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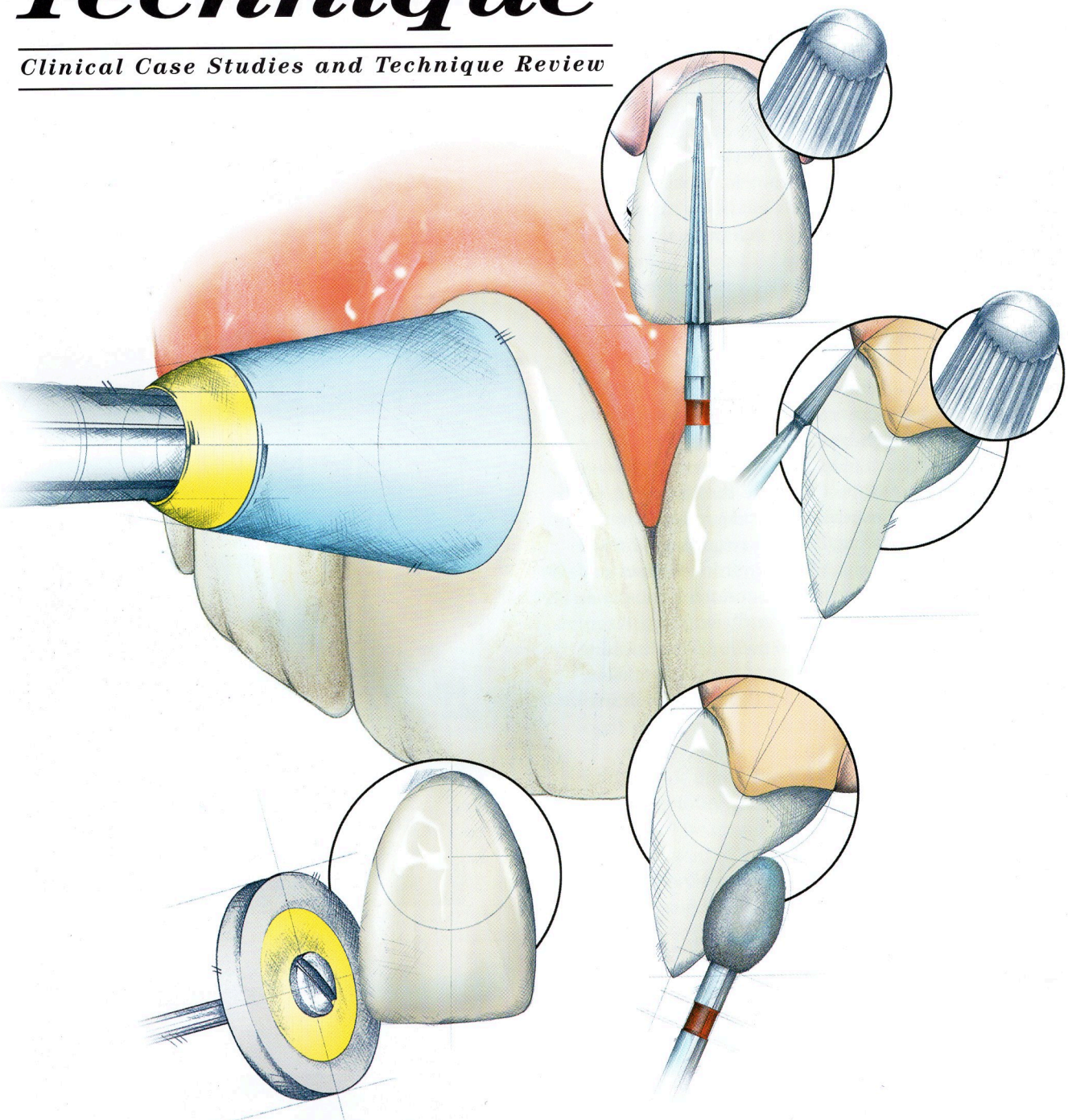
Clinical Case Studies and Technique Review



Finishing and Polishing for Function, Esthetics, and Longevity

Douglas A. Terry, DDS

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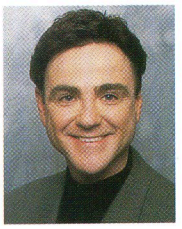

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Abstract

There are many objectives to fulfill when finishing and polishing teeth restored with composite or porcelain. In the past, when amalgam and gold were the primary materials used, the ultimate objectives of finishing and polishing were refining anatomical morphology, contours, marginal integrity, and occlusion while enhancing the surface smoothness of the restored teeth. These objectives have not changed; but with today's tooth-colored restorative materials, one new objective has emerged with great importance—esthetics. Esthetic restorative dentistry strives to create beautiful, natural-looking teeth that will maintain function and ensure structural integrity while eliminating the appearance of metal. To achieve this goal, many finishing and polishing devices are now available to the laboratory technician and restorative dentist, and several acceptable finishing and polishing protocols exist. In this article, the author provides his preferred methods for finishing and polishing various surfaces and materials. The discussion is divided by each material: composite and porcelain.

Learning Objectives

After reading this article, the reader should be able to:

- discuss the differences in protocol for finishing and polishing composite and porcelain restorations.
- describe the instrumentation used for finishing and polishing composite and porcelain restorations.
- discuss the factors that determine the smoothness of composite and porcelain.
- discuss the factors that determine the esthetic appearance of composite and porcelain.

A special characteristic is their opalescence, a rainbow-like iridescence which changes with the angle of observation. Until the 1960s, it was thought to be caused by the refraction of light from the thin surface layers. The real cause was discovered under electron microscope using a magnification of 20,000; tiny spheres of mineral cristobalite layered in siliceous jelly cause the reflection or interference appearances.[1] For appropriate finishing and polishing to achieve an esthetic outcome and protection against damage, a diamond-embedded sanding material is used ranging from coarse to extrafine. Final polishing is accomplished with a suede or soft leather polishing wheel (Richard Settles, gemologist, oral communication, 2002).

The paragraph above might well have been discussing tooth morphology and finishing methods; however, the recitation concerns information on preparation of rough opals into fine gems. Many of the internal characteristic discussions of other gemologists, as well as finishing and polishing protocols, are similar to those found in restorative dentistry. The Greek term *opallios* defines the word opal as "to see a change of color," similar to the polychromatic effect sought for a dental restoration. An unfinished, unpolished restoration is no more appealing than a chunky piece of rough material, of which two thirds will be ground away and then polished to create a beautiful gem (Figures 1A and 1B). Finishing and polishing methods correlate regardless of the material—gemstones, wood, enamel, porcelain, or composite resin. A pleasing esthetic outcome for any material requires a regimented protocol to produce optimal results.

Restorative materials of the past, such as amalgam and gold, required finishing and polishing procedures to

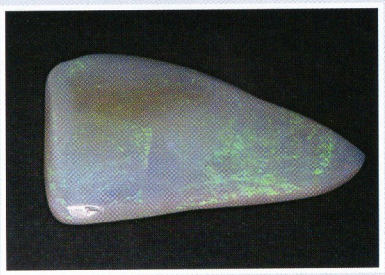

Figure 1A—*A rough opal before it is finished and polished.*

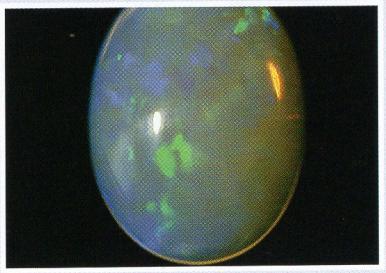

Figure 1B—*The final polished stone becomes a beautiful gem (3x magnification).*

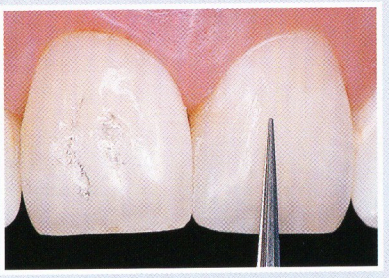

Figure 2—*Replicating natural form and texture, anatomical markings are achieved during initial contouring and shaping with the 8-fluted needle-shaped bur (ET9®).*

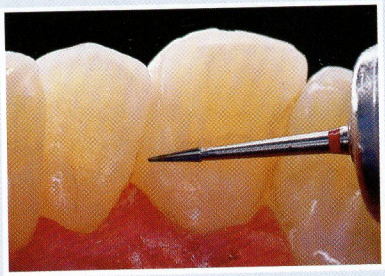

Figure 3—*Proper lingual embrasure is developed on this Class III composite restoration with a short, 8-fluted, needle-shaped bur (ET3®).*

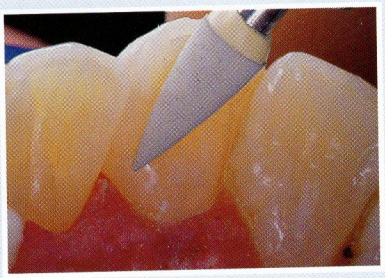

Figure 4—*Final polishing of the lingual embrasure was accomplished with a high-shine rubber point (DC1).*

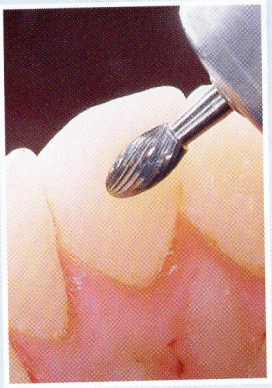

Figure 5—*Lingual finishing can be achieved with a rounded, egg-shaped finishing bur (OS1) that conforms to the appropriate curvature of the tooth surface and restoration.*

refine anatomical morphology, contours, marginal integrity, and occlusion while enhancing the surface smoothness of the restorations. Today, the objectives of the finishing and polishing techniques of tooth-colored restorations are the same, except the development of tooth-colored restorative materials has introduced a new element in the restorative equation—esthetics. The objective of esthetic restorative dentistry has become one of achieving and displaying restorations of beautiful, natural-looking teeth that will maintain function and ensure the structural integrity of the teeth while eliminating the appearance of metal, such as gold and amalgam, during smiling or phonation.[2] An optimally finished esthetic restoration should provide the following: a smooth surface that will prevent plaque accumulation[3-7] and resist stain[8]; ideal contours and emergence profile for improved tissue compatibility[8]; proper anatomical form for occlusal harmony[8]; shade coordination to surrounding dentition[8]; symmetrical surface texture to adjacent or opposing natural teeth[8]; improved marginal adaptation and integrity[9]; longevity[7,9,10]; and esthetics.[10]

An unfinished, unpolished restoration is no more appealing than a chunky piece of rough material.

Finishing focuses on contouring, adjusting, shaping, and smoothing the restoration while polishing concentrates on producing a smooth surface luster and highly light-reflective surface.[11] Using the proper composite finishing and polishing protocol can influence the longevity of both the direct and indirect restoration by affecting wear resistance[12,13] and marginal integrity.[9] A proper porcelain finishing and polishing protocol influences the wear behavior[12,13] and marginal integrity[9] of the restoration, as well as the wear rate of the opposing and/or adjacent teeth[13-16] and the strength of the porcelain restorative material. A multitude of finishing and polishing devices is available to the laboratory technician and restorative dentist, including: ceramic diamond rotary instruments, multifluted carbide burs, silicon carbide-coated and aluminum oxide-coated abrasive discs, light-cured resin points, and impregnated rubber or silicone discs, wheels, points, and cups.

While several acceptable finishing and polishing protocols exist, this article provides the author's preferred methods for finishing and polishing various surfaces and materials. The discussion is divided by each material: composite and porcelain.

Composite

The fabrication of direct and indirect composite resin restorations requires careful development and shaping of the composite resin according to the confines of the preoperative occlusal registration before curing the material, which facilitates the establishment of anatomic morphology and minimizes the finishing protocol.[17] A meticulous finishing protocol may provide the benefit of increased longevity of the restoration.[8,18] The smoothness of the composite surface depends on the curing system, the components within the restorative material, and the finishing instruments.[19]

Finishing and polishing methods correlate regardless of the material—gemstones, wood, enamel, porcelain, or composite resin.

The degree of polymerization determines the clinical performance of the curing system. The highest degree of polymerization occurs with heat-curing and the least occurs with chemical-curing. Insufficient light-curing can result in a soft surface that exhibits an opaque characteristic.[19] The various combinations of light, heat, pressure, and vacuum—as well as the use of nitrogen to enhance the degree of conversion through postcuring—continue to enhance the physical properties of the indirect resin systems.[20-24] The

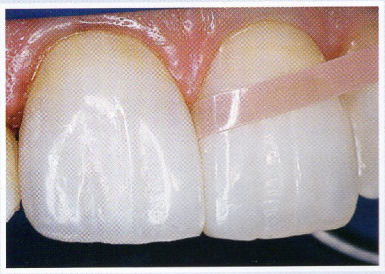

Figure 6—*Proximal surfaces and contours can be completed with finishing strips. The gingival region should be respected while finishing.*

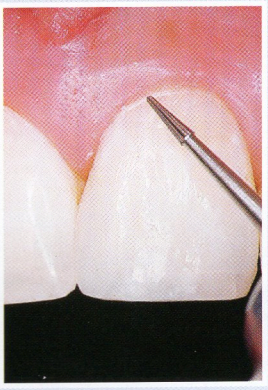

Figure 7—*Gingival contouring of this Class V composite restoration is effected with a short, tapered, straight-edge finishing bur (ET3®) that conforms to the straight emergence profile as the tooth emerges from the gingival sulcus.*

elimination of oxygen with pressure, vacuum, or nitrogen removes the entrapped air pockets[25,26] that contribute to the strength, wear resistance, and stain resistance of the restorative material.

Manufacturers have altered newer formulations of small-particle hybrids and microhybrids by incorporating filler components with finer filler size, shape, orientation, and concentration, improving their physical and mechanical characteristics, and allowing the resin composite to be polished to a higher degree.[27] The variation in hardness between the inorganic filler and the matrix can result in surface roughness because these two components do not abrade uniformly.[27,28] Accordingly, it is imperative that the surface gloss between the restorative material and the tooth interface are similar because the gloss can influence color perception and shade matching of the restoration and tooth surface.[29,30]

A pleasing esthetic outcome for any material requires a regimented protocol to produce optimal results.

The esthetic appearance of the surface of a composite resin restoration is a direct reflection of the instrument system used.[31] The surface of the composite can be finished and polished with a variety of techniques. Diamonds, multifluted burs, discs, and polishing points and cups have all been used to reproduce the shape, color, and luster of the natural dentition. As Pratten and Johnson have indicated, there is no statistical difference between finishing and polishing anterior and posterior restorative materials[32]; the consideration factors for finishing and polishing any restoration depend on the instrument shape, the surface shape and texture of the tooth and restoration, the surfaces of the finishing and polishing instruments, and the sequence of the restorative treatment.[32]

Intraoral Finishing and Polishing of Direct and Indirect Anterior Composite Restorations

Facial Regions

For finishing the labial surface, a long needle-shaped finishing bur allows the proper anatomical contours of the facial aspect of the anterior tooth to be followed. To replicate natural form and texture, initial contouring and shaping can be achieved with the 8-fluted, needle-shaped bur (Figure 2). The ET9®,[a] has sufficient length to overlap the tooth–resin interface and provide a parallel plane to the tooth surface of the maxillary and mandibular anterior teeth. It is important to use a dry protocol[33] and closely observe the tooth–resin interface. A smooth surface can be achieved by following a sequential increase in the number of flutes (ie, use an 8 first, then a 12, then a 30).

Polishing of the facial surface can be achieved with prepolish (40 µm to 60 µm blue-green) and high-shine

[a]Brasseler USA®, Savannah, GA 31419; 800-841-4522

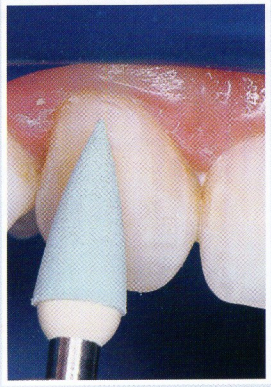

Figure 8A—*Polishing the gingival with prepolish point (DC1M).*

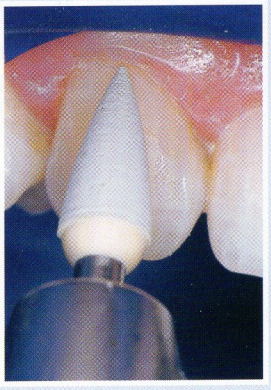

Figure 8B—*Polishing the gingival with high-shine point (DC1).*

Figure 8C—*Polishing the gingival with prepolish rubber hollow cups (DC3M).*

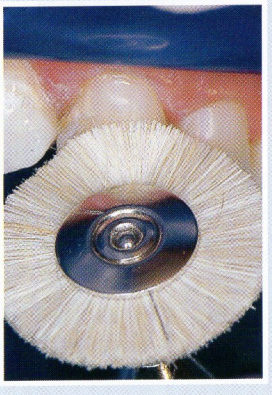

Figure 8D—*Polishing the gingival with a goat-hair brush (10019HP) and polishing paste (165070000).*

Figure 9—*The preoperative facial view of the patient demonstrates the existing unesthetic composite resin restoration.*

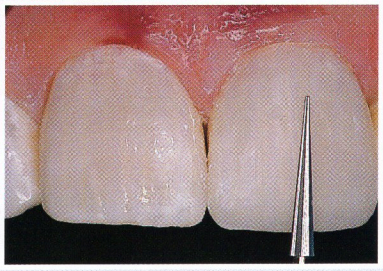

Figure 10—*To reproduce natural form and texture on this direct composite veneer, the initial facial contouring was initiated with 8- and 16-fluted burs (ET9®).*

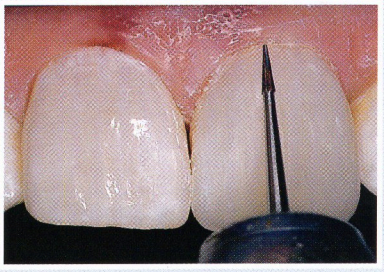

Figure 11—*The gingival and interproximal contouring and finishing on this direct composite veneer was completed with 8- and 16-fluted burs (ET3®), respectively.*

rubber points (1 µm to 3 µm gray) (DC1M, DC1, Diacomp™,a). These rubber points can be used to create indentations, lobes, grooves, and ridges. However, it is imperative not to overpolish and remove the anatomical contours previously created.

Embrasure Regions

Facial, lingual, and incisal embrasures can be developed with a short needle-shaped bur (ET3®,a) (Figure 3) used sequentially with an increase in flutes (ie, starting with an 8, then 16, and then 30) and/or aluminum oxide finishing discs, used sequentially according to grit, ranging from coarse to extrafine. It is important to use a dry protocol and closely observe the position of the line angles. Final polishing of the facial and lingual embrasures can be accomplished with a prepolish and high-shine rubber points (Figure 4), following the proximal contours.

Restorative materials of the past, such as amalgam and gold, required finishing and polishing procedures to refine anatomical morphology, contours, marginal integrity, and occlusion while enhancing the surface smoothness of the restorations.

Lingual Regions

Lingual finishing can be accomplished with a rounded, egg-shaped finishing bur (OS1a) that conforms to the appropriate curvature of the tooth surface and restoration (Figure 5). Excess composite resin can be removed with the 8-fluted, egg-shaped bur at medium speed with air coolant, light intermittent pressure, and a staccato motion. Choosing the size and shape of the bur depends on and is directly related to the amount of excess composite resin and the shape of the lingual surface. A smooth surface can be achieved by following a sequential increase in the number of flutes (ie, 8, 12, and 30). After removing the rubber dam, any necessary equilibration can be accomplished with an egg-shaped bur.

Polishing of the lingual surface can be accomplished with a prepolish (40 µm to 60 µm blue-green) and high-shine (1 µm to 3 µm gray) rubber points following the concave lingual surfaces of the anterior teeth.

Proximal Regions

The proximal surfaces and contours can be completed with aluminum oxide discs and finishing strips. The thin strips should be used for contouring because the wider strips flatten the proximal contour and remove too much material at the contact region, and extend too far gingivally (Figure 6).

Incisal Regions

The final incisal edge adjustment in length is performed with the patient in an upright position. Aluminum oxide discs or a needle-shaped finishing bur (ET6®,a,

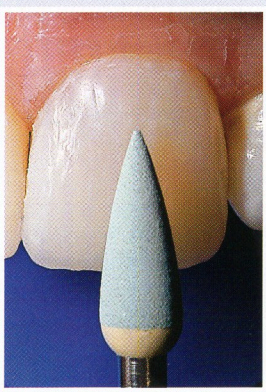

Figure 12A—*For characterization, a prepolish rubber point (DC1M) was used to create indentations, lobes, and ridges.*

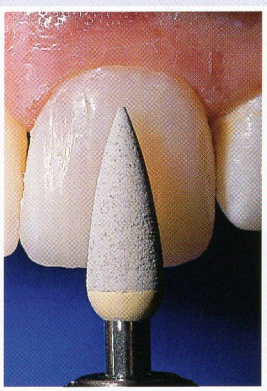

Figure 12B—*After prepolishing, a high-shine rubber point (DC1M) was used.*

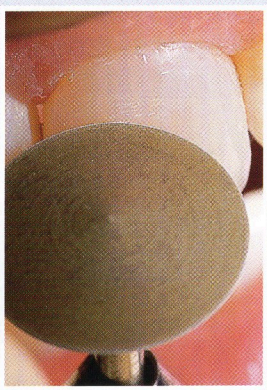

Figure 13—*To recreate the surface texture of the contralateral central incisor, a knife-edge wheel was used horizontally in an intermittent staccato motion.*

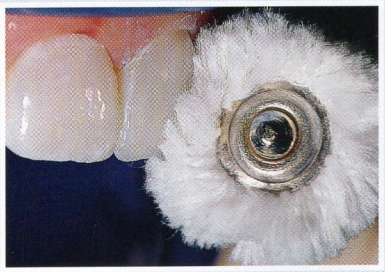

Figure 14—*A final polishing surface gloss can be achieved with a dry cotton buff (15122HP) using an intermittent staccato motion applied at conventional speed.*

Figure 15—*The final postoperative result reflects the harmonious integration of color, form, and texture achieved with proper finishing and polishing techniques.*

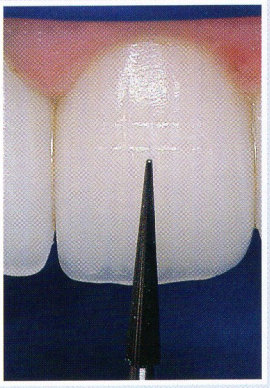

Figure 16—*After the use of diamond instruments at moderate speed with a water spray, a 30-bladed carbide (ET9®) at maximum speed (dry) is employed for final polishing of porcelain.*

ET9®,[a]), 8- or 16-fluted, are excellent choices for this final adjustment. Incisal length can be evaluated with a small piece of precut black plastic placed lingual to the tooth and restoration. A variation in the angle of the incisal edge can alter the thickness and the degree of translucency of the restoration.

Polishing of the incisal surface can be accomplished with prepolish and high-shine rubber points following the incisal edge.

Gingival Regions

Gingival contouring is accomplished with a short, tapered, straight-edge finishing bur (ET3®,[a]) that conforms to the straight emergence profile as the tooth emerges from the gingival sulcus (Figure 7). Excess composite resin can be removed with the 8-fluted, egg-shaped bur at medium speed with air coolant, light intermittent pressure, and a staccato motion. A smooth surface can be achieved by following a sequential increase in the number of flutes (ie, 8, 12, and 30). It is important to use a dry protocol and retract the gingiva with an 8A instrument, closely observing tooth structure and the gingival margin area. The ET®-series finishing bur is designed with a round tip that minimizes the possibility of scarring or gouging the root surfaces when finishing gingival regions.

The development of tooth-colored restorative materials has introduced a new element in the restorative equation—esthetics.

Polishing of the gingival and subgingival region can be performed with prepolish, high-shine rubber hollow cups, points (DC3M, DC3[a]), and polishing paste. The impregnated cup follows the contour of the gingival neck and reaches into the sulcus to smooth any rough areas (Figures 8A through 8D).

Finishing and Polishing of a Composite Veneer on the Maxillary Left Central

In this case, the tooth to be restored with a direct composite resin restoration was a maxillary left central with an existing composite veneer (Figure 9). After completion of the restoration, to enhance the esthetics and longevity of the restored maxillary left central, the initial contouring was performed with a series of finishing burs. Particular attention was given not only to the relationship between the expanse and direction of the ridges and grooves and the anatomic variations of the teeth that were adjacent to the restoration, but also to the light refraction and surface reflection resulting from the microstructure of

Figure 17—*The facial embrasure and mesiofacial line angle can be modified with a short, tapered diamond (DET3) with a 30-µm grit.*

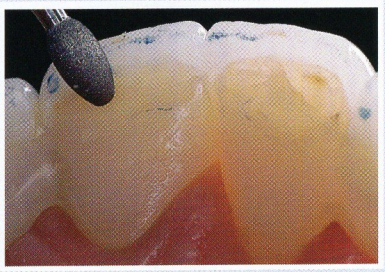

Figure 18—*The concave surface of the lingual aspect of the anterior porcelain restorations is most optimally finished with a rounded, egg-shaped finishing diamond (DOS1) because it conforms to the curvature of the restoration.*

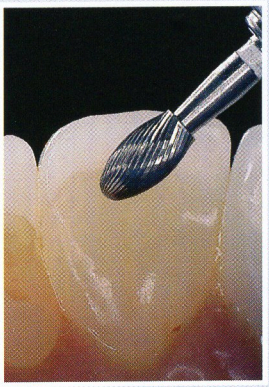

Figure 19—*After finishing with diamonds, a smoother porcelain surface can be achieved with a 30-bladed carbide (OS1UF) at maximum speed (dry).*

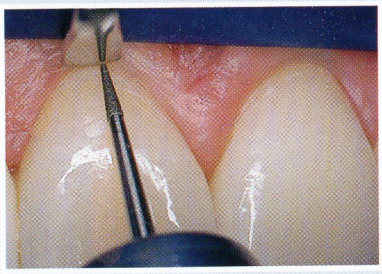

Figure 20A—*Resin cement can be finished at the tooth restorative interface of the maxillary incisors by retracting the gingiva with an 8A instrument (DET3), and while closely observing tooth structure and the gingival margin area, finishing the margins with gentle sweeps.*

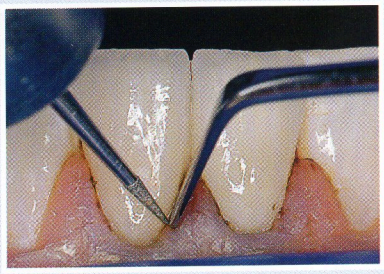

Figure 20B—*Resin cement can be finished at the tooth restorative interface of the mandibular incisors by retracting the gingiva with an 8A instrument (DET3), and while closely observing tooth structure and the gingival margin area, finishing the margins with gentle sweeps.*

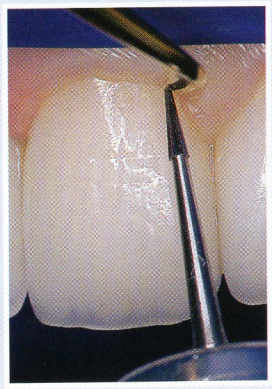

Figure 21—*After finishing with diamonds a smoother porcelain surface can be achieved with a 30-bladed carbide (ET3UF) at maximum speed (dry).*

the tooth surface.[34] To replicate natural form and texture, the initial facial contouring was initiated with 8- and 16-fluted burs (ET9®) (Figure 10). Gingival and interproximal contouring and finishing were completed with 8- and 16-fluted burs respectively (Figure 11). The lingual surfaces were contoured with 8- and 16-fluted burs (OS1).

The objective of esthetic restorative dentistry has become one of achieving and displaying restorations of beautiful, natural-looking teeth that will maintain function and ensure the structural integrity of the teeth.

When preliminary contouring was completed, the proximal, facial, and incisal angles were finished with aluminum oxide disks and finishing strips. These were used sequentially according to grit, ranging from coarse to extrafine. For characterization, rubber wheels, points, and cups (Diacomp™ composite polishers) were used to create indentations, lobes, and ridges (Figures 12A and 12B). To recreate the surface texture of the contralateral central incisor, a knife-edge wheel was used horizontally in an intermittent staccato motion (Figure 13).

To impart a high luster or surface reflectivity on the restoration while maintaining the existing texture and surface anatomy, the final polishing can be accomplished with composite polishing paste and goat-hair brushes applied at conventional speed. These loose abrasive pastes allow the anatomical details to be maintained while imparting an enamel-like appearance to the restored tooth. Superfine finishing strips were used with composite polishing paste to refine the interproximal regions. The interproximal areas were examined with unwaxed dental floss to verify adequate contacts and the absence of gingival overhangs, and the margins were inspected.

Finishing focuses on contouring, adjusting, shaping, and smoothing the restoration while polishing concentrates on producing a smooth surface luster and highly light-reflective surface.

Figure 22A—*Polishing the gingival and subgingival regions of the mandibular incisors can be performed with a prepolish rubber point (0352C—alternate product available: W16DM Dialite™).*

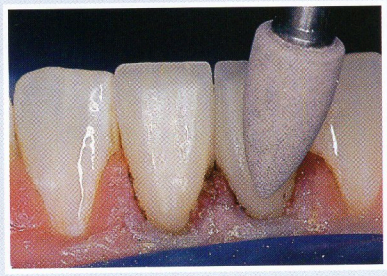

Figure 22B—*A higher luster can be achieved by polishing the gingival and subgingival regions of the mandibular incisors with a high-shine rubber point (0362C—alternate product available: W16D Dialite™).*

Figure 23—*The rubber cup follows the contour of the gingival neck of the tooth and restoration and reaches into the sulcus to smooth and polish any subgingival porcelain and/or tooth structure (0365C—alternate product available: W17D Dialite™).*

Figure 24—*The preexisting facial view of maxillary anterior teeth before porcelain laminate veneers were placed.*

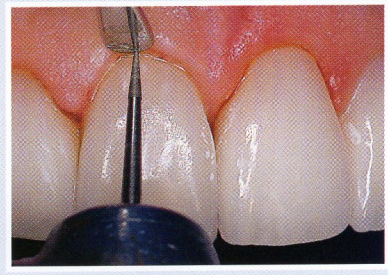

Figure 25—*The gingival and interproximal region is finished with a short, tapered, straight diamond by retracting the gingiva with an 8A instrument (DET3), and while closely observing tooth structure and the gingival margin area, finishing margins with gentle sweeps.*

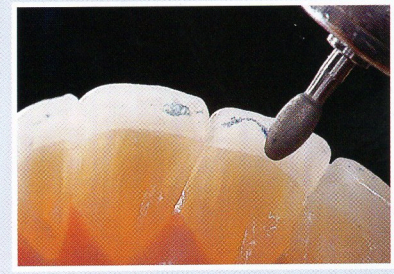

Figure 26—*Lingual surfaces were finished with a large, rounded, egg-shaped finishing diamond (DOS1) following the ceramic–enamel interface.*

To evaluate occlusion, the patient was asked to first perform closure without force and then centric, protrusive, and lateral excursions. Any necessary occlusal equilibration was accomplished with an egg-shaped finishing bur (OS1) and the final polish was repeated. A final polishing surface gloss can be achieved with a dry cotton buff (Ceroshine[a]) using an intermittent staccato motion applied at conventional speed (Figure 14). After the polishing procedure is completed, a final 2-minute postcuring improves the degree of conversion and ensures the hardest surface possible.[8,35] The final postoperative result reflects the harmonious integration of color, form, and texture achieved with proper finishing and polishing techniques (Figure 15).

Using the proper composite finishing and polishing protocol can influence the longevity of both the direct and indirect restoration by affecting wear resistance and marginal integrity.

Porcelain

The ceramic materials used for dental restorations are feldspathic porcelain, hot-pressed ceramics, and machinable ceramics designed for use with CAD/CAM systems.[36] The structure of porcelain is similar to that of composite resin, which also has a filler component and a matrix. Dental porcelains have a filler component of crystalline minerals (feldspar, silica, and alumina) that are dispersed in a glass matrix.[37] The smoothness of the porcelain surface depends on the components within the restorative material, the firing temperature and the number of times the porcelain has been fired, and the finishing instruments.

The smoothness (less abrasiveness) of porcelain is mainly a result of the size of the crystalline particles and the microstructural surface features, but requires adequate firing conditions to allow the grains of the porcelain to come close together to produce a well-condensed porcelain surface, because porosities in the porcelain surface cannot be completely eliminated by polishing.[14,38]

The appearance and vitality of porcelain can be influenced by finishing and polishing procedures. Surface characterizations and morphology can affect the surface gloss. Macromorphological or micromorphological surfaces allow diffuse reflection, whereas flat or smooth surfaces allow specular reflection.[39] This optical scattering has an effect on color perception and should be considered during shade matching between a restorative material and natural tooth.[29,30]

A multitude of finishing and polishing devices is available to the laboratory technician and restorative dentist, including: ceramic diamond rotary instruments, multifluted carbide burs, silicon carbide-coated and aluminum oxide-coated abrasive discs, light-cured resin points, and impregnated rubber or silicone discs, wheels, points, and cups.

The finishing and polishing of porcelain can be divided into two procedures: laboratory and intraoral. Manufacturers usually provide two different types of procedure kits to polish porcelain: laboratory (extraoral) and clinical (intraoral). The finishing and polishing techniques are compared in the literature to a "gold standard," which is the original glaze.[14] Of course, laboratory finishing and polishing can produce smoother and denser surfaces,[12] assuming the porcelain was fired at the proper protocol to allow

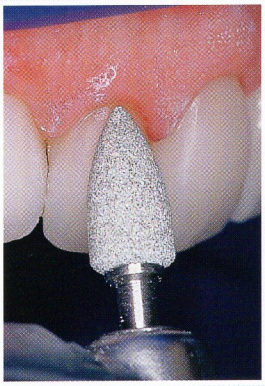

Figure 27A—*The facial surface is polished with a prepolish rubber point (0352C—alternate product available: W16DM Dialite™) following the anatomical contours of the tooth and restoration.*

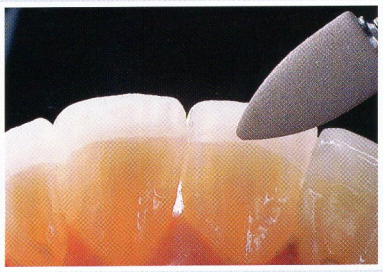

Figure 27B—*Facial and lingual surfaces are polished with prepolish and high-shine rubber points (0362C—alternate product available: W16D Dialite™) following the anatomical contours of the tooth and restoration.*

a dense surface.[38] However, with bonded porcelain restorations, final occlusal adjustments and polishing are required after the bonding procedure because of the fragility of the unbonded porcelain restoration and the risk of fracture.[40] These adjusted rough surfaces of the porcelain restoration can result in abrasion to adjacent and opposing dentition,[15,16] plaque accumulation and retention,[10,41,42] mechanical irritation of the surrounding periodontium,[10,42] and reduction in the strength of the porcelain restoration.[43,44] Therefore, surface abrasiveness of porcelain should be minimized by finishing and polishing procedures to achieve and enhance biocompatibility.[45]

A meticulous finishing protocol may provide the benefit of increased longevity of the restoration.

Investigations by Haywood et al and studies by Wiley concluded that intraoral polishing of porcelain can equal or surpass the smoothness of glazed porcelain.[16,46-48] Furthermore, hand-polishing has been shown to increase the fracture toughness[49] and strength of porcelain.[50] And the combined use of glazing and polishing can be used to improve the total esthetics through surface characterization.[14]

Intraoral Finishing and Polishing of Anterior Porcelain Restorations

Facial Regions

If modifications are required to achieve proper anatomical contours of the facial aspect of the anterior tooth, a long, tapered diamond (DET6®,[a], DET9®,[a]) with a 30-µm grit (red band) can be used to redefine lobes, ridges, and line angles for the proper light reflectance from the surface. The DET9® has sufficient length to provide a parallel plane to the restorations of the maxillary and mandibular anterior teeth. A smoother surface can be achieved by using a sequential finishing from fine (30 µm, red) to extrafine (15 µm, yellow) to a final ultrafine (8 µm, white). An improvement in the efficiency of porcelain polishing has been reported with the use of diamond instruments at moderate speed, with a water spray,[47] followed by a 30-bladed carbide at maximum speed, dry (Figure 16).[48-51] Also, the same sequence with these finishing diamonds can be used in finishing adhesive preparations before impression making and provisionalization.

Polishing of the facial surface can be accomplished with prepolish and high-shine rubber points (W16DM[a], W16D[a]). These points are impregnated with diamond particles and can be used to polish indentations, lobes, grooves, and ridges. To optimize their efficiency, moderate pressure must be applied.

Embrasure Regions

Facial, lingual, and incisal embrasures can be modified with a short, tapered diamond (DET3®,[a]) with a 30-µm grit (red band) (Figure 17) or aluminum oxide finishing discs, used sequentially according to grit and ranging from coarse to extrafine. A smoother surface can be achieved by using a sequential finishing from fine (30 µm, red) to extrafine (15 µm, yellow) to a final ultrafine (8 µm, white) at moderate speed, with water spray.

Polishing of the facial and lingual embrasures can be performed with a prepolish and high-shine rubber points (W16DM, W16D, Dialite™,[a]) following the proximal contours. To optimize their efficiency, a moderate pressure must be applied.

The smoothness of the composite surface depends on the curing system, the components within the restorative material, and the finishing instruments.

Lingual Regions

The concave surface of the lingual aspect of anterior porcelain restorations can be finished most optimally with a rounded, egg-shaped finishing diamond because it conforms to the curvature of the restoration (Figure 18). Choosing the size and shape of the diamond depends on and is directly related to the amount of porcelain reduction and the shape and size of the lingual surface of the restoration. The variation in shape and size of these egg-shaped diamonds corresponds to the lingual surfaces as follows: large egg-shaped (DOS1[a]), small and thin (DOS2[a]), and a small and very thin (DOS3[a]). A smoother surface can be achieved with sequential finishing using first fine (30 µm, red), then extrafine

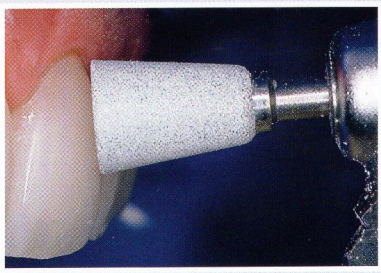

Figure 28—*Gingival and subgingival regions are polished with prepolish and high-shine rubber hollow cups and polishing paste (W17DM, W17D).*

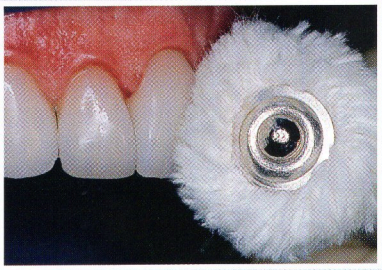

Figure 29—*Final luster is achieved with a cotton buff (15122HP) using a staccato motion.*

Figure 30—*The postoperative facial view of the maxillary anterior teeth reflects the total esthetics that can be achieved after finishing and polishing the porcelain restorations.*

(15 µm, yellow), and then final ultrafine (8 µm, white) diamonds at moderate speed, with water spray, followed by a 30-bladed carbide (OS1UF[a]) at maximum speed, dry (Figure 19).[48,51]

Polishing the lingual surface of the restoration can be performed with a prepolish and high-shine rubber points (W16DM, W16D, Dialite™,[a]) following the concave surface. To optimize their efficiency, moderate pressure must be applied.

The various combinations of light, heat, pressure, and vacuum—as well as the use of nitrogen to enhance the degree of conversion through postcuring—continue to enhance the physical properties of the indirect resin systems.

Proximal Regions

The proximal surfaces and contours of the porcelain restoration can be smoothed and adjusted with aluminum oxide discs and metal diamond strips (Visionflex Diamond Strips[a], Gateway™ Diamond Finishing Strips[a]). A smoother surface can be achieved with sequential finishing discs and strips progressing from medium (45 µm) to fine (30 µm) to a final extrafine (15 µm). It is important to protect the contact because overuse of these metal strips can open the contact. The coarse strip of the Gateway™ Diamond Finishing Strips also can be used for orthodontic stripping.

Incisal Regions

The incisal edge adjustment in length can be best accomplished with the patient in the upright position. Aluminum oxide discs or a long, tapered diamond (DET6®, DET9®), 30-µm grit, are excellent choices for this final adjustment. As indicated previously, incisal length can be evaluated with a small piece of black plastic placed lingual to the tooth and porcelain restoration. Also, any variation in the angle of the incisal edge can alter the thickness and the degree of translucency of the final restoration.

Gingival Regions

Modifications in the gingival contour are accomplished with a short, tapered, straight diamond (DET3®), 30 µm, that conforms to the straight emergence profile as the tooth emerges from the gingival sulcus. Resin cement can be finished at the tooth restorative interface by retracting the gingiva with an 8A instrument, and closely observing tooth structure and the gingival margin area, finishing the margins with gentle sweeps (Figures 20A and 20B). A smoother surface can be achieved by using a sequential finishing from fine (30 µm, red) to extrafine (15 µm, yellow) to a final ultrafine (8 µm, white) at moderate speed with water spray, followed by a 30-bladed carbide (OS1UF[a]) at maximum speed, dry (Figure 21).[48,51]

Polishing the gingival and subgingival region can be performed with prepolish and high-shine rubber points (Figures 22A and 22B) hollow cups (Dialite™), and polishing paste. The cup is impregnated with diamond particles and the shape follows the contour of the gingival neck of the tooth and restoration and reaches into the sulcus to smooth and polish any subgingival porcelain and/or tooth structure (Figure 23).

The esthetic appearance of the surface of a composite resin restoration is a direct reflection of the instrument system used.

Finishing and Polishing of Maxillary Anterior Porcelain Veneers

In this case, the maxillary teeth were restored with porcelain laminate veneers to change the size, shape, contour, orientation, function, and color (Figure 24). After the porcelain veneers were bonded and

the residual excess resin cement at the gingival margins was removed with a scalpel (Bard Parker blade No. 12), the final restorative phase was accompanied by finishing and polishing, which is critical to the function, esthetics, and longevity of the restored teeth.[8,18] The gingival and interproximal regions were finished with a short-tapered straight diamond (DET3®), 30 µm, using sequential finishing from fine (30 µm, red) to extrafine (15 µm, yellow) to a final ultrafine (8 µm, white) at moderate speed with water spray, while retracting the gingiva with an 8A instrument, and closely observing tooth structure and the gingival margin area and finishing the margins with gentle sweeps (Figure 25).

With the improved formulations of composite and porcelain restorative materials, the finishing instruments and techniques become a reflection of the knowledge and expertise of the clinician.

The lingual surfaces were finished with a large, rounded, egg-shaped finishing diamond (DOS1[a]) following the ceramic–enamel interface (Figure 26), using sequential finishing from fine to ultrafine at moderate speed with water spray. Finishing strips were used in the interproximal and cervical areas to ensure adequate contact without gingival overhangs. The facial and lingual surfaces and embrasures were polished with prepolish and high-shine rubber points (W16DM, W16D, Dialite™) (Figures 27A and 27B), following the anatomical contours of the tooth and restoration. The gingival and subgingival regions were polished with prepolish and high-shine rubber hollow cups (Dialite™) (Figure 28) and polishing paste.

It is important to final polish the restoration so that the surface reflectivity harmonizes with the surrounding dentition, which can affect the final value of the polished restoration[30,39,52] and total color perception. The final polishing of the restoration surface was accomplished with loose abrasive diamond pastes and a goat-hair wheel applied at conventional speeds, which allow all of the anatomical details to be reached and polished.

The rubber dam was removed, and the patient was asked to perform closure without force and then centric, protrusive, and lateral excursions. Any necessary equilibration was accomplished with a rounded, egg-shaped finishing diamond, and the final polishing was repeated. The final luster was achieved with a cotton buff (Ceroshine) (Figure 29) using a staccato motion. By controlling the luster, the clinician created total esthetics for the restorations (Figure 30).

Conclusion

Finishing and polishing techniques for any material require a methodical protocol to achieve a pleasing esthetic outcome. While dental restorations from "the past to the present" have shared the common interests of function and longevity, the clinician must now also possess and continually update his or her knowledge of esthetics. With the improved formulations of composite and porcelain restorative materials, the finishing instruments and techniques become a reflection of the knowledge and expertise of the clinician.

This article describes a general protocol and sequence for finishing and polishing porcelain and composite restorations. Understanding proper finishing and polishing protocols and using new restorative materials and finishing instruments allow the clinician to provide improved function, esthetics, and longevity. The result may be the difference between a chunky piece of rough material or a beautiful gem.

References

1. Schumann W: *Gemstones of the World*. New York, NY: Sterling Publishing Co Inc; 1986.
2. Touati B: Bonded ceramic restorations: achieving predictability. *Pract Periodontics Aesthet Dent* 7(4):33-37, 1995.
3. Stewart GP, Bachman TA, Hatton JF: Temperature rise due to finishing of direct restorative materials. *Am J Dent* 4(1):23-28, 1991.
4. Cooley R, Barkmeier WW, White JH: Heat generation during polishing of restorations. *Quintessence Int* 9(12):77-80, 1978.
5. Bollen CM, Lambrechts P, Quirymen M: Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. *Dent Mater* 13(4):258-269, 1997.
6. Kaplan BA, Goldstein GR, Vijayaraghavan TV, et al: The effect of three polishing systems on the surface roughness of four hybrid composites: a profilometric and scanning electron microscopy study. *J Prosthet Dent* 76(1):34-38, 1996.
7. Berastegui E, Canalda C, Brau E, et al: Surface roughness of finished composite resin. *J Prosthet Dent* 68(5):742-749, 1992.
8. Goldstein RE: Finishing of composites and laminates. *Dent Clin North Am* 33(2):305-318, 1989.
9. Yap AU, Ang HQ, Chong KC: Influence of finishing time on marginal sealing ability of new generation composite bonding systems. *J Oral Rehabil* 25(11):871-876, 1998.
10. Jefferies SR: The art and science of abrasive finishing and polishing in restorative dentistry. *Dent Clin North Am* 42(4):613-627, 1998.
11. Schwartz RS, Summitt JB, Robbins JW: Finishing and polishing. In: *Fundamentals of Operative Dentistry: A Contemporary Approach*. Chicago, IL: Quintessence Publishing Co Inc; 1996:201-205.
12. al-Wahadni A, Martin DM: Glazing and finishing dental porcelain: a literature review. *J Can Dent Assoc* 64(8):580-583, 1998.
13. Jagger DC, Harrison A: An in vitro investigation into the wear effects of unglazed, glazed, and polished porcelain on human enamel. *J Prosthet Dent* 72(3):320-323, 1994.
14. Magne P, Oh WS, Pintado MR, et al: Wear of enamel and veneering ceramics after laboratory and chairside finishing procedures. *J Prosthet Dent* 82(6):669-679, 1999.
15. Monasky GE, Taylor DF: Studies on the wear of porcelain, enamel, and gold. *J Prosthet Dent* 25(3):299-306, 1971.
16. Wiley MG: Effects of porcelain on occluding surfaces of restored teeth. *J Prosthet Dent* 61(2):133-137, 1989.
17. Liebenberg WH: Successive cusp build-up: an improved placement technique for posterior direct resin restorations. *J Can Dent Assoc* 62(6):501-507, 1996.
18. Jefferies SR, Barkmeier WW, Gwinnett AJ: Three composite finishing systems: a multi-

site in vitro evaluation. *J Esthet Dent* 4(6): 181-185, 1992.
19. Wilson F, Heath JR, Watts DC: Finishing composite restorative materials. *J Oral Rehabil* 17(1):79-87, 1990.
20. Miara P: Aesthetic guidelines for second-generation indirect inlay and onlay composite restorations. *Pract Periodont Aesthet Dent* 10(4):423-431,1998.
21. Touati B, Aidan N: Second-generation laboratory composite resins for indirect restorations. *J Esthet Dent* 9(3):108-118, 1997.
22. McLaren EA, Rifkin R, Devaud V: Considerations in the use of polymer and fiber-based indirect restorative materials. *Pract Periodont Aesthet Dent* 11(4):423-432, 1999.
23. Leinfelder KF: New developments in resin restorative systems. *J Am Dent Assoc* 128(5):573-581, 1997.
24. Ceramic polymer crowns and fixed prostheses. *CRA Newsletter* 21(5), 1997.
25. Bennett ME, Puckett AD, Parsell DE, et al: Conversion of a heat and pressure-cured composite. *J Dent Res* 75(Special Issue): 291, 1996. Abstract 2188.
26. Howard NY: Advanced use of an esthetic indirect posterior resin system. *Compend Contin Educ Dent* 18(10):1044-1050, 1997.
27. Chung KH: Effects of finishing and polishing procedures on the surface texture of resin composites. *Dent Mater* 10(5):325-330, 1994.
28. Chen RC, Chan DC, Chan KC: A quantitative study of finishing and polishing techniques for a composite. *J Prosthet Dent* 59(3):292-297, 1988.
29. Vanini L: Light and color in anterior composite restorations. *Pract Periodontics Aesthet Dent* 8(7):673-682, 1996.
30. Judd DB, Harrison WN, Sweo BJ, et al: Optical specification of light-scattering materials. *J Res Nat Bur Stand* 19:287-317, 1937.
31. Northeast SE, van Noort R: Surface characteristics of finished posterior composite resins. *Dent Mater* 4(5):278-288, 1988.
32. Pratten DH, Johnson GH: An evaluation of finishing instruments for an anterior and a posterior composite. *J Prosthet Dent* 60(2):154-158, 1988.
33. Dodge WW, Dale RA, Cooley RL, et al: Comparison of wet and dry finishing resin composites with aluminum oxide discs. *Dent Mater* 7(1):18-20, 1991.
34. Hegenbarth EA: Teeth and esthetics. In: *Creative Ceramic Color: A Practical System.* Chicago, IL: Quintessence Publishing Co, Inc; 1989:9-36.
35. Simonsen RJ, Kanca J III: Surface hardness of "posterior" composite resins [abstract]. *J Dent Res* 65:191, 1986. Abstract 196.
36. Roberson TM, Heymann HO, Swift EJ: Classes I and II indirect tooth-colored restorations. In: Roberson TM, *Sturdevant's Art and Science of Operative Dentistry.* 4th ed. St. Louis, MO: Mosby, Inc; 2002:574.
37. Anusavice KJ; ed. *Phillips' Science of Dental Materials.* 10th ed. Philadelphia, PA: WB Sanders; 1996.
38. Sulik WD, Plekavich EJ: Surface finishing of dental porcelain. *J Prosthet Dent* 46(2):217-221, 1981.
39. O'Brien WJ, Johnston WM, Fanian F, et al: The surface roughness and gloss of composites. *J Dent Res* 63(5):685-688, 1984.
40. Magne P, Dietschi D, Holz J: Esthetic restorations for posterior teeth: practical and clinical considerations. *Int J Periodontics Restorative Dent* 16(2):104-119, 1996.
41. Clayton JA, Green E: Roughness of pontic materials and dental plaque. *J Prosthet Dent* 23(4):407-411, 1970.
42. Swartz ML, Phillips RW: Comparison of bacterial accumulations on rough and smooth enamel surfaces. *J Periodontal* 28(4):304-307, 1957.
43. McLean JW: Science and art of dental ceramics. In: Vol. 1: The Nature of Dental Ceramics and Their Clinical Use. 1st ed. Chicago, IL: Quintessence Publishing Co, Inc; 1979.
44. Bessing C, Wiktorsson A: Comparison of two different methods of polishing porcelain. *Scand J Dent Res* 91(6):482-487, 1983.
45. Campbell SD: Evaluation of surface roughness and polishing techniques for new ceramic materials. *J Prosthet Dent* 61(5):563-568, 1989.
46. Haywood VB, Heymann HO, Kusy RP, et al: Polishing porcelain veneers: an SEM and specular reflectance analysis. *Dent Mater* 4(3):116-121, 1988.
47. Haywood VB, Heymann HO, Scurria MS: Effects of water, speed, and experimental instrumentation on finishing and polishing porcelain intraorally. *Dent Mater* 5(3):185-188, 1989.
48. Ward MT, Tate WH, Powers JM: Surface roughness of opalescent porcelains after polishing. *Oper Dent* 20(3):106-110, 1995.
49. Rosenstiel SF, Baiker MA, Johnston WM: Comparison of glazed and polished dental porcelain. *Int J Prosthodont* 2(6):524-529, 1989.
50. Fairhurst CW, Lockwood PE, Ringle RD, et al: The effect of glaze on porcelain strength. *Dent Mater* 8(3):203-207, 1992.
51. Haywood VB, Heymann HO, Scurria MS: IADR poster No. 2116, Montreal, Canada, March, 1988.
52. Ancowitz S, Torres T, Rostami H: Texturing and polishing. The final attempt at value control. *Dent Clin North Am* 42(4):607-612, 1998.

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