The Platinum Foil Technique: History, Indication, Fabrication, and Adaptation

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Veneers are commonly used restorations in modern dentistry. Since the advent of pressed ceramics in the early 1990s, the popularity of veneers in Europe has further increased. These paper-thin restorations are an important component of modern cosmetic dentistry. Traditional fabrication methods include refractory die materials, pressed ceramics, and more recently, computer-aided design/computer-assisted manufacture (CAD/CAM) technology. An older method for the fabrication of porcelain veneers is the so-called platinum foil technique.

This handcrafted fabrication method is in stark contrast to the rapid development of CAD/CAM technologies, which currently dominate publications and lectures. In some circles, however, the platinum foil technique has experienced a remarkable renaissance over the past 6 years. In central Europe, this trend is credited to the Zürich-based dental technician Willi Geller and members of his international Oral Design Group.

The platinum foil technique is often seen as a method used only by experts, and many dental technicians reject the technique due to their lack of familiarity.[1] This is regrettable and does not do justice to this exceptional fabrication technique.

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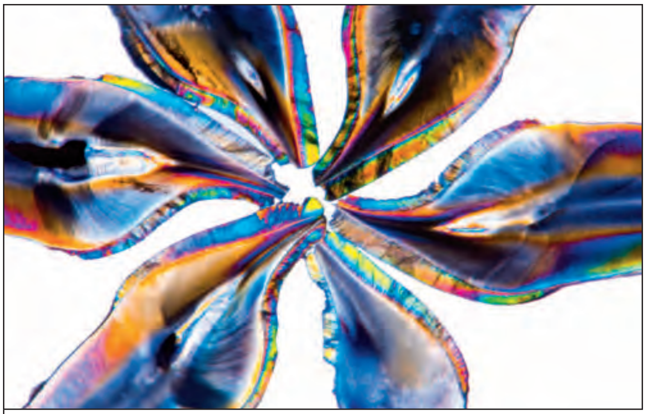
HISTORY

The combination of ceramic and platinum foil is as old as modern dentistry itself. Charles H. Land,[2,3] a dentist from Detroit, filed a patent for this method as early as 1886 and 1888. Land describes how he produced so-called enamel fronts or facings with the aid of a platinum foil matrix (30 gauge) that he adapted to the prepared tooth. He also developed low-fusing dental



1a

1b

Fig 1 Iridescence of natural teeth under polarized light.

porcelain, which he used to finish the veneers on the platinum foil matrix with a gas-fired furnace. Several decades later, in the 1930s, Hollywood dentist Charles Pincus developed the modern dental veneer.[4,5] These thin porcelain coverings were used to give movie stars a temporary improvement of their "mouth personality."

It took another 50 years until, in 1983, Simonsen and Calamia described methods to achieve a secure and predictable bond between ceramic and composite resin,[6] ie, to allow permanent luting of a veneer restoration to the tooth. This procedure was confirmed clinically by Calamia in the same year.[7] Also in 1983, Horn described the use of platinum foil to fabricate veneers.[8] However, it appears that the American dental technician Daniel Materdomini was the true inventor of the modern platinum foil veneer. Pinhas Adar is another dental technician who was instrumental in the further development and dissemination of the platinum foil technique.[9]

INDICATIONS

Regardless of the fabrication technique, porcelain veneers are commonly used in cosmetic and esthetic dentistry. The frequently described esthetic properties of these restorations are based on the unimpeded transmission of light (translucency) and the preserved natural iridescence of the lightly prepared tooth. These restorations optically mimic adjacent natural teeth, minimizing metameric effects associated with conventional metal-ceramic restorations (Figs 1a and 1b).

The platinum foil technique has the following indications:

- Conventional and minimally invasive veneer preparations.
- Noninvasive (structure preserving) veneers, also known as "non-prep" or "contact lens" veneers.
- Full crowns with 360-degree circumferential preparation.
- Support for porcelain shoulders in the porcelain-fused-to-metal technique (ie, Maxi-Shoulders, according to Geller)

Invasive Veneer Preparations

Invasive veneer preparations represent the original design of this restoration (Fig 2). This method is used predominantly in English-speaking areas, whereas the pressed porcelain technique and refractory dies are more frequently used in Europe and Asia.

MINIMALLY INVASIVE AND NONINVASIVE VENEERS

Minimally invasive and noninvasive veneers are very popular in Europe to close small- to medium-sized gaps without preparation. This type of restoration is also known as a contact lens veneer. This design calls for the refractory technique, ie, fabrication directly on refractory dies.

CASE 1

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Fig 2 Initial situation of a patient with fractured incisal edges of the maxillary central incisors and right lateral incisor.

Fig 3 The platinum foil should be 0.025-mm thick. A clinical preparation with rounded edges is recommended.

Full Crowns

Like the platinum foil technique, this is an older technology originating from the jacket crown design by John McLean.[10] He unveiled this technique in the mid-1960s; it involved the layering and firing of aluminous core porcelain onto an adapted platinum foil matrix coping, which was then layered with dental porcelain. Currently, full porcelain crowns are fabricated using refractory dies, pressed ceramic, CAD/CAM technology, or with the platinum foil technique. It should be mentioned that the longevity of any such restoration does not depend primarily on the mechanical properties of the framework, but rather on successful adhesive luting.[11]

Support for Porcelain Shoulders

This is a popular technique in Switzerland, in which the platinum foil is temporarily adapted to a previously opaqued porcelain-fused-to-metal coping to support a full porcelain shoulder during subsequent firings. This results in a homogeneous porcelain shoulder with good adaptation and translucency. Alternative methods of porcelain shoulder fabrication include pressed ceramics and refractory die techniques.[12]

FABRICATION

Literature describing the fabrication of veneers on platinum foil is sparse.[9,13,14] The approach presented in this paper is based not only on information gathered from Willi Geller (Zürich, Switzerland), Pinhas Adar (Atlanta, USA), and Jason Kim (New York, USA), but also on the primary author's own experience. Four cases were selected to demonstrate the indications, fabrication method, and esthetic potential of platinum foil–based porcelain veneers.

Platinum Foil

The platinum foil should be 0.025-mm thick (Dead Soft .0005, Jensen, Metzingen, Germany; or 0.025 mm, Wieland, Pforzheim, Germany). Some manufacturers offer templates to aid in cutting the foil. This helps at the beginning stage; however, it is not absolutely necessary. Cutting and trimming the foil to the die is best performed with sharp fine-pointed Nail scissors and a scalpel (Fig 3).

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Fig 4 Adapting and swaging the foil to the die is simplified when the foil is annealed.

Fig 5 An orange wood stick and metal instrument are recommended to swage the foil.

Before Adaptation

Adapting and swaging the foil to the die is simplified when the foil has been previously annealed (Fig 4). After successful adaptation, the platinum foil should be heated several times using a Bunsen burner to remove any grease.[9] An older recommendation stemming from the heyday of the jacket crown suggests adapting tinfoil for practice, which is then removed and folded back. From the outline of the tinfoil, the exact amount of the much more expensive platinum foil can be determined.[15]

Instruments for Swaging

In addition to fingers, two instruments are recommended to swage the foil: an orange wood stick and a metallic instrument (eg, a Beavertail burnisher). The stick is presumably gentler and should be used to adapt the foil to the margin. However, a metallic instrument (Fig 5), when used carefully, may also be of value.

Adaptation of the Foil

After a foil segment of adequate size has been prepared, it is placed beginning at the facial aspect of the die (Fig 6a). Next, the central part of the foil, extending over the incisal edge, is pushed to the palatal aspect, creating two seams mesio- and distoincisally. These seams are then flattened with straight or angled pointed tweezers (cotton pliers) (Fig 6b) and trimmed flat with scissors (Fig 6c). The excess is then burnished toward the incisal edge. The marginal gap will be largest in the area of these two major seams due to accumulation of the foil material. This gap can be easily minimized via trimming with a diamond disk (Fig 6d). Next, the facial veneering surface and incisal margin are swaged cervically. The apical margin can be trimmed with a scalpel (Fig 6e) **[Au: Previous two sentences correct?]**.

Before Veneering

The incisal seam is particularly problematic in cases with sharp incisal edges at the canines or peg lateral incisors. Extra care should be taken to close the incisal seams. The porcelain can get underneath the foil from these seams, which makes removal of the foil much more difficult. A simple method to seal the incisal seam against porcelain ingress is to solder the seams with low-fusing gold coating (Aurofilm, Metalor, Redwitz, Germany) over a Bunsen burner (Figs 6f and 6g).

6a

6b

6c

Figs 6a to 6g *(a)* After a foil segment of adequate size has been prepared, it is placed beginning at the facial aspect of the die. *(b)* The central part of the foil, extending over the incisal edge, is pushed to the palatal aspect, creating two seams mesio- and distoincisally. *(c)* The seams are trimmed flat with the nail scissors. The excess is then swaged toward the incisal edge. *(d)* The large marginal gap at the two main seams can be easily trimmed with a diamond disk. *(e)* The facial veneering surface and incisal margin are swaged cervically, and the apical margin is trimmed with a scalpel **[Au: Correct?]**. *(f and g)* The swaged foil prior to porcelain layering.

6d

6e

6f

6g

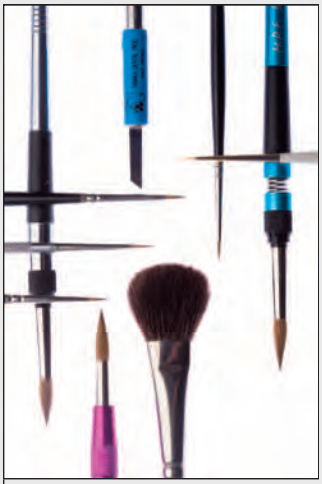

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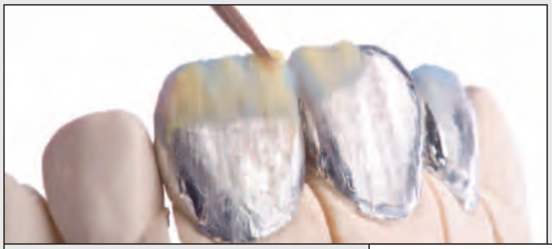
Fig 7 Traditional instruments may be used to apply, sculpt, and layer the porcelain.

Figs 8a to 8d *(a)* Larger defects and fractures are blocked out with opaque dentin porcelain. *(b)* Transition dentin porcelain (Creation CC) is used to create the anatomical form. *(c)* After placing the incisal platform with transparent and enamel porcelain, the mamelons will be created according to photographic documentation. *(d)* The facial outline is sculpted with a blend of transparent and enamel porcelain. A significant extension labially beyond the defect is needed to better blend the restoration.

8a

8b



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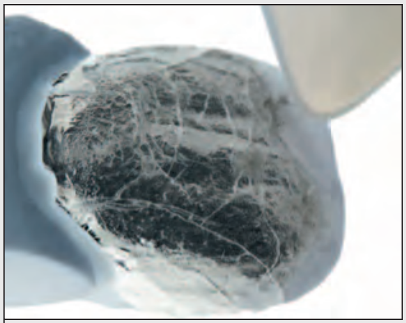
Ceramic System and Veneering

Veneering of the platinum foil can be performed regardless of the coefficient of thermal expansion of the porcelain used. This means that veneering ceramics for zirconia, alumina, and all other porcelain-fused-to-metal materials may be used. However, care should be taken to use leucite-based, and therefore etchable, porcelain (eg, Creation CC, Creation Willi Geller, Baar, Switzerland). Alternatively an adhesive bond from resin to porcelain may be obtained with a silane-coupling agent.

Layering and First Firing

Traditional instruments (Fig 7) may be used to layer and manipulate the porcelain. The first step often requires blocking out larger defects and fractures with an opaque dentin porcelain to avoid any discontinuity in translucency (Fig 8a). Transition chroma-rich dentin porcelain (Creation CC) can then be used to create the internal anatomical form (Fig 8b). After building the dentin-body base porcelain, the incisal platform with transparent and enamel porcelain and the mamelons will be built up (Fig 8c) according to photographic documentation. The facial outline is then sculpted with a blend of transparent and enamel porcelain. A significant extension labially beyond the defect is required to blend the restoration with no visible transition line. This extension is best done with a completely clear transparent porcelain (eg, UC Creation CC, Willi Geller) (Fig 8d). For small restorations (eg, to close interproximal gaps), it is possible to complete porcelain layering and perform only one firing. All firings are done under vacuum at up to 910°C with no hold time.



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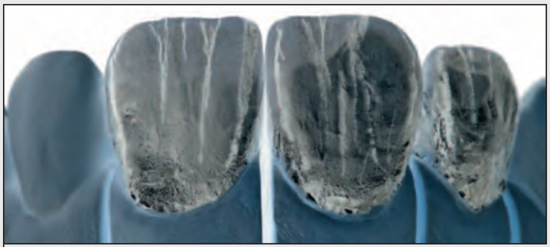

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Fig 9 After all firings up to the final glazing, the laminate must be separated from the foil with a glass or agate spatula to compensate for the shrinkage of the porcelain during firing.

Fig 10 Prior to the second firing, any gaps caused by shrinkage are filled with porcelain and layered.

Fig 11 The second firing may be limited to small corrections in shape using a mixture of enamel and transparent porcelain on the individual die.

Figs 12 and 13 Surface texture is created with the usual methods.

Fig 14 The marginal section should be trimmed with a thin diamond disk.

Separation and Re-adaption

After the first firing and every subsequent firing up to the final glazing, the ceramic must be separated from the foil with a glass or agate spatula to compensate for the shrinkage of the porcelain. The foil has to be re-adapted onto the die every time (Fig 9). Any gap between foil and the restoration must be filled with porcelain and layered (Fig 10).

Second Firing

The second firing is usually limited to small corrections in shape using a blend of enamel and transparent porcelain and is done on the individual die, not while inserted on the cast (Fig 11). This way, the three-dimensionality of the restoration is better appreciated, and small shape aberrations are more easily recognized and corrected.

Finishing and Contouring

Surface texture is created with the usual methods (Figs 12 and 13). Trimming of the marginal section is best performed with a thin diamond separating disk to minimize damage to the feather-thin margins (Fig 14).


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17a


17b

Fig 15 Wetting the foil after the final firing facilitates easy removal with cotton pliers.

Fig 16 Restorations made with platinum foil can be created with very fine margins because the foil reflects heat directly into the ceramic without gas entrapment.

Figs 17a and 17b Platinum foil-based restorations show an acceptable marginal fit that is equally good or even better than that of pressed, milled, or refractory technique–based veneers.

Removing the Foil and Final Glaze Firing

Final glazing is done at 910°C without vacuum after separating the restoration and re-adapting the platinum foil. After firing, adding water to the foil reduces surface tension and facilitates its removal with cotton pliers (Fig 15).

Experience has shown that restorations made with platinum foil can be created with finer margins than laminate veneers fabricated with the refractory technique (Fig 16). The investment material in the refractory die releases gases during heating, which in turn lead to gas bubbles in the ceramic restoration. The heavy platinum foil, however, reflects the heat directly into the ceramic without gas entrapment. This creates a more homogenous surface and apparently higher strength. This may be reason that the foil can be removed even in very delicate restoration without damaging the margins.

ADAPTATION

It is hard to believe that platinum foil restorations have clinically acceptable marginal fit. However, a study by Suh et al[16] showed that platinum foil–based restorations usually had better fit than pressed or milled veneers. Moreover, in direct comparison with refractory technique–based veneers, the fit of platinum foil veneers is equally good or even better (Figs 17a and 17b).[17–19] This well-documented fit of platinum foil veneers may be explained by the function of the foil as a homogenous spacer. All micro-undercuts or sharp edges are mitigated, and the restoration can be seated only according to the line of draw. A separate try-in of the restoration is rarely needed.

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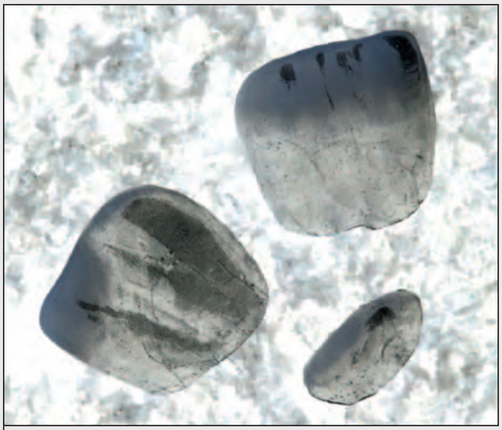

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Fig 18 After try-in, the veneers are etched with 10% hydrofluoric acid for 90 seconds and then cleaned with 37% phosphoric acid followed by an ultrasonic water bath.

Fig 19 The etched veneers prior to luting.

Figs 20a to 20c The luted platinum foil veneers after cementation.

Preparation for Bonding

It is recommended to adjust proximal contacts using a solid cast to enable easy seating of the restoration. With platinum foil veneers, heavy proximal contacts are difficult to detect intraorally. After try-in, the veneers are etched with 10% hydrofluoric acid for 90 seconds.[20] Etching dissolves the glass matrix and reveals retentive undercuts between the leucite crystals. However, after a water rinse, this very rough surface will be contaminated with porcelain debris, binder flakes, and remineralized salt, producing a typical white surface.[21] This appearance may be mistaken for a well-etched surface, but additional cleaning with 37% phosphoric acid followed by an ultrasonic water bath is required to remove this surface layer and optimize micro-retention (Figs 18 and 19). Silane is typically applied in the dental office, permitting a second try-in. After silane application, the restoration is adhesively luted with dual-cure resin cement (Variolink, Ivoclar Vivadent, Schaan, Liechtenstein) (Figs 20a to 20c).

21a

21b

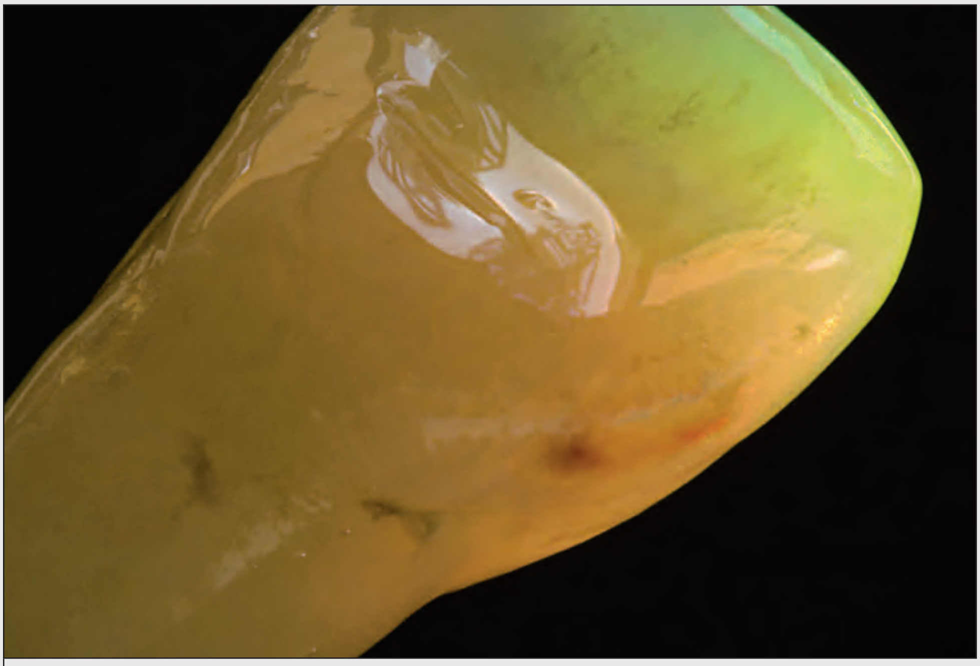

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Fig 21 An esthetically precise restoration should match the detailed anatomy of natural teeth.

Fig 22 Luminosity is crucial to ideal esthetics.

An esthetically precise restoration owes its visual adaptation to both the exact implementation of anatomy based on the appearance of natural teeth (Figs 21a and 21b) and the acquisition of luminosity (Fig 22).

SPECIAL APPLICATIONS

Discolored Teeth

The second case called for a minimally invasive single-tooth veneer to be placed on an abutment with medium discoloration (Fig 23). The foil was swaged as described earlier (Fig 24a). The discoloration was masked with a mix of opaque dentin and powder opaquer (3:1) (Fig 24b).[22] After firing this opaque mix, the veneer was conventionally layered according to the photographic documentation of the clinical situation (Fig 24c) and then fired.

An important aspect of single-tooth reconstructions is the exact approximation of biologic microstructures found in adjacent teeth. These include mamelon configurations, imbrication lines, hypoplasia, enamel craze lines, and the distribution of translucent areas. An authentic appearance depends on the accuracy

CASE 2

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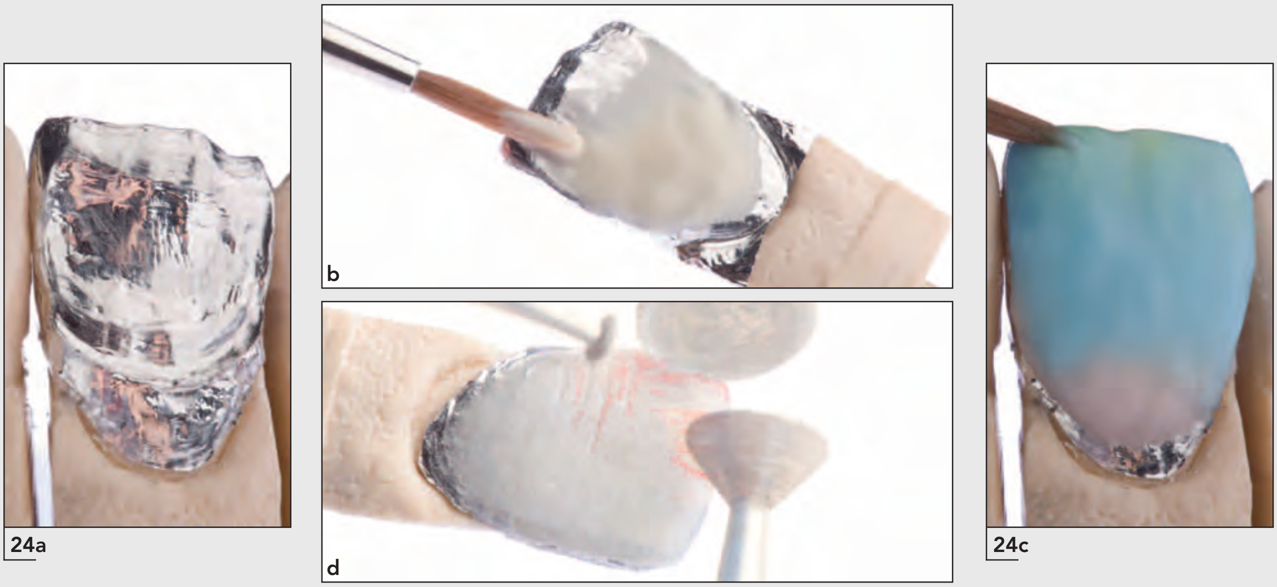

24a

b

d

24c

Fig 23 Initial situation of a patient who required a minimally invasive veneer for an abutment tooth with medium discoloration.

Figs 24a to 24d *(a)* The foil is swaged as described earlier. *(b)* The discoloration is masked with opaque dentin and powder opaquer (3:1). *(c)* After firing this mix, the veneer is conventionally layered and fired. *(d)* Magne's envelope technique may be used to recreate the biologic microstructures found in adjacent teeth.

with which these elements can be copied; this is sometimes impossible with conventional porcelain layering. In such cases, Magne's envelope technique may be used. In this technique, desired effects are ground into the ceramic core (Fig 24d) after the first firing, and the areas are then filled in with modifiers and effect porcelain and, if needed, fired several times at lower temperatures (790°C). To increase predictability of this step, the porcelain may be mixed with Prevu liquid (Synspar, Jeneric Pentron, Kusterdingen, Germany) to

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Fig 25 The porcelain may be mixed with Prevu liquid (Synspar, Jeneric Pentron, Kusterdingen, Germany) to simulate the shade and optical effects prior to firing.

Fig 26 After removal of the foil, the opaque zone designed to mask the discoloration becomes visible (3:1 mixture of opaque dentin and powder opaquer).

Figs 27a and 27b Using the envelope technique, the resemblance of the single-tooth restoration to the natural teeth is stunning.

27a

27b

simulate the shade and optical effects prior to firing (Fig 25). A single-tooth restoration can be deliberately and carefully designed. After removal of the foil, the opaque zone, which was created to block out the discoloration of the abutment tooth, becomes visible (Fig 26). The restoration closely matches the appearance of the adjacent tooth (Figs 27a and 27b).

CASE 3

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Fig 28 In some cases, the platinum foil technique can be used to fabricate adhesively luted full crowns. This patient presented with an anterior open bite.

Fig 29 The platinum foil is swaged and adapted to the die.

Fig 30 If a thicker layer of porcelain is needed, a thinner should be layered and fired first.

Fig 31 The shape is sculpted to create an anatomical form.

Fig 32 The adhesively luted restoration shows excellent esthetics.

Full Crowns

In some cases, platinum foil lends itself to the manufacture of adhesively luted full crowns. This is realized in the third case shown, in which the patient presented with an anterior open bite. Another indication may be restorations for mandibular anterior teeth that offer too little space for a coping, regardless of the material. The main seam is typically located lingually and is soldered with low-fusing gold coating. If a thicker layer of porcelain is needed, it is recommend to place and fire a thinner layer first. With full crowns, this is best done with a mix of dentin and opaque dentin (50:50) to prevent a gray restoration (Figs 28 to 30). Next, the shape is sculpted to create the anatomical form (Fig 31). As expected, the adhesively luted restoration is visually pleasing (Fig 32).

Closing a Diastema

Closing a central diastema with a minimally invasive or noninvasive approach may be the classical indication for veneers. The fourth and last case illustrates an even simpler and faster method to adapt and swage the foil. Here, the foil is pressed between a silicone

CASE 4

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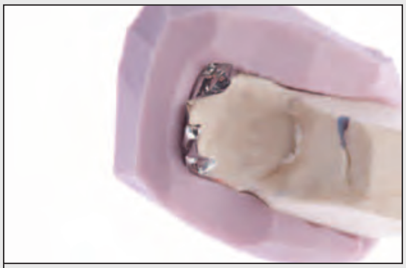

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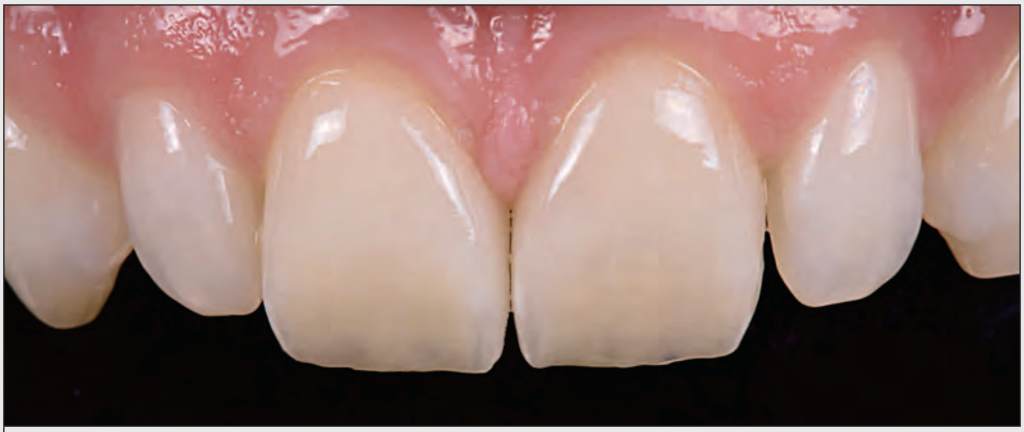
36a

Fig 33 Closing a central diastema is a classical indication for veneers. In this case, a mock-up has suggested that a noninvasive approach would create an unfavorably wide shape for the central incisors.

Figs 34 and 35 In this alternative method to swaging and adapting the foil, it is pressed between a silicone putty matrix impression and the die.

Figs 36a and 36b After frenectomy, both central incisors were lightly prepared. The final results were esthetically pleasing.



36b

putty matrix impression and the die. This secures a very close initial adaptation, and only small corrections are needed (Figs 33 to 36). A high frenum attachment has contributed to the creation of a significant central diastema. A mock-up was used to test the feasibility of a noninvasive approach, but it was determined that this would have created an unfavorably wide shape for the central incisors. After frenectomy, both central incisors are slightly prepared, not only to close the gap, but also to trim the proximal enamel in an attempt to create narrower teeth (compare Figs 36a and 36b).

CONCLUSION

Dental technology is still at the beginning of the high-tech age. The platinum foil technique is driven by craftsmanship and thus stands in contrast to the current CAD/CAM trends. The cases presented here show that manual dexterity alone can create excellent esthetic restorations, without the need to invest in advanced technology. The good fit of platinum foil–based restorations, in conjunction with shorter production times, suggests that this approach is an alternative to con-

The cases presented in this article illustrate the excellent esthetic restorations that are attainable without investment in the newest technology. Consider that the first landing of man on the moon was achieved by NASA with technology of the 1960s.

ventional methods of veneer fabrication. No specialized cast system is required, and the time-consuming practice of die duplication and double pouring of casts is eliminated. In contrast to the use of pressed ceramic and refractory die techniques, porcelain cracks related to thermal expansion are unheard of in platinum foil restorations. Similarly, the use of special investment materials for die fabrication is unnecessary; these materials have drawbacks such as high viscosity, short working times, and continuous release of gases. Finally, the four clinical cases clearly demonstrate that platinum foil–based restorations show excellent esthetic results.

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