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Continuing Education

Course Number: 172

Using Microscopes in Fixed Prosthodontics:

Try-In, Adjustment, and Insertion of Crowns and Bridges

Authored by
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Upon successful completion of this CE activity 2 CE credit hours may be awarded

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Using Microscopes in Fixed Prosthodontics:

Try-In, Adjustment, and Insertion of Crowns and Bridges

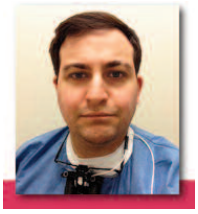
Effective Date: 4/1/2014 Expiration Date: 4/1/2017

LEARNING OBJECTIVES

After participating in this CE activity, the individual will learn:

- To use microscope-level magnification and head-mounted coaxial illumination to obtain optimal seating of crowns and bridges.
- To use magnification and coaxial illumination to properly adjust the occlusion of crowns and bridges.

ABOUT THE AUTHORS



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INTRODUCTION

Various authors have described the benefits of using a surgical operating microscope or loupes with microscope-level magnification when performing general dentistry procedures. Such benefits include diagnosis and treatment of microscopic cracks in teeth,[1] locating a microscopic root canal orifice,[2] extremely detailed and will-lit intraoral photography,[3-5] preparing fixed partial denture (FPD) abutments that are free of microscopic undercuts,[6] performing prophylaxis procedures,[7] and performing extraction procedures.[8] This article reviews the basic clinical techniques[9-11] of adjusting crowns and bridges during try-in and insertion using microscope-level magnification (6x to 8x loupe magnification or a surgical operating microscope) combined with head-mounted coaxial illumination.

The use of microscope-level magnification allows a dentist to see microscopic amounts of elevation of FPD marginal ridges or microscopic amounts of elevation of the FPD margin above the abutment margin,[5] to more precisely identify the microscopic obstructions to FPD seating and to identify which adjustments result in microscopic incremental improvements in seating the FPD.

When adjusting an FPD, the dentist wishes to achieve 2 functional goals: (1) obtaining optimal seating of the FPD, followed by (2) adjusting the occlusion of the FPD such that the patient feels comfortable with the occlusion, and the FPD does not prevent the patient from closing into a clinically acceptable maximum intercuspation position. (If a patient is anesthetized for the insertion procedure, the patient may not be able to accurately assess how comfortable the occlusion of the FPD is, so the dentist will have to rely more on clinical judgment concerning optimal FPD occlusion.)

The optimal seating of an FPD is achieved when the following occur: the margin of the FPD is seated as far apically intraorally as it is on the model (typically such that the FPD margin covers the entire abutment margin approximately at the level of the cemento-enamel junction); the marginal ridges (for posterior teeth) are seated as far apically intraorally as they are on the model (typically the laboratory technician sets both marginal ridges to be level with the marginal ridges of the neighboring teeth, although if an abutment tooth is extruded, the technician may design the marginal ridges to be at different levels to those of the neighboring teeth); the incisal edge (for anterior teeth) is seated as far apically intraorally as it is on the model; there are no clinically unacceptable marginal gaps (more than 100 µm)[12-13] around the margins; and the space between the

intaglio surface of the FPD and the abutment surface does not prevent the FPD from being optimally retentive,[14] given the height and taper of the FPD abutment(s).

Figure 1. On initial try-in of this all-gold crown, there is a marginal gap at the interproximal aspect and the margin is elevated on the lingual, due to an interproximal obstruction.

Figure 2. Using microscopes allows a dentist to adjust the interproximal aspect of the crown in fractions of a millimeter increments while avoiding ditching or ledging of the interproximal surface.

ADJUSTING INTERPROXIMAL OBSTRUCTIONS TO OPTIMAL SEATING

The cause of an FPD not seating optimally when first tried in is usually interproximal obstructions to FPD seating (Figure 1).[9-11,15] The dentist detects which contact is obstructive by flossing the contact with dental floss while the dentist (or, ideally, the assistant) holds the FPD down with his or her fingers. If the floss does not pass through one of the contacts, or there is too much resistance to floss passage, the dentist must adjust this contact. Thin floss probably gives a more accurate indication of tight contacts than thick floss or floss tape.

Using a microscope, the dentist observes the resistant interproximal contact area to see the contour of the porcelain interproximally and to see at what point the resistant contact is contacting the neighboring tooth. If the obstructive contact area is broad, then a broad reduction of the interproximal contact is needed. If the obstructive contact is more of a point obstruction, such as a small point-like area on the interproximal of a canine contacting a small point-like area on the interproximal of a lateral incisor crown being placed next to the canine, then only that point should be reduced. A small piece of articulating paper placed between the FPD and the neighboring tooth can more precisely mark obstructive contacts, although the dentist may need to lightly roughen the FPD interproximal surface to improve the ability of the articulating paper to mark the surface.

Using a microscope, the dentist can reduce the interproximal surface a fraction of a millimeter while avoiding creating microscopic pits in the porcelain with the bur, giving the porcelain a reasonably smooth surface texture which can be verified via direct microscopic observation of the porcelain surface.

After reducing the obstructive interproximal surface (Figure 2), the dentist uses a microscope to see if such adjustment resulted in the marginal ridge aspects of the FPD becoming microscopically more level with each other, or if certain aspects of the FPD margin became microscopically closer to the level of the abutment margin (Figures 3 to 5). If so, then this confirms that the adjustment of this obstructive contact was useful, and the dentist may choose to continue adjusting this contact until there is no further microscopic incremental improvement in FPD seating, or until the contact is too light for it to substantially obstruct seating, or until the FPD is optimally seated. Microscopes combined with coaxial illumination allow a dentist to directly observe how closely the interproximal margin of the FPD seals the interproximal aspect of the abutment, while a microscopically precise tactile sensation allows a dentist to detect microscopic interproximal overhangs due to the FPD not being fully seated; these advantages may obviate the need to take a radiograph to assess if the FPD fully seals the interproximal aspects of the abutment.

Often, however, if the FPD has 2 interproximal contacts, the adjustment of one contact that results in improved seating of the FPD causes the other contact, which previously was not obstructive, to now become obstructive due to the more apical seating of the FPD. Therefore, after every interproximal contact adjustment that results in increased apical seating of the FPD, the dentist re-flosses all such contacts to re-check them for excess floss resistance. The dentist then continues to adjust resistant contacts until no further microscopic incremental improvements in FPD seating are observed. If both

contacts show a light resistance to floss, but the FPD is still not optimally seated, then the dentist may consider adjusting the intaglio surface of the FPD.

ADJUSTMENT OF THE FIXED PARTIAL DENTURE INTAGLIO SURFACE

The adjustment of the intaglio surface of an FPD is an unscientific way of trying to reduce exactly those aspects of the intaglio surface that are obstructing the restoration from optimally seating. However, this imprecise clinical adjustment process can be performed with maximum control if the adjustments required are few in number, the adjustments are made in microscopic increments, and the adjustments change the intaglio surface by a microscopic amount. Adjusting the FPD in microscopic increments helps to prevent over-adjusting the FPD, which may result in clinically unacceptable lack of retention.

The dentist can place a thin layer of a fast-setting, low-viscosity polyvinyl silicone disclosing material[16-17] into the intaglio surface of the FPD, and then seat the FPD onto the abutment. When the silicone polymerizes, the dentist examines the intaglio surface of the FPD with magnification to see if part of the intaglio surface shows through at some points on the thin layer of silicone coating that surface. These areas of exposed intaglio surface are then reduced with a bur, and the dentist seats the FPD to observe if reducing these potential intaglio surface high spots resulted in microscopic incremental improvements in the apical seating of the FPD.

After each adjustment of the intaglio surface, the dentist examines the seating of the FPD using microscopes to see if the adjustment resulted in a microscopic incremental im - provement in FPD seating. If so, this specific intaglio surface adjustment may be repeated until it no longer results in such improvements. At that point, the dentist re-checks the interproximal aspects of the FPD to see if increased apical seating of the FPD due to the intaglio surface adjustment has resulted in reactivation of an interproximal contact obstruction. If so, the dentist should stop further adjustment of the intaglio surface of the FPD, and instead revert to adjusting the interproximal aspects of the FPD until such adjustments no longer result in microscopic incremental improvements in seating. At that point, if the FPD is still not optimally seated, the dentist returns to adjusting the intaglio surface of the FPD.

Figure 3. After adjusting the interproximal surface, a second try-in of the crown reveals that the marginal gap has closed and the crown seats more apically by a microscopic amount, sealing the marginal gap.

Figure 4. An all-porcelain crown does not fully seat due to an interproximal obstruction, resulting in a microscopic marginal gap.

Figure 5. After adjusting the interproximal obstruction, the all-porcelain crown seats completely, sealing the marginal gap.

The above information describes, in general, how interproximal obstructions should be adjusted before adjusting intaglio surface obstructions. Further, if an intaglio surface adjustment results in the reactivation of an interproximal obstruction, then the dentist should stop adjusting the intaglio surface until all reactivated obstructions are adjusted.

Conservative Adjustment of the Intaglio Surface

When examining the intaglio surface of an FPD using microscopes, the dentist may detect that the intaglio aspect

of the FPD margin curls slightly in an axial direction (Figure 6). A tooth contour may slope in an axial direction as it transitions from the CEJ to the subgingival tooth surface. This sloping would result in a slightly axial curling of the FPD margin if the laboratory technician finished the margin below the abutment CEJ. A dentist can adjust the intaglio surface of an FPD without significantly changing its overall surface dimensions by trimming away this curling using a straight diamond. This trimming flattens out the part of the intaglio surface that is within approximately 0.5 to 1.0 mm from the FPD margin, so that the intaglio surface at each respective point of the margin is approximately flush with the rest of the intaglio surface that is located occlusal to that specified point.

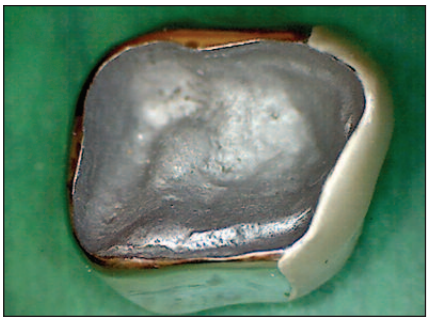

Figure 6. A microscope-level view of the intaglio surface of a PFM crown shows that the lingual margin curls slightly axially, which may obstruct crown seating.

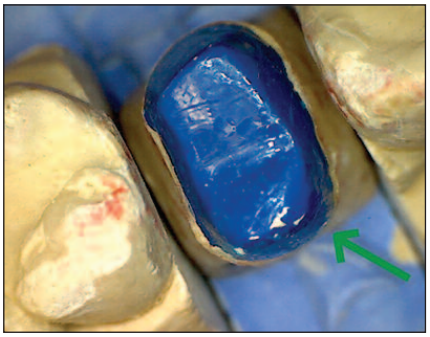

Figure 7. A microscope-level view of the model of a premolar abutment shows that interproximal surfaces of neighboring teeth are nearly parallel with the path of placement of the premolar crown and are unlikely to substantially obstruct initial seating of the crown. The abutment margin is completely visible and is therefore not undercut, although there is possibly a microscopic undercut at the mesiobuccal aspect of the preparation (green arrow). This is a possible target of intaglio surface adjustment if the crown does not seat initially.

More Substantial Adjustment of the Intaglio Surface

If a conservative adjustment of axial curling of the margin does not result in optimal seating of the FPD, then the dentist may consider a more substantial adjustment of the FPD intaglio surface. There are 8 intaglio surface aspects that can be adjusted: the mesiobuccal, mesiolingual, distobuccal, and distolingual line angles of the FPD on the intaglio surface, and the mesial, distal, lingual, and buccal surfaces between those line angles. In deciding which aspect of the FPD intaglio surface should be adjusted, the dentist may examine the laboratory counter model of the abutment using an inspection microscope or a surgical operating microscope at 10x to 12x magnification (Figure 7). This shows where microscopic undercuts in the abutment axial wall, if any, are located.

In addition, the dentist may examine the FPD intraorally to see if all aspects of the FPD margin are fully seated in the mouth except for one aspect. The dentist may then adjust the aspect of the FPD intaglio surface that is located above the margin point where the FPD elevation exists, and then see if this results in a microscopic incremental improvement in FPD seating. Sometimes, however, an obstruction on one aspect of the FPD intaglio surface may elevate the FPD at a location on the margin that does not correspond with the margin location corresponding to the aspect of the axial wall that has the obstruction.

If an abutment axial wall is undercut, some aspects of the axial wall surface may slope in an axial direction. Such sloping may be microscopically subtle, but this sloping can be detected using a microscope-level visual magnification combined with coaxial illumination of the intaglio surface of the FPD made for that abutment. If a thin, straight diamond bur is placed flat on the intaglio surface of an FPD that was made for an abutment that is undercut, and the bur is oriented approximately perpendicular to the FPD margin, a space may be visible between some aspects of the diamond bur and the intaglio surface. This space occurs if the intaglio surface curves in a concave way from the gingival to the occlusal at a specific point along the FPD margin. This curvature develops on the intaglio surface if the actual abutment was undercut, or if the abutment is not undercut but the die spacer that the laboratory technician placed on the abutment die made the abutment axial wall more convex.

If there is space between the diamond and the intaglio surface when the bur is held in this manner, then the dentist may consider drilling on the intaglio surface until the diamond bur is flush against the intaglio surface at that point along the FPD margin perimeter. The dentist then checks to see if this adjustment results in a microscopic incremental improvement

in FPD seating. If so, then the dentist may want to repeat this drilling adjustment process for other points along the FPD perimeter, and perhaps for all points along the perimeter, until the diamond bur, when held this way, is flush with the FPD margin at all points along the margin perimeter. Since the apical aspect of the abutment axial wall is more likely to be undercut, and because this aspect is more difficult for the dentist to see, such drilling perhaps should be concentrated at the apical 3 to 4 mm of the FPD intaglio surface.

Deciding Whether or Not to Remake a Nonoptimally Seated Fixed Partial Denture

The general process of alternating between adjustment of the intaglio surface of the FPD and the interproximal contacts of the FPD, depending on which kind of adjustment is indicated, continues until the FPD is optimally seated. If, however, at some point neither interproximal nor intaglio surface adjustments are resulting in further microscopic incremental improvements in FPD seating, and the FPD is still not optimally seated, then the dentist must determine if the current amount of seating is clinically acceptable, or if the FPD should instead be refabricated.

If the retention of the FPD is clinically acceptable at its maximum (but not necessarily optimal) apical seating, and the marginal ridges are mismatched by only a fraction of a millimeter, a minor adjustment of the occlusal and marginal ridge porcelain may result in clinically acceptable occlusion, hopefully without exposing the underlying coping metal for a PFM crown. Exposure of the metal understructure may be prevented by a microscopic examination of the occlusal surface while it is being polished to detect when the opaquing layer, which is typically of a different shade than the aesthetic porcelain, is starting to be revealed, since this layer is fractions of a millimeter above the metal coping surface. However, on a posterior FPD, tiny areas of exposed coping metal may be clinically acceptable as an aesthetic blemish.

If the FPD interproximal contacts are unacceptably light or open, or if adjustment of the intaglio surface of the FPD results in clinically unacceptable marginal gapping or excess space between the FPD and the abutment that compromise FPD retention, or if the FPD does not rest on the abutment in one position, but rather shifts or slides while seated on the abutment, then the FPD requires refabrication.

ADJUSTING THE OCCLUSION OF THE FIXED PARTIAL DENTURE

The occlusion on the FPD should not be adjusted until optimal (or at least maximal) seating of the FPD is obtained.[9-11] Without optimal seating of the FPD, it may be in hyper-occlusion. This may cause the patient to occlude into the FPD with enough force (compressive or tensile) to cause porcelain fracture.

Preliminary Assessment of the Fixed Partial Denture Occlusion Site

Before adjusting the occlusion of the optimally seated FPD, the dentist observes which cusps and fossae are in occlusion, and which incisal edges are in occlusion, when the patient occludes in maximum intercuspation without the FPD in place. The dentist also notes which opposing wear facets intermesh with one another, and how they appear when they intermesh, without the FPD in place.

Prior to adjusting the FPD occlusion, the dentist uses microscopes to locate 2 points of occlusion to use as reference points; each point is respectively located on either side of the midline and intercuspate completely when the patient is occluding in maximum intercuspation without the FPD in the mouth. A reference point on the contralateral side of the FPD is needed to prevent a “deceptively adjusted” FPD occlusion, where the reference point on the ipsilateral side of the FPD is in occlusion when the FPD is in place, but there is still some excess separation between teeth on the contralateral side.

Using microscopes, the dentist also examines the occlusion of the opposing tooth with the abutment (without the FPD in place) to see if the opposing tooth would occlude into the abutment such as to impart excess shear forces on some aspects of the FPD porcelain if the FPD were placed on the abutment. An example of this is an opposing plunger cusp that occludes into the interproximal area, with the plunger cusp tip protruding below the occlusal plane. The dentist may trim up to one mm of the protruding cusp with an aluminum oxide composite polishing bur prior to having the patient bite down onto the optimally seated FPD. Ideally, such trimming will not expose dentin within the cusps, which may cause sensitivity.

Alternatively, the dentist may prefer to perform trimming of opposing protruding cusps prior to taking the final impression for the FPD, so that the laboratory can form the FPD occlusal surface to occlude into the modified occluding cusp. However, there is a risk that the opposing tooth could extrude into the prepared tooth during the typical 2- to 3-week temporization phase, possibly necessitating further reduction of the opposing protruding cusp during the insertion visit.

If such a protruding cusp were the original cause of an interproximal fracture of a tooth that is now being prepared for a crown, the dentist can request that the laboratory technician make the FPD for that tooth such that the interproximal contact or the entire interproximal aspect of the FPD is made entirely in metal (Figure 8). Metal has greater tensile strength than most forms of porcelain, so it resists interproximal plunger cusp forces, and in general can bridge large interproximal gaps (2 to 3 mm or more) better than most forms of porcelain.[18] Further, porcelain placed on the occlusal aspect of an FPD over an interproximal contact that is constructed of metal will be under compression forces, which the porcelain is most capable of withstanding. However, recent literature shows that some types of zirconia-based porcelain crowns, particularly all-zirconia crowns such as BruxZir crowns (Glidwell Laboratories), have higher tensile strength than both leucite-based porcelain crowns and all-metal crowns.[19-26]

Using microscopes and head-mounted illumination, the dentist can visually estimate the interocclusal distance between a posterior abutment and the opposing tooth structure. If there is a small interocclusal distance (such as 0.5 to 1.0 mm) above a particular point or area on a posterior abutment occlusal surface, the dentist may reduce that aspect of the opposing tooth that occludes into this area, or reduce porcelain on the FPD surface that corresponds to that point, if the porcelain seems to protrude higher than the interocclusal space allows. These adjustments increase the interocclusal space at these points before initially having the patient occlude into the FPD, to preemptively reduce excess shear and compression forces on the porcelain at that area or point.

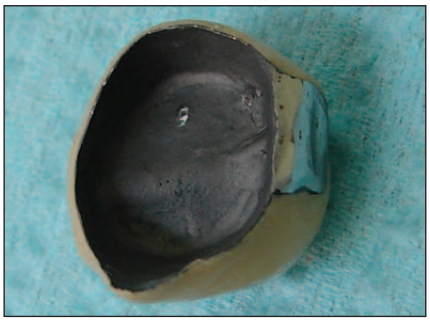

Figure 8. Intaglio surface of a PFM with an all-metal marginal ridge aspect to provide extra tensile support for closing a particularly wide interproximal diastema. This also prevents fracture of interproximal porcelain due to tensile forces exerted by the opposing tooth when the patient occludes into the crown.

Using Articulating Paper to Adjust the Fixed Partial Denture Occlusion

To initially evaluate the FPD occlusion, the dentist places the optimally seated FPD on the abutment(s) and instructs the patient to bite down with light pressure to minimize shear forces on the porcelain at potential prematurity areas. If the patient is not occluding into maximum intercuspation, then the dentist instructs the patient to "bite on the back teeth," a command that often induces the patient to occlude into maximum intercuspation. When the patient is occluding into the FPD at maximum intercuspation, the dentist observes the occlusion using microscopes to see if there is added separation between the 2 occlusion reference points or between opposing wear facets. If there is no added separation, the dentist asks the patient if the bite feels "completely natural" and if the teeth on both sides are "touching the way they normally do." If the patient answers "yes," then the dentist can cement the FPD. Otherwise, articulating paper is used to adjust the FPD occlusion.

After initially marking the occlusal surface of the FPD with the articulating paper, the dentist observes the marks using microscope-level magnification to identify both the macroscopic and microscopic articulating paper marks. Articulating paper marks on cuspal inclines may indicate deflective contacts on inclines, even if the marks are microscopic. Articulating paper marks at marginal ridge areas or at occlusal-lingual or occlusal-buccal line angles may place heavy shear forces on porcelain in those areas. Articulating paper marks on the FPD occlusal surface that are just underneath protruding cusps on opposing teeth may indicate the need to reduce the opposing cusps 0.5 to 1.0 mm, which may substantially improve the occlusion on the FPD. An articulating paper mark at the distal aspect of an FPD located on a distally located tooth (such as a mandibular second molar) may

indicate an especially deflective prematurity, since this location is nearer to the fulcrum of the mandible, where a slight deflection of fractions of a millimeter can result in substantial occlusal separation of the anterior teeth.

After adjusting the articulating paper marks that the dentist believes are causing occlusal discrepancies, the occlusion reference points are re-examined using microscopes to see if the separation between them has decreased by a microscopic increment. If so, this indicates that the articulating paper marks accurately show the locations of occlusal prematurity points. The dentist then repeats the process of marking and adjustment until the 2 reference points are in contact with one another as they would be if the FPD was not in place, and there is no microscopic amount of separation between the 2 points, and the patient declares that the FPD feels comfortable. Then, after further adjustment of excursive contact prematurities as needed, the dentist cements the FPD.[9-11]

If the patient is anesthetized for the insertion procedure, the patient may not be able to accurately determine the comfort of the crown. In this case, the dentist relies more on verifying that the crown when seated does not cause microscopic increases in the separation of teeth when determining if the crown occlusion is optimally adjusted. If after this adjustment is reached, the anesthetized patient still feels that the crown is uncomfortable, the dentist may reduce the crown by a further microscopic amount, in case there are microscopic occlusal prematurities that the patient can feel, or have the patient go home with the crown and evaluate it after the anesthetic has worn off, and return after that point for a further adjustment if the crown still feels uncomfortable.

When reducing the occlusal surface of an FPD, the dentist must be careful not to over-reduce the thickness of any point on the occlusal surface. A caliper can be helpful in gauging occlusal thickness for all-porcelain crowns, particularly if the crowns are monolithic and do not feature a differently shaded underlying coping layer (Figure 9). All-metal and monolithic all-zirconia crowns should have at least one mm thickness of material at all aspects of the occlusal surface, while leucite-reinforced ceramic, which has less compressive strength than monolithic zirconia ceramic, should be at least 2 mm in thickness.[20] Generally,

Figure 9. A caliper helps monitor the thickness of occluding surfaces of all-porcelain crowns, where there is no underlying metal or opaque layer to warn when adjustments are thinning out some points on the occluding surface.

if the dentist removes occlusal porcelain from a PFM crown but does not reduce the underlying metal understructure, the exposed metal occlusal points should be strong enough to resist occlusal compressive forces.

Inaccurate Articulating Paper Marks

If grinding of articulating paper marks does not result in microscopic incremental reductions in the separation between the 2 occlusion reference points, and the patient still cannot occlude into maximum intercuspation with the FPD in place, then the articulating paper marks may be inaccurate. Roughening up the FPD occlusal surface with a diamond bur may improve the ability of the FPD surface to capture articulating paper marks. Removing the FPD and observing it outside of the mouth may reveal microsopic articulating paper marks that the dentist could not see when viewing the FPD intraorally. The dentist may try articulating paper of different amounts of thickness to see if a different guage of articulating paper gives more accurate marks.[27] Coating articulating paper with petroleum jelly may result in the articulating paper forming more legible markings. The dentist may also observe the crown on the mounted casts using microscopes to determine the characteristics of the occlusion as intended by the laboratory technician.

Articulating paper marks dry surfaces most accurately; therefore, the dentist must dry the FPD and the opposing tooth prior to using articulating paper, which itself must also be dry.[11] A microscope-level observation of the FPD occlusal surface ensures that there are no microscopic areas of wetting on the FPD surface. Pools of saliva in the back of the throat must also be vacuumed prior to placement of the articulating paper, since the saliva may flow over the FPD as the patient is closing into the articulating paper, thus wetting the FPD occlusal surface

just before occluding into the FPD. The dentist can observe the FPD using microscope-level magnification and head-mounted illumination to see if microscopic amounts of saliva flow onto the FPD while the patient is closing.

If the articulating paper marks continue to be inaccurate, the dentist may need to directly observe, using microscopes and coaxial illumination, the occlusion site between the opposing tooth and the FPD to directly see the points of occlusion between the FPD and the opposing tooth,[28] and to see if the points of contact that the dentist sees seem to directly correspond to the articulating paper marks made on the FPD surface. The dentist may have to adjust the occlusion by adjusting visually estimated points of FPD occlusion, and then see if such adjustment results in microscopic incremental reductions in the interocclusal distance separating the 2 occlusal reference points. Sometimes, the articulating paper may mark areas on the FPD surface that correspond to areas where there is actually a microscopic separation between the FPD surface and the opposing tooth.

ADJUSTING AND SEATING TWO NEIGHBORING CROWNS

To adjust 2 crowns that are next to one another, the dentist first adjusts each crown individually, such that each crown, when placed by itself, seats optimally and its occlusion is adjusted. In this manner, when the 2 crowns are both placed simultaneously, only an interproximal obstruction between the 2 crowns may prevent their optimal seating.

Using microscopes, a dentist can observe if, when the 2 crowns are placed simultaneously, one or both crowns is microscopically more elevated above its respective abutment margin, or if the marginal ridge of one or both crowns is microscopically more elevated than when each crown was placed singly. If so, the dentist can adjust the interproximal contact of one of the crowns until optimal seating of both crowns occurs when they are placed simultaneously.

Sometimes, however, placing the crowns in a specific order results in their being seated optimally, without needing to adjust the interproximal contacts of one of the crowns. The interproximal surface of one of the crowns, when it is seated before the other crown, may obstruct the interproximal margin of the other crown as that margin aspect passes along the interproximal surface of the seated crown. The dentist may see if seating one crown first and then the other, or vice versa, or seating both crowns simultaneously by holding them both while seating them, results in optimal seating of the crowns. If so, the crowns can be cemented if the dentist uses that same seating sequence when placing the crowns on their abutments during the cementation phase.

To adjust 3 or more crowns that are next to one another, the dentist, after adjusting each crown individually, adjusts all possible different combinations of 2 neighboring crowns that can exist among this number of crowns, so that for any possible combination of 2 neighboring crowns, both crowns seat simultaneously with optimal seating and acceptable occlusion. The dentist then cements the crowns, perhaps cementing them no more than 2 at a time to minimize the number of potential complications that could occur during the cementation process.

Ideally, the multiple crowns of the provisional restoration would have been fused together to prevent shifting of the 2 abutments with respect to one another, such that the permanent crowns would be less likely to interfere with one other when they are tried in simultaneously.

ADJUSTMENT OF A BRIDGE

After adjusting interproximal contacts as a source of bridge obstruction, the dentist tries in the bridge using light finger tapping forces to observe how well the bridge seats with passive force.

Microscope-level magnification and coaxial illumination allow a dentist to observe if there are marginal gaps at points that are on the underside of the bridge, between the abutments. The dentist can also observe if the underside of the pontic is prematurely contacting the edentulous ridge underneath. This may happen if the bridge was made shortly after extracting the tooth that was in the pontic area, such that the gingiva in the pontic area expanded in an occlusal direction during the healing process from the time the bridge was first prepared to the day of insertion. Ideally, the pontic site should be allowed to heal for 6 to 8 weeks after an extraction prior to taking a definitive impression for a bridge.[9-10]

If the bridge does not seat optimally with light tapping forces, the dentist may try using stronger finger pushing forces

to seat the bridge. If the bridge seats optimally with strong finger pushing forces, this shows that the obstructions to the bridge seating are microscopic. The abutments could have shifted during the provisionalization phase, becoming inclined closer to one another. This could result in the intaglio surfaces of the bridge that cover those aspects of the axial wall of each abutment that face the axial wall of the other abutment to obstruct optimal seating of the bridge. A microscopic adjustment of these intaglio wall surfaces, or of the axial wall line angles of the bridge, may result in microscopic incremental improvements in bridge seating.

If one abutment seems to show microscopically more resistance than the others, or if the bridge seems to rotate around a specific pier abutment that functions like a fulcrum, the dentist may adjust the intaglio surface of the bridge that corresponds to that abutment.[28] Even if such rotation is microscopic, a microscopic examination of the seating may result in detection of this rotation. After adjusting the pier abutment, the dentist observes the seating of the bridge to see if there is a microscopic reduction in the range of oscillation of the bridge around this pier abutment fulcrum.

If the bridge does not seat optimally after adjustments, the dentist may need to remake the bridge. Here, the dentist observes all of the abutments with one eye closed, and using a visual axis that is continuously held perpendicular to a single imaginary plane,[6] to verify that there are no microscopic undercuts among bridge abutments. The dentist then reshapes abutments as needed to remove any undercuts that are detected, prior to making another impression to remake the bridge, or making a solder index of the sectioned bridge crowns. The dentist may provisionalize these abutments by cementing the provisional bridge using a strong carboxylate cement, to prevent shifting of abutments during the provisionalization phase. Later, the dentist will have to cut off this strongly cemented provisional bridge prior to the next bridge insertion visit.

Cementation of the Fixed Partial Denture

After definitively adjusting the FPD, the dentist burnishes the margin as needed (only FPDs made using high noble metal can be burnished, while base metal or porcelain materials cannot be burnished) (Figure 10), microetches the FPD intaglio surface as needed (generally only metal intaglio surfaces can be microetched, and not porcelain intaglio surfaces), and uses microscopes to ensure that all aspects of the intaglio surface have been microetched.

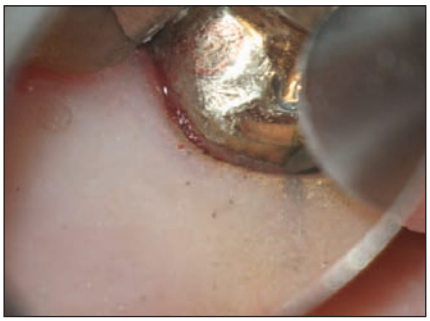

Figure 10. Microscopes allow a dentist to precisely burnish a full gold crown margin and to efficiently detect 100-µm marginal gaps solely through visual inspection.

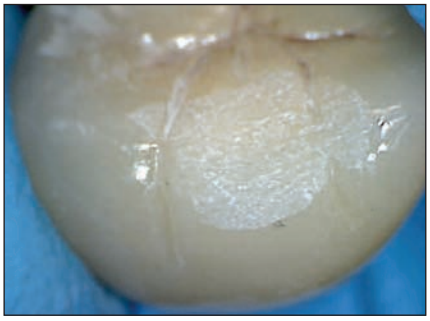

Figure 11. Microscopes allow for direct observation of microscopic rough spots on a porcelain surface after adjusting occlusion.

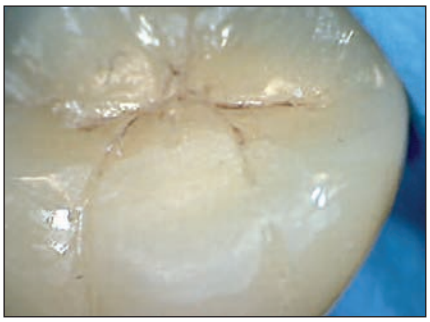

Figure 12. A microscope-level view shows a smooth and matte, almost shiny, finish after chairside polishing of the porcelain of an adjusted occlusal surface. If a surface appears smooth and matte under microscope-level magnification, it is unlikely that the patient will feel that surface to be rough to the tongue.

To polish the metal aspect of an FPD, the dentist generally uses rubber-tipped brown and green points of varying grit levels. To polish porcelain aspects of an FPD, the dentist uses diamond-impregnated soft burs, of varying levels of grit. The authors advise dentists to use a preassembled commercial porcelain polishing kit, specific for a particular type of porcelain used for the FPD, to ensure consistent, efficient results when polishing porcelain. Chairside porcelain polishing can be as effective as reglazing of porcelain with a laboratory.[29] Microscope-level magnification of 6x to 8x or more allows a dentist to observe microscopic rough surface textures in metal and porcelain (Figure 11), and microscopic spikes of porcelain

that protrude from FPD surfaces, and to observe their removal with microscopic precision (Figure 12). Microscopes allow observation of how a surface texture changes from rough to varying degrees of smoothness due to polishing procedures, and to observe microscopic changes in the reflectivity of surfaces as the surfaces progress during the polishing procedure from dull to matte, to slightly shiny, to shiny, reflecting incremental microscopic improvements in smoothness (Figure 12). In the authors' experience, a surface that appears smooth when viewed under 8x magnification is likely to be felt as smooth by the patient's tongue. Microscopes allow rapid verification of FPD surface smoothness, in that the dentist can quickly verify through direct visual observation alone that all FPD surface textures are smooth enough for the tongue to detect the surfaces as smooth.

The dentist then permanently cements the FPD.[9-11] Microscopes allow the dentist to detect if the cementation has resulted in a microscopic elevation of the margins or marginal ridges of the FPD, or in a microscopically increased separation at occlusal reference points when the patient occludes into maximum intercuspation. Lightly tapping the FPD may vibrate the cement under the FPD to facilitate increased seating of the FPD. A microscope level examination of the cemented FPD facilitates detection and removal of excess subgingival or interproximal cement.[28]

CONCLUSION

This article reviews the basic techniques of adjustment and cementation of FPDs, and describes how microscopes and head-mounted illumination aid the dentist in implementing these techniques. Use of such magnification allows the dentist to detect microscopic incremental improvements in FPD seating resulting from adjustments, to verify that minor adjustments can progressively and efficiently result in optimal FPD seating. Microscopes allow detection of microscopic amounts of separation between teeth of opposing arches when the patient is occluding into the FPD, and detection and removal of microscopic amounts of surface roughness. Since optimal seating of an FPD requires margin gaps to be less than 100 µm, and optimal occlusion requires teeth of opposing arches to occlude without even a microscopic separation between the teeth, the process of crown insertion may be viewed as a microscope-level problem-solving process, where a variety of microscopic visual details are clinically significant.

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POST EXAMINATION QUESTIONS

1. **In order to provide microscope-level magnification, binocular loupes should provide the following magnification:**
   a. 2x to 4x.
   b. 4x to 6x.
   c. 6x to 8x.
   d. None of the above.

2. **Optimal seating of a fixed partial denture (FPD) is achieved when the following occur(s):**
   a. Margin of the FPD is seated as far apically intraorally as on the model.
   b. Posterior marginal ridges are seated as far apically intraorally as on the model.
   c. Anterior incisal edges are seated as far apically intraorally as on the model.
   d. All of the above.

3. **The following marginal gap for an FPD is clinically unacceptable:**
   a. 50 µm.
   b. 75 µm.
   c. > 100 µm.
   d. Both a and b.

4. **The cause of an FPD not seating optimally when first tried in is usually:**
   a. Obstruction on the intaglio surface.
   b. Inaccurate fit at the gingival margin.
   c. Interproximal obstruction.
   d. Both a and b.

5. **Although adjustment of the intaglio surface of an FPD is imprecise, it can be performed with maximum control if:**
   a. The required adjustments are few in number.
   b. The adjustments are made in microscopic increments.
   c. The adjustments overall change the intaglio surface by a microscopic amount.
   d. All of the above.

6. If an intaglio surface adjustment results in reactivation of an interproximal obstruction, the dentist should stop adjusting the intaglio surface until all reactivated obstructions are adjusted.

a. True.
b. False.

7. After making all appropriate adjustments, an FPD requires refabrication if:

a. Interproximal contacts are unacceptably light or open.
b. The FPD shifts or slides while seated on the abutment.
c. Marginal gapping or space between FPD and abutment compromises retention.
d. All of the above.

8. Prior to adjusting FPD occlusion, the dentist uses the microscope to locate ___ points of occlusion to use as reference points:

a. 2.
b. 3.
c. 4.
d. 5.

9. All-metal and monolithic all-zirconia crowns should have at least ____ thickness at all aspects of the occlusal surface.

a. 1 mm.
b. 2 mm.
c. 3 mm.
d. 4 mm.

10. Ideally, a pontic site should be allowed to heal for _____after tooth extraction prior to taking a definitive impression for a bridge.

a. 2 weeks.
b. 2 to 4 weeks.
c. 4 to 6 weeks.
d. 6 to 8 weeks.

Using Microscopes in Fixed Prosthodontics

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3.	❑ a	❑ b	❑ c	❑ d	8.	❑ a	❑ b	❑ c	❑ d
4.	❑ a	❑ b	❑ c	❑ d	9.	❑ a	❑ b	❑ c	❑ d
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