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3/14

Monolithic restoration: inside and out
Efficient and reliable reconstruction of an endodontically treated tooth

Straightforward technique solves complicated case
Screw-retained implant-supported anterior bridge made of zirconium oxide

The best of two worlds
Long-span bridges fabricated with the CAD-on technique

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Dear Readers

High-end technology equipment and materials are entering our everyday lives with a speed never experienced before. Modern dentistry has also undergone great evolution with excellent quality materials and equipment that allow dentists and technicians to provide incomparable functionality and lifelike esthetics to smiling faces.

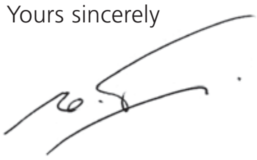
But what is extremely interesting is that the innovation that now enters our world of dentistry is mostly based on high-end technology and outstanding quality materials that have already existed for some time, but can now be joined together by more efficient processes. This is a simple explanation of a term that we have been hearing recently: Disruptive Innovation.

This kind of innovation can only be achieved when you are close to your customers, when you understand their needs and when you are prepared to invest time and knowledge to find solutions and support them. As a new momentum starts to move dentistry, in a highly competitive and economically difficult scenario, Ivoclar Vivadent plays a leading role. That is the integration between the most advanced technology and the high quality materials that were developed specifically for it, simplifying processes and bringing predictable and reliable esthetic results in a very efficient way.

And you know very well that beautiful smiles depend on the right choices, right materials and right techniques. It is not rare that complicated cases can be treated with simple techniques. Or maybe CAD/CAM can help to achieve great results when you have no time to lose. Sometimes direct anterior smile design can be as efficient as the indirect option. Who knows what to choose – translucent zirconium, IPS e.max, or highly efficient direct restoratives such as Tetric EvoCeram Bulk Fill? On the next pages you will have the opportunity to see how dental specialists in different parts of the world use their ability and the support of Ivoclar Vivadent's innovative products to create beautiful smiles.

Enjoy your reading!

Yours sincerely



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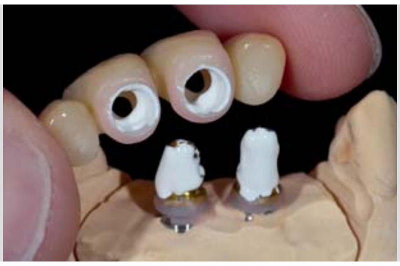

Page 10

Page 15

Page 18

Take advantage of the versatile options offered by digital magazines for tablets and experience the iPad edition of the article: "Straightforward technique solves complicated case" by Dr Giancarlo Bianca, Dr Aurélie Dubois and Denis Rizzo (pp. 8-11). Benefit from the interactive photo sequences with additional pictures, and learn more about the products used and the authors.

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PUBLISHER'S CORNER

Publisher Ivoclar Vivadent AG
Bendererstr. 2
9494 Schaan/Liechtenstein
Tel. +423 / 2353535
Fax +423 / 2353360

Publication 3 times a year

Total circulation 65,000
(Languages: German, English, French, Italian, Spanish, Russian, Greek)

Coordination André Büssers
Tel. +423 / 2353698

Editorial office A. Büssers, Dr. R. May, N. van Oers, T. Schaffner

Reader service info@ivoclarvivadent.com

Production teamwork media GmbH, Fuchstal/Germany

Monolithic restoration: inside and out

Efficient and reliable reconstruction of an endodontically treated tooth

Dr Eduardo Mahn, Santiago/Chile

Composite materials have undergone significant improvements to allow enhanced esthetic results in recent years. The advent of bulk-fill materials and universal adhesives has resulted in a streamlined application procedure.

Restoring teeth after endodontic root canal therapy has always presented a challenge. The wide range of materials available for post-endodontic treatment is paralleled by an equally large range of selection criteria. Glass ionomer cements and composite resin materials are generally the material of choice for clinical situations that require no endodontic posts. Sometimes amalgam is also employed because of legacy use. When endodontic posts are required, more treatment options are available as the pulp chamber is filled with an additional material after placement of the endodontic post.

Prior to the advent of adhesive dentistry, cast metal posts presented the preferred treatment option. In such cases, a customized cast metal post and core build-up were placed in the root canal and pulp chamber and cemented using a zinc phosphate cement. Due to the rising demand for glass fibre endodontic posts, composite cements are now being increasingly utilized. This has led to the rise of two different clinical approaches:

1. The first approach is to create a monoblock, consisting of the core build-up material and the endodontic post. For this purpose, the core build-up material is required to feature a flowable consistency that is suitable for cementing the endodontic post. At the same time, the material should offer a sufficiently high level of strength and stability to be used as a core build-up.
2. The second approach is to fill the tooth with a universal composite using a rather time-consuming layering technique either in conjunction with an endodontic post or without.

Most users prefer the first option because this approach affords a more efficient method than the second. It should be noted that the use of an endodontic post is in many cases often not necessary. The indication for insertion of a root canal post is based on the extension of the contact surface.

> It has long been known that root canal posts do not provide any additional strength to a tooth. Posts are indicated if reliable retention of the core build-up cannot be ensured without anchorage in the root canal.

Fig. 1: Preoperative situation: tooth in need of treatment due to deep caries reaching into the pulp chamber

This is often the case in molars because of their large pulp chambers. Without a post, appropriate retention can often not be achieved in these teeth. The need for a post is often diminished in posteriors with two or more remaining walls in particular.

Bulk-fill composites

What are known as bulk-fill composites were introduced a few years ago. Given the increased translucency of these materials, clinicians were for the first time able to place single increments in a thickness of up to 4 mm. This means that most pulp chambers can be filled using one or at maximum two steps. The material is 100 % compatible with the composite cement used for cementing the glass fibre post in the root canal.

Tetric EvoCeram® Bulk Fill is a posterior composite designed for the fabrication of direct restorations and is part of this new category of materials. The filler composition contains patented shrinkage stress relievers to reduce polymerization shrinkage and shrinkage stress. The composite is characterized by a filler content of 53 to 54 % (by volume) with particle sizes ranging from 40 nm to 3,000 nm. To accelerate the polymerization process, Tetric EvoCeram Bulk Fill contains the new patented initiator Ivocerin® in addition to standard initiator systems (camphorquinone and Lucirin® TPO). As a result, 4-mm increments, high esthetics and short curing times are no longer mutually exclusive. If a high-performance curing light (e.g. Bluephase® Style) is used, the bulk-fill composite can be cured in 10 seconds.

Combined with a universal adhesive

A new generation of universal adhesives have recently gained in popularity due to their flexible application possibilities, efficiency and ease of use. The new Adhese® Universal is a light-curing, universal single-component adhesive for direct and indirect restorations. Adhese Universal can be ideally combined with Tetric EvoCeram Bulk Fill. The universally applicable Adhese Universal establishes a strong bond to various types of restorative materials. The material's low film thickness minimizes the risk of fitting inaccuracies after cementation. No dual-cure activator is required for the cementation of indirect restorations. Adhese Universal combines hydrophilic and hydrophobic properties. It is tolerant of moisture and penetrates open dentin tubules effectively. Since Adhese Universal is moderately acidic, it is compatible with all etching methods and ensures an optimum bond between the tooth structure and the restoration.

The simple "Click" activation of the VivaPen® delivery form allows the exact amount of material to be dispensed each time, eliminating the need for dispensing the material into a dish prior to applying it. As a result, considerably less material is wasted. The VivaPen contains 2 ml of adhesive, which is sufficient for approx. 190 single-tooth applications. Compared to conventional bottle delivery forms, this amounts to almost three times more applications per millilitre (Source: Berndt & Partner, VivaPen Benchmarking Study, August 2013).

Clinical case

The following clinical case describes the use of Tetric EvoCeram Bulk Fill as a core build-up material in combination with Adhese Universal. The report outlines an efficient procedure for building up a tooth after endodontic treatment and restoring it with a monolithic crown (IPS Empress® CAD) (Figs 1 to 13).

Fig. 2: Access to the cavity after removal of the temporary filling

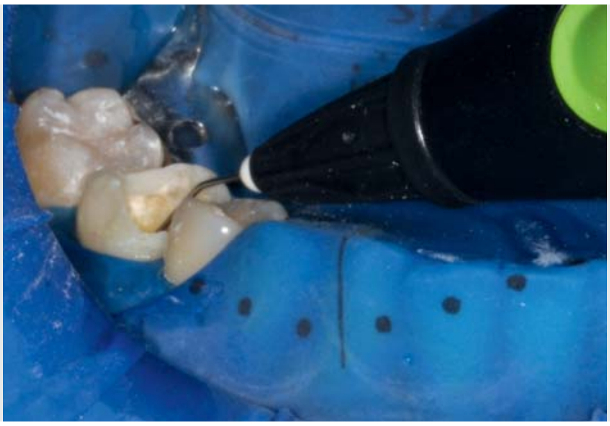

Fig. 3: Direct intraoral application of Adhese Universal with the VivaPen

Fig. 4: Agitation of Adhese Universal into the surface for 20 seconds

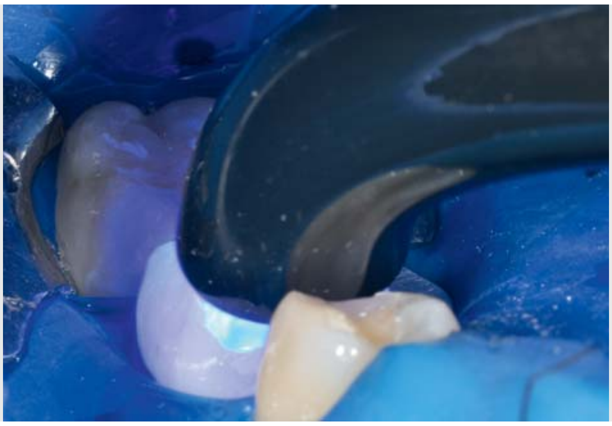

Fig. 5: Quick and reliable light-curing of Adhese Universal with a high-performance light (10 seconds, Bluephase Style)

Fig. 6:
Application of flowable composite (Tetric EvoFlow®) to smooth out small irregularities in the pulp chamber

Fig. 7:
Contouring of a 4-mm increment of Tetric EvoCeram Bulk Fill

Fig. 8:
Adaptation of Tetric EvoCeram Bulk Fill to the cavity walls

Fig. 9: Hybrid dentin composite core after placement of a retraction cord, ready for the next step

Fig. 10: Due to the composite's hardness level, the smooth surface (without irregularities and scratches) feels more similar to the natural dentin than the surface of a flowable material with less stability. This is particularly evident when preparing the core with a bur.

Fig. 11: Post-operative situation after the completion of the restoration (IPS Empress CAD crown)

Fig. 12: Natural-looking appearance of the monolithic restoration after polishing

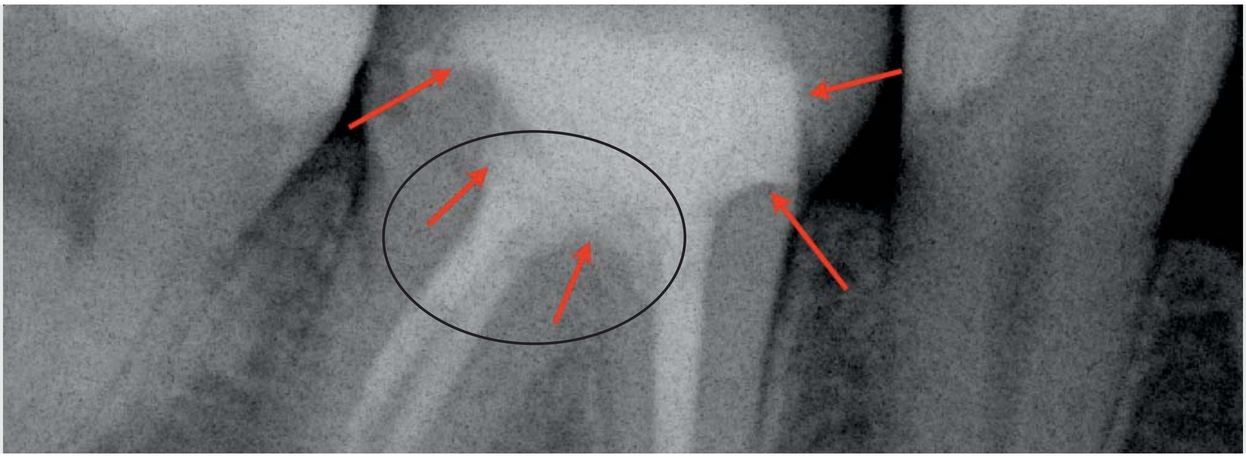

Fig. 13: Final X-ray demonstrating the high radiopacity of Tetric EvoFlow and Tetric EvoCeram Bulk Fill

Conclusion

By using a modern bulk-fill composite in combination with a universal adhesive, endodontically treated teeth can be restored easily, effectively and reliably. Root canal posts are, in many cases, no longer required, for instance when restoring a molar with two or more residual cavity walls.

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Straightforward technique solves complicated case

Screw-retained implant-supported anterior bridge made of zirconium oxide

Dr Giancarlo Bianca, Marseille, Dr Aurélie Dubois, Sausset-les-Pins, and Denis Rizzo, St Victoret/France

This case skilfully combined a translucent zirconium oxide framework, a pressed dentin core and ceramic characterization materials in addition to gingiva-coloured laboratory composites (pink-white esthetics) to produce a very attractive outcome.

The patient consulted us because she was dissatisfied with the appearance of her smile. We were able to meet her needs with an implant-based prosthetic treatment protocol. At the time of the first consultation, the patient's dentition was restored with a bridge which extended from tooth 22 to tooth 12. The clinical and radiological examination of the situation revealed several lesions at the root tips.

Treatment plan

The condition of the anterior teeth was found to be unsuitable for conventional restorative treatment measures (Figs 1 and 2). Therefore, various other options were carefully evaluated. Finally, the decision was taken to extract the teeth and insert two implants and place an immediate implant restoration. Due to biocompatibility reasons and mechanical and esthetic considerations, translucent zirconium oxide (Zenostar Zr Translucent, Wieland Dental) was chosen for the restoration framework. A fluorapatite glass-ceramic (IPS e.max® ZirPress) would subsequently be pressed to the framework. The restoration would then be customized (IPS e.max Ceram) and in a final step it would be cemented to a titanium base.

Surgical procedure

The surgical intervention was carefully planned and performed with an implant imaging software (SimPlant®, Materialise Dental) and computer-assisted navigation (surgical guide). The implants were inserted in the gaps left by tooth 11 and 21. An immediate implant restoration (provisional composite bridge) was placed and the patient was released from the practice. The contact areas of the bridge were suitably lined for the purpose of conditioning the soft tissue during the healing phase. The aim was to produce a convex emergence profile and concave tissue structures. This type of treatment provides a natural-looking basis for life-like implant-supported bridge restorations (Fig. 3).

Figs 1 and 2: Preoperative view: The teeth could not be preserved and had to be extracted.

Fabrication of the permanent restoration

Zirconium oxide framework

Since the patient had very high expectations and the treatment was expected to be quite lengthy, an esthetic mock-up of the permanent restoration was produced first. Prefabricated teeth (SR Phonares® II) were used for this purpose. As a result of the feminine tooth shape requirements, the tooth mould B62 was selected to satisfy the patient's expectations at this early stage of the treatment. The denture teeth of this mould are highly esthetic, since

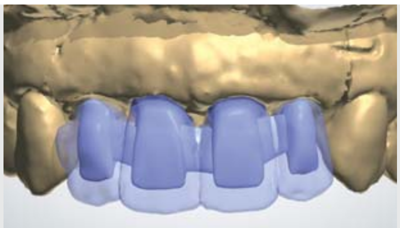

Fig. 3: View after the insertion of the two implants and the conditioning of the soft tissue

Fig. 4: Evaluation and approval of the esthetic mock-up

Fig. 5: Construction of the CAD framework on the basis of the esthetic set-up

Fig. 6: CAD image of the screw-retained framework in the CAM module

Fig. 7: Image of the zirconium oxide framework bonded to the titanium bases

Fig. 8: Application of various liners for the creation of natural-looking colour effects

they feature a sophisticated layering design consisting of Dentin, Incisal and Effect materials. Furthermore, they demonstrate an exceptional macrostructure (Fig. 4). When the restoration was tried in, it became obvious that the interdental gingiva would have to be reconstructed to eliminate any unsightly black triangles.

The approved esthetic try-in was used as a scanning template for the zirconium oxide framework (Fig. 5), which would subsequently be fabricated in a CAD/CAM procedure. The situation was digitally scanned and then the reduction parameters of the computer software were activated: At the click of a button, the framework was reduced to an ideal scale (Fig. 6). This substructure was designed to be strong enough to withstand the mechanical forces in the mouth and to optimally support the veneer restorations. A translucent zirconium oxide disc (Zenostar Zr Translucent) was used to mill the framework. This material allows light to penetrate into the substructure and therefore imparts the entire restoration with a natural-looking appearance. The CAD/CAM system (Zenotec select, Wieland Dental) that was used in this case was selected because of its high precision and excellent reproduction capabilities. The zirconium oxide framework showed outstanding fit and was cemented to the titanium base (Biomet 3i) after only a few minor adjustments had been made (Fig. 7).

Screw-retained/cement-retained restorations on titanium offer biocompatibility, esthetics and stress-free cementation in the permanent placement of dental bridges.

The titanium-titanium combination used in this case is very popular and has been extensively studied.

A suitable liner (IPS e.max Ceram ZirLiner) was applied to prepare the substructure for the veneers. This liner is designed to establish a sound bond with the zirconium oxide, and it ensures high light transmission and excellent fluorescence. Three different product variants were applied on the framework surface and fired together. IPS e.max Ceram ZirLiner Gingiva was used in the cervical third of the bridge to enhance the illusion of dental gum tissue and to create a natural transition between the gingiva and the ceramic. The orange-coloured ZirLiner was applied on the palatal and interdental surfaces in order to achieve a satisfying balance of saturation and depth (Fig. 8). ZirLiner Clear was used on the remaining surfaces due to the fact that the framework already demonstrated the desired shade in these areas.

Dentin core

Since the tooth shape was confirmed during the trial stage, the mock-up was used as the pattern for the fabrication of the permanent restoration. The press-on technique (IPS e.max ZirPress) was used for this purpose. A silicone mould was produced from the mock-up and a wax copy of the restoration was created. The wax-up was placed on the prepared zirconium oxide framework and tried in the patient's mouth (Fig. 9). The restoration was checked in this process and a few final adjustments were made as a result. The need to eliminate the black triangles between the teeth became evident once again. The gaps would have to be filled with a gingiva-coloured material. The laboratory composite SR Nexco® would be suitable for this purpose. A dedicated shade guide was used to determine the appropriate gingiva material (Fig. 10).

In the dental laboratory, the wax-up was cut-back slightly (Fig. 11) and the framework was prepared for the press-on procedure. When the press-on technique is used, a dentin core is produced, which provides a sound base for reproducing the shape and colour of the teeth.

Fig. 9: Try-in of the wax-up in preparation for the recreation of the teeth using the press-on technique

Fig. 10: Determination of the gingiva colour with the help of the dedicated shade guide

Fig. 11: Silicone matrix after the final precision cut-back of the wax-up

Fig. 12: Fine layering with various Effect materials

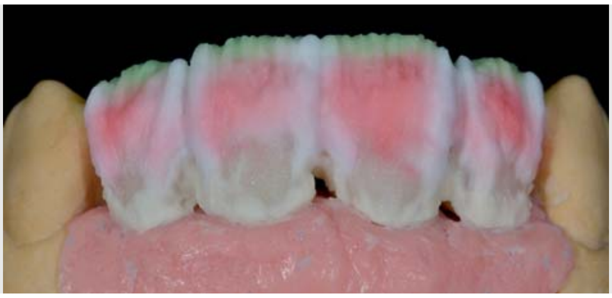

Fig. 13: Layering of the mamelons (OE and TN Effect powders)

Fig. 14: After firing of the individualized bridge

Fig. 15: Cementation of the framework to the titanium base

Individualized layering

Only the incisal edges of the restoration had to be completed with layering ceramic (IPS e.max Ceram), since the other parts had been pressed on the framework. As a result, the need for intricate ceramic layers was eliminated. All that remained was to create the final lifelike touches with Incisal and Effect powders.

The increments were applied according to the individual requirements using customary techniques (Figs 12 and 13). Dentin material was not needed, since the dentin core had already been pressed in a previous step. Individual cervical characteristics were applied with a translucent orange shade. The aim was to produce a deep orange colour. A bluish transparent material was applied to the edges in order to enhance the three-dimensional appearance. In the incisal third, an effect of depth was achieved with the Essence powder "profundo". Finally, a thin transparent (clear) coating was applied to the restoration. This step was indispensable to obtaining an even glaze.

The result after the first firing procedure exceeded all our expectations. Ceramic shrinkage was controlled at all times, which ensured an optimum outcome. The dentin core made of IPS e.max ZirPress served as a support and allowed the axes to be balanced out properly, which would have been more difficult to achieve with a layering ceramic. The opalescence of the ceramic material was appropriately accentuated, since the translucent zirconium oxide framework permitted light to penetrate the veneers (Fig. 14).

Cementation

A thin wax strip was placed in order to ensure a clean bonding surface for the bridge and the titanium bases. The wax provided the necessary protection in this area and allowed any excess cement to be removed with ease. Cementation was performed according to the instructions of the manufacturers of the products used. The contact surfaces of the ceramic crowns were suitably prepared and Monobond Plus was applied to establish a chemical bond. The self-curing composite Multilink® Hybrid Abutment HO was used to cement the components (Fig. 15). This cement shows excellent opacity and effectively disguises the titanium base, without affecting the actual colour of the ceramic. Any excess cement and the wax strip were removed at the end of the cementation process.

Completion with a laboratory composite

The surfaces of the restoration were selectively finished. In the process, different textures (macro and micro) were cre-

Fig. 16: Individually layered bridge on a pressed-over zirconium oxide framework. The interdental gingiva has been recreated with a gingiva-coloured laboratory composite.

Fig. 17: Result on the model ...

Fig. 18: ... and in the mouth

Fig. 19: The spaces between the teeth can easily be cleaned with an interdental brush.

ated to produce a three dimensional effect. Furthermore, the surfaces were adjusted to those of the neighbouring teeth. For this purpose, the restoration was successively finished with rotating instruments. A high-gloss shine was accomplished with mechanical polishing involving polishing medium, diamond paste and a cotton polishing wheel.

Next, the mentioned black triangles in the cervical region were addressed. A gingiva-coloured composite was used to achieve natural-looking pink-white esthetics. The ceramic surface was locally etched (alternatively: blasted with AL_20_3). Then the universal primer Monobond Plus was applied for 60 seconds and the bonding agent Heliobond® for another 60 seconds. The laboratory composite SR Nexco (shade G3) was applied and the gingival embrasures were closed (Figs 16 and 17). This easy-to-use technique created a natural gingival appearance and eliminated the need for additional ceramic firing. Further benefits: Should the gingival tissue retract after a certain time, the embrasures can be easily closed with composite resin, without undertaking any risks.

Seating of the completed restoration

The ceramic bridge was seated without any problems, since a previously established protocol was in place. The restoration blended in seamlessly with the remaining dentition (Fig. 18). In the reconstruction of the gingiva, special consideration was given to providing enough space for interdental cleaning brushes, which would enable the patient to take the best possible care of her restorations (Fig. 19). The final outcome fulfilled all the requirements of this implant denture case.

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Make good use of what you have

Fabrication of ultra-thin veneers for invisible, non-invasive restorative dental treatment

Dr Necib Sen and Hilal Kuday, CDT, Istanbul/Turkey

A systematic approach is essential when the aim is to achieve the best possible esthetic results in tight situations. Apart from the tooth morphology, the parameters of brightness, opacity and translucency have to be taken into account.

A radiant smile suggests a positive attitude and plays an important role in human interaction. When a person's smile is changed, this influences the way in which the person is perceived by others. In order to change a patient's smile in a way that will be attractive and effective, a wax-up and/or mock-up should be used to determine the treatment goal at the outset. This approach also allows as much tooth structure as possible to be preserved. Once a favourable basis has been established, the permanent restoration can be created, without any significant preparation in some cases.

A wax-up is an indispensible aid in diagnosing and analyzing the individual restorative needs of the patient, since it reflects the actual conditions. Furthermore, the cementation protocol must be established at the beginning of the treatment, so that the wax-up can be used to anticipate and avoid any possible problems.

Case study

In the following case, a young actress wished to have the composite restorations in tooth 11 and 21 replaced with a long-lasting, esthetic solution. In addition, the patient was dissatisfied with the dark appearance of her central incisor (Figs 1 and 2). Therefore, the aim of the treatment was to apply non-invasive principles and use only very little restorative material to achieve an outstanding result.

Fig. 1: Portrait picture of the patient before the treatment

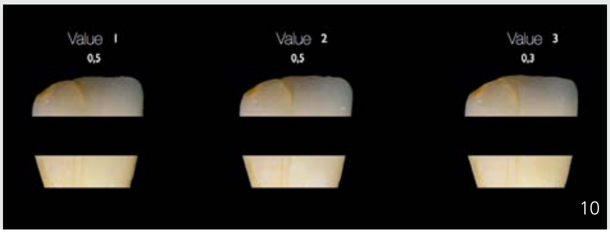
Fig. 2: Preoperative situation: The close-up view shows the esthetic shortcomings of the teeth.

Fig. 3: Dentition after the careful removal of the old composite restorations

Figs 4 and 5: The wax-up was crafted with an opaque wax.

Fig. 6: Trial run with the mock-up after surgical crown lengthening

Fig. 7: Working model for the fabrication of the veneers on teeth 15 to 25



Figs 8 to 10:
An examination which we undertook in our laboratory showed the effect that the existing dental enamel had on the brightness of the restorations. Dental enamel exhibits various levels of translucency. Nevertheless, it can also effectively mask the duller appearance of dentin. As a result, we found that we could regulate the brightness value with only minimal enamel reduction.

Wax-up

First of all, the teeth were internally bleached. Next, the old composite restorations were carefully removed with the help of finishing discs. The tooth surfaces remained virtually untouched in the process (Fig. 3). A special modelling wax was used to create the wax-up, since the space requirements were very restricted. Since some of the conventional waxes demonstrate a very low opacity, we decided to use the highly opaque material CX-5 (ABI Inc., USA), which is also used for sculpturing purposes. This material exactly suited our needs (Figs 4 and 5). The shape, morphology and micro-texture of the final restoration were crafted in wax and then handed to the attending dentist. The wax try-in was checked in the dental office and a few minor modifications were made. We decided to give the patient a "full smile design" treatment which would involve teeth 15 to 25. For this purpose, the crowns were surgically lengthened according to a state-of-the-art protocol. After the healing phase, an impression was taken without soft tissue having to be additionally retracted (Fig. 6).

Fabrication of the permanent restorations

In the next step, the waxed-up veneers were converted into ceramic using a hot-pressing process (IPS e.max® Press). For this purpose, the restoration margins were carefully marked with a red pen on the study model (Fig. 7). The markings were made on the labial surface approx. 0.3 mm from the gingival margin. For the fabrication of the veneers we looked for a material that would offer the highest possible level of brightness (value). Furthermore, the material would have to be able to simulate the translucent properties of natural tooth structure.

The IPS e.max Press Value ingots exhibited the luminosity required in this case, and they would allow the desired translucent properties to be achieved in the incisal areas (Figs 8 to 10). As mentioned, the waxed-up restorations were reproduced in ceramic (Value 2 ingot) using the familiar press technique. The pressed veneers were approx. 0.3 mm thick. Consequently, they were somewhat bulky in the marginal area in particular. As a result, these areas

Fig. 11:
In order to make space for the application of individual characteristics, the pressed veneers had to be cut back selectively.

Figs 12 and 13: The marks which were made on the contact surfaces of the restorations were visible on the labial side and could be removed accordingly.

Figs 14 and 15: The ultra-thin veneers were prepared for the characterization step.

would have to be adjusted with silicon carbide burs after the restorations were placed. The plan was to characterize the veneers with a layering ceramic. Therefore, they had to be cut back slightly. The ultra-thin veneers were ground with utmost precision, since subsequent re-measuring is not recommended and can lead to flawed results. We cut back the restorations according to the markings we had made (Fig. 11). These horizontal and vertical lines had been drawn on the contact surfaces of the restorations. Due to the high translucency of the ceramic, these lines were visible on the labial surfaces and served as a guide for the removal of the restorative material (Figs 12 and 13).

The finished cut-back areas showed that very little space was available for the characterizations (Figs 14 and 15). Merely the incisal and centre areas were individualized as a result (Figs 16 and 17). The veneers were finished and then sent to the dental practice for placement. Since the restorations were ultra-thin, final polishing would be done in the patient's mouth.

Fig. 16: The veneers were characterized with a very small amount of layering ceramic.

Fig. 17: Try-in of the completed restorations

Fig. 18:
The restorations were placed with adhesive cement and then the margins were carefully finished.

Figs 19 and 20: The cemented restorations in the patient's mouth. The transition between the tooth and the ceramic is invisible.

Fig. 21:
Portrait picture of the patient after the treatment

Seating of the restorations
The restorations were permanently seated with the products of the Variolink® Veneer Cementation Kit, which were used according to the instructions of the manufacturer.

When the adhesive cementation technique is used, it is important to retract the soft tissue for the finishing and polishing steps.

The restorations were seated and the transitions to the dental hard tissue were carefully finished with silicon carbide burs to attain the desired surface gloss (Fig. 18). The veneers looked very natural in the mouth. The ceramic restorations were indiscernible from the tooth structure (Figs 19 to 21).

Conclusion
Non-invasive veneers offer many advantages, for example, maximum preservation of the tooth structure. In the case described, we were able to satisfy yet another patient with an esthetic restoration without having to remove any healthy tooth structure.

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The best of two worlds

Easy and effective: long-span bridges fabricated with the CAD-on technique
Massimiliano Pisa, Florence/Italy

The CAD-on technique (IPS e.max) harnesses the advantages of two outstanding ceramic materials and maximizes the esthetic appearance of lithium disilicate glass-ceramics on high-strength zirconia frameworks.

For several years we have been taking advantage of a working technique (IPS e.max® CAD-on/Veneering Solutions) that combines two widely studied materials: lithium disilicate (LS_2) and zirconium oxide (ZrO_2).

Using the CAD-on technique involves the following components:
- IPS e.max ZirCAD blocks (zirconium oxide, framework),
- IPS e.max CAD blocks (lithium disilicate ceramic, veneering),
- Ivomix high-frequency vibrating device,
- especially designed thixotropic fusion glass-ceramic to join the ceramic structures.

Initial situation

The patient came to the practice because she was unhappy about her upper anterior restoration and wanted it to be replaced (Fig. 1). The ceramic material had flaked off at several sites and the function of the metal-ceramic bridge was impaired. A detailed examination of the clinical situation revealed that teeth 11 and 21 were not suitable for anchoring a new dental prosthesis to them because of severe bone atrophy. They had to be extracted. Since the patient refused to undergo any augmentative procedures, placing an implant-retained prosthesis was not an option. We decided on a fixed bridge that would be anchored to abutment teeth 14 and 12 on one side and to 24 and 22 on the other. The area around teeth 11/21 was to be reconstructed with artificial gingiva.

Fig. 1: The patient required a new prosthetic restoration. Teeth 11 and 21 could no longer be saved and had to be removed.

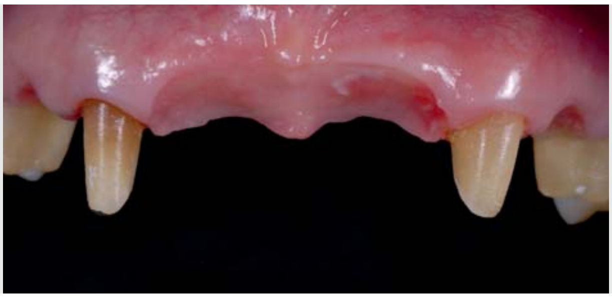
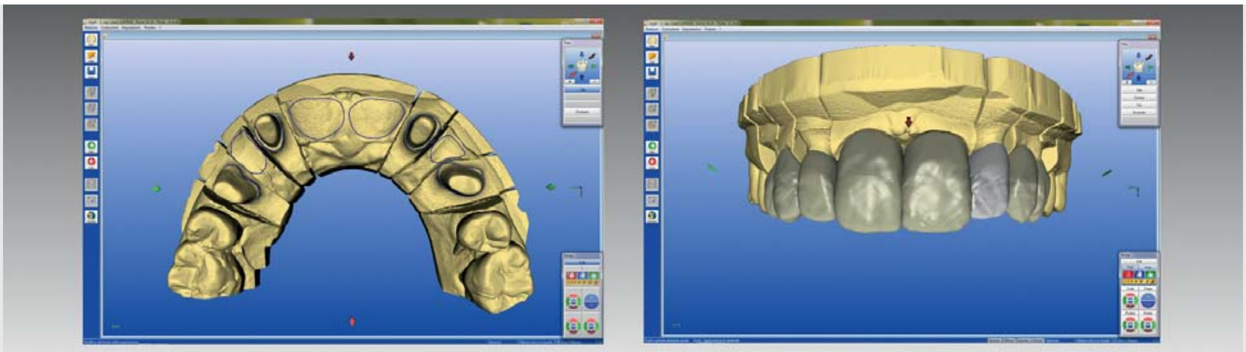


Fig. 2: Situation after tooth 11 and 21 had been extracted and the site allowed to heal for a suitably long period

Figs 3a and b: The esthetic and functional parameters were evaluated in the patient's mouth with the help of a temporary.

Fig. 4: The gingival contour was shaped in the oral cavity.

Fig. 5: The temporary in its targeted, ideal situation



Figs 6a and b: The temporary and master model were digitized (CAD software).

Treatment procedure

After gentle removal of teeth 11 and 21, the extraction site was allowed to heal for a suitably long period (Fig. 2). Subsequently, the technician fabricated a diagnostic temporary to evaluate the esthetic and functional parameters. To achieve a harmonious smile, the incisal edges of the anterior teeth had to be considerably lengthened (Figs 3a and b). At the wax-up try-in, the contour of the artificial gingiva was determined and shaped (Fig. 4).

Detailed evaluation and adaptation of the planned restoration in the oral cavity of the patient (during the diagnostic phase) is essential in the treatment of esthetically demanding cases, regardless of the technological innovations available.

Based on the wax-up, the technician created a temporary that was again evaluated in the oral cavity and adapted to the esthetic and functional requirements of the patient. The situation established with this gradual approach was used as a reference in the subsequent fabrication of the final restoration (Fig. 5). The time had now come to select the materials and manufacturing method that would allow the data gathered in the previous processes to be converted into a high-strength esthetic restoration. In order to achieve this, we opted for the IPS e.max CAD-on technique/IPS e.max CAD Veneering Solutions. This method results in an accurate reproduction of the diagnostic wax-up. A dedicated software program divides the data into two sets: one set to produce the zirconium oxide framework and the other set to manufacture the lithium disilicate veneering structure. The model and the wax-up were both digitized and the resulting data imported to the software program (Figs 6a and b).

Manufacturing the prosthetic restoration

The primary structure (framework) was created using zirconium oxide in the CAD/CAM technique. Its accuracy of fit

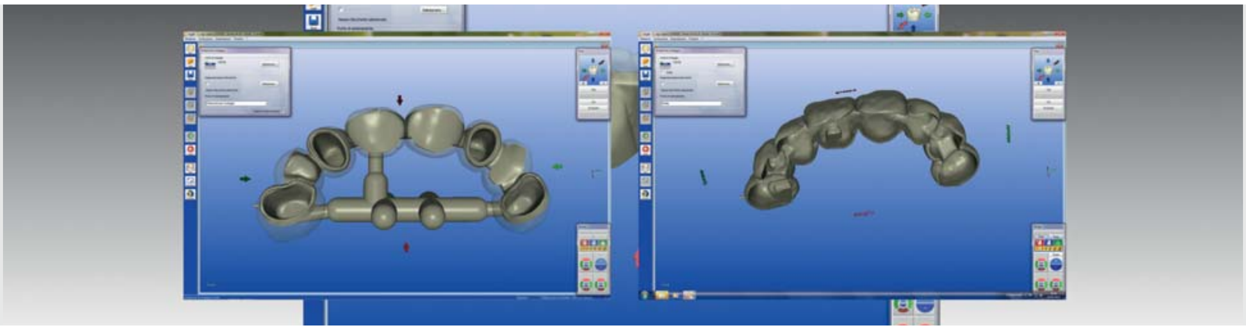


Fig. 7: The zirconium oxide framework was prepared for milling (CAM software).

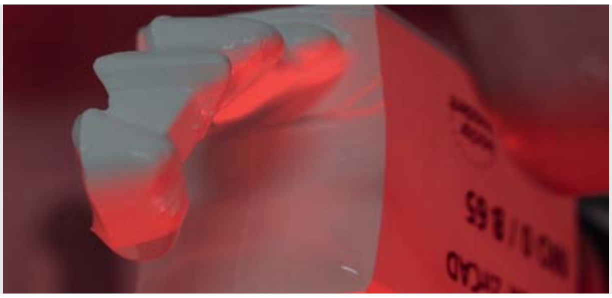
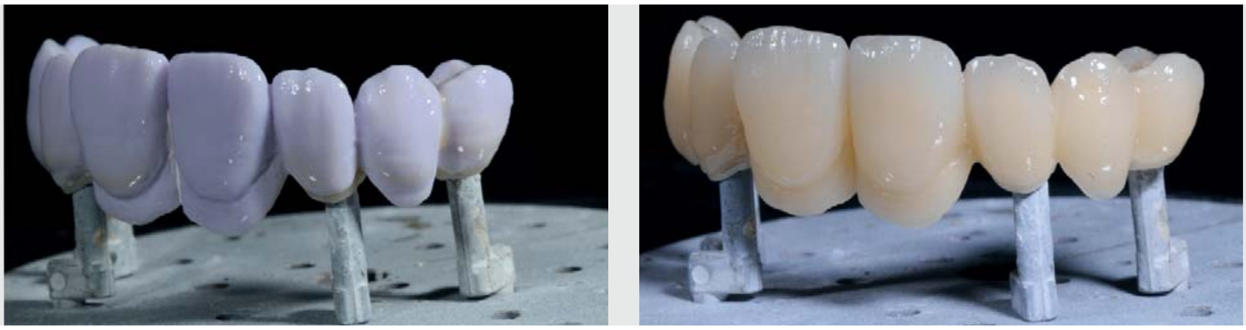


Fig. 8: Zirconium oxide framework in the process of being milled

Fig. 9: As the primary structure, the sintered zirconium oxide framework provided the basis for the digital manufacturing of the veneering structure.

Fig. 10: Zirconium oxide framework on the model

Fig. 11: Situation after milling the veneering structure (lithium disilicate)



Figs 12a and b: Joining the framework and veneering structure (IPS e.max CAD Crystall./Connect)

was checked on the model and then the framework was sent to the practice for a try-in (Figs 7 to 9). The framework showed an excellent fit and did not require any reworking (Fig. 10). Based on the data available, the veneering (secondary structure) was milled using IPS e.max CAD.

The milled secondary structure was easy to adapt to the framework (Fig. 11). While still in the intermediate (pre-crystalline) state, the lithium disilicate veneers were adjusted to match the given morphological characteristics. When in its intermediate state, LS_2 can be easily processed. A base for veneering the gingival parts was also created. The dentist would contour the artificial gingiva with composite material at a later stage. Now, we were ready for the final stage: After checking the functional and morphological parameters, we joined the ZrO_2 framework and LS_2 veneer using the IPS e.max CAD Crystall./Connect fusion glass-ceramic and an Ivomix mixing device (Figs 12a and b). Crystallization/fusion firing was carried out in a Programat furnace using a dedicated firing program. Next, the restoration was

Fig. 13:
Restoration on the model after completion of the fusion process

Fig. 14:
Try-in on the patient

Fig. 15: The artificial gingiva parts were reconstructed using composite material.

Fig. 16: The completed restoration one week after having been seated – indiscernible and esthetic.

Fig. 17: Lithium disilicate ceramic features ideal properties to create a lifelike shade effect.

customized to match the specific characteristics of the patient's dentition and subjected to a characterization/glaze firing process (Figs 13 and 14).

Completing the restoration

After the try-in, the restoration was returned to the lab to add the final touches. A few characterizations were applied in line with the given requirements. Those areas of the framework that were to be veneered with composite were etched to prepare them for the application of the composite material. In the practice, the gingival parts were reproduced using gingiva-coloured composite. For this, the temporary was used as a guide (Fig. 15). A natural looking "gingiva shield" was achieved by applying the material in small quantities in several steps. Finally, the all-ceramic bridge was seated using the usual procedures. The result was a restoration that blended in so well that it could hardly be distinguished from the surrounding natural tooth structure (Figs 16 and 17).

Proven strength

Chipping of the veneering ceramic on zirconium oxide frameworks can often be traced back to a failure of observing the material-specific technical requirements. By using the CAD-on technique described in this report, the risk of failure can be minimized for these restorations, because the strength of the "veneering" ceramic used with this technique is four to five times higher than that of conventional veneering ceramics. The high strength of the ceramic has been confirmed in a study that compared bridges manufactured using the CAD-on technique with ZrO_2 bridges veneered using an individual layering technique (Tauch D, Albrecht T: In vitro-Festigkeitsprüfung von viergliedrigen Brücken. Die CAD-on-Technik, Teil 3. Das Dental Labor 2010, 12, LVIII, 16-23). The results of this study showed that the strength of the CAD-on bridges was twice as high (2188 ± 305 N) as the strength of conventionally veneered bridges.

Conclusion

A natural looking and functional result: accurate diagnostic measures conducted at the pre-operative stage, sound knowledge of the materials involved in the treatment and excellent collaboration led to a highly esthetic result, without the need for surgical intervention. The procedure ideally combines two outstanding materials and has proven to be both reliable and cost-effective.

Acknowledgements

This case involved the collaboration of DT Paolo Vigiani and Dr Leonardo Bacherini, both based in Florence, Italy, and I would like to thank them both for their support.

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Team players: efficiency and esthetics

Full-contour posterior restorations made with translucent zirconium oxide

Dieter Knappe, CDT, Schweigen-Rechtenbach/Germany

Modern zirconium oxides fulfil three major requirements of contemporary dental technology: high strength, esthetics and efficiency. The author describes the fabrication of monolithic posterior tooth restorations with the translucent zirconium oxide Zenostar Zr Translucent.

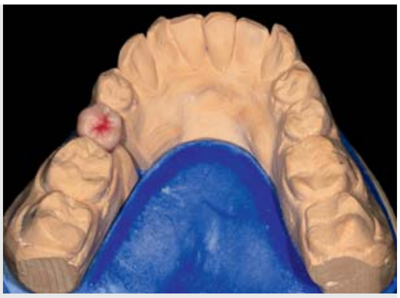
This article is written in celebration of zirconium oxide, a material which has firmly established itself in the dental laboratory over the past 15 years or so. If appropriately used, zirconium oxide restorations produce very strong and durable results. They also satisfy demanding esthetic requirements due to their translucent properties. The following case study shows how monolithic zirconium oxide is effectively incorporated into the digital manufacturing chain to produce highly cost-effective dental restorations without having to compromise on esthetics. In the case presented, a wax-up was crafted which served as a basis for fabricating a provisional restoration (Telio® CAD for Zenotec, Wieland Dental) and a permanent restoration (Zenostar Zr Translucent, Wieland Dental) with one digital data set and CAD/CAM milling equipment.

Preoperative situation

The patient presented to the dental practice with a fractured ceramic inlay restoration in tooth 26 which she wished to have replaced. The tooth had been restored many years previously. Since tooth 25 and tooth 35 were discoloured as a result of root canal treatment, they were included in the treatment plan. The existing tooth structure of tooth 26, which had been prepared to accommodate the inlay in the past, was preserved to the best possible extent. The patient had very high esthetic expectations and wanted the explicit assurance that the crowns would look completely natural. Nonetheless, we decided to use a very efficient fabrication method in which monolithic restorations are produced with translucent zirconium oxide (Zenostar Zr Translucent). Three options are available for fabricating monolithic restorations with this approach:

1. milling, sintering, glazing (efficient, cost-effective);
2. milling, sintering, individualization with ceramic characterization materials, glazing;
3. milling, individualization with infiltration liquids, sintering, glazing (highly esthetic).

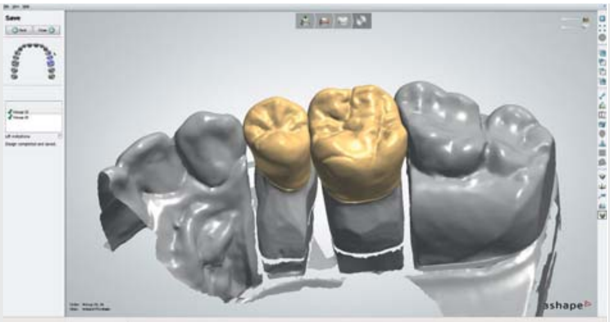
We chose to pursue the third method, which would be very cost-effective as a result of the benefits offered by the digital workflow.

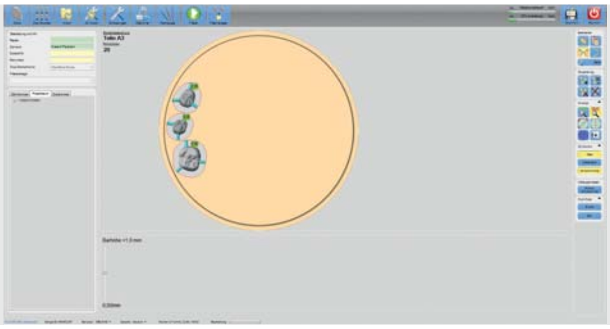


Figs 1 and 2: Manual waxing up of the crowns

Advanced zirconium oxide

Zirconium oxide is more than twice as strong as other dental ceramics, and it exhibits excellent mechanical properties. Due to its translucent characteristics, the material has been fulfilling highly esthetic requirements for quite some time now. The material is used to fabricate full-contour (monolithic) restorations and frameworks that provide a base for individualized veneers. The zirconium oxide





Figs 3 and 4: CAD/CAM images of the scanned wax-up and the PMMA-based long-term temporaries (Telio CAD for Zenotec)

Fig. 5: The milled crowns before they were trimmed from the PMMA disc

Fig. 6a: The completed long-term temporaries made of PMMA on the model and ...

Fig. 6b: ... in the mouth

material Zenostar Zr Translucent shows excellent light transmission. In this system, efficiency teams up with esthetics to offer impressive results. The wide range of discs, the matching stains and the brush infiltration technique allow lifelike effects to be imparted to restorations in a relatively short time.

Preparation

The following aspects were paramount in preparing teeth 25, 35 and 26 for the ceramic restorations: avoidance of sharp edges and observation of a minimum wall thickness. The benefits of using zirconium oxide include the material's high strength and as a consequence, the fact that very little tooth structure needs to be removed. The cavity in tooth 26 already showed extensive preparation. However, in order to properly anchor the new restoration, re-preparation was shown to be inevitable. The cavity had to be extended towards the buccal aspect. Despite being very thin, the buccal cusp walls were in an acceptable condition. The main objective was to maintain the tooth by restoring it with a crown. Following the preparation phase, impressions were taken of the upper and lower jaws and the occlusal relationship was established. Then, the clinician fabricated the provisional restoration chairside with the help of a customized tray.

Fabrication of long-term temporaries

According to the treatment plan, the patient would have to wear long-term temporaries for a period of several months. In order to fabricate these restorations, a wax-up was created (Figs 1 and 2). In this type of situation we prefer to use the manual wax-up technique, because we have found this method to be faster. Alternatively, the restorations could have been virtually designed. Irrespective of the method used, a lasting result can only be achieved if the technician has an in-depth knowledge of the principles of functional occlusion.

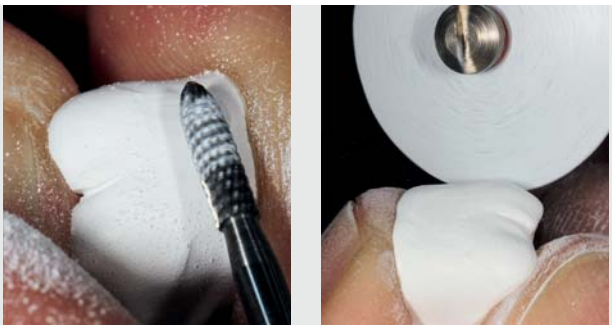
The waxed up crowns were transformed into long-term temporaries with CAD/CAM equipment. First, the physical models and wax-ups were digitally scanned (Zenotec D500, Wieland Dental) and the STL file was imported into a corresponding design software (Dental Designer™, 3Shape) (Fig. 3). Then, all the parameters were suitably adjusted and the construction data was transferred to the milling machine (Zenotec select, Wieland Dental), where the restoration was cut from a PMMA-based disc (Telio CAD for Zenotec) (Figs 4 and 5). The milled crowns were re-worked only minimally and then placed on the model. In order to impart the PMMA restorations with a natural-looking appearance, their surface texture was finished in such a way that a natural play of light was achieved. The crowns were subsequently polished with a special polishing medium and goat's hair brushes (Fig. 6a). Next, the clinician removed the chairside provisional restorations and cemented the long-term temporaries with a suitable luting composite (Telio® CS Link) (Fig. 6b).

Fabrication of the permanent restorations

Three months later, it was time to focus on the permanent restorations. In an effort to keep the treatment with monolithic restorations as straightforward as possible, the existing data set, which had been validated by means of the long-term temporaries, was used (Fig. 7). We selected the translucent zirconium oxide Zenostar Zr Translucent for the restorations. This material comes in disc form and in six

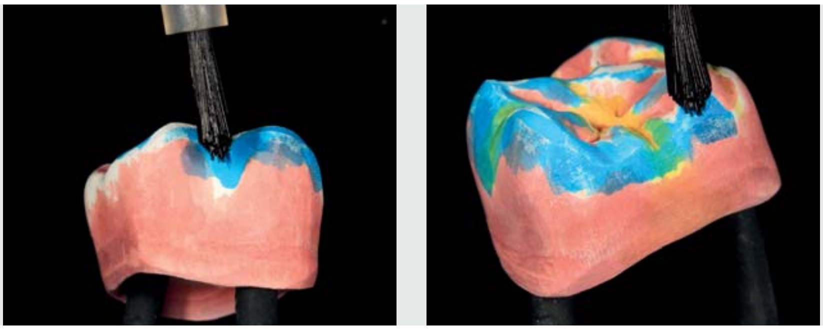
Fig. 7: Same digital data set: preparation for the fabrication of the zirconium oxide crowns (Zenostar Zr Translucent) with CAD/CAM equipment

Fig. 8: The milled crowns before they were trimmed from the zirconium oxide disc



Figs 9a and b: The unsintered structure is carefully ground and smoothed.

Figs 10a and b: Brush infiltration before sintering: The colouring liquid is applied in the cervical areas.



Figs 11a and b: Brush infiltration: The colouring liquid is applied on the cusp tips and in the fissures.

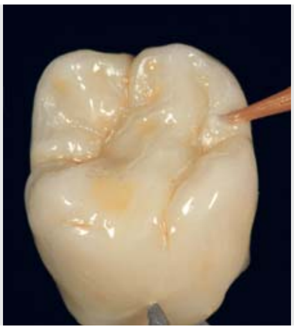
Fig. 12: The occlusal surfaces are polished before the stains are applied.

different shades. We decided to use the "sun" variant, which would give the restorations a warm, reddish foundation. Various possibilities of finishing the restoration were available after the milling process (Zenotec select) (Fig. 8). In this case, the unsintered structures were characterized with the colour infiltration method.

Finishing: brush infiltration

In the brush technique, the milled structures (crowns) are infiltrated with a colouring liquid (Zenostar Color Zr, Wieland Dental). In this process, the restorations acquire a lifelike appearance, showing a tooth-like progression of shade, already before the sintering procedure. All the A-D shades can be reproduced with these colouring solutions. Five additional characterization stains are available. In the case at hand, the bar joints were removed from the milled crowns 26, 25 and 35 by grinding, and the surfaces were smoothed (Figs 9a and b). Subsequently, the colouring liquid was selectively brushed on the cusp tips, around the margins and in deep fissures (Figs 10a to 11b).

The charm of this colourless liquid lies in the fact that it can be made visible. For this purpose a drop of colour concentrate (Zenostar VisualiZr, Wieland Dental) is added to the solution. As a result, the individual liquids can be easily distinguished from each other when they are brushed on the restoration. The colouring material is composed of organic pigments which fire without leaving any significant residue. Next, the restorations were sintered at 1450 °C (Zenotec Fire P1, Wieland Dental). After the sintering process, the crowns appeared lifelike and showed a warm and natural glow due to the reddish zirconium oxide used. Only a few minor adjustments had to be made on the basis of the inspection on the model. As a result, this approach not only ensures savings in terms of time and money, but it also heightens quality assurance.




Figs 13 and 14: The stains were applied and sprayed with another coating of glaze.

Fig. 15: The zirconium oxide crown on tooth 25 immediately after it was placed. Tooth 26 was provisionally restored with a PMMA crown.

Fig. 16: A suitable alternative to a veneered crown and a cast crown – the full-contour zirconium oxide crown on tooth 35. It smoothly blends into the surrounding dentition.

Microcracks are prevented by reducing the grinding work to a minimum.

At this stage – before the staining materials were applied – the zirconium oxide crowns were polished and the surfaces were smoothed (Fig. 12). This effectively counteracted the common concern of abrasion.

Before the crowns were fired, a glaze (Zenostar Magic Glaze, Wieland Dental) was sprayed on their surfaces in order to establish an even base for the application of the staining materials. Stains in paste form (Zenostar Art Module Pastes, Wieland Dental) were used to characterize the restorations. The pastes had to be mixed to a soft, smooth consistency before they could be applied. The cervical and incisal areas of the restorations were individualized with the stains (Fig. 13). A film of glaze was sprayed on the restorations (Fig. 14) before they were fired. The combination of the stains and the lightly fluorescent spray glaze produced a three-dimensional effect.

After the final firing, the crowns did not appear any different from layered restorations. On the contrary, they looked very lifelike and showed a natural internal play of colour. In the next step, the occlusal contacts were checked in the articulator and the proximal contacts on the model. Then the crowns were sent to the dental practice for placement.

Seating of the restorations

Teeth 25, 35 and 26 were suitably prepared for the permanent restorations. Unfortunately, the attempt to save tooth 26 failed. The buccal crown wall fractured when the long-term temporary was removed. Right from the beginning, we were aware of the fact that the remaining part of this tooth might not be strong enough to withstand the treatment. At this stage, therefore, it became quite clear that the tooth could not be preserved. Consequently, the long-term temporaries were re-seated and a new treatment plan was presented to the patient for tooth 26 on the basis of a detailed analysis. A few weeks later, the permanent all-ceramic crowns were cemented (SpeedCEM®) on tooth 25 and tooth 35. The plan was to replace tooth 26 with an implant-supported restoration at a later date.

Conclusion

The monolithic zirconium oxide crowns on tooth 25 and tooth 35 were indiscernible from the other teeth (Figs 15 and 16). The patient reported that she was able to chew comfortably and naturally. The CAD/CAM fabrication protocol allowed the crowns to be cost-effectively produced. The translucent material (Zenostar Zr Translucent) that was used in this case showed a high level of light transmission. Therefore, it offered the ideal basis for reproducing the optical properties of the natural teeth. The described approach will help to satisfy the rising number of cost-conscious and esthetically discerning patients, since it offers an attractive alternative to individually layered ceramic crowns and cast crowns made of precious or non-precious metal.

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