Crowns
## Crowns

### Fee per tooth:

**Anterior**

<table>
<thead>
<tr>
<th>Material</th>
<th>Fee</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-Ceramic</td>
<td>$1,467</td>
<td>($800–$3,000)</td>
</tr>
<tr>
<td>Ceramometal</td>
<td>$1,459</td>
<td>($734–$3,000)</td>
</tr>
<tr>
<td>All-Resin</td>
<td>$1,196</td>
<td>($508–$2,000)</td>
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**Posterior**

<table>
<thead>
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<th>Material</th>
<th>Fee</th>
<th>Range</th>
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<tbody>
<tr>
<td>All-Ceramic</td>
<td>$1,315</td>
<td>($734–$2,500)</td>
</tr>
<tr>
<td>Ceramometal</td>
<td>$1,317</td>
<td>($734–$2,500)</td>
</tr>
</tbody>
</table>

### No. of appointments: 4

### Length of time for appointment per tooth:

1st appointment: 60–90 minutes  
2nd appointment: 40–60 minutes  
3rd appointment: 20–40 minutes  
4th appointment: 10–30 minutes

### Insurance Codes

- D2710 Crown — resin (indirect)
- D2720 Crown — resin with high noble metal
- D2721 Crown — resin with predominantly base metal
- D2722 Crown — resin with noble metal
- D2740 Crown — porcelain/ceramic substrate
- D2750 Crown — porcelain fused to high noble metal
- D2751 Crown — porcelain fused to predominantly base metal
- D2752 Crown — porcelain fused to noble metal
- D2783 Crown — 3/4 porcelain/ceramic
Photos 1–5 Patient has home-bleached his maxillary arch and is now ready to have the opaque and slightly fractured ceramometal crown on the maxillary right central incisor replaced, along with replacing the porcelain veneer on the left central incisor. Incisal view also shows that both the crown and veneer are bulky in a facial direction, causing them to totally dominate the smile.
Crown is removed first. Since the facial margin was supragingival, the only gingival inflammation was on the mesial.

Seven months after luting IPS d.Sign crown and veneer. Restorations blend well into smile and, as incisal view shows, have corrected the bulky contours that doomed the original restorations. However, gingival response is only fair.
Photos 13 & 14 IPS d.Sign crown and veneer after 2.5 years. Restorations are functioning well and gingival inflammation has virtually disappeared.
Patient presents with very opaque, high value ceramometal crowns on the maxillary incisors, with the remaining teeth being quite dark. There is also spacing present between all of the crowns and a very high lip line, causing a “gummy” smile. Present crowns were done just six years prior to these photos. Closing spaces was the reported reason for doing the crowns.

In addition, overbite is virtually 100%. The mandibular anterior teeth are quite small, possibly as a result of attrition caused by the porcelain on the opposing arch. While orthodontics could possibly intrude the anterior teeth while extruding the posterior teeth to open the bite, this treatment plan is not acceptable to the patient. Therefore, the problems will be solved through a joint effort of the periodontist and restorative dentist.
Photos 20–23 To reduce the gummy smile, tooth lengthening has been done by periodontist. Smile view shows the upper lip now virtually consistent with the gingival crest of the central incisors. Unfortunately, interdental papillae are now blunted, an untoward sequela of the surgery.

Photo 24 Original preparations immediately after removing ceramometal crowns.

Photo 25 Refined preparations for all-ceramic crowns. Note that marginal configuration was more chamfer than shoulder; since the ceramic material being used (Optec) does not utilize an opaque, high strength core. For more translucent materials, chamfers are more esthetic than shoulders. Cord has been placed to protect the tissue during preparation.
Photos 26–29 Definitive Optec crowns two weeks after luting. In the smile view, it can be seen that the upper lip is exactly aligned with the gingival apex of the left central incisor, but the right central incisor still reveals about 1.0mm of gingiva. This asymmetry should have been discovered in the provisional phase.

Note that, due to the blunted papillae, the gingival embrasures were not completely closed. In addition, crowns could not be shortened incisally due to the smile line and, therefore, even partial correction of the 100% overbite was not possible. Patient received a nightguard to protect the mandibular teeth from additional attrition.
Photos 30–32 Optec crowns 19 months after luting. Tissue health is satisfactory and, remarkably, the blunted papillae have completely regenerated and now all the gingival embrasures are fully closed.

Photo 33 Optec crowns 11.5 years after bonding. Tissue health appears to have improved and crowns have performed well, with the only failure being the left lateral incisor, which fractured at the 11-year anniversary. Spaces have not reopened and papillae are maintaining their positions well.
Anterior All-Ceramic Crowns: Multiple Units — Initial Placement

Reason for Crowns: Large, Discolored Restorations and Darkened Teeth

Photos 34–36 Patient presents with darkened maxillary right canine and lateral incisor, both of which had large existing and stained restorations. The canine had also been endodontically treated.

Photo 37 Treatment begins with preparation and provisionalization of the lateral incisor. The provisional crown, which closed the space between the lateral incisor and canine, is used to illustrate that just treating the lateral incisor without the canine would create a length-to-width discrepancy for the lateral incisor and an imbalance for the entire smile. While it is also possible to demonstrate this type of problem using a diagnostic wax-up and/or a cosmetic mock-up intraorally, the provisional crown method was chosen since the lateral incisor required a crown anyway. Once the patient can see for himself that one crown would not suffice, it is a simple matter to reduce the width of the provisional crown prior to fabricating the second provisional crown for the canine.
Canine has been prepared and provisionalized. Note how treating both teeth creates much more esthetic length-to-width ratios and balance to the smile.

Photos 38 & 39

In-Ceram Spinell crowns are shown in addition to a belleGlass veneer for the right central incisor (see VENEERS – PORCELAIN & INDIRECT RESIN).

Photo 40

Immediate postoperative view of In-Ceram Spinell crowns on lateral incisor and canine. Dark root surface of the endodontically-treated canine is slightly visible at the equigingival margin of the crown.

Photo 41

Crowns on lateral incisor and canine four years posttreatment. There has been no change in the tissue level for either crown, both of which have maintained their original surface texture, anatomy, and gloss.

Photo 42

Crowns on lateral incisor and canine six years posttreatment. There has been virtually no changes with the lateral incisor, but recession has exposed a small area of the dark, nonvital root surface on the facial of the canine. However, this slight root exposure does not concern the patient. Both crowns continue to maintain their original surface texture, anatomy, and gloss.

Photo 43
Anterior All-Ceramic Crowns (Implant & Conventional): Multiple Units — Initial Placement

Reason for Implant Crown: Failed Endodontics

Photo 44 Patient presents with unesthetic provisional crown on maxillary left central incisor. In addition, the right central incisor, which has an all-ceramic crown, will be prepared for a new crown to match the one to be placed on the implant. Remaking this crown also allows for a fixed cantilever provisional during the period the implant is healing.

Photo 45 Provisional crown has been removed, exposing composite core and recurrent caries. In addition, fistula indicates endodontic treatment is failing.

Photo 46 Periapical radiograph shows large gutta percha fill in root canal, while radiolucency suggests periapical pathosis.

Photo 47 Incisal view gives preview of the potential position of implant.
Crows

Photo 48 Socket site following extraction of maxillary left central incisor.

Photo 49 2.0mm diameter depth drill establishes angulation into socket. The maximum recommend setting is 800 RPM for your handpiece when using this drill.

Photo 50 3.5mm diameter tapered drill is used to prepare the bone to accept the proper size implant.

Photo 51 4.3mm diameter tapered drill continues the preparation of the bone in a stepwise fashion.

Photo 52 5.0mm diameter tapered drill prepares the bone to the proper depth. This is followed by the corresponding color-coded threadformer. The maximum recommended setting is 30 RPM. Firm pressure is applied and the threadformer is rotated slowly. When the threads become engaged, the threadformer is allowed to advance without pressure into the prepared implant socket to the single depth reference line.
With the proper implant removed from sterile packaging, the implant is threaded into the prepared site using the white premounted plastic carrier.

Implant is hand-tightened into position.

When more torque is needed to complete the placement, attach the ratchet and ratchet adapter to the insertion assembly and place the implant to its final depth. The dot indicating one of three channeled internal connections is placed to the facial.

The tri-channeled internal connection is positioned to accept an esthetic abutment. 3mm tall healing abutment will then be placed. No sutures are needed to close implant site and the interdental papilla was maintained.
Healing around the abutment has progressed uneventfully. After four months, final impressions are made using a transfer assembly. A titanium abutment is reshaped in the laboratory to accept an all-ceramic Procera crown. At the final seating appointment, the esthetic abutment is placed in the implant, engaging the internal tri-channel connection and tightened using a hex driver and torqued to 35Ncm. The crown over the implant is placed using a provisional cement.

Photos 60 & 61 Final Procera crowns in position, establishing esthetics and proper contours.
Anterior All-Ceramic Crowns & Veneers: Multiple Units — Initial Placement
Reason for Crowns: Large, Discolored, and Dislodged Restorations and Residual Spaces after Orthodontics

Photos 62–67 Preoperative views of patient who had completed orthodontics several years prior to these photos. Patient is finally motivated to continue treatment due to the loss of large restoration in the maxillary left lateral incisor.
Preparations for full crowns on the incisors and wrap-around veneers (also known as reverse three-quarter crowns) on the canines have been completed. Due to the patient’s low lip line and no desire on the part of the patient to lighten his teeth, the margins are primarily equigingival or, in some cases, slightly supragingival. Axial depth of the chamfer or shoulder margins is shallow to preserve tooth structure and to allow a more gradual transition from crown to tooth. This gradual transition, combined with using translucent porcelain at the margins, creates a “contact lens” effect, which makes even supragingival margins virtually invisible.
Photos 72–75 IPS d.SIGN restorations six months after bonding. Despite some margins being supragingival, they are very difficult to see, even at this magnification and with the teeth being dry. Tissue health continues to be exemplary.
Crowns

Photos 76–79 IPS d.SIGN restorations 2.5 years after bonding. Even though the patient has not had any prophylaxes since the restorations were seated, only very slight staining at a few isolated areas along the margins can be seen. These stains could easily be removed by polishing during a routine hygiene visit.
Anterior All-Ceramic Crowns: Multiple Units — Initial Placement
Reason for Crowns: Badly Worn and Discolored Teeth

Photos 80 & 81 Patient presents with worn, dark teeth. Note extremely translucent incisal on maxillary left central incisor due to very thin tooth structure. Patient reports teeth started to stain and discolor three years prior to these photos being taken. She blames leakage from her silicone breast implants, which she since had removed, for her dental problems.

Photo 82 Lingual view shows advanced wear from incisal edges almost to the gingival margins.

Photo 83 Preparations for all-ceramic crowns. Note health of tissue due to the primarily equigingival or slightly subgingival margins. Chamfers were mainly used for the margin design to preserve tooth structure.

Photos 84 Post-operative views showing IPS Empress crowns. Note that many patients with dark teeth demand their crowns be very light. Regardless of what the dentist thinks, patients have the right to choose the shades they prefer.
Anterior All-Ceramic Crowns: Multiple Units — Initial Placement
Reason For Crowns: To Replace Unesthetic Veneers

**Photo 85** Patient with unesthetic veneers. Note that patient will not show teeth in pretreatment smile.

**Photo 86** With crowns seated, patient smiles with confidence.

**Photo 87** Close-up pretreatment view shows thin resin veneer on left central incisor allowing dark tooth underneath to shine through. Other veneers have experienced fractures and staining. Note that left central incisor, left lateral incisor, and left canine have been endodontically treated.

**Photo 88** Post-operative view with In-Ceram Alumina crowns. Due to the opaque, high strength coping, even very dark teeth can be color-modified with reasonable ease. Crowns were necessary due to the large existing and failing restorations. Note that vertical dimension has been opened with a repositioning appliance, which will be worn until the posterior reconstruction can be performed. The patient wanted the anterior teeth completed first due to their negative effect on her smile.
Anterior All-Ceramic Crown: Single Unit — Retreatment
Reason for Retreatment: Opaque, Artificial-Appearing Ceramometal Crown

Photos 89 & 90 Opaque, artificial appearance of ceramometal crown on maxillary right central incisor displays darkened gingival area. Gingival position is also slightly asymmetric. This patient, however, has a medium lip line, which displays the gingival asymmetry.

Photo 91 Incisal view reveals bulky, almost convex contours on the lingual surface of the maxillary right central incisor. Slight misalignment of the maxillary right lateral incisor is also evident.

Photos 92 & 93 Right lateral incisor has been aligned with orthodontic treatment. Note that the crown on the right central incisor has been “slenderized”, especially on the distal, to provide room to rotate the lateral incisor.
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Crows

Photo 94 Lingual surface of crown on right central incisor has been contoured to mimic the contralateral incisor. The thickness of this new lingual surface will be measured after removing the crown. This thickness will be a guide to determining how much additional tooth structure, if any, has to be removed from the preparation to allow the new crown to have adequate thickness and proper anatomical contours.

Photos 95 & 96 Ceramometal crown has been removed from the maxillary right central incisor, revealing an underprepared tooth. The opaque facial marginal area of the crown was partially due to inadequate tooth removal. An underprepared tooth does not give the technician enough space to mask the opaque applied to the metal coping. The lingual reduction was also inadequate, although the original thickness of the metal on the lingual surface of the crown was excessive in its own right.

Photos 97 & 98 Preparation has been completed with retraction cord in place to protect the soft tissue from any trauma. Due to the darkness of the tooth, a full shoulder has been prepared to allow for more porcelain thickness without overcontouring. The incisal view also shows that the lingual surface has been prepared with a definite concavity to mimic the contour of the definitive crown. Ideally, this reduction will provide 1.5mm of clearance between the preparation and the opposing teeth. In addition, enamel has been preserved on the lingual margin. Regardless of what type of adhesive is used, bonding to enamel is more reliable than bonding to dentin.
Photos 99 & 100
Preparation after two tooth lengthening procedures. Nine months have elapsed since the initial removal of the ceramometal crown. Note that the preparation has darkened somewhat, presumably due to microleakage as a result of the provisional crown having been cemented with a provisional resin cement for an excessive period of time. While this staining can usually be controlled by treating the preparation with an antimicrobial agent such as Consensus prior to cementation, this approach may not be effective when provisionalization extends significantly beyond typical crown fabrication times of a few weeks.

Photos 101 & 102
Incisal and lingual views of definitive Procera AllCeram crown. Note how the incisal and lingual contours precisely mimic those of the contralateral central incisor.
Photos 103 & 104 Facial views of definitive Procera AllCeram crown. Note that, despite the two crown lengthening procedures, the gingival symmetry is still not identical. The photographs reveal that the patient could have benefited from slight recontouring of the gingiva of the left central incisor. Fortunately, this is a simple procedure that can be performed quickly at the patient's request. Also note that the dark root of the endodontically-treated right central incisor still causes a slight graying effect to the gingiva.

Photos 105 & 106 After 2.5 years, Procera AllCeram crown blends into dentition reasonably well, but pink, stippled gingiva has not been achieved. Note that, since patient has not been wearing orthodontic retainer, the right lateral incisor has slightly relapsed.
All-Ceramic Crowns: Multiple Units — Retreatment
Reason for Retreatment: Opaque, Artificial-Appearing Ceramometal Crowns

Photos 107 & 108 Opaque, artificial appearance of ceramometal crowns on maxillary central incisors display dark, metal margins. Gingival position is also asymmetric. Fortunately, patient has a low lip line, which hides gingival asymmetry.

Photo 109 Crown lengthening has been performed on the left central incisor to equalize gingival positions of both teeth. Even though patient has a low lip line, this could change once the crowns have been remade.

Photos 110 & 111 Maximum reduction preparations, including full shoulder margins at least 1.0mm in depth. Note the healthy gingival tissue after preparation and provisionalization.
Crowns

Photos 112 & 113 Optec crowns on maxillary central incisors display excellent gingival health and blend well into the smile. The new crowns have also been lengthened incisally to give the patient a younger, more attractive, convex smile line. Unfortunately, the crowns were not cantilevered over the tissue in the midline, leaving the embrasure open. Note that, even though the new crowns have been placed, the patient is still not confident enough to smile more broadly.

Photos 114 & 115 Optec crowns on central incisors after 11 years. Even though the crown on the left central incisor has needed a repair on the lingual (See REPAIRS — PORCELAIN), the gingiva has remained healthy and the full smile view shows the crowns still blend well into the oral landscape. Note that the patient’s lip now covers less of the crowns compared to her smile as shown in Photo 113. This signifies she has retrained herself to smile more broadly and more confidently. Also note that the papilla between the crowns has regenerated and now fills up most of the gingival embrasure.

Photo 116 Optec crowns 12.3 years after luting. Patient has home bleached adjacent natural teeth and wants to remake crowns at lighter shade. Even though crowns will be replaced shortly, they have functioned well for over a decade, except for the lingual fracture on the left central incisor. However, once repaired, the crown has continued to function properly.
Anterior All-Ceramic Crown: Single Unit — Retreatment
Reason for Retreatment: Opaque, Artificial-Appearing, and Poorly Contoured Ceramic Crown

Photos 117–119 All-ceramic crown on maxillary left central incisor not only has a shade mismatch, but shape is not consistent with adjacent central incisor. In the incisal view, it is easily seen that the adjacent central incisor has a relatively flat facial surface, while the crown is actually somewhat convex and in labioversion. In addition, the gingiva investing the crown is inflamed and not symmetric with adjacent central incisor.

Photo 120 Tooth lengthening has been performed to create similar gingival contours for both central incisors.
Crowns

Photo 121 Groove is placed in facial surface of ceramic crown to begin the removal process.

Photo 122 Crown remover is placed in the prepared groove and torqued to loosen the crown.

Photo 123 After torquing the crown remover, half of the crown was dislodged. If the remaining section of the crown has not been loosened, then another groove should be prepared and the process repeated.
Photos 124 & 125 Preparation immediately after removing crown. Note that the margins are almost indistinct, especially on the facial. This is an incorrect preparation for a ceramic crown.

Photo 126 Retraction cord is packed to protect the gingiva prior to beginning the repreparation of the tooth. Note that the knife-edge margins are definitely contraindicated for metal-free materials, since they require the restorative material to be very thin. While this is certainly possible with metal, it is very difficult to achieve with ceramic materials.
Photos 127 & 128 Preparation immediately after removing retraction cord. Note the definitive shoulder margin that allows enough space for the restorative material.

Photos 129 & 130 Preparation after definitive crown has been provisionally cemented for several months. A small amount of residual cement can be seen on the distofacial of the margin. Note the healthy condition of the gingiva.
Photo 131 Three years posttreatment. New all-ceramic crown not only matches the adjacent central in color quite well, but also has a much more pleasing shape.

Photos 132 & 133 Four years posttreatment. Note excellent health of gingiva and durability of surface texture. Incisal view shows flat facial surface of crown that mimics that of the adjacent central incisor.
Anterior All-Ceramic Crowns: Multiple Units — Retreatment

Reason for Retreatment: Opaque, Artificial-Appearing, and Fractured Ceramometal Crowns

**Photo 134** Pretreatment view of intact and fractured ceramometal crowns on the maxillary central incisors. The gingival tissue around both crowns is enlarged, nonstippled, and discolored while the intact crown displays a flat, opaque, “dead” appearance.

**Photo 135** Posttreatment view of In-Ceram Alumina crowns on maxillary central incisors shows excellent gingival response and vital, natural appearance. This material was chosen due to its superior strength.
Anterior All-Ceramic Crowns: Multiple Units — Retreatment
Reason for Retreatment: Opaque Ceramometal Crowns with Open Gingival Embrasures

Photos 136 & 137 Patient with unattractive ceramometal crowns wants replacements. Note generalized blunted papillae as a sequelae to acute necrotizing ulcerative gingivitis. Generalized 5mm pockets are also present.

Photo 138 Provisionals after six weeks in the mouth. Gingival embrasures were closed as much as possible. Patient had completed periodontal therapy.

Photo 139 Try-in of new ceramic crowns shows lab did not use soft tissue model as directed. In addition, prescription specified crowns were to duplicate contours of provisionals as closely as possible. The crowns were improperly contoured and did not close gingival embrasures.

Photos 140 & 141 Modified definitive Duceram crowns were able to close most of the embrasures, but lack of papillae prevents total closure. Smile shows improved contours, color, and smile line.
Anterior All-Ceramic Crowns and Veneers: Multiple Units — Initial Placement and Retreatment

Reason For Retreatment: Opaque, Artificial-Appearing Ceramometal Crowns
Reason For Veneers: Size Discrepancy

Photos 142–145 Patient presents with opaque, artificial appearance of ceramometal crowns on maxillary central incisors that dominate the smile. This domination is accentuated by small, peg-like lateral incisors. Remaking the crowns on the central incisors will help, but the lateral incisors must be included in the treatment plan for more optimal results.

Photos 146–149 In-Ceram Alumina crowns have been placed on the central incisors, along with Colorlogic veneers on the lateral incisors. Using veneers to enlarge the lateral incisors de-emphasizes the central incisors, keeps them from overwhelming the smile, and gives the dentition more balance. Shape of the central incisor crowns is also softer and more pleasing than the rather sharp angles of the previous crowns.
Photos 150–153 After 10 years, patient presents with maxillary right central incisor fractured slightly apical to the gingival crest. Patient had bitten into an apple and tooth fractured. Patients with anterior restorations should be properly cautioned about biting into hard objects directly with their front teeth. Note that the porcelain veneers on the lateral incisors and existing crown on the left central incisor are functioning well and blend into the dentition nicely.
Anterior All-Ceramic Crowns: Multiple Units — Retreatment

Reason for Retreatment: Dicor Crowns with Open Margins and Open Gingival Embrasures

Photo 154 Routine exam revealed grossly open margins on Dicor crowns on maxillary incisors and canines. Note the flat, non-characterized surface. Crowns also have a poor length-to-width ratio (too short).

Photos 155 & 156 Radiographs clearly show large marginal gaps.

Photo 157 First crown has been removed to reveal full shoulder preparation reasonably well done.

Photo 158 Before preparing subgingivally, cord is packed, revealing gross leakage on the existing shoulder of the preparation.

Photo 159 Shoulder and rest of preparation have been refined. Finishing disc is used to smooth any sharp angles.
Photo 160 Maximum preparation was dictated by the previous dentist. Note the bloodless preparations. Even though preserving tooth structure is a noble goal, it can’t always be accomplished.

Photo 161 In-Ceram Spinell crowns were selected due to more natural appearance compared to the original In-Ceram Alumina.

Photo 162 Provisionally cemented Spinell crowns on maxillary canines and incisors after 3.5 months in the mouth. Note the surface texture and anatomy, which gives the crowns a much more natural appearance. Additional length to the central incisors gives the patient a younger look.

Photo 163 Richwil crown remover, after being softened in hot water, is applied to the incisal edge of the provisionally cemented central incisors and pressed apically with reasonable force to cover as much of the facial and lingual surfaces of the crowns as possible. It is then cooled using the air-water syringe.

Photos 164 & 165 Provisionally cemented central incisors being removed by engaging the hardened Richwil with a curved hemostat. Primary pressure is vertically downward, but a slight faciolingual torquing can help break the cement seal. Excessive horizontal movement, however, can fracture the ceramic material.
Photos 166 & 167 Dual-cure provisional resin cement (Provilink) being removed from lateral incisor. Note how it dislodged in one piece, leaving the preparation virtually free from cement. Also note the clean facial surface of the canine. The cement still adhering to the lingual surface of the canine was dislodged easily.

Photo 168 Cement adhering to crown is easily removed.

Photo 169 Preparations of teeth after the provisionally cemented crowns were removed. Note that there is no evidence of leakage or gingival inflammation as a result of the provisional cementation for 3.5 months.
Anterior All-Ceramic Crown: Single Unit — Retreatment
Reason For Retreatment: Bulky and Opaque Ceramometal
Mandibular Incisor Crown

Photos 170–172 Patient presents with overcontoured and poorly shaded crown on mandibular left central incisor. The full arch and incisal views particularly show its obvious nonconformity with the rest of the teeth.

Photos 173 & 174 Minimum reduction preparation after removal of overcontoured ceramometal crown. Margin is a chamfer to preserve tooth structure. A full shoulder would have weakened tooth and is typically unnecessary with bonded crowns on anterior teeth.

Photos 175–177 Optec crown has been bonded and demonstrates excellent conformity with the rest of the teeth, with proper shape and more translucent appearance. Optec was chosen since it did not require any type of coping. This lack of a coping allows you to keep the tooth preparation conservative, which is especially important with small mandibular incisors. Occlusal view also shows proper contours and incisal staining to mimic adjacent teeth.
Photos 178–180 Patient with large, failing MOD amalgam in mandibular left first premolar. Facial view also shows unesthetic gray shine-through caused by the amalgam. Due to the large size of the amalgam and the presence of a facial abfraction lesion, a full crown was recommended as the procedure of choice.

Photos 181 & 182 Preparation is completed.
Photos 183 & 184 Tooth and adjacent areas are dusted in preparation for optical “impression”. Explorer is used to trace margin, making it more visible for optical “impression”.

Photo 185 Optical “impression” is being captured.

Photo 186 Preparation as it appears on the Cerec 3 monitor. Restoration now can be designed and milled.

Photo 187 Vitabloc Esthetic Line crown immediately after removal from milling chamber. Note the residual “sprue” on the facial surface.
Photos 188 & 189 Initial try-in of crown. Tight contacts prevent complete seating. Contacts were designed to be slightly tight to allow them to be perfected in the mouth.

Photo 190
Completed polished crown after adjusting contacts and occlusion.

Photos 191–193 Completed Cerec 3 crown after luting. Despite its monochromatic composition, the translucent nature of the ceramic material blends reasonably well into the dentition and certainly better than the adjacent ceramometal crown. While the occlusal anatomy, which was milled into the crown by the Cerec 3, is rudimentary at best, it could have been manually detailed by the operator if desired. In addition, marginal integrity and tissue response are very good.
Photos 194–196 Cerec crown after two years. Tissue response remains very good, while the crown itself is unchanged from baseline.
Posterior All-Ceramic Crowns: Multiple Units —
Initial Placement
Reason for Crowns: Large, Failing Restorations

Photos 197–199 All-ceramic crown preparations for mandibular first molar and second premolar have been completed. For maximum strength, full shoulder margins were used as well as a minimum axial and occlusal reduction of 1.5mm.

Photos 200 & 201 In-Ceram Alumina crowns were chosen for their strength. Note the thickness of the crowns at the margins. This thickness also enhances strength.
Photos 202 & 203 In-Ceram Alumina crowns after being cemented. Note how well the all-ceramic crowns blend into the mouth and harmonize with the soft tissue.

Photo 204 Radiograph shows the excellent marginal integrity that is possible with any all-ceramic crown.
Four years after luting, In-Ceram Alumina crown on mandibular right first molar has fractured.

Six months after cementing new In-Ceram Alumina crown on mandibular right first molar with Advance, it has fractured again. The expansion tendency of Advance was just being discovered during this era and was the most likely reason for this failure. However, the original In-Ceram Alumina crown on the mandibular second premolar, which was initially seated with provisional cement, was luted with Advance along with the first molar crown. Interestingly, this crown has not suffered from any type of failure.

Seven years after remaking the first molar crown and 12 years of clinical performance for the second premolar, both crowns are functioning well. It is interesting to note that the gingiva has receded on the facial of the natural first premolar and the crown on the first molar, but the tissue does not appear to have changed at all around the second premolar.

In addition, the second premolar, which is the older of the two crowns by five years, is significantly more esthetic by virtue of its better translucency and more natural appearance, whereas the first molar is more opaque and higher in value. Since both of these crowns were fabricated by the same technician from the same material, the only difference was presumably the veneering porcelain, which was supposed to be more esthetic. Maybe ceramic materials are not getting better!
Anterior and Posterior All-Ceramic Crowns and Veneers: Multiple Units — Initial Placement and Retreatment

Reason For Crowns/Veneers: Esthetics and Failing Restorations

Photos 209–216 Patient with opaque and high value ceramometal crowns on maxillary central incisors and maxillary premolars, in addition to dark maxillary lateral incisors and canines, seeks a total smile makeover. Treatment plan includes new all-ceramic crowns to replace the ceramometal crowns combined with porcelain veneers for the lateral incisors and canines. Also note the mandibular anterior crowding, for which orthodontics is planned.
Case begins with removing the unesthetic ceramometal crowns on the maxillary central incisors, since the patient was very self-conscious about the appearance of these crowns.

Long-term provisional crowns were then placed for better esthetics during orthodontic treatment of the mandibular arch.

Orthodontic treatment has been completed. Note that the provisional crowns in this photo have been in the mouth 18 months. However, tissue health is still excellent.

Provisional crowns have been removed and veneer preparations have been completed. Note the lack of bleeding and inflammation in the gingivae around the central incisors, despite the fact that the provisional crowns had been in place for 18 months.
Photos 223–226
Completed IPS Empress restorations from maxillary right canine to maxillary left canine two weeks after seating. Patient is now ready to proceed with remaking the crowns on the premolars. For ultimate shade matching, the premolars should have been done at the same time as the other teeth. However, the patient preferred to complete the anterior segment first before proceeding to the premolars.
Crows

Photo 227 Ceramometal crowns on maxillary left premolars with exposed and visible margins due to gingival recession. Lack of papilla between the crowns also creates a food trap and typical “black” triangle. Note the facial composite that was placed to hide the exposed root on the second premolar.

Photo 228 Preparations for IPS Empress2 crowns show ideal occlusal reduction of 2.0mm and axial reduction of 1.5mm.

Photo 229 IPS Empress2 crowns show lack of an opaque core, the absence of which adds to its natural appearance.

Photos 230 & 231 Bonded IPS Empress2 crowns on maxillary left premolars. Note that the “black” triangle has been closed between the premolars and the tissue health is excellent. However, crowns are slightly too high in value.
Photos 232–236 Posttreatment views 6.25 years after completing anterior restorations, 5.25 years after completing right premolar crowns, and 3.25 years after completing left premolar crowns. All restorations except the left premolar crowns are the original IPS Empress, while the left premolar crowns are the newer IPS Empress2, which has now been replaced with IPS Eris.

Note that, even though the restorations are unchanged and the tissue is healthy, there has been gingival recession, exposing margins on the right first premolar and left canine. In addition, virtually all the gingival embrasures are now open due to loss of papillae. However, these changes do not concern the patient at this time.
Anterior Ceramometal Crown — Single Unit: Initial Placement
Reason for Crown: Caries

Photo 237 Patient presents with a carious maxillary right canine. Due to the subgingival extension of the carious lesion, a ceramometal crown is chosen as most suitable. In addition, esthetics is only a secondary concern after function.

Photos 239 & 240 Ceramometal crown with coping cutback and facial porcelain margin. This cutback is a popular technique to eliminate any chance that the coping may cause a shadow in the root that in turn could affect the vitality of the restoration at the gingival margin.

Photo 241 Postoperative view of ceramometal crown after one month. Note that even though the facial margin was supragingival, the coping cutback makes the margin very difficult to see.

Photo 242 Postoperative view after 2.3 years. Crown and tissue health are stable.
Anterior Ceramometal Crowns: Multiple Units — Initial Placement
Reason For Crowns: Attrition, Caries, and Failing Restorations

Photos 243 & 244 Patient presents with maxillary anteriors having attrition, caries, and failing restorations. Due to the poor condition of her teeth and her desire to have the strongest, most durable restorations, ceramometal crowns are selected.

Photos 245 & 246 Postoperative view of ceramometal crowns. Asymmetric gingival line has not been corrected due to patient’s low lip line.
Anterior Ceramometal Crowns: Multiple Units — Retreatment

Reason for Retreatment: To Splint Periodontally-Weakened Teeth and Close Open Embrasure

Photo 247 Pretreatment view of patient with maxillary central incisors that have drifted facially, creating a diastema, due to alveolar bone loss.

Photo 248 Patient after periodontal surgery. Despite the best efforts of the periodontist, the papilla between the maxillary central incisors has been lost. Due to mobility, ceramometal crowns have been splinted with an internal wire on the lingual surface.

Photos 249 & 250 Preparations showing facial and proximal shoulder margins and lingual chamfers. Shoulders are approximately 0.5mm subgingival.
Splinted crowns returned from lab. Note cutback coping on facial margins to minimize any shadowing on the gingiva. Also pink porcelain was used to replace the lost papilla. Metal lingual margins are designed to give crowns enhanced rigidity.

Postoperative views show soft tissue is healthy under porcelain papilla.

Full smile shows crowns with porcelain papilla blend well with rest of dentition.
Photos 256–258 After 6.5 years, crowns are functioning reasonably well and soft tissue appears healthy. The ceramic papilla is especially well integrated with the gingiva. However, patient required additional periodontal surgery around these teeth due to purulence and more attachment loss one year prior to these photos or 11 years after the original surgery. The new procedure consisted of debridement and a bone graft. Unfortunately, the prognosis on both teeth is guarded. Note the difference in lingual tissue level of the left central incisor compared to immediately after the crowns were seated.
Anterior All-Resin Crowns and Veneers: Multiple Units — Initial Placement

Reason for Crowns: Large, Failing and Dislodged Restorations

Photo 259 Mandibular anterior teeth show numerous large, existing, and mostly defective restorations. Crowns are the treatment of choice for all the teeth with the large defective restorations, since the restorations should be totally encased. Resin was chosen to minimize possible wear on opposing natural dentition and lower cost.

Photo 260 Depth-limiting diamond is used to create grooves in the incisal edges. The depth of the grooves is 1.0mm, which corresponds with the minimum incisal reduction recommendation.

Photo 261 Completed incisal grooves.

Photo 262 Cylinder diamond is then used to reduce the incisal edges to the bottom of the grooves, which is approximately 1.0mm.

Photo 263 Completed incisal reduction.

Photo 264 Facial reduction is begun with a facial groove prepared to a depth of 0.5mm.
Crows

**Photo 265** Groove is made in all teeth to be reduced.

**Photo 266** Tooth reduction continues with concavities being created in the lingual surfaces to mimic the natural contour of mandibular anterior teeth.

**Photo 267** Preparations are smoothed with a finishing disc.

**Photos 268 & 269** Completed minimum reduction preparations. Margins on lingual are supragingival, since they are in enamel, preserve tooth structure, and simplify both impression taking and luting.
Photos 271 & 272
Facial and lingual postoperative views of Targis crowns and veneers. Note healthy tissue and supragingival margins on the lingual.

Photo 273 Three years posttreatment shows Targis restorations maintaining their gloss, but the dark area close to the margin of the left lateral incisor appears to be microleakage since it is on the inside of the crown. To remove the leakage, the crown would need to be opened in that specific area to access the leakage, and then a direct resin would be done to restore the margin. Note: This area of leakage was identified at the two year recall and does not appear to be progressing.
Photos 274–276 Targis restorations 5.25 years after luting. While the gloss is still evident, heavy plaque build-up has started to take its toll. The dark area close to the margin of the left lateral incisor appears to be getting worse. In addition, there is a faint darkened area at the cervical of the left central incisor, recurrent caries at the facial margin of the right central incisor, a small fracture at the incisal edge of the right lateral incisor, and slight staining at the facial margin of the right canine.
Posterior All-Resin Crown: Single Unit — Retreatment
Reason for Retreatment: Gold Visible In Smile

Photo 277 Patient, who is also a dentist, did not like the gold crown on the maxillary right first molar since it was visible in a full smile.

Photo 278 Close-up view of gold crown shows gingival recession on mesiofacial root. Patient was given the option of having a graft instead of extending the preparation onto the root surface.

Photo 279 Gold crown has been removed and hidden secondary caries has been excavated.

Photo 280 Provisional crown has been fabricated and seated. The margin has not been moved apically, but has been kept at the same level as it was with the gold crown.

Photo 281 Graft has been done and covers most of the exposed root surface.
**Photo 282** Refined preparation with composite core buildup and full shoulder margin for strength. Note that there is very little space between the distal margin and the adjacent second molar. As long as the die can be separated by the lab, there is no advantage to moving the margin more apically. A more coronal margin with a bonded restoration is advantageous due to easier isolation, better access for cement cleanup, and higher likelihood of having enamel for optimal bonding.

**Photo 283** Provisional crown after preparation refinement and remargination. Note how well the graft has integrated and healed.

**Photo 284** Targis/Vectris crown was chosen due to the maximum strength of the Vectris core.

**Photos 285 & 286** Postoperative view eight months after bonding. Note the excellent tissue health and gloss of the crown.
Photos 289 & 290
Posttreatment views 4.5 years after bonding. Patient is still in obvious need of prophylaxis, but gloss has been lost. Despite the continued presence of stain, plaque, and calculus, tissue health is satisfactory. Occlusal view shows wear resistance is still very good.

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Photos 287 & 288
Posttreatment views 2.5 years after bonding. Patient is in obvious need of prophylaxis, but calculus and stain appear to be equally adherent to the natural teeth and crown. Occlusal view shows very little if any, evidence of wear.
Photos 291 & 292 Targis/gold crown has been fabricated for maxillary right first molar. Existing ceramometal crown has suffered numerous porcelain fractures, probably due to the bruxing, but patient has resisted remaking crown in the past. Targis bonded to gold was chosen instead of another ceramometal crown due to the more forgiving nature of composite rather than the harder, but more brittle porcelain.

Photo 293 After 3.3 years, mesial section of Targis has fractured, leaving the gold coping exposed. Note that no special mechanical retentive devices were used on the gold to help secure the Targis. In this case, the composite was bonded to the gold using a proprietary coupling agent developed by the manufacturer. However, most coupling agents have not been successful in bonding composite to gold. Regressing to mechanical devices such as beads on the surface of the gold would have probably been a more prudent choice.

Also note the exposed area of gold just distal to the fracture. Patient had evidently worn through the Targis even before the fracture. It is obvious that, in this instance, composite was not more successful than porcelain.

Photo 294 New crown with gold occlusal surface. After two failed attempts to restore the tooth with a crown using porcelain or composite over most of its surface, patient has selected the more sensible option. While most crowns with occlusal surfaces of porcelain (and, in some cases, resin) can provide many years of service, the reliability of gold cannot be forgotten in the esthetic frenzy of the current era.

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- DENTISTRY BY M. MILLER
- IMPLANT SURGERY AND CROWNS BY T. KOSINSKY
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- DUCERAM BY S. MCGOWAN
- IPS D.SIGN BY M. ROBERTS
- IPS EMPRESS BY M. ROBERTS
- IPS EMPRESS2 BY M. ROBERTS
- IN-CERAM ALUMINA BY M. ROBERTS
- IN-CERAM SPINELL BY M. ROBERTS
- OPTEC HSP BY M. ROBERTS
- PROCERA ALLCERAM BY M. ROBERTS
- TARGIS BY D. GRIN AND M. ROBERTS
CROWNS

With the advent of numerous types of partial coverage restorations, full crowns have been disparaged widely as overly aggressive and old-fashioned. Conservative restorative techniques abound as many practitioners take much pride in saving as much intact tooth structure as possible. However, crowns are still the bedrock procedure for many in the profession when dealing with badly broken down teeth (Photos 34–36, 80–82, 87, 237, 243 & 244, 259).

When crowns are mentioned to many astute patients, there are several objections that immediately are raised:

• I don’t want crowns since they all have that dark line at the gum line (Photos 15–19, 109). The exposed metal collar of the ceramometal crown has turned off many potential candidates for crowns. Explaining that few if any crowns have need a metal collar goes a long way in alleviating this fear.

• I don’t want my teeth ground down into little stumps. The original all-ceramic crowns were porcelain jackets. These crowns were not very strong and achieved most of their strength from the thickness of the porcelain. While some of the ceramic materials with high strength cores require a full thickness crown preparation (Photos 110 & 111, 197–199), others gain their strength from being bonded to the teeth (as opposed to being cemented). The preparation for bonded, all-ceramic crowns can mimic that of a 360° porcelain veneer. Patients can be reassured that their teeth will not be unnecessarily reduced.

• I don’t want crowns since they are irreversible. Despite the fact that a few teeth can be veneered without preparation, most esthetic restorations (including veneers) are placed on altered teeth. This also makes them irreversible.

• I don’t want crowns because they always look so fake (Photos 1–5, 15–19, 89 & 90,107–108,117–119, 134, 142–145, 170–172, 107–109). Some people do not want naturally appearing teeth and request “white” crowns. This can give other people the impression that all crowns are artificial in appearance. Reassuring the patient that crowns can be very natural in appearance without being too white or too big will usually suffice.

FIRST APPOINTMENT

STEP 1: Shade Selection (See p.56)

STEP 2: Check Existing Restorations (See p.11)

STEP 3: Preparation

A. Minimum Reduction Preparation for Bonded Crowns (Photos 68–71, 173 & 174)

This type of preparation is mainly indicated when you do not need a major color change, as the porcelain will be about 1.0mm thick. It could be described as a full coverage veneer and is specifically indicated when crowns and veneers are to be done adjacent to each other (for a more consistent color match). If the least amount of tooth removal is desired, the preparation is similar to that of a porcelain veneer except it is circumferential. If the teeth to receive the crowns are aligned properly, 0.5–0.8mm depth cuts are made on the facial using a depth-limiting diamond. Misaligned teeth are reduced in proportion to the degree of misalignment.

It is usually ideal to align individual teeth through selective preparation and/or resin augmentation prior to beginning the overall preparation of multiple teeth. This will ensure equal porcelain thickness for all the crowns. When all the crowns are equally thick, their appearance will typically be more uniform. Different thicknesses of porcelain can lead to crowns of the same shade looking differently in the mouth, especially if the facial thickness is less than 0.5mm.

The lingual surface is reduced to provide a minimum of 1.0mm of clearance in the occlusal contact area. This amount of clearance is mainly empirical but seems to be consistent with the necessary thickness of porcelain that is needed to resist fracturing when a restoration is bonded to tooth structure. It is also necessary for provisional fabrication. Provisional crowns less than 1.0mm thick lack strength and are difficult to fabricate. Due to their lack of strength, these thin provisionals are subject to fracturing during removal. This may preclude using them again if the definitive crowns need to be modified after the try-in.

The proximals are then prepared with a thin, tapered diamond to provide about 2.0mm clearance between adjacent teeth, assuming both teeth are being prepared. The incisal is reduced about 1.0mm. The overall preparation will have greater reduction near the incisal third than the gingival third to allow for a proper path of insertion.

The gingival finish line is initially placed even with the gingival crest. If you are not changing the color of the teeth being crowned or the color change is minimal, the margin can be finished at the gingival crest. Otherwise, you will still want to place the margin subgingivally. Place a single strand of nonmedicated retraction cord or surgical silk in the sulcus. Use the smallest cord possible to reduce the chance for injury to the gingiva due to cord placement (which can lead to recession). The visible margins are then extended subgingi-
C. Mandibular Teeth

The minimum reduction crown is highly advantageous for mandibular anteriors, especially the incisors due to their small dimensions. Traditional maximum reduction preparations severely compromise the strength of these teeth due to their size. Optimally, all surfaces are reduced a minimum of 1.0mm to provide for adequate porcelain thickness, although the cervical third can be prepared to a depth of only 0.5mm without any apparent negative sequelae. For extra strength, it may be prudent to have 1.5mm for incisal clearance.

**Note:** Pay particular attention to the lingual surface, which is frequently underprepared. This lack of proper reduction usually leads to final lingual crown contours that are convex instead of concave, causing the crown to look unnaturally bulky.

D. Accelerated Preparation Method

To accelerate the method of preparation, you can place the cord prior to preparation (if the cord can be manipulated through the interproximal space without damaging the tissue). If your assistant is trained and skilled, the time to pack cord is eliminated from your schedule. However, unless you are fast and organized, it might be prudent to wait until the basic preparations are completed to pack the cord. The longer the cord is in the sulcus, the more chance there is for the cord to cause recession. This is especially true in patients who have thin and delicate tissue.

E. Variations

If multiple teeth are being prepared and they are in correct alignment, there may be good reasons to prepare every other tooth and take an impression. This can help assure proper incisal edge placement and contours in new crowns or help verify the amount of reduction desired by having the underprepared teeth as a guide. Although this procedure takes extra time, it can help when the lab is trying to predictably duplicate natural tooth contours.

**STEP 4: Provisional (Temporary) Restorations**

Please see PROVISIONAL CROWNS & BRIDGES for complete information on their fabrication.

**STEP 5: Delay Impression**

Even though the impression can be taken at the preparation appointment, it is prudent to delay it for several weeks to give you an opportunity to assess the reaction of the tissue to the procedure. Even if you are extra careful not to cause any soft tissue trauma, there may be some tissue shrinkage.

Another advantage to delaying the impression is the ability to modify the preparation as dictated by the provisional. For example, you may find that to achieve the best esthetics, you will need to flatten the facial surface of the provisional. However, once this is done, the provisional may be too thin. If the provisional is too thin, the definitive crown will also be too thin.

The solution, of course, is to reprepare the tooth, rel ine the provisional, and check it again for thickness. This technique will insure that the definitive crown will be the proper thickness. This is especially important with ceramics with high strength cores and ceramometal. If the veneering porcelain is too thin, the core or opaque over the coping will shine through and the crown will not be esthetic. If you cannot remove enough tooth structure to provide room for a high-strength ceramic core without endangering pulp vitality, then you may want to change the type of material to be used for the crown.
SECOND APPOINTMENT

(2–4 weeks after first appointment)

Since tissue health is so important to the success of all restorations, especially when bonding them in place, the extra appointment with the inherent overhead of sterilization and chair time is justified. This appointment also allows a re-evaluation of the provisional after the patient has had a chance to live with it for a while.

STEP 1: Check Tissue

Evaluate the post-preparation position of the gingival tissues. Make sure the tissue has reacted positively to the provisionals and the margins of the preparations have not been exposed due to recession. If the tissue is healthy, you are ready to take the impression. If the tissue is inflamed, you must first ascertain the etiology of the inflammation and resolve the problem before proceeding to the impression. Inflammation may be the result of residual provisional cement that was not removed when the provisionals were cemented or could be caused by ill-fitting margins on the provisionals.

STEP 2: Check Provisionals

Ask the patient if he or she is happy with the appearance of the provisionals. If any changes are desired, now is the time to do them. Once you and the patient are satisfied with the provisionals, take an alginate impression so you can give the lab a model of the way that provisionals look in the mouth. This will give the lab guidance when building the definitive crowns. It is also prudent to take photos of the provisionals in the mouth, both in a full smile and retracted.

STEP 3: Remove Provisionals and Reprepare

After administering local anesthesia (the previous steps were done unanesthetized so the provisionals could be viewed in a natural smile), remove the provisionals and check the margins for their position in relationship to the gingival crest. If the tissue has migrated and the margins are no longer in your preferred position, pack a single strand of nonmedicated cord only on the facial and visible sections of the proximal margins. Reprepare the margins and remove the cord to inspect their new position.

You should also recheck the thickness of the provisional. If its thickness is inadequate for the definitive crown, additional tooth structure must be reduced.

STEP 4: Take Impression

(See p.30)

Repack medicated cord and take the impression.

STEP 5: Reline Provisionals

If you reprepped the teeth at this appointment, the provisionals will need to be relined or margins will need to be added. Please see PROVISIONAL CROWNS & BRIDGES for this technique.

STEP 6: Recement Provisionals and Dismiss Patient

BETWEEN APPOINTMENTS

STEP 1: Lab Prescription

(See p.39)

STEP 2: Check Crowns Returned From Lab

(See p.41)

THIRD APPOINTMENT

Use anesthesia if necessary. However, it is best to delay the administration of the anesthesia until after the try-ins if at all possible. With the patient anesthetized, it is difficult to assess the effect of the crowns on the smile line.

STEP 1: Remove Provisional Crowns

Clean out the provisional cement so the provisionals can be used in the next step and/or recemented if necessary.

STEP 2: Clean Teeth

Once the preparations are clean, reseat the provisionals to keep the tissue from collapsing onto the margins.

STEP 3: Try-In Crowns for Fit

If you are seating multiple crowns, remove one provisional at a time and seat each crown separately. If the adjacent provisionals interfere with seating the crown, remove them just for the time it takes you to check the margins. Seating the crowns individually allows direct evaluation of proximal margins and negates the effect of overly tight contacts. The margins on metal-free crowns should be very close to what we have come to expect from a well-fitting casting. Any gross marginal openings should have been discovered when trying the crowns on the unaltered solid model when they were returned from the lab. But, if a gross marginal opening is only discovered at this time, a return trip to the lab is indicated.

In addition, other marginal problems need to be handled at this time. For example, even after all your precautions, the tissue may still have receded, leaving a margin supragingival. If it is visible and not esthetic, the tooth must be reprepared. A new impression is made, sent back to the lab, and provisional material is added to the provisional where the tooth was reprepared. Any overcontoured margins should be reduced with an abrasive wheel such as a Busch Silent Stone or with highspeed finishing diamonds and then polished before seating the crowns.

Once the margins have been checked and verified, multiple crowns are seated together and the contacts checked with unwaxed floss. Check the margins after seating all the crowns to make sure the margins are identical to when the crowns were individually seated. If the contacts are not tight enough, have the lab add porcelain to them. It is also prudent to check the proximal margins with unwaxed floss to help detect any additional marginal problems. However, be careful when flossing subgingivally to prevent any bleeding at this point.
STEP 4: Try-In Crowns for Color
In order to properly assess whether the shade will blend with the rest of the dentition, the crowns must be fully seated with enough stability to allow the patient to get out of the chair. If the crowns do not have enough inherent retention, use a small amount of a provisional cement or water-soluble try-in paste to stabilize them. Then, view the patient under different lighting conditions.

Since the thickness of metal-free crowns usually does not allow for much color change at the chair, this try-in is mainly to verify that the shade corresponds to the one that was selected and to have the patient accept the result. It will also show you whether a supragingival margin will be visible or not. Use a water-soluble material such as glycerin or K-Y Jelly as translucent trial cement. If the shade is slightly off, use an appropriate shade of water-soluble, try-in paste from the resin cement system you are using to try to correct it. This procedure is not applicable to ceramics with high strength cores or ceramometal, which are opaque and do not allow shade modification by the cement.

If changing the shade of the cement is not successful, photograph the crowns in the mouth next to the natural teeth you are trying to match and/or next to the selected shade tab to show the lab what you are seeing and return the crowns to the lab for reshading or remake.

For the patient to accept delays of this sort without becoming antagonistic, it is important that your provisionals be as esthetic as possible and that the patient be properly informed prior to beginning the procedure that one or more trips back to the lab may be necessary to get the color just right. When the patient knows about this possibility from the beginning and understands how truly difficult it is to match shades on the first attempt, he or she will usually express very little objection to these types of delays.

STEP 5: Try-In Crowns for Contour
It is advantageous to adjust the contours of crowns prior to seating them. After placing the crowns in the mouth, sit the patient upright in the chair. It may be necessary to use a try-in paste to stabilize the crowns prior to sitting the patient upright, since dry crowns tend to lack retention. Both the dental team and the patient should view the restorations in an upright position to evaluate his or her smile line, etc. Make modifications as needed for final approval and polish the modifications. It is possible to polish porcelain extraorally to the same high gloss as possible with glazing. This ability to polish porcelain negates the need to return the crowns to the lab.

STEP 6: Check Occlusion
Have the patient carefully occlude to check the occlusion. But being careful is the main consideration with this procedure — if the patient bites too hard, the crowns (even ceramometal) can fracture. It is advantageous to adjust the occlusion at this time, since polishing any adjusted areas is much easier extraorally than it is after the crowns have been bonded. However, if you have any doubt that the patient can follow your directions not to bite hard with thin, metal-free crowns, it is probably prudent to wait to adjust the occlusion until they are firmly bonded to the teeth.

STEP 7: Provisional Cementation
Allows viewing of the crowns outside the office. If there is any questions whether the crowns are acceptable or not, provisionally cement the crowns. Otherwise, skip this step and proceed to Step 8.

A. Clean Crowns (See p.17)
B. Clean Preparations (See p.15)
C. Pack Cord
Placing cord for provisional cementation is also not usually necessary, unless the tissue restricts access to the margins.

D. Mix Cement and Seat Crowns
Resin-based provisional cements have performed well for this purpose (Photos 162-169).

E. Clean Excess Cement
Allow cement to set completely before you remove the excess. For resin-based cements, light cure for 30 seconds on the facial and 30 seconds on the lingual before cleaning the excess.

STEP 8: Clean Crowns (See p.17)

STEP 9: Apply Silane (See p.18)
This is not necessary for ceramometal crowns.

STEP 10: Clean and Prepare Teeth for Bonding (See p.15)
With ceramometal, you have your choice to either bond or more conventionally cement the restoration.

STEP 11: Etch or Condition Preparations (See p.16)
Treat the preparations according to the adhesive you are using. With ceramometal, this may not be necessary.

STEP 12: Apply Adhesive (See p.17)
Follow the directions of the adhesive you are using. See DENTAL ADHESIVES (in the annual edition) for guidance. With ceramometal, this may not be necessary.
**STEP 13: Mix Cement and Coat Inside of Crowns**

Your assistant mixes the dual-cure resin cement and coats the inside of the crowns including the margins with a medium-thick layer. For ceramics with high strength cores and for ceramometal, a self-cure resin cement may be preferred over dual-cure. For ceramometal, you can also use a resin ionomer or compomer cement.

**STEP 14: Seat the Crowns**

Seat the crowns firmly in a predetermined order. Be sure they are fully seated by checking one or two locations at the margins with an explorer while holding them firmly in place. View from the incisal with a mirror to validate their correct alignment. If you are bonding the crowns, it is probably prudent to not have the patient occlude, as contamination from oral fluids could occur. In addition, if you have not yet adjusted the occlusion with thin, metal-free restorations, having the patient occlude could fracture the crowns. In an unadjusted state, the patient could also move the crowns out of their correct seating position. Clean only the bulk excess of the cement at this time.

With conventional cementation of ceramometal crowns, the patient would typically occlude after the crowns are seated.

**STEP 15: Spot or “Gel” Cure the Cement**

When bonding metal-free crowns, hold them firmly in place if you are satisfied with their position. Your assistant then spot-cures each crown 10-30 seconds (depending on your light and the thickness of the restoration) in the center of the facial surface using a small (2–3mm) light-curing tip. Self-cure cements obviously do not require light curing.

An alternate technique is to briefly cure a dual-cure cement at the margins for 1-2 seconds using a conventional curing tip (11mm). This will typically “gel” the cement and allow the excess to be removed more easily than if the cement was allowed to fully harden before removing the excess. This technique should only be used when your margins are excellent. If you are hoping to fill in some marginal gaps with your cement, then this is not the technique to use.

**STEP 16: Remove Additional Excess Cement**

After metal-free crowns are “tacked down” by spot curing, you can more definitively remove all but a slight excess of cement off the crowns with a sable brush — only leave a small amount at the margins to counteract any polymerization shrinkage of the cement. However, once the cement begins its chemical cure, stop removing the excess. If you try to remove more cement at this “doughy” stage, you can pull the cement out of small defects in the margins leaving voids.

It is better to wait until the cement is rock hard and then remove the slight excess with a sharp hand instrument.

Apply a thin layer of glycerin to the margins to prevent the formation of an air-inhibited layer. Some cements have their own proprietary gels for this purpose.

If your margins are excellent and you are using the “gel” technique, then remove the partially cured cement with an explorer or scaler, being especially careful not to cause any bleeding. If bleeding occurs before the cement is fully polymerized, staining can result that could be difficult to remove. In addition, since the cement is not fully cured, restrict any pressure on the crowns that could interfere with the developing adhesion to the tooth.

**STEP 17: Cure Crowns**

Each metal-free crown should be cured on the facial and on the lingual. Two lights with large diameter tips help to speed up this curing. This does not apply to self-cure cements.

**STEP 18: Remove Cured Excess Cement**

Remove excess cement from the crowns using scalpels and other composite carvers.

**STEP 19: Remove Cord**

**STEP 20: Check Margins**

Check the margins with an explorer. If there is any residual excess cement that cannot be removed with a hand instrument or if you discover a porcelain overhang, contour these areas carefully using a finishing diamond or, proximally, use the Profin. For resin-based crowns, a #12 scalpel blade will usually remove proximal excess. If there are any small voids, fill these areas with a light-cured flowable composite. It may be necessary to repack areas to be repaired with cord to gain proper access and moisture control. When filling a void, clean the area with a disinfectant, re-etch with phosphoric acid (unless you are using a self-etching cement system), apply adhesive, and then place the flowable composite. If the void is large, use a sculptable instead of flowable composite.

**STEP 21: Seal Margins** *(See p.19)*

**STEP 22: Check and Adjust Occlusion** *(See p.20)*

**STEP 23: Smooth and Polish Porcelain** *(See p.21)*

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**FOURTH APPOINTMENT**

**STEP 1: Check Occlusion**

Be sure the crowns provide the proper anterior guidance and do not cause fremitus in centric occlusion.

**STEP 2: Check Gingival Health** *(Photos 30–32, 129 & 130, 253 & 254)*

This is a critical area. The health of the soft tissue is essential for the crowns to blend into the overall oral landscape without sticking out like a sore thumb. The tissue should typically be pink and stippled. If the gingiva was not healthy at the beginning of the procedure, the time to improve its health is either before starting the crowns (in teeth that have..."
not been crowned previously) or during the period of time the provisional crowns are in the mouth (and prior to the final impression). Assuming the crowns were placed in the presence of healthy gingiva, it should stay that way after their placement.

If there are problems, a differential diagnosis must be made. This may range from the crowns being overcontoured in the gingival third (especially in the area of the emergence profile) to residual cement remaining in the sulcus. Since resin cement is more difficult to detect due to its more translucent color (compared to conventional cements), very careful tactile examination is necessary.

Any roughness must be eliminated. If the roughness is residual cement, it can usually be removed with a hand instrument. However, if the roughness is due to a porcelain overhang, finishing diamonds in a highspeed handpiece or the Profin should be used to remove the overhang. In any event, tissue problems must be resolved for the crowns to be successful over the long term.

**STEP 3: Check Esthetics (Photos 131, 146-149)**

Evaluate the overall esthetics including shade, contour, texture, facial anatomy, smile line, etc. You obviously must please the patient, but it is your responsibility to guide the patient into making informed decisions on esthetics. Unless you provisionally cemented the crowns, your only option with bonded crowns (other than remake) is recontouring. Minor problems with provisionally cemented crowns can be handled without removing them while major deficiencies such as being too short need to be corrected by returning the crowns to the lab. Due to this possibility, be sure to keep the provisional crowns for reuse if necessary.

**STEP 4: Definitive Cementation for Provisionally Cemented Crowns**

Assuming both you and your patient agree that the provisionally cemented crowns are acceptable (Photo 162), they can be removed and recemented using a definitive cement. If adequate time does not remain in the appointment, the patient should be rescheduled.

**A. Apply Richwil Crown Remover**

An atraumatic crown removal technique utilizes thermoplastic Richwil crown removers. Remove one Richwil from the plastic bag in which they are packaged and place in steaming hot water for two to three minutes. Remove the Richwil from the water with cotton pliers and place immediately over the incisal edges of the crowns you want to remove. With moderate finger pressure, push the thermoplastic material over the facial and lingual surfaces of the crowns to be removed (Photo 163). One crown remover can be used for one or two teeth. After pushing the material as far gingivally as possible (before it starts to cool and harden), rapidly harden it using an air/water spray for about 10–15 seconds.

**B. Engage Richwil with Hemostat and Remove Crown**

Using a curved hemostat, grab the Richwil, apply a slight torquing force, and remove the crowns (Photos 164 & 165). Be careful to keep the torquing force minimal — excessive facial and lingual rocking movements can cause porcelain fractures.

**C. Clean Preparations and Crowns and Proceed with Cementation (Photos 166–168)**

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**Note:** If you are ever in doubt about the length of the crowns, it is better to err on the side of making them slightly long. After the trial period, if the crowns are indeed too long, you can merely shorten them very easily. However, if they are too short, you have no choice but to return them to the lab.