Konrad Meyenberg

RESTORATIVE GAP MANAGEMENT IN THE ESTHETIC ZONE

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Direct Composite Bonding
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Implants

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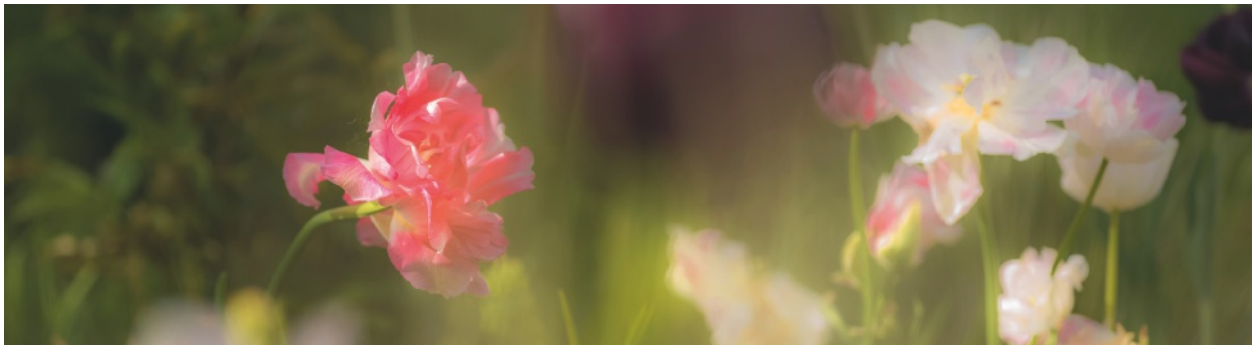

Chapter 1

Some general considerations

An unfavorable relationship between the form and dimension of the dental arch and the number, dimension, and shape of the existing teeth (typical Bolton 6 or 12 discrepancy, Bolton anterior or overall analysis[1], malformed or undersized teeth, tooth agenesis, tooth loss due to early trauma) can pose several esthetic, biologic, and functional problems. In many cases, an optimal result cannot be achieved through orthodontic, restorative or reconstructive means alone. Furthermore, patient desires and capacity to comply with the treatment as well as financial considerations are important factors to be included in the treatment concept.

For all options discussed below, the clinical sustainability is well documented in the literature; all show high survival rates and low complication rates in the hands of the experienced clinician.

From the multitude of long-term studies, systematic reviews, and case documentations, it can be extrapolated that both **resin-bonded bridges** and **veneers** behave similarly well and may reach **10-year survival rates** of 95% or more and **10-year reintervention rates** lower than 5% to 10%, given proper indication and handling.

The cost-effectiveness of resin-bonded bridges extrapolated over the lifetime of a patient is also very favorable compared with full-crown bridges and single tooth implants. Since the current standard extension of a resin-bonded bridge is two-unit (one wing), and not three-unit (two wings) as it was before, the risk of secondary caries due to loose wings is no longer relevant.

The standard materials for resin-bonded bridges are either zirconia or lithium disilicate glass-ceramics.

There is certainly still an indication for **traditional full-crown and bridge work** where existing sound tooth structure is extensively reduced or damaged, but it is no longer the standard of care due to its inherent biologic and technical risks (devitalization, fracture, and caries of abutment teeth). However, the long-term success is excellent, provided the indication is well selected and a conservative preparation concept is used. In contrast to single crowns, all-ceramic bridges seem not to perform as excellently as porcelain-fused-to-metal (PFM) constructions. The overall quality of all the steps involved in the treatment, however, is always crucial for long-term success. Therefore, long-term studies, including reviews, might not reflect the entire potential of traditional crowns and bridgework.

Glass-ceramic veneers seem to perform slightly better than feldspathic veneers, indicating that materials with increased strength show better clinical performance[25]. There are also attempts by manufacturers to use even stronger materials such as zirconia to fabricate veneers. However, since there are neither long-term results nor sufficient clinical experiences available, these materials should be considered experimental at present.

Direct restorations with composites are today an indispensable and attractive noninvasive way of reshaping teeth. The essential techniques for success are widely available and very well documented. A multitude of parameters such as the type of adhesive materials and procedures, handling properties, curing techniques, and operator skills have an important influence on the outcome. In line with this, a recent systematic literature review showed reasonably inhomogeneous results, although some data reach the same level as veneers. In view of easier modes of reintervention, and given a proper indication, direct composites can no longer be regarded as generally inferior to veneers.

Single-tooth implants are today another indispensable way to replace missing teeth. Implantology is probably one of the best-documented fields in dentistry. However, above all, esthetic problems in the long run still represent a major challenge in the esthetic zone. Due to their ankylotic nature, implants cannot adapt as well as natural teeth do to the changing functional and biologic conditions.

This can lead, over time, to the well-known phenomenon of the apparent intrusion, infraocclusion, and protrusion of implants in relation

to the adjacent teeth, when anterior teeth may move downward and simultaneously forward or backward. This may be understood as the lifelong adaptation of the stomatognathic system to the changing functional and physiologic conditions, and may be described as constant adaptation and remodeling.

In addition, the loss of interproximal contact points is also observed. This may not only occur in young patients, but over the entire lifetime of a patient. Therefore, delaying implants in young patients until later in adulthood when skeletal growth is considered to be completed may not completely resolve this problem.

In which incidences and to what extent these changes take place is difficult to predict and is part of an ongoing discussion.

An orthodontic retainer should of course be considered in all these anterior implant cases. Whenever feasible, a fixed lifelong wire retainer is the retention device of choice.

Existing large restorations (for example, full crowns) on adjacent teeth may also make more sense for tooth-supported restorations to close a gap, if these need a replacement anyway.

The following **two cases** serve to illustrate in an exemplary way the dilemma the clinician faces when looking for a sustainable solution for the patient and being confronted with the lifelong adaptation and remodeling of the oral structures over more than 20 years (in each case).

Case 1-1 shows a patient with a missing right central incisor. The tooth was replaced 30 years previously, when the patient was 22 years old, with an implant-supported all-ceramic crown. The implant type was a soft tissue-level implant with a buccally modified shoulder (scallop) and an adhesively bonded glass-ceramic crown. The left central incisor was restored with a glass-ceramic veneer to rebuild the deeply fractured incisal edge.

Case 1-2 shows a patient with a hopeless left central incisor. The root remnants were extracted, and a ridge augmentation procedure was realized with a xenogenic material (Bio-Oss; Geistlich Pharma, Wolhusen, Switzerland) and a soft tissue graft. Finally, when the patient was 20 years old, a three-unit adhesive PFM bridge with palatal micropreparations was placed. Twenty-five years later, in addition to alveolar remodeling, a slightly open bite could be observed due to growth and remodeling of the maxillary and mandibular jaws.

Both these cases are good examples of the apical and slightly forward-directed movement of both the teeth and the alveolar process over time, in contrast to the edentulous area. Both zones, which are free of periodontal structures, are in themselves stable. However, neither the implant site nor the augmented ridge adapted to the remodeling of the adjacent structures. The passive eruption of the adjacent teeth can at least partially compensate esthetically for their active eruption at the cervical level. This is again a reminder of the importance of the potential for reintervention over time.

Case 1-1

Fig 1-1a Radiograph of initial situation. Implant-supported all-ceramic crown to replace right central incisor.

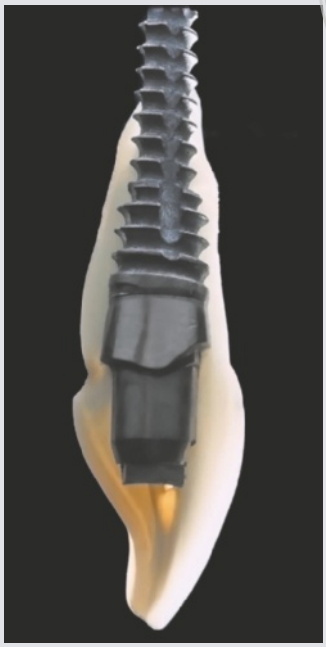

Fig 1-1b Type of soft tissue-level implant with buccally modified shoulder.

Fig 1-1c Initial clinical situation. Implant-supported all-ceramic crown on right central incisor with glass-ceramic veneer on left central incisor.

Fig 1-1d Initial clinical situation after placement of reconstructions: smile line. Dental technology: Arnold Wohlwend.

Fig 1-1e Clinical situation. Right central incisor 30 years after implant placement.

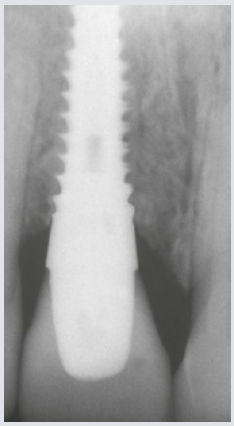

Fig 1-1f Radiograph 30 years after implant placement.

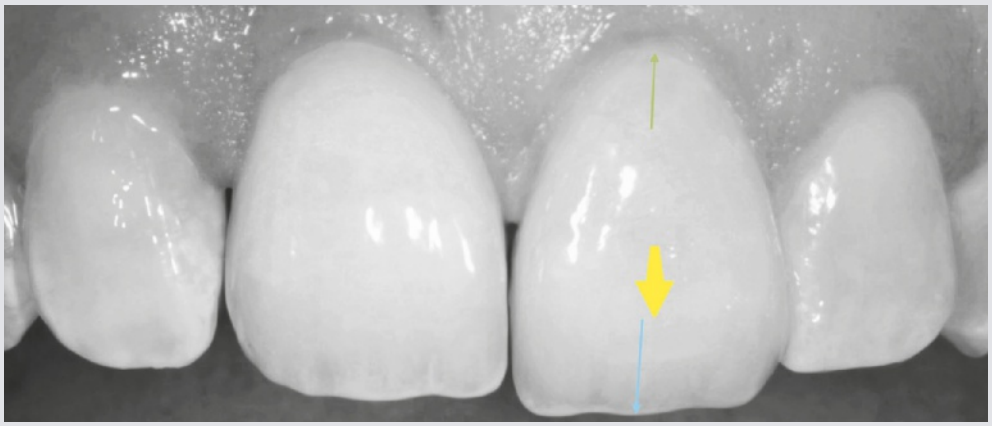

Fig 1-1g Active eruption (blue arrow) with slight protrusion (yellow arrow) and passive eruption (green arrow) of left central incisor.

Case 1-2

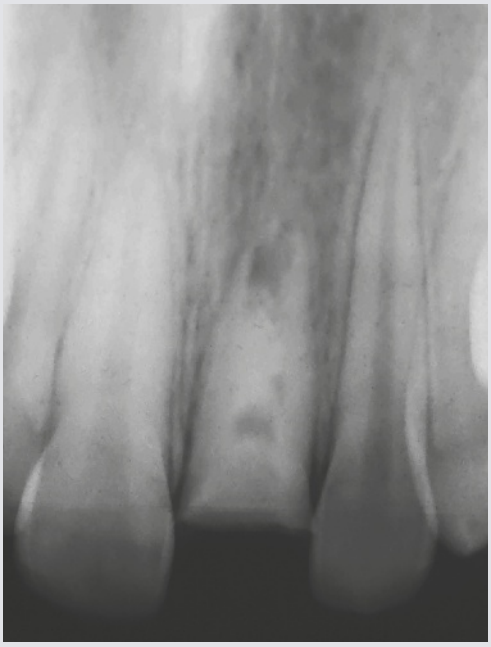

Fig 1-2a Radiograph of initial situation. Hopeless left central incisor showing root remnants.

Fig 1-2b Radiograph of ridge augmentation and reconstruction with three-unit adhesive porcelain-fused-to-metal (PFM) bridge replacing the left central incisor. Periodontal plastic surgery: Dr Marco Imoberdorf.

Fig 1-2c Final situation after 25 years. Ridge augmentation and reconstruction with three-unit adhesive PFM bridge replacing the left central incisor, and incisal composite buildup mesially at the right central incisor. Dental technology: Walter Gebhard.

Fig 1-2d Initial clinical result.

Fig 1-2e Clinical result after 10 years. Slight loss of volume at the augmented site.

Fig 1-2f Clinical result after 25 years. Incisal composite buildup mesially at the right central incisor is renewed.

Fig 1-2g Radiograph 25 years after ridge augmentation with xenogenic material.

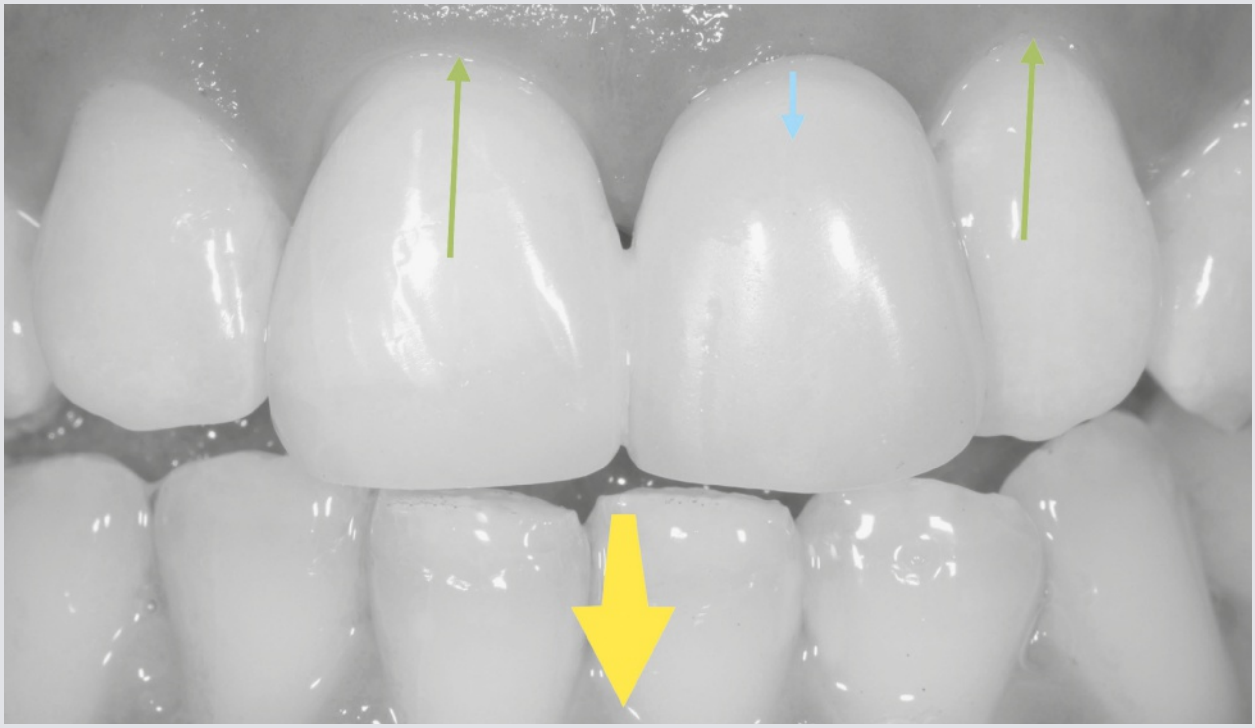

Fig 1-2h Clinical result after 25 years. Slight active eruption (blue arrow) and passive eruption (green arrows) with a partial anterior open bite due to growth and remodeling of the maxillary and mandibular jaws (yellow arrow).

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whereas the left lateral incisor was reconstructed with a new crown for a new four-unit bridge to replace the two missing central incisors. A metal framework was used. Microretentions on the palatal surface of the right lateral incisor were prepared for proper retention of the adhesive wing. A zirconia framework was not considered due to the mechanical risk it would involve.

Case 4-15 shows a patient who was dissatisfied with her smile. Her primary concerns were the gaps between her maxillary anterior teeth due to the missing right lateral incisor and the overall very small teeth. In addition, her teeth were barely exposed during speaking and smiling due to the short incisal length.

The case shows a combination of a two-unit fixed partial denture (FPD), some all-ceramic veneer crowns, and some partial crowns.

The aim of the treatment was to use a minimally invasive approach with supragingival margins for full crowns on the three incisors, and partial crowns on the canines and both premolars on each side, to compensate for the missing tooth substance and establish a good function and occlusion.

First, some minor tooth movement was achieved with the aligner technique to place the abutment teeth in the ideal position. After the retention phase, the reconstructive phase began. All reconstructions were performed with pressed lithium disilicate glass-ceramic material (IPS e.max) and bonded with a light-cured filling composite (G-aenial Flo; GC, Tokyo, Japan) and a two-step bonding system (Clearfil SE Protect; Kuraray Noritake). The ceramic was monolithic on the occlusal and palatal sides for maximal strength. The buccal side was thinly veneered with a compatible veneering ceramic for optimal esthetics.

The goal of using enamel on all bonded surfaces is that it is the optimal prerequisite for a long-lasting successful adhesion. This requires a careful minimal preparation not extending too far cervically, otherwise dentin will be exposed at the walls of the preparation. The use of a high-strength glass-ceramic material with a refractory index similar to enamel allows a smooth transition of the incident light to the tooth substance. Hence, all margins could be retained in a supragingival position with no negative effects on esthetics or on the biology of the marginal soft tissue.

The finishing and polishing of the margins are also perfectly feasible, provided a highly polishable filling composite is used for the bonding procedure.

This case is a good example of the application of minimally invasive preparation designs in combination with high-strength all-ceramic materials with optimal optical properties. Technically, it is certainly much more demanding than any other more traditional approach; however, it is the optimal solution when all factors involved in such a case are taken into consideration.

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Case 4-13

Fig 4-13a Initial situation. Two three-unit PFM bridges in the maxilla to replace the missing lateral incisors. Crowded anterior teeth in the mandible.

Fig 4-13b The maxillary anterior crowns are in a protruded position. Both maxillary canines are too prominent due to the buccal position.

Fig 4-13c Initial situation: right side.

Fig 4-13d Initial situation: left side.

Fig 4-13e Radiographic overview.

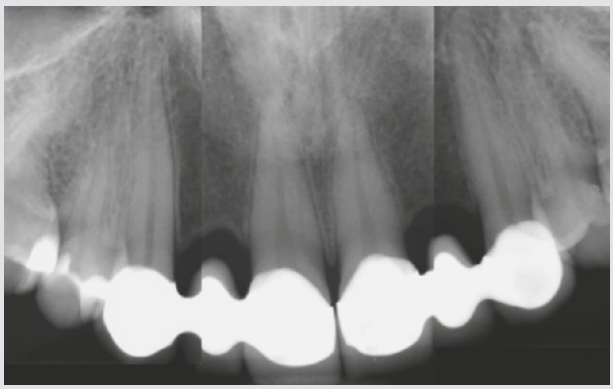

Fig 4-13f Detailed radiograph. Due to the large root canals (shown here), a minimalist new preparation is essential to avoid devitalization of the abutment teeth.

Fig 4-13g Existing PFM bridges: palatal view.

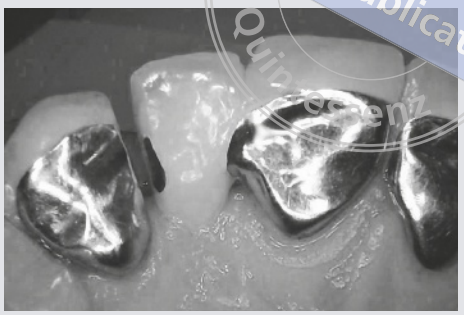

Fig 4-13h The existing bridges are separated and the pontics reduced to create space for retrusion: right side.

Fig 4-13i Separated bridge: left side.

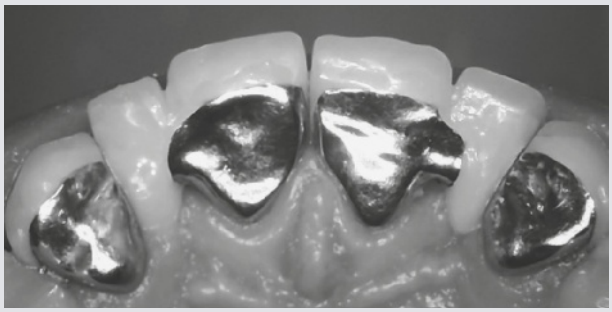

Fig 4-13j After orthodontic recursion: palatal view. Orthodontics: Dr Alexandra Holst.

Fig 4-13k Repositioned maxillary anterior teeth (retrusion).

Fig 4-13l Repositioned mandibular anterior teeth (gap closure after extraction of left central incisor).

Fig 4-13m Minimally reprepared abutment teeth with retraction cords in place. Both pontic receptor sites augmented with soft tissue. Periodontal plastic surgery: Dr Christian Ramel.

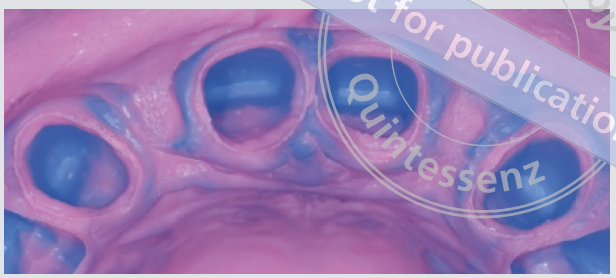

Fig 4-13n Analog polyvinyl siloxane impression (Imprint 4; 3M ESPE, Seefeld, Germany).

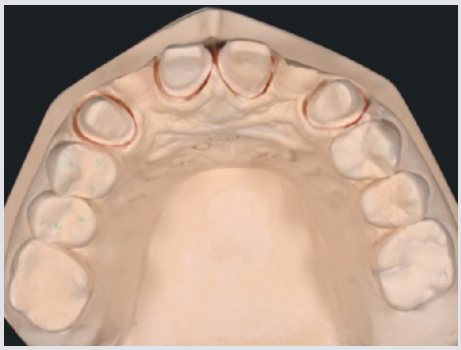

Fig 4-13o Analog stone cast as the most exact base for a highly precise laboratory scan process.

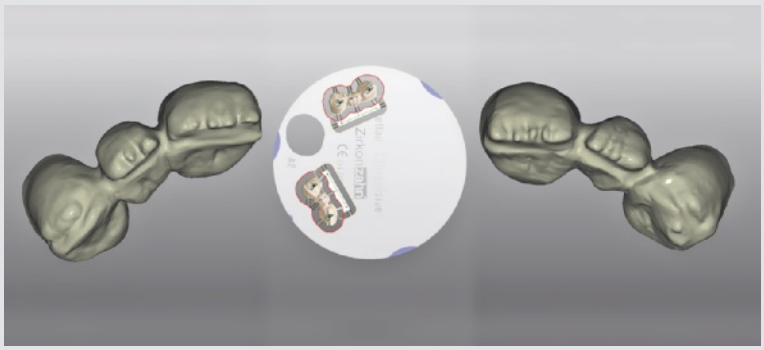

Fig 4-13p After the laboratory scan, processing of the digital data to design the laboratory provisional try-in and the final frameworks (Zirkonzahn, Gais, Italy).

Fig 4-13q Try-in of the CAD/CAM provisionals to check the final shapes of the new reconstruction.

Fig 4-13r Reduced frameworks in zirconia with first wash-bake (Prettau 2 Dispersive; Zirkonzahn).

Fig 4-13s Final zirconia bridges, buccally veneered.

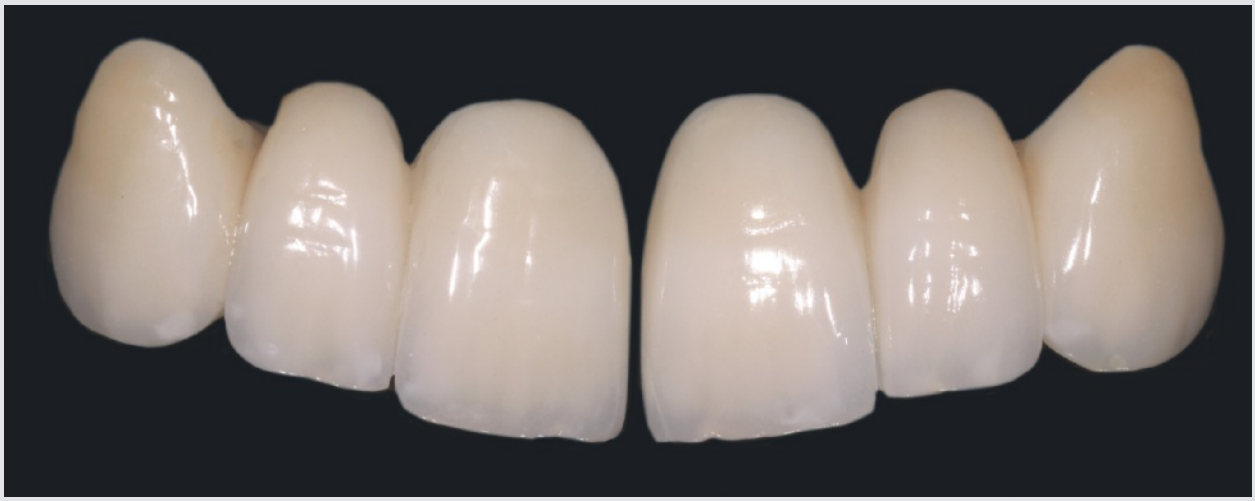

Fig 4-13t Final zirconia bridges: buccal view.

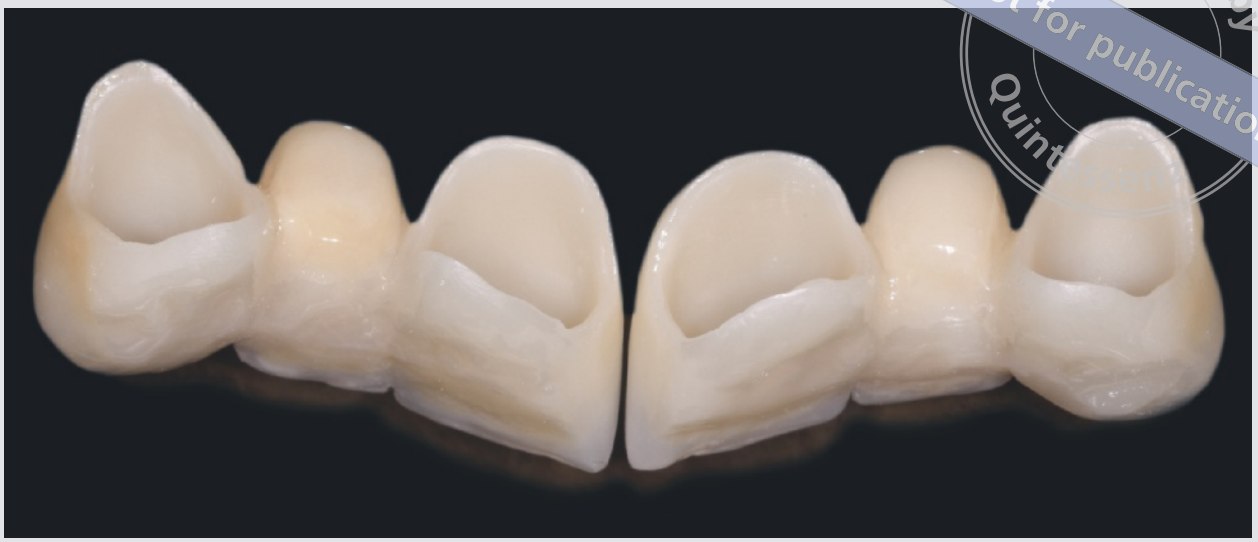

Fig 4-13u Final zirconia bridges: palatal view.

Fig 4-13v Final zirconia bridges, cemented (RelyX Universal; 3M ESPE).

Fig 4-13w Final zirconia bridge: right side. The canine is tinted a slightly darker shade at the distal part to allow a smoother color transition to the natural teeth.

Fig 4-13x Final zirconia bridge: left side. The canine is tinted a slightly darker shade at the distal part to allow a smoother color transition to the natural teeth.

Fig 4-13y Final smile: right side. Smooth color transition from the zirconia reconstruction to the natural teeth.

Fig 4-13z Final smile. Dental technology: Walter Gebhard.

Case 4-14

Fig 4-14a Initial situation. Existing unesthetic three-unit PFM bridge from maxillary right central incisor to left lateral incisor. The right central incisor is lost.

Fig 4-14b Radiograph of initial situation. The right central incisor has a hopeless prognosis due to periodontal reasons (deep mesial pocket) and will be extracted.

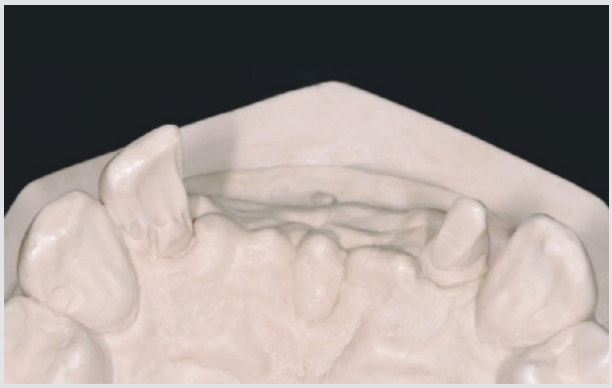

Fig 4-14c Microretentions on the palatal surface of the right lateral incisor are prepared for proper retention of an adhesive wing, which avoids a full-crown preparation with a higher complication risk.

Fig 4-14d Combined adhesive wing with full-crown PFM bridge: buccal view.

Fig 4-14e Combined adhesive wing with full-crown PFM bridge: palatal view.

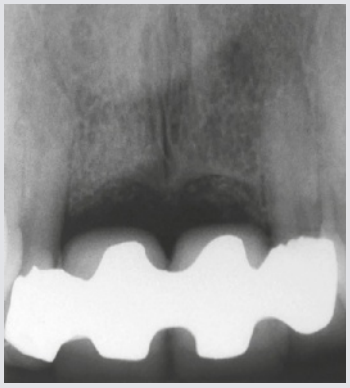

Fig 4-14f Final radiograph. Combined hard and soft tissue ridge augmentation at the pontic sites. Periodontal plastic surgery: Dr Marco Imoberdorf.

Fig 4-14g Final situation: lips retracted. An opaque adhesive cement was used for the wing on the right lateral incisor to prevent a grayish appearance.

Fig 4-14h Final smile. Dental technology: Walter Gebhard.

Case 4-15

Fig 4-15a Initial situation. Teeth barely exposed during speaking and smiling due to the short incisal length and inverted smile line.

Fig 4-15b Gaps between the maxillary anterior teeth due to missing right lateral incisor and overall very small teeth. Some minor tooth movement was achieved with the aligner technique. Orthodontics: Dr Marco Tribo.

Fig 4-15c Careful minimal preparation with margins in a supragingival position.

Fig 4-15d All reconstructions are done with pressed lithium disilicate glass-ceramic.

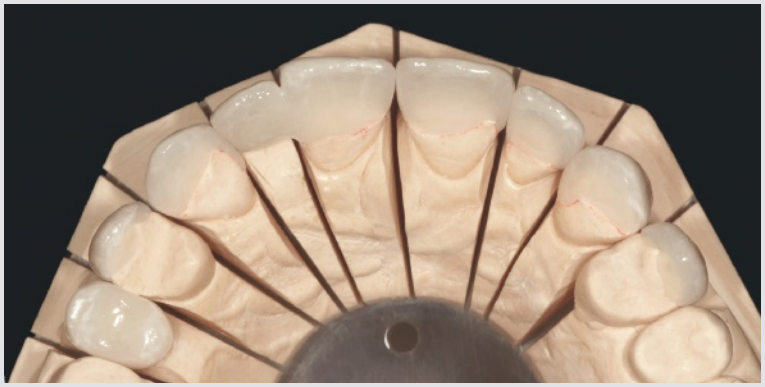

Fig 4-15e The ceramic is monolithic on the occlusal and palatal sides for maximal strength. The buccal side is thinly veneered with veneering ceramic for optimal esthetics. Note the flat palatal connector of the right lateral incisor pontic for maximal strength.

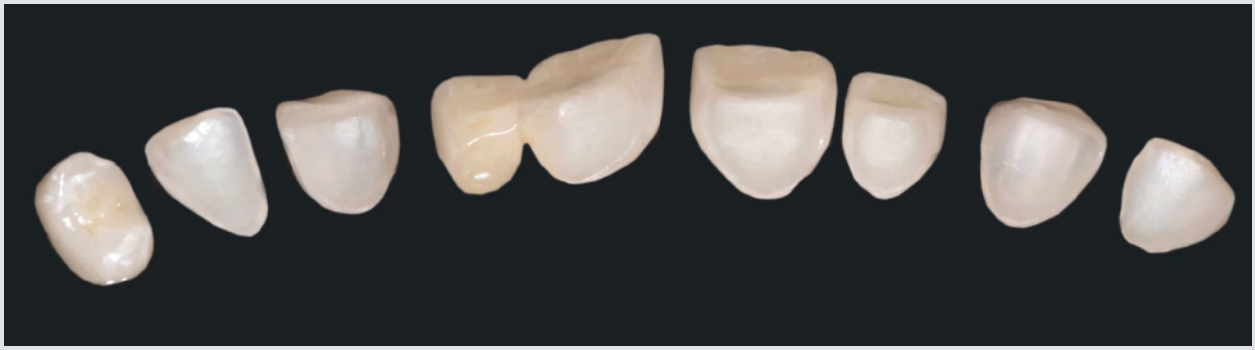

Fig 4-15f Etched reconstructions in pressed lithium disilicate glass-ceramic.

Fig 4-15g Details of the reconstructions in pressed lithium disilicate glass-ceramic. The inside is etched with hydrofluoric acid (HF).

Fig 4-15h Etched tooth surfaces: right side.

Fig 4-15i Final photograph after insertion and meticulous marginal polishing of light-cured cementation composite.

Fig 4-15j and k Final photographs: slight smile. Note the difference in incisal length compared with the initial situation. Dental technology: Nic Pietrobon and Reto Michel.

Multiple gaps *are present initially between most teeth with an uneven distribution.*

Restorative compensation *of gaps by direct composite bonding or veneers.*

Chapter 4.3

Gap distribution and restorative compensation

Gap distribution and restorative compensation implies that the restorative transformation of teeth with direct composite, veneers or veneer crowns is needed for esthetic reasons. Often the maxillary lateral incisors are too small in relation to the dimensions of the remaining teeth, or all the anterior teeth are too small in relation to the tooth arch. In such cases, merely closing the gaps by orthodontic means alone would lead to an overall unesthetic appearance, since the dimension of the arch would then end up being too short and narrow, which would result in an unharmonious composition and proportion of the lower face. In addition, if the natural crown is too narrow, closing the gaps would lead to a very small interdental alveolar bone septum and a very small corresponding papilla, which, in turn, would result in a high risk of low resistance to periodontal infections and subsequent bone loss.

According to the general rules for treatment planning discussed in Chapter 2, one should always plan as if all the teeth were present in their ideal shape, dimension, and position. Therefore, the orthodontic planning has to achieve a position for the (too small) teeth according to the dimension of the ideal crown width in relation to the tooth arch dimension that is aspired to, as well as the ideal distance between the roots of the anterior teeth.

In this section of the chapter, special emphasis is given to some details of direct composite bonding. For many clinicians, an indirect restoration seems to be more attractive because it appears to require fewer skills. However, it is not less demanding if one aspires to a high-quality level of treatment. Very often, indirect restorations lead to unnecessary invasive removal of tooth substance. In fact, an indirect restoration is always a combination of direct composite bonding and indirect techniques and requires almost the same level of skill as a direct restoration. Indirect techniques, however, make it easier to retain overall control over the shape, function, and color of more extensive restorations. Therefore, it is very important to master direct composite bonding techniques and to apply them, whenever this is feasible.

Case 4-29 is a typical simple case that illustrates the principle of **restorative compensation** of gaps by direct composite bonding. The patient presented with very small peg-shaped mandibular incisors. She did not want an adhesive bridge as an additional fifth anterior tooth in combination with the four very narrow mandibular incisors. Therefore, the mandibular left central incisor was orthodontically moved into a favorable position for the enlargement of the clinical crowns of three of the mandibular incisors. A direct mock-up was performed to test the occlusion and the overall esthetic appearance. Besides a local enlargement of the mesial side of both central incisors and the left lateral incisor, the two central incisors were slightly lengthened to achieve better proportions and improved harmony with the lower lip. The incisal edges were rounded to achieve an 'airier' look.

A highly polishable nano-filled composite was used (Filtek Supreme XTE) with a two-layer technique (A1 Body and A1 Enamel).

The patient depicted in *Case 4-30* is a young professional classical singer. She presented with gaps between all her maxillary anterior teeth. The teeth were overall too small with regard to the desired maxillary arch dimension. After an orthodontic fine-tuning of the positions of each individual tooth by the aligner technique, a direct mock-up was performed to test the appearance and the influence on her vocal performance. After this had proven to work well, it was transferred into final restorations.

As in the previous case (*Case 4-29*), a highly polishable nano-filled composite was used (Filtek Supreme XTE) with a two-layer technique (A1 Body and A1 Enamel).

A reconstructive solution by means of veneers was rejected for three reasons:

1. The age of the patient (19 years old) and the pleasing color of her teeth, which did not require a full buccal veneering.

2. The potential for reintervention, even a possible nondestructive complete removal, if the treatment resulted in a compromise of the patient's vocal performance.
3. The cost efficiency of direct composites compared with ceramic veneers.

Case 4-31 is a simple but instructive example of the typical shape of a maxillary lateral incisor. Initially, this young patient had a unilateral peg-shaped lateral incisor, which is a frequently seen situation that is corrected with a direct composite technique.

This case may help the clinician to understand the correct orthodontic positioning of maxillary peg-shaped lateral incisors. This is of crucial importance for a believable appearance of the final shape and the maintenance of the papillae to avoid interdental spaces (black triangles). In addition, it may help to understand how to sculpt both a harmonious and characteristic shape for a maxillary lateral incisor.

Whereas the width of both central incisors should ideally always be symmetric, the width of both lateral incisors may differ. From an esthetic point of view, in terms of how these teeth are viewed by others, the only necessity is that the line angles are at the same position. The measured overall width is not so important for the esthetic outcome.

Case 4-32 demonstrates the workflow in a complex case, where all six maxillary anterior teeth and the first premolars needed to be built up. This young student patient preferred the treatment option of aligner therapy for the spaced maxillary dentition. This was combined with the direct composite bonding technique.

The direct composite mock-up during the aligner therapy was used to test the potential final outcome and to define the final adjustments of the orthodontic therapy. The advantage of the aligner therapy is evident, since there was no need to remove any of the attachments for the mock-up.

In cases such as these, in contrast to fixed appliances, the result is esthetically easier to evaluate during the workflow. The direct mock-up also greatly helps to refine the clinician's handiwork and to check the layering for the final restorations. The direct mock-up may also help the clinician to decide whether it is possible to achieve the desired result with the respective technique being employed. A sole digital smile design approach without going through this prototype phase is not constructive enough and may lead to an incorrect assessment of the challenges of the process and the clinician's clinical capabilities.

Case 4-33 explains in detail how the direct composite bonding technique is executed in anterior esthetic cases to improve the shapes of the natural crowns. It also details the instruments used to achieve a predictable successful result.

Both maxillary lateral incisors were peg-shaped and were orthodontically perfectly positioned according to the considerations made in *Case 4-31*. They were built up with a direct composite bonding technique (all the details are described in the respective figure legends).

Black-coated, smooth instruments were used to adapt the composite perfectly to the tooth surfaces (Deppeler SA, Rolle, Switzerland, and Hu-Friedy, Chicago, USA).

The spatula should be stiff and as thin as possible to allow optimal control for the interdental 3D shaping. A pear-shaped instrument is used for the modeling of the soft lobes on the buccal surfaces. The goal is to form the composite as perfectly and as close to the final result as possible so that no major finishing or removal of excesses is necessary after polymerization. Only thorough polishing should then be finally required. This greatly helps to avoid destructive, uncontrolled, and time-consuming trimming with drilling or filing instruments in areas where there is only limited access for refining the three-dimensionally curved shapes of the tooth.

Case 4-34 is an impressive example of what can happen if a mismatch between the arch

size and the tooth size in the maxillary anterior jaw is compensated for by closing the gaps and retruding the mandibular incisors. Over time in this young patient, the resulting steep axis of the anterior teeth and the deep bite led to extensive wear due to the restricted envelope of function. Both the incisal edges of the mandibular anterior teeth and the palatal incisal surfaces of the maxillary anterior teeth had become extremely thin and had begun to chip.

In a first phase, fixed orthodontic appliances were utilized to correct the sagittal axes of the maxillary incisors and to again open up the spaces in the maxillary anterior segment and slightly intrude the maxillary incisors. In this way, space was created for the planned minimally invasive restorations, and the functional envelope was opened up.

In the second phase, indirect restorative techniques were used after finalizing the orthodontic alignment of the teeth.

Not only did horizontally missing tooth structure have to be compensated for, but also vertical missing enamel in both the anterior segments. In this case, the use of composite was not the primary choice due to the less favorable wear pattern compared with ceramics. Since the intention was to utilize a noninvasive concept, which was also what the patient wanted, noninvasive to minimally invasive preparations were performed.

Thin partial and full veneers were realized with a lithium disilicate glass-ceramic material (IPS e.max). The material was heat pressed, since CAD/CAM techniques do not allow the material to be milled in the required thinness.

To protect the restorations, a hard acrylic night guard was provided, which the patient used on a regular basis. She maintained the restorations herself perfectly, including the application of optimal oral hygiene. The very positive long-term result confirms the concept under these clearly defined conditions.

Further reading

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Case 4-29

Fig 4-29a Initial situation. Very small peg-shaped mandibular incisors. The mandibular left central incisor was orthodontically moved into a favorable position for an enlargement of the clinical crowns of three of the mandibular incisors.

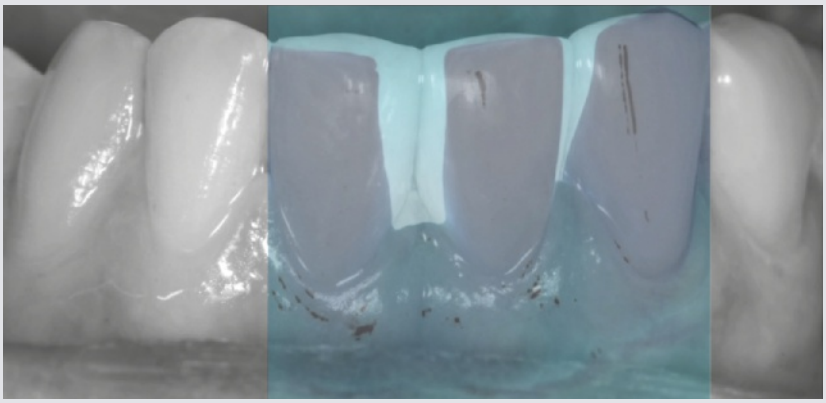

Fig 4-29b Direct mock-up (marked up in white) performed to test the occlusion and overall esthetic appearance. Besides the local enlargement of the mesial side of both central incisors and the left lateral incisor, the two central incisors are slightly lengthened to achieve better proportions and improved harmony with the lower lip. The incisal edges are rounded to achieve an 'airier' look.

Fig 4-29c Final result. All four mandibular incisors now have pleasing proportions.

Fig 4-29d Final result. Length of the mandibular incisors now esthetically and functionally in harmony with the lower lip and maxillary incisors.

Case 4-30

Fig 4-30a and b (a) Initial situation after minor orthodontic gap redistribution according to the determined ideal arch dimension. (b) Initial situation after aligner therapy. As the patient is a professional singer, the correct arch dimension is imperative to allow the optimal intraoral space for the articulation of the voice. This could be ideally tried out during the orthodontic phase through the use of the aligner technique. Orthodontics: Dr Marco Tribo.

Fig 4-30c Direct mock-up with composite, non-bonded for esthetic and functional analysis and to test the effect on the potential vocal performance.

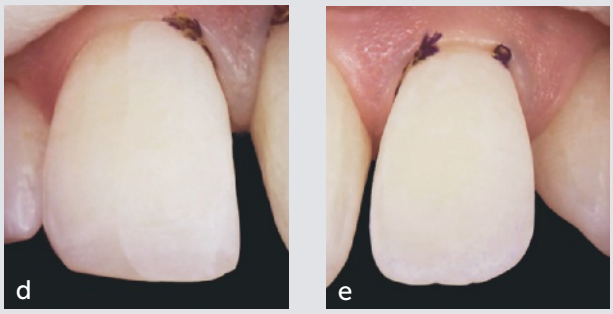

Fig 4-30d and e Detailed photographs during the direct bonding workflow. Isolation with cotton rolls and lip retractors. Use of non-impregnated cotton cords (size 00), carefully placed in the sulcus to avoid any soft tissue trauma. Enamel etched with phosphoric acid, ready for bonding.

Fig 4-30f Final photograph: lips retracted.

Fig 4-30g Final smile. Incisal length individually adjusted to the lower lip line and the function.

Case 4-31

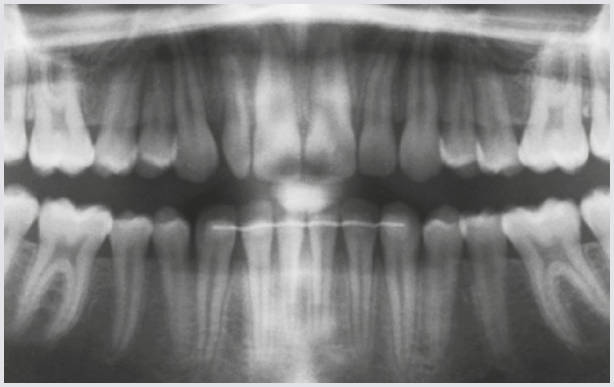

Fig 4-31a Initial radiograph. The maxillary peg-shaped right lateral incisor is perfectly placed during the orthodontic treatment. The main consideration is to provide good support to the mesial papilla by the mesial root surface of the lateral incisor and the distal surface of the central incisor. Ideally and to avoid any root kissing, a space of no less than 1 mm should be maintained for the interdental bone septum; distally, this space can be larger, since a slightly flatter papilla is less critical at this location.

Fig 4-31b Initial situation of the maxillary peg-shaped right lateral incisor.

Fig 4-31c Micro retraction cord in place. Enamel-etched folded matrices placed without wedges. The matrices are removed after placement of the adhesive but before the composite is applied.

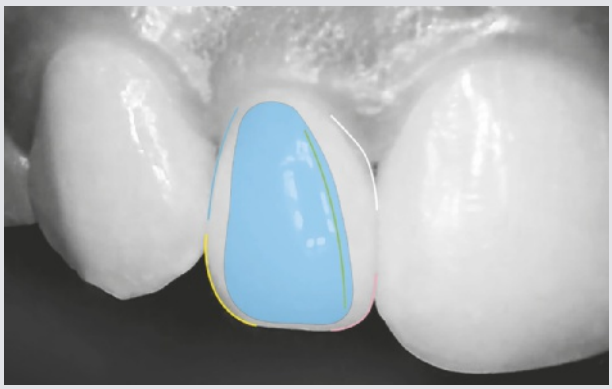

Fig 4-31d Shape principles of the lateral incisor. The blue area is flat and defines the apparent dimension of the tooth. The incisal edge is more rounded distally (yellow line) than mesially (pink line). Distally, the cervical contour should have less convexity (blue line) than the mesial cervical contour (gray line). The latter supports the papilla in the mesial sulcus to avoid black triangles. The most important feature, however, is the mesial green line. It depicts the line angle at the transition from the mesial surface to the flat buccal plane (blue area) and needs to be sharp enough to produce a white light reflection to make the effective shape visible to the eye.

Fig 4-31e Final photograph of the composite buildup of the right lateral incisor. Overall shape and contour realized according to the principles of the previous photograph (Fig 4-31d). White reflections of the incident light depict the effective shape, which is due to the correct convexities and the sharp line angles within the contour of the tooth.

Case 4-32

Fig 4-32a Initial situation during aligner therapy. The spaces are distributed evenly, since all the maxillary anterior teeth are too small. The space between the central incisors is closed. The mesial part of the clinical crowns has a sufficient dimension so that the central papilla is well supported both by the teeth and the interdental bone. Orthodontics: Dr Marco Tribo.

Fig 4-32b and c (b) Direct composite mock-up during the aligner therapy to test the potential final outcome and define the final adjustments of the orthodontic treatment. One advantage of the aligner therapy is that there is no need to remove any of the attachments for the mock-up. In contrast to fixed appliances, the result is esthetically easier to evaluate during the workflow. Minor enameloplasty is marked with a black felt tip pen, so it disappears when viewed with narrowed eyes. (c) After the mock-up is ready to be realized, the orthodontics therapy is finalized. It is of paramount importance to document the mock-up from all sides and to exactly measure the aspired tooth dimensions. An impression for a stone cast in a more complex case such as this is also helpful. A clear workflow must be developed that pinpoints where to begin with the direct bonding. The mock-up also greatly helps to refine the clinician's handiwork and to check the layering for the final restorations.

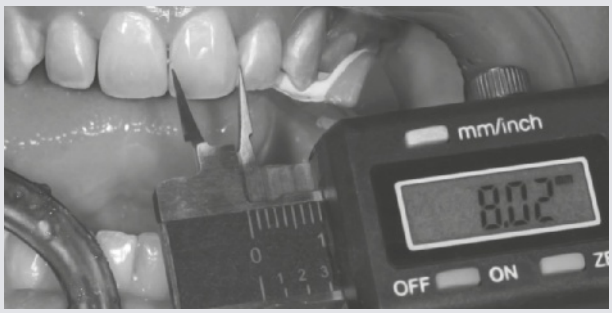

Fig 4-32d It is always advisable to start with both central incisors during the direct composite bonding procedure. The measurements from the mock-up are imperative to retain control over the shapes. Both central incisors are now built up, and the width is controlled with a precise electronic gauge. The next step is to build up the lateral incisors. Finally, the canines and first premolars are rebuilt.

Fig 4-32e Final result after 4 years in function. All six maxillary anterior teeth and the first premolars are built up with the direct composite bonding technique using a nano-filled hybrid composite (Filtek Supreme XTE; 3M ESPE) with a simple two-layer technique (A1 Body on the palatal side; A1 Enamel on the buccal side). The excellent polishability to maintain the surface gloss, also during the maintenance phase by the patient, is remarkable.

Case 4-33

Fig 4-33a Initial situation. Both maxillary lateral incisors are peg-shaped.

Fig 4-33b Direct composite mock-up of both maxillary lateral incisors. Relationship to the dental arch, mandibular and maxillary lip, occlusion, and function is checked and approved.

Fig 4-33c Etching the enamel with folded protective matrices: right lateral incisor.

Fig 4-33d Untreated retraction cord (size 00) and new folded matrices in place before enamel bond is applied.

Fig 4-33e First composite increment placed cervically and perfectly adapted with a thin spatula to avoid any excesses that would be difficult to remove later. Instruments: Deppeler SA, Rolle, Switzerland.

Fig 4-33f Second composite increment placed mesially. The contact area is perfectly formed to avoid corrections after polymerization. It is applied directly toward the adjacent surface with a thin straight spatula.

Fig 4-33g Third composite increment placed on the entire buccal surface. The lobes are formed with a pear-shaped instrument. Final polymerization after final shape control.

Fig 4-33h Left lateral incisor. Folded protective matrices in place for enamel etching, followed by drying.

Fig 4-33i Folded protective matrices are removed after enamel bonding is polymerized. First composite increment is adapted with a thin stiff angulated spatula.

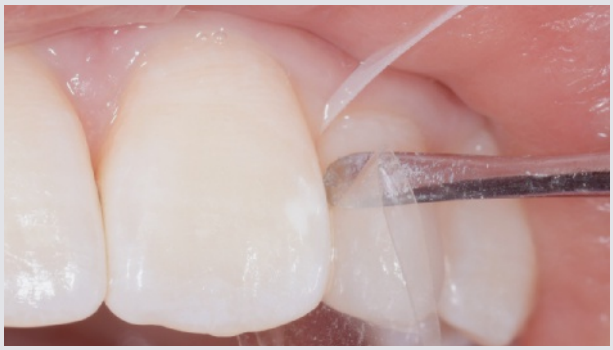

Fig 4-33j Buildup completed. Teeth are separated with a thin spatula. Matrix placed to open up the space cervically for cervical finishing with a fine plastic polishing strip.

Fig 4-33k Approximal contact area is opened with a rotated spatula. Thin polishing discs with the finest grain are used to avoid open approximal contact surfaces.

Fig 4-33l A two-step polishing system is used for final smooth contouring and polishing (nano diamond particle soft rubbers (pink composite polisher; Rodent; Montlingen, Switzerland).

Fig 4-33m High gloss is achieved with nano diamond particle soft rubbers, super fine grain (white composite polisher; Rodent) with water cooling. A nano-filled hybrid composite (Filtek Supreme XTE) is used, which is not sticky during application and keeps its inherent gloss well over time. A simple two-layer technique is used (A1 Body on the palatal side; A1 Enamel on the buccal side).

Fig 4-33n Final result: lips retracted. For the overall result, a perfect shape is more important than a sophisticated multilayer technique, where there is more risk of losing control over the final shape. The direct mock-up is therefore also essential to determine the right choice of color for the layers and their respective thicknesses to retain control over the overall color.

Fig 4-33o Final result 4 years later. Note the surface quality, thanks to the patient's daily hygiene maintenance and avoidance of tooth-damaging beverages. All excessive texturing was avoided to prevent discoloration over time. A smooth surface is optimally resistant from both the chemical and mechanical points of view.

Today, adhesive techniques for partial crowns and bridges have become routine protocol, complementing established treatment options for fixed prosthodontics. Minimally invasive or noninvasive treatment options such as direct bonding with composite, veneers or resin-bonded bridges greatly help to reduce esthetic, technical, and biologic complications and increase the potential for reintervention. Therefore, these alternatives to anterior implants have gained increasing importance.

Consequently, this book covers a wide spectrum of therapeutic means to deal with gaps in the anterior region. The content is divided into the following sub-themes: **moving** (the orthodontic approach), **bonding** (the restorative, noninvasive approach), placing **pontics** (the reconstructive approach with bonded or full-crown bridges), and placing **implants** (the implantologic approach).

The book is based on long-term clinical experience, with cases that are precisely described and richly documented with full-color images. It is not a literature review but rather a type of atlas that presents its practical and knowledgeable content in the context of the relevant literature. It can therefore be regarded as an inspiring **recipe book for clinical success**.

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