Smile for more self-confidence?

Authors_Manfred Kern & Karl-Heinz Kunzelmann, Germany

Fig. 1

Fig. 1_Ceramic veneer, barely distinguishable from a natural tooth. (Photo Ivoclar Vivadent)
Fig. 2_Shirley Temple: veneers for the teenager parts. (Photo MGM)

Fig. 2

_The child star Shirley Temple, well known from many feature films made by Fox Studios in the 1930s, was part of the American dream and reality. Her picture was not only found in cinemas, but also on soap boxes and shampoo bottles. She bewitched millions with her resplendent child's smile and was also photographed on the lap of President Franklin Roosevelt. Hollywood, hungry for success, accelerated the career of the child star and shaped her for new teenager parts. Shirley grew with the task, but her juvenile teeth did not quite fit her new appearance. A resourceful dentist made anterior tooth shells of thin porcelain, which were bonded to Shirley's teeth prior to each shooting. The mockups had to be attached repeatedly since there was still no adhesive technology at that time. Shirley's unselfconscious smile did not always succeed for fear of losing the seemingly juvenile "props" (Fig. 2).

Achieving a harmonious, appealing smile is still one of the most interesting dental challenges. In the meantime, fully ceramic veneers offer fascinating possibilities and are unbeatable from the esthetic and functional point of view (Fig. 3). The minimum substance loss, the long-lasting esthetics and resistance against wear are extremely beneficial. Application is limited if the enamel quantity only offers an insufficient bonding area or the remaining crown length is too short due to an unfavorable anatomical shape. Veneers are problematic if teeth rotate or are too close. Treatment with veneers has, however, been perfected to such an extent that "the labial covering of anterior teeth with ceramic veneers can nowadays be defined as the scientifically recognized, definite restoration method."[1]

The success of the treatment depends on whether one can conjure up the definite appearance from the start. A perfect result is possible if each detail of the smile is initially correctly recorded. Fully ceramic veneers are universally applicable and offer therapy solutions to repair prosthetic elements with coverings particularly in the anterior tooth region for extended, insufficient fillings (Fig. 4), position anomalies (Fig. 5), tooth fractures, diastema (Figs. 11, 12), form corrections, and discolorations or color corrections in the case of fluorosis and following tetracycline treatment. The focus was on esthetic indication until now, but restoration indication has also become increasingly important in the past years.

Restorative veneers also offer the possibility of reestablishing the palatinal front eyetooth guidance, apart from their aesthetic quality. Permanent function-correcting measures following functional diagnostics open up a third indication. Ceramic veneers can repair an occlusopathia with a faulty dynamic occlusion while chewing surface veneers enable dental occlusion modifications. Anterior teeth partial crowns are extensively designed veneers. They are indicated if the incisal, ap-

proximal, vestibular and lingual surfaces are completely or partly included during defect-oriented preparation (Fig. 13). Partial crowns bonded with adhesive thereby include a ceramic veneer if an extensive defect-therapeutic preparation is necessary.[2]

Fig. 3_The veneer reflects the surrounding colors due to its light-conducting properties. (Photo Reichel)

_Adhesion as door opener

The combination of ceramics and bonding composites with tooth-like translucence has considerably advanced the clinical application of bonding technology in the past years and opened up an era of new restorative treatment possibilities. The preservation of dental enamel is a substantial, determining preparation factor for adhesively bonded restorations. Ceramic veneers especially participated in this development. A fundamental principle is, ie, that function and esthetics are guaranteed with a minimal risk for the biological structures involved. One can still hear, that fully ceramic restorations require extremely invasive preparation. The removal rate for veneers is however far less than during the classical preparation for a metal-ceramic full crowns, if modern fully ceramic systems are used.

Both authors are associated with the Arbeitsgemeinschaft für Keramik in der Zahnheilkunde e.V., a registered association that is the working group for ceramics in German dentistry.

Up to 70 percent of the hard substance of a natural tooth crown must be removed to place a conventional, metal-ceramic crown. The substance removal for a veneer only amounts to 7 to 30 percent depending on preparation method (Fig. 14).[3] The substantially reduced removal rate has important advantages for the patient and for the dentist. The treatment is less traumatic, taking impressions is easier and the number of post-surgical complications is reduced. The life expectancy of the restored teeth is moreover increased. Objections, that this technology still has an experimental character, are not valid anymore.

Alternatives to ceramic veneers are direct and indirect composite veneers. The advantage of the direct composite veneer is that it can be applied in layer technology in one session, while sparing the substance. The reduced wear resistance and color stability are however disadvantageous. The dentist must spend a lot of time and requires artistic abilities. The indirect, laboratory-fabricated composite veneer can be equipped with increased esthetics; the life expectancy corresponds to the above-mentioned chairside fabricated composite veneer.[4,5]

_Clinical proof

Numerous clinical studies with observation periods up to 15 years show that ceramic veneers have proved themselves, if correctly applied during this period. The survival rate (after Kaplan-Meier) is over 90 percent.[6] The DGZMK has therefore also given fully ceramic veneers their scientific acknowledgment.[7]

Failures up to 4 percent with ceramic veneers concentrate on veneers, whose preparation border among others ended cervically in the dentine.[8] Veneers made of feldspar ceramic, manufactured chair-side with the Cerec system and applied during one session, exhibit a survival rate of 93 percent after 9.5 years, whereby veneers on natural teeth fared somewhat better than on crowns and bridges.[9]

_Preparation

The color and design concept should be discussed with the patient first as preparation for a veneer application, so that his ideas can be considered and the feasibility judged. Existing characterizations such as stains, mamelons, enamel fissures, cracks must be recorded on sketches or photographically. The light-dark borders are decisive for the dental technician to determine the color and record the color gradient. The face shape with laughter lines, gloss, texture, bite, gingival and lips are documented photographically. The dental technician can alternatively fabricate an individual ceramic sample for the dentine color, so that the accuracy can be judged initially on the patient to achieve a subsequent ideal match to the laboratory result.

The laboratory diagnosis begins with a sample design of the pre-therapeutic study model (Fig. 6). It is determined at this time, where the teeth must be reduced, in order to accommodate a ceramic veneer. The upper incisor teeth must be elongated to optimize the laughter line; worn-down eyeteeth must be restored for better guidance as well as to protect the elongated incisor teeth. The study model shows the dental technician, where the new smile should be established. A wax model supplies the principle position, function and size of the teeth; the function is corrected by means of the front and eyeteeth guidance.

Thorough oral hygiene should be carried out one week before the actual preparation session, in order to ensure that existing gingivitides can heal. Professional tooth bleaching can be planned as pre-treatment. A silicone preparation template is made with the help of the wax situation model. Such a temporary solution can also be fabricted as an intermediate solution (Fig. 15). The shape for the temporary solution can be a silicone key or a surgical guide stent. It must be noted however with regard to the surgical guide stent that it shows all these details precisely, since otherwise the expenditure for stent production is not worthwhile. A "mockup" is made of composite, if the Cerec system (chairside) is used, in order to determine the definite veneer shape.


Fig. 4


Fig. 5


Fig. 6


Fig. 7


Fig. 8

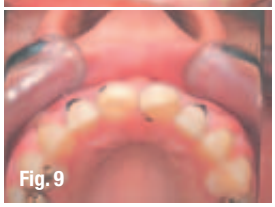


Fig. 9

The teeth should be worked on symmetrically, if it is necessary to a pply several veneers, ie eg from mesial to distal, in each case in teeth groups (1–1, 2–2, 3–3, etc.), in order to attain a harmonious overall appearance.

_Veneer preparation

Extensive preparation is not advisable from today's point of view for several reasons. Pulpnear dentine with a increased portion of dentine tubuli is thereby exposed, the ratio of the remaining dentine to the cavities (Pulp cavity, dentine tubuli) is negatively affected, resulting in a reduced firmness and rigidity of the stump of the tooth. Dentine liquor drains increasingly on account of the increased number of dentine tubuli, which can then impair adhesive bonding and therefore increase the danger of post-surgical problems. Excessive removal also limits the indication range for juvenile teeth with expansive pulp cavities.


Fig. 10

The superficially located aprismatic tooth enamel should be removed in any case during veneer preparation. The deeper located prismatic tooth enamel, which is better conditionable, becomes accessible. Dentine should not be exposed. Teeth with a very similar color to the final ceramic veneer do not have to be prepared deeply. A deeper preparation should be taken into consideration to improve color accuracy in the case of strongly discolored teeth, eg with a dark Tetracycline discoloration. The color accuracy can be improved by increasing ceramic thickness, if the strongly discolored tooth is not prepared deeply enough, but the veneer is then very voluminous.

It is almost impossible to mask the background color effectively with a ceramic veneer, if the preparation depth is marginal. If this succeeds, then only by achieving a monotonous tooth color, either by using more opaque ceramic particles or a more opaque bonding composite. Ceramic veneers seem slightly gray in the case

Fig. 4_Extended, insufficient anterior tooth synthetic fillings.
Fig. 5_Position anomalies, a challenge for veneers.
Fig. 6_Study model with wax-up veneers on rotated teeth.
Fig. 7_Silicone key for later monitoring of substance removal.
Fig. 8_Approximal margins within the non-observable region. The cervical chamfer ensures a suitable parodontal transition.
Fig. 9_Veneer preparation from occlusal.
Fig. 10_A difficult case with rotated teeth, perfectly solved with veneers. (All photos Kunzelmann)

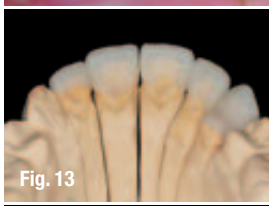
Fig. 11_ Diastema, gaps and enamel edge crack prior to veneer application. (Photo Linne)

Fig. 12_Edge trauma and diastema treated with veneers. The teeth 12 and 22 were included to achieve a harmonious front. (Photo Linne)
Fig. 13_Extensively arranged veneers as FZ partial crowns, here on the once-fire fitting model. Defects on the incisal, approximal, vestibular and lingual surfaces were included. (Photo Pröbster)
Fig. 14_The veneer preparation (left model) requires far less material loss than a conventional, circular enclosing VMK crown (right). (Photo Edelhoff)
Fig. 15_Temporary veneer solution from the surgical guide stent. (Photo Hajto)
Fig. 16_Horizontal depth marking for definite enamel removal. Vertical grooves cause "chatter marks". (Photo Leistner)
Fig. 17_Preparations for bridging and approximal margins not observable. The strong discoloration, which also included the dentine, was the reason for the extensive preparation, in order to obtain a sufficient layer thickness for color masking. (Photo Leistner)

of Tetracycline discolorations, particularly in the gingival zone, where both the tooth enamel as well as the ceramic exhibit a relatively marginal thickness. This can only be solved by extending the preparation labial into the dentine and concluding below the gingiva, which surely only represents a compromise with regard to stability and adhesive bonding, so that the pros and cons must be carefully clarified with the patient.

Preparation planning should consider that the enamel gets increasingly thinner with increasing age on account of erosion and abrasion.[10] The age-dependent tooth color or the existing discoloration influences the substance erosion and the veneer design. This results in the fact that the scope of necessary corrections is the indicator for the veneer layer thickness. A color shift by one step on the Vitapan Classical Scale requires 0.7 mm layer thickness; no color correction is possible, if this is less than 0.7 mm. The lips sag or elongate with increasing age due to decreasing tissue turgor, which can possibly require an elongation of the upper jaw eyeteeth when integrating veneers. This results in a visible rejuvenation of the physiognomy. This incisor edge elongation can only be carried out, if there is sufficient free space or if an occlusion increase can be created in the posterior tooth range, similar to the loss of occlusion height due to abrasion. Existing filling cavities must be included in the veneer preparation. The veneer risk increases, if the preparation border is located within a filling.[11]

Three substantial points should be considered when preparing teeth for ceramic veneers: 1) The preparation depth, 2) The position of the cervical preparation margins, and 3) The expansion of the approximal preparation. We recommend, before beginning the preparation, to carefully retract the gingiva with an inserted thread, in order to avoid an injury of the gingiva. The substance abrasion can be checked with the silicone key (Fig. 7). The approximal margins should be positioned in a non-visible area (Fig. 8). A cervical chamfer ensures a parodontally tolerable transition. The scope of the abrasion extends to iso-gingival. The preparation must extend sufficiently far to palatinal to close a gap; this achieves a external convex veneer shape. The later veneer insertion direction must be considered here. Minimum layer strength is also necessary at the margin for color masking. A minimum distance must be observed for occlusion. Margin preparation is also necessary for very marginal layer thickness. The dental technician recognizes the preparation margin; it defines the final position. The renewal of existing fillings is included into the preparation. The defective-oriented adhesive partial crown is developed out of this.



0.3 to 0.5 mm enamel is removed for a traditional ceramic veneer. The cylindrical "Groove grinder" (depth marker after Goldstein), which is led horizontally, is suitable to determine the erosion depth on the central upper incisors (Fig. 16); "chatter marks" develop on vertical grooves. The labial regions receive a moderately deep perimeter, the approximal contact points remain. The gingival-near margin is prepared as a chamfer and 0.5 mm incisal is removed from the enamel cement margin (SGZ). 0.2–0.3 mm are removed in the cervical third, in the middle third 0.5 mm and in the incisal third 0.5–0.7 mm from the labial area.

0.2 mm is additionally removed from dark teeth. The cervical preparation margin should be carried out slightly subgingival for a high laughter line, otherwise supragingival. The margin can be located at 1 mm supragingival in the lower jaw. It is however rarely necessary to use veneers in the lower jaw.

Bridging by including the incisal edge is not necessary for stability reasons. Tension-optical comparisons with bridgings have shown that the incisal edge is more pressure resistant with buccal reduction; the bridging can only take on smaller loads.[12] The tapered support offers slightly better results than the incisal enclosure, if preparation of the incisal edge is necessary.[13] Bridging is indicated, if the tooth crown must be elongated due to wear or fracture (Fig. 17).

A full veneer with deep margin requires the removal of the approximal edge contacts. The incisal edge termination should be 0.5 mm from the SGZ. The incisal reduction requires the removal of 1.5 mm (Tooth 31) or 2.0 mm (Tooth 21, 23) substance. Fine-grained diamond grinders are normally used. Corroding acid for the preparation of the adhesive bond creates better retention conditions than a coarse-grained diamond instrument.

The cervical restoration margins should be located subgingivally for discolored root structures, eg, in the case of endodontically treated teeth,. The gingival edge restoration can be accomplished supragingivally, if the lips are low. This also applies to the lower row of teeth, ie, that the edges remain covered by the lower lip. Supragingival restoration margins on the tooth enamel do not only improve the adhesion strength, but also are more tolerable to the gingiva. Early gingival recessions can be due to iatrogene effects. Do not injure the gingiva when applying subgingival preparation margins.

_Material selection

Sintered ceramic, pressed ceramic as well as industrially prefabricated ceramic blocks for CAD/CAM treatment are suitable for the production of veneers. Sintered ceramic enables layer strength of 0.3 mm. Micro-porosity can however develop during sintering, which reduces the bending strength and thereby increases the danger of fracture during fitting and fastening.[14] Pressed ceramic made of leuzit-reinforced silicate ceramic (Empress 1 and a.) exhibits clearly higher mechanical characteristics, such as bending strength and fracture toughness, if a layer strength of 0.5 mm is not under run. This means that 0.6 to 0.8 mm tooth substance must be removed during preparation, because the film thickness of the various conditioning layers must be added on account of the adhesive fastening. The difference in cohesiveness between pressed ceramic and millable CAD/CAM ceramic is not clinically relevant, because the durability predominately depends on the adhesive technique. The veneer thickness can be reduced to 0.4 mm, if the ceramic is manually layered on a fireproof stump; to 0.2 mm, if platinum foil is used as substrate. However thicker layers offer more color modulation options.

_Impression taking, temporary provision and wax-up

Taking the impression for laboratory-fabricated veneers is accomplished with addition-curing silicone with inserted retraction threads. Polyether impressions can also be taken alternatively. The double mixing technique has proved to be unfavorable, because the extremely viscous body mass pushes through and casts diffuse thin edges. A reinforcement groove should be built-in to the impression in the case of thin remaining tooth substance, in order to prevent the plaster tooth model breaking. Exposed dentine should be treated prophylactically against hypersensitivity before taking the impression. A face bow transferal as well as photos of the current overall situation with consideration of the laughter line facilitates the precision articulation, function and esthetics laboratory work.

We recommend a laboratory-fabricated interim solution for superior aesthetic pretensions. The possible later final result can thereby be shown to the patient. The chair-side method with an in-situ impression or surgical guide stent with a sharp-drawing film is suitable in all other cases. The temporary veneer should be removable. The direct modellation option has the drawback that the already shaped preparation margin can be damage during work.

_Contralateral veneer

It can be meaningful in some cases in order to achieve optimal esthetics or a harmonious tooth appearance, to duplicate an anterior tooth (eg, tooth 11) for a neighboring veneer (eg, for tooth 21). An anterior tooth can be digitally shot with CAD/CAM technology, using replication software, so that two mirror-symmetrical veneers can be created by means of contrast-lateral mirroring (Cerec 3D).

The construction software takes the preparation shape into consideration when milling it out of the silicate ceramic block. Anterior shape corrections can thereby be easily accomplished, a diastema easily closed and a harmonious overall appearance obtained (Fig. 18).

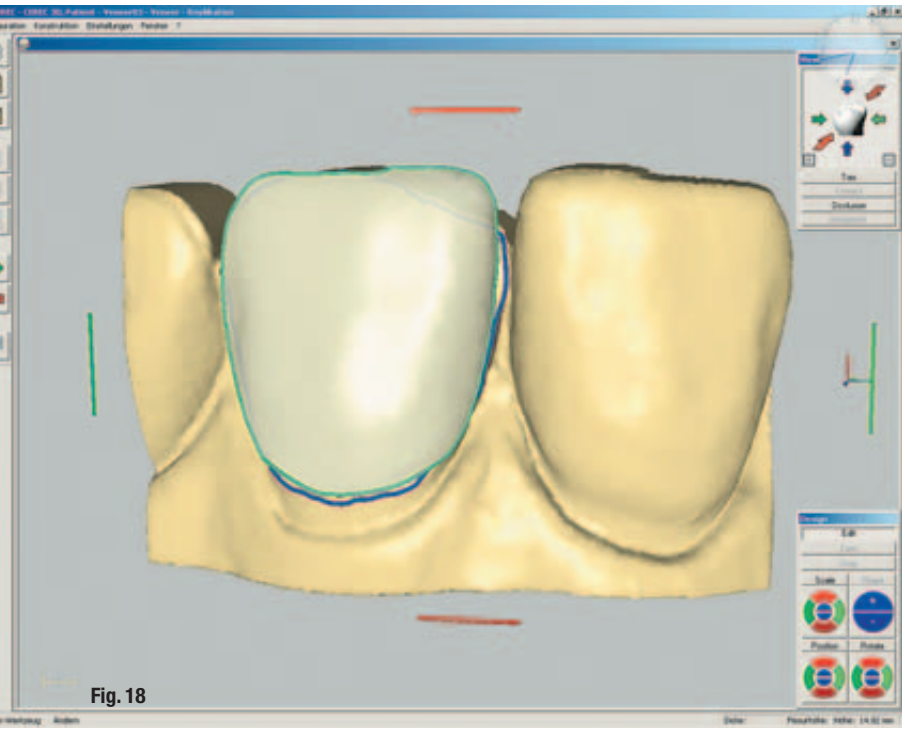


Fig. 18

Fig. 18_Cerec 3D enables a counter-lateral veneer construction, whose shape is replicated by the neighboring tooth. An identical shape for a harmoniously appearing row of teeth is thereby achieved. (Photo Sirona)

_Adhesive bonding

Water, saliva or glycerin gel is used when fitting the ceramic veneer, in order to fill the joint gap between veneer and tooth. This is necessary, since the refractive index of air in the joint gap would prevent color evaluation. This is followed by adhesive bonding. It can often be seen in practice that extreme tooth discolorations are masked with a thick layer of opaque composite after the laboratory has applied several layers of placeholder varnish. This usually results in an impairment of the bonding between ceramic and enamel. Bonding synthetics are subject to a polymerization contraction of 2.6 to 5.7 percent.[15] This property can cause adhesion loss or an edge gap. Since the bonding composite has a different thermal expansion coefficient than the tooth and ceramic, it is better to keep the film thickness as small as possible.

The correct veneer color should be specified when building up the ceramic. The veneer must be designed in such a way, that it fits as tightly as possible and covers the entire pertinent tooth surface (Fig. 10).

Adhesive bonding, elaboration, occlusion examination, polishing and follow-up examination will be the topic of a following report, which will soon be presented in this magazine.

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_Literature

1. Gemeinsame Stellungnahme der DGZMK und der DGZ – 1998.
2. Pröbster, L.: Sind vollkeramische Kronen und Brücken wissenschaftlich anerkannt? Wissenschaftliche Stellungnahme der DGZMK und DGZPW. ZM 1, 28–29, 2002.
3. Edelhoff, D.: Vollkeramik von A bis Z. J Aesthet Zahnmed 1, 16–25, 2003.
4. Dumfahrt, H., Schäffer, H.: Klinische Nachuntersuchungen von Keramik-Veneers. Quintessenz 51, 1.037–1.047, 2000.
5. McComb, D.: Porcelain veneer technique. Ont Dent 65, 25–32, 1998.
6. Kern, M.: Möglichkeiten der keramischen Restauration im klinischen Einsatz. Referat Keramiksymposium 2004. Abstract: Vollkeramische Restauration auf dem Symposium-Prüfstand. ZWR 113, 7/8, 344–347, 2004.
7. Stellungnahme der DGZMK: Keramik-Inlays und Keramik-Veneers. DZZ 56, 01, 2001.
8. Dumfahrt, H., Schäffer, H.: Porcelain Veneers. A retrospective evaluation after 1 to 10 years of service. Part II clinical result. Int J Prosthodont 13, 9–17, 2000.
9. Wiedhahn, K.: Farb- und Formmanagement von Cerec-Veneers. Referat DGCZ-Jahrestagung 2004. Abstract: Schenk, O.: ZWR 113, 11, 514–518, 2004.
10. Ferrari, M. et al. Messung der Schmelzstärke bezüglich der Präparation für die Schalentechnik. Int J Par Rest Zahnheilkd 12, 389–395, 1992.
11. Edelhoff, D., Sorensen J. A: Tooth structure removal associated with various preparation designs for anterior teeth. J Prosthet Dent 87, 503–509, 2002.
12. Hui, K.K. et al. A comparative assessment of the strenghts of porcelain veneers for incisor teeth dependent on their design characteristics. Br Dent J 171, 51–55, 1991.
13. Gilde, H. et al. Untersuchungen zur Belastbarkeit von Keramikfacetten. Dtsch Zahnarztl. Z 44, 869–871, 1989.
14. Dumfahrt, H.: Entwicklung und klinische Anwendung von Keramik-Veneers. Quintessenz 51, 357–367, 2000.
15. Shinkay, K., Suzuki, S., Leinfelder, F., Katoh, Y.: Effect of gap dimension on wear resistance of luting agents. Am J Dent 8, 149–151, 1995.

_contact

cosmetic dentistry

Manfred Kern
Wiesbaden, Germany

Prof Dr Karl-Heinz Kunzelmann
University Munich – Arbeitsgemeinschaft für Keramik in der Zahnheilkunde e.V.
E-mail: info@ag-keramik.de
Web site: www.ag-keramik.de