tested materials are listed in Table 3.

In conclusion, this study showed that the modality of polymerization with 60 s with key, and 120 s without key, exhibited the highest values compared to other lengths of polymerization ($P < 0.001$).



Table 3 Curing composite evaluation according to the various thickness of the different keys

Modality	Thickness	Distance			Diff
		0 mm	1 mm	2 mm	
20 s K	1 mm	75.7 ± 4.1 C-b	68.7 ± 2.3 B-a	68.5 ± 3.7 C-a	<i>P</i> < 0.001
	2 mm	68.8 ± 4.3 B-b	61.2 ± 2.7 A-a	63.8 ± 3.7 B-a	<i>P</i> < 0.001
	3 mm	59.3 ± 3.0 A-a,b	62.4 ± 2.9 A-b	55.8 ± 3.2 A-a	<i>P</i> < 0.001
	Diff	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001	
60 s K	1 mm	81.2 ± 3.6 D,E,F-b	76.3 ± 3.1 a	73.7 ± 3.9 D,E,F-a	<i>P</i> < 0.001
	2 mm	78.8 ± 3.1 C,D-b	74.5 ± 3.5 a,b	72.3 ± 2.9 C,D-a	<i>P</i> < 0.001
	3 mm	77.4 ± 3.2 C,D-b	74.7 ± 2.3 b	69.1 ± 3.8 C-a	<i>P</i> < 0.001
	Diff	<i>P</i> < 0.05	NS	<i>P</i> < 0.05	
60 s	1 mm	80.8 ± 3.2 b	79.3 ± 3.6 a,b	76.0 ± 1.8 a	<i>P</i> < 0.001
	2 mm	80.4 ± 3.2 b	78.2 ± 3.1 a,b	75.5 ± 2.9 a	<i>P</i> < 0.001
	3 mm	80.9 ± 3.8 c	78.2 ± 3.2 b	72.9 ± 3.6 a	<i>P</i> < 0.001
	Diff	NS	NS	NS	
60 s K + 120 s	1 mm	90.8 ± 4.9 G-b	87.3 ± 3.9 E-b	82.5 ± 1.1 G-a	<i>P</i> < 0.001
	2 mm	86.3 ± 3.0 F,G-b	82.0 ± 3.0 D-a,b	78.2 ± 2.3 F,G-a	<i>P</i> < 0.001
	3 mm	84.4 ± 3.9 E,F-b	77.0 ± 2.4 C-a	77.4 ± 2.2 E,F-a	<i>P</i> < 0.001
	Diff	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001	
Diff Among Modality	1 mm	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001	
	2 mm	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001	
	3 mm	<i>P</i> < 0.001	<i>P</i> < 0.001	<i>P</i> < 0.001	

Modality: 20 s K and 60 s K = curing time through the key; 60 s = curing time without the key; 60 s K + 120 s = curing time through the key and curing time without the key; Thickness: different thicknesses of key in mm; Distance: light curing tip distance.

Note 1: For each vertical column, values with identical uppercase letters indicate no significant difference using Tukey's pairwise comparison test.

Note 2: For each horizontal row, values with identical lowercase letters indicate no significant difference using Tukey's pairwise comparison test.



Posterior restorations

The evaluation and selection of the suitable restorations to be placed on each posterior tooth has to be done taking into consideration the amount of healthy residual hard tissue, the thicknesses of the present enamel and dentin, the endodontic and periodontal implications, and the amount of OVD that needs to be increased. However, it is important to note that in some cases where tooth wear is moderate it is not necessary to treat all 4 posterior sextants, ie, treat-

ing only the 2 lower posterior sextants is enough.

Wherever possible, according to the indications and when the residual tooth tissue allows, a direct restoration (index technique) will always be performed using the same protocol described in this article on the anterior sextants. Various degrees of wear have been classified, all requiring different types of restorations. In some cases, only occlusal, lingual/palatal, or buccal restorations will need to be placed (Figs 35 to 39), while in other cases the interproximal areas will



Fig 35 Wax-up and transparent index on sextant 6.



Fig 36 The prepared cavity after removal of an old composite restoration. The silicone index being checked for fit on 46; three-step etch-and-rinse protocol being applied; a thin layer of flowable composite cured on the cavity floor; microhybrid composite layered freehandedly and cured to have a low “C factor” contraction.



Fig 37 Index technique: heated composite is layered on 46; index is placed and excess material is removed with a probe; curing for 60 s; occlusal view of the restoration prior to finishing.

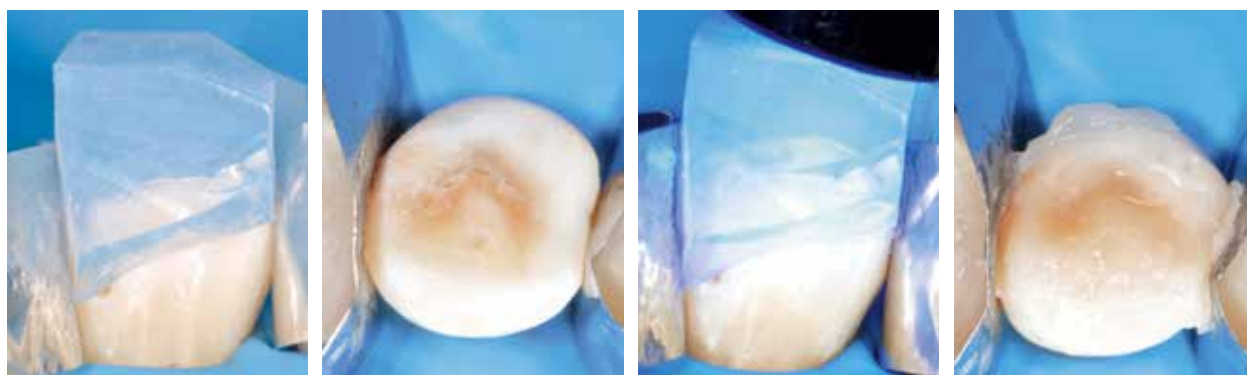


Fig 38 In this situation, since the “C factor” is not unfavorable, the index technique protocol can take place immediately.



Fig 39 Sextant 6 finished and polished before removing the rubber dam, and a follow-up control.



Fig 40 To minimize contraction “C factor” on 47, after adhesive protocol, composite is layered in a first stage, applying a conventional approach (freehand layers), curing each layer.

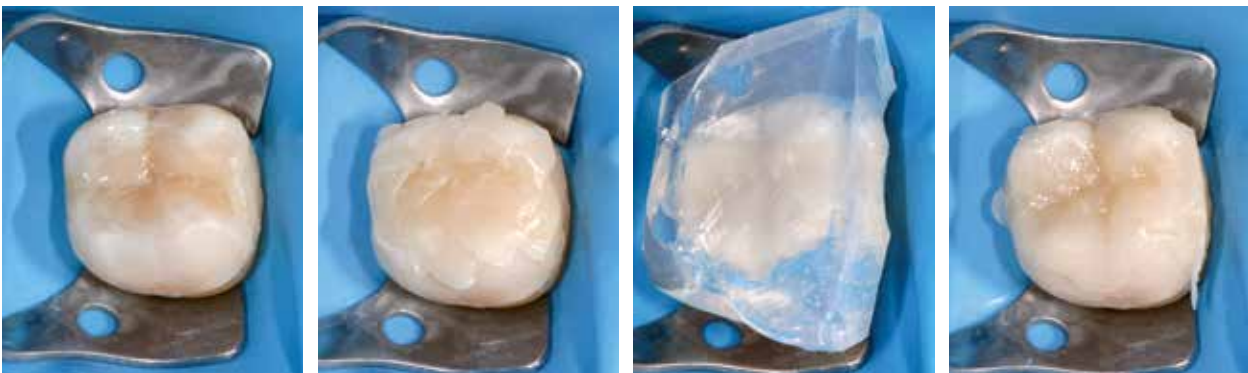


Fig 41 Heated composite is placed and the index technique can be carried out.

also have to be restored. Metal matrices and wooden wedges should be used accordingly (increasing their size in order to achieve maximum mesial-distal displacement), with a properly fitting index in order to achieve a correct contact point. As previously mentioned, great care should be taken to check the anatomical landmarks for the correct positioning of the index to obtain a predictable restoration. Generally, sextant 1 is treated in the first appointment, sextant 3 in the second, sextant 4 in the third, and

sextant 6 in the fourth appointment. It is also possible to treat two sextants in the same appointment, or all posterior sextants, depending on the time available.

Where there is an indication for indirect restorations varying from ceramic or composite onlays to full coverage metal-ceramic crowns, the conventional prosthetic techniques should be carried out by means of standard impressions or CAD/CAM technology (Figs 40 to 43).

There is no real correct clinical sequence when applying indirect restor-



Fig 42 Following a build-up, a composite overlay is cemented on 45.



Fig 43 Pre- and post-treatment on sextant 6. Index technique was performed on 47 and 44; a metal-ceramic crown has been cemented on 46 after crown lengthening and root canal treatment due to a large caries; 45 was restored with a composite overlay.

ations, since all the direct restorations will already have been carried out and a stable occlusion achieved. In situations where all the posterior restorations are indirect, occlusion will have to be stabilized and tested with the correct provisionals, in which case normal prosthetic protocols apply. The canines will always be the guidelines for the occlusion, with bilateral contacts holding shimstock and articulating paper, as previously described.

Posterior index technique and “C factor”

Where large and deep cavities are present on posterior teeth, performing the index technique following adhesion

could be very stressful for residual sound tissue due to an unfavorable “C factor” situation.⁴⁴ Hence, to minimize contraction, the first part of the layering is done according to a conventional approach (freehand layering), while the last occlusal part is performed with the index technique, as previously described. The heated composite is applied on the tooth with a spatula, and the single transparent index, previously tried and modified accordingly, is fitted on top prior to polymerization (Figs 40 and 41). Keeping two fingers on the key, the excess composite is removed with a probe. Thereafter, 60 s light curing through the key is performed, and another 120 s after removal of the key (Figs 40 and 41).

In situations where the “C factor” component is not so unfavorable (small



Fig 44 Initial situation.



Fig 45 Final outcome at 2 years recall, where no chipping or fracture has occurred.



Fig 46 Final outcome at 2 years recall. 17, sextant 2, 26, 24, 35, 34, sextant 5, 44, 47 were restored with direct composite restorations (index technique); 14, 25, 27, 37, 36, 45 were restored with composite onlays; 16, 15, 46 were restored with full metal-ceramic crowns.



Fig 47 3 years recall showing a correct canine guidance and a good integration of direct index technique restorations (11, 12, 13, 17, 31, 41, 42, 43, 44, 47); partial indirect restorations (14, 45); full metal-ceramic crowns (15, 16, 46).

cavities, moderately worn posterior and anterior dentition), the standard index technique protocol is routinely applied following the initial adhesive steps. The protocol requires the removal of any excess material before proceeding with light curing (according to the previously mentioned timing). Finishing is performed with interproximal metal strips, paper discs, fine diamond burs, and an Eva handpiece. Polishing is carried out with rubber burs and aluminum oxide paste.⁴⁵

Partial indirect restorations (composite or ceramic onlays) and full indirect restorations (ceramic crowns) are planned for all teeth that have lost a significant amount of healthy hard tissue in order to achieve function and esthetics for each tooth, as well as a correct occlusal stability in static and dynamic conditions (Figs 44 to 47).



Complications and repair

One of the significant benefits of using composite resin for a full-mouth rehabilitation with the index technique is that the most likely complications are wear and chipping, while full loss or detachment of the restoration is an unlikely occurrence. Partial failure can be easily repaired with fresh composite following proper surface treatment: sandblasting, silanization, and bonding of all surfaces.¹

Nano hybrid composite has good wear characteristics,⁴⁶ and superficial gloss is maintained in the long term following polishing. Further, it is very easy to repolish this material during patient recalls.

Conclusions

The index technique protocol proposes a conservative and alternative approach for the treatment of moderate tooth wear, based mainly on minimally invasive composite restorations on both anterior and posterior teeth. In all the cases described, the main benefit relates to a modifiable, repairable, and/or

totally reversible clinical situation. The anterior teeth are not prepared with a rotary instrument, and hence complete reversibility is possible. The initial situation can be reestablished at any time, if and when required.

Ideally and whenever possible, dentistry should be additive, not subtractive—additive. Increasing the OVD leads to less tooth structure removal and improved behavior from a biomechanical perspective.⁴⁷ Adhesion and composite resin have become very reliable,⁴⁸ allowing the restorations to be retained without requiring retentive cavity preparations.

Finally, the driving force behind this approach is to intercept tissue destruction and avoid or postpone a more costly and invasive prosthetic solution. Long-term studies are needed to further understand the potential of this technique.

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