Preparation design and considerations for direct posterior composite inlay/onlay restoration

Jason Fligor[1]

Abstract

In order to ensure a functional, aesthetic, and long-lasting porcelain result, clinicians need to anticipate the strengths and limits of the restorative material, as well as the specific requisites of the presented case. As flaws in preparation design can have significant and detrimental effects on the final result, clinical comprehension of the dimensions and limitations during this step is of utmost importance. This article discusses a case presentation in which porcelain restorations were placed for two adjacent teeth. Although the clinician anticipated placing inlay or onlay restorations, the degree of decay and the location of hairline fractures would necessitate prophylactic removal of a weakened or undermined cusp.

Learning Objectives

This article presents the factors that must be addressed when considering the type of tooth reduction required for contemporary inlay/onlay restoration. Upon reading this article, the reader should:

- Understand the role of correct preparation design on the success of a posterior composite restoration.
- Recognize the preparation sequence associated with successful inlay/onlay restoration.

The long-term success of an indirect posterior restoration is dependent upon many factors. The clinician must first assess the tooth being treated, and then select a restorative material that will provide a durable result, while preserving sound tooth structure wherever possible. Current materials and adhesive techniques have demonstrated predictable, aesthetic results. These bonded restorations, under the proper conditions, will serve patients for many years. Long-term intraoral success and the ability to create conservative preparations make bonded porcelain an ideal restorative material in many situations.[1-3]

[1] *Jason Fligor, DDS*

Corresponding author:
Jason Fligor
Private practice, Seattle, Washington.
4915 25th Ave NE, Suite 107, Seattle, WA 98105
Tel: 206-381-0732
E-mail: drfligor@new32dental.com

Preparation and Convenience Form

Individual preparation design for inlays and onlays can vary greatly, and is dictated by the existing conditions within the tooth being restored. If an area of tooth

Figure 1: Preoperative occlusal view demonstrated the presence of failing amalgam restorations in the posterior region, as well as recurrent decay and multiple fracture lines with staining.

Figure 3: Rubber dam isolation was achieved after preoperative occlusal analyses were performed.

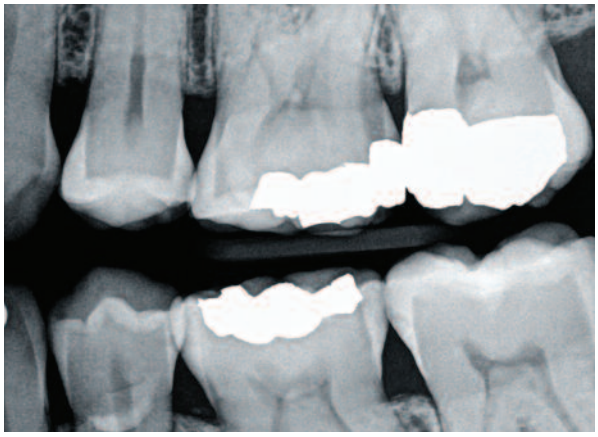

Figure 2: Preoperative radiographic evaluation revealed the depth of the preexisting restorations, with no periapical abscesses or other significant findings.

structure has already fractured, the cause of the fracture must first be determined, and the preparation design may need to be altered in response. The strength of undermined cusps should be considered, and decisions should be made on whether or not to overlay a cusp in porcelain.[4] The strength and limits of the porcelain should be well understood (eg, occlusal clearance, porcelain thickness). It is also valuable to consider how the restoration will be constructed; the preparation requirements for CAD/CAM-generated restorations are slightly different from laboratory-made pressed restorations.[5] While the overall porcelain thickness requirements are essentially the same, CAD/CAM users need to be aware of the shapes and bur limitations in restoration milling.[6] Even the thinnest milling burs available will not be able to mill out very acute angles in the preparation. A laboratory technician will have more success pressing ceramic into tight angles. However, in either case, acute preparation angles should be avoided as the margins will be difficult to finish for the lab tech, the margins will not be accurate in a milled restoration, and both restorations will potentially not seat properly.

When creating porcelain inlay/onlay preparation designs, the clinician should also consider the convenience form, which allows for easy seating, cementing, and finishing of the restoration. The restorative clinician must create a preparation that lends itself to simplified finishing and cement removal, while being careful not to over-prepare the structures. When placing indirect porcelain restorations, the margins should provide easy access for finishing burs and sanding strips.[7] Regardless of the type of adhesive system used, cement cleanup can be a tedious process. If not properly performed, however, patients may return to the office with discomfort, floss shredding, rough edges, and a number of other potential concerns. If special attention is paid to proximal boxes, buccal and lingual clearances, and gingival margins, convenient cement cleanup can be readily achieved; a 1-mm to 1.5-mm clearance is adequate. Tissue management (eg, cord, laser, expanding foam) at the gingival margin will minimize bleeding and allow for a strong adhesive bond and the complete removal of excess cement.[8]

Although in ideal clinical circumstances, preparation margins should be conveniently positioned, decay, existing restorations, and the presence of fractures will determine the final shape of a preparation. Many porcelain restorations will replace failing amalgam restorations. A traditional, interproximal amalgam filling features many undercuts; bonded porcelain restorations should not contain any undercuts, as porcelain will not fill these spaces, and the final outcome will be weaker.[9,10] Unfortunately, existing undercuts will sometimes force the clinician to remove an otherwise sound cusp. Bonded porcelain, however, will restore strength to the tooth and allow maintenance of a thinner cusp if the cusp is nonfunctional.[11] While bonded restorations provide a degree of freedom with the preparation designs, the

Figure 4: Occlusal appearance immediately following removal of the preexisting amalgam restorations.

Figure 5: The preparation design was further refined to ensure complete removal of decay, fractures, and undermined cusps.

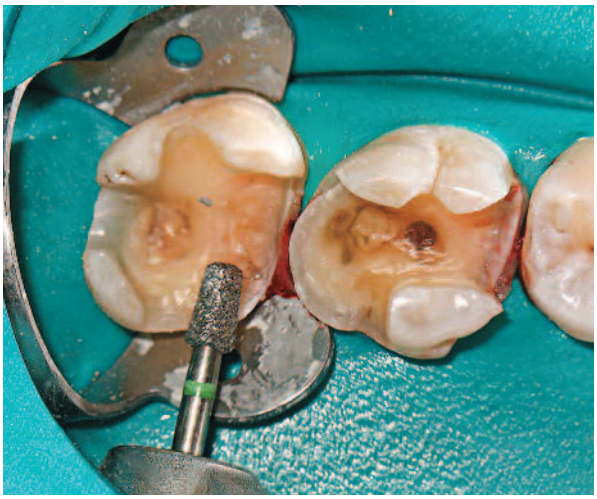

Figure 6: A round-end diamond bur was used to smooth the occlusal anatomy of the preparation.

structural properties of porcelain must be considered.

While generalized preparation designs can be used in most instances, it is important to know the material's preparation requirements for the type of porcelain being used.[12,13] It is the author's opinion that nearly all porcelain failures are due to preparation design. A feathered edge, short butt joint margin, or sharp internal line angles will lead to a sheer fracture. An interproximal box leading to a narrow isthmus width and shallow depth will also cause the porcelain restoration to break. The vast variety of bur shapes and sizes available can assist the clinician in achieving an appropriate depth and width. Although the choice of burs is a personal one, it is important that the clinician fully understand the dimensions and limitations of the burs being used. Mistakes are inevitable. When a porcelain fracture occurs, however, it is prudent to analyze where and why the break occurred. Occlusion, depth of porcelain, and width of porcelain may all be causes to the fracture.[14]

Case Presentation

A 33-year-old female patient presented for routine dental care. Failing amalgam restorations were evident on teeth #14(26) and #15(27), and recurrent decay with multiple stained fracture lines were noted (Figure 1). Radiographic evaluation revealed deep existing restorations with no periapical abscesses or other significant findings (Figure 2). The patient was asymptomatic in both teeth, and porcelain restorations were planned. Although the clinician anticipated the need to place inlay or onlay restorations, the amount of recurrent decay and the location of fractures would necessitate prophylactic removal of a weakened or undermined cusp.[15]

The first step in restoring teeth #14 and #15 was to mark the patient's bite with articulating paper (ie, Accu-film 2, Brazos Valley Dental Supply, Hewitt, TX; Bausch Articulating Silk, Pulpdent Corp, Watertown, MA). Major centric stops and functional movements were noted, and the marks were left on the teeth. Rubber dam placement was facilitated following anesthesia delivery (Figure 3). Using a CAD/CAM system (eg, Cerec, Sirona, Charlotte, NC; e4D, D4D Technologies, Richardson, TX; Lava, 3M ESPE, St. Paul, MN), preoperative images were then

obtained and saved.

Preparation began with the removal of the previous alloy using a carbide bur (eg, H21E, Brasseler USA, Savannah, GA; 557, Dentsply Midwest, York, PA). Following alloy removal, the teeth were evaluated for recurrent decay, fractures, and undermined cusps (Figures 4 and 5). Diamond burs (eg, C1P2, Brasseler, USA, Savannah, GA; C274-016, Axis Dental, Coppell, TX) of varying shapes and sizes were then used to further remove decay and refine the preparations (Figure 6). Once all the decay and fractures were removed, the remaining cusps and tooth structure were examined for potential areas of weakness. Positioning of the cavosurface margins was based on the patient's preoperative occlusal patterns to ensure proper bite maintenance.

The mesiolingual cusp of tooth #15 was severely undermined and had a horizontal fracture line running beneath it. Bonding to this cusp would not provide for a strong, long-term, restoration.[16] The cusp was, therefore, removed, and a broad, flat, butt joint was placed for the porcelain margin. Because the distolingual cusp of tooth #14 remained and could create a challenging spot for a ceramist to press porcelain as well as a difficult spot for the CAD/CAM machine to mill. Either fabrication technique would leave a small finger of porcelain on the lingual that would be very susceptible to fracture either on handling or seating. This cusp was also removed, and a butt margin was prepared.

The preparations were then further refined. Any sharp internal line angles were removed, the pulpal and gingival floors were smoothed, and the buccolingual walls of the proximal boxes were finished with a fine flame-shaped diamond (ie, Axis Dental, Coppell, TX) (Figures 7 and 8). Adequate clearances were created for easy seating and finishing of the margins, and hemostasis was achieved (Figure 9). The preparations were then scanned using the CAD/CAM system, and the restorations were milled using an A2 shade block (eg, IPS.CAD, Ivoclar Vivadent, Amherst, NY; Wide YZ Cube, Vident, Brea CA; Paradigm, MZ100, 3M ESPE, St. Paul, MN).

Both restorations were milled and tried in together (Figure 10). It should be noted that the CAD/CAM system was operated in "correlation mode," which copied the

Figure 7: A flame shaped bur was used to create proper marginal anatomy on the pulpal and gingival floors.

Figure 8: The buccolingual walls of the proximal boxes were then finished to ensure proper retention and seating.

Figure 9: Following refinement of the dentinal walls, adequate clearances were formed and the margins were finished.

Figure 10: The restorations were tried in to verify correct fit and position prior to cementation.

Figure 11: The restorations were simultaneously seated following application of a dual-cured cement material.

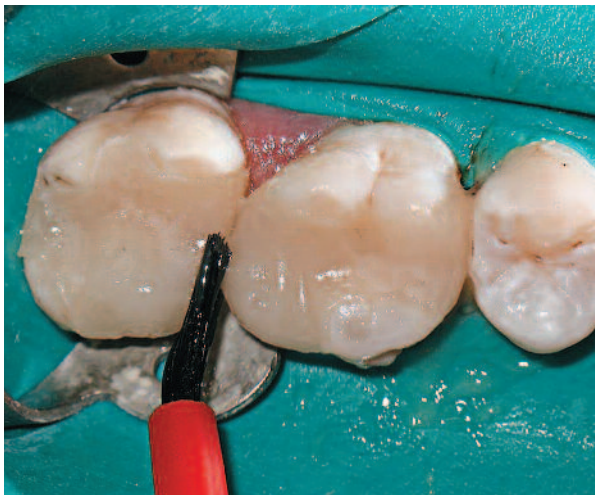

Figure 12: Gross cement removal was accomplished using multiple applicators and brushes to minimize tissue trauma and bleeding.

patient's existing bite. As a result, there was no need to create any additional occlusal anatomy. Adjustments were made to the interproximal contacts where needed. Once the fit was deemed satisfactory, the restorations were prepared for cementation based on the manufacturer's instructions. The teeth were prepared for bonding using a total-etch technique.[17] A dual-cure cement (eg, Variolink II, Ivoclar Vivadent, Amherst, NY; Calibra, Dentsply International, York, PA; RelyX, 3M ESPE, St. Paul, MN) was placed in the preparations, and both restorations were seated simultaneously. The clinician evaluated the restorations to ensure cement was expelled out from all margins, to ensure they were seated completely (Figure 11).[18]

Gross cement removal was accomplished using multiple applicators (eg, Benda Brushes, Centrix, Shelton, CT; Rubber tip stimulator, Butler/Sunstar Americas, Chicago, IL) (Figures12 and 13). These tools effectively cleaned away cement without causing tissue trauma or bleeding. The restorations were spot-tack cured into place and excess cement was removed from the interproximal regions using dental floss. Once all excess cement was removed, the restorations were cured for a total of 30 seconds (ie, 10 seconds for the occlusal, buccal, and lingual aspects, respectively) (Figure 14).

Following the final cure, the margins were finished with fine flame- and football-shaped burs. The interproximal areas were flossed a final time and polished with fine, diamond, sanding strips (Figure 15). Clincial and radiographic evaluation took place to ensure a seamless bond and complete seating (Figures 16 and 17). The rubber dam was removed and the patient's occlusion was adjusted. A three-step polishing system (eg, Cera-glaze, Axis Dental, Coppell, TX; Enhance Pogo, Dentsply Caulk, Milford, DE) was used to apply the final polish to the restorations (Figure 18).

Conclusion

This case demonstrated the effective use of indirect, bonded porcelain in achieving lasting, aesthetic restorations. Because the requisites of porcelain were considered during preparation, the final restoration was durable, functional, and will serve the patient for many

years. Proper bonding procedures and cement removal also contributed to the long-term success of the restoration, tissue health, aesthetics, and overall patient satisfaction. As materials continue to evolve, clinicians will be able to enjoy more options, in regard to both tools and techniques, and the freedom to restore each tooth in the most appropriate manner.

The author declares no financial interest in any of the products cited herein.

Reprinted with permission courtesy of Montage Media Corporation © 2008. Fligor J. Preparation design and considerations for direct posterior composite inlay/onlay restoration. Practical Procedures & Aesthetic Dentistry 2008;20(7):413-419.

References

1. Frankenberger R, Petschelt A, Krämer N. Leucite-reinforced glass ceramic inlays and onlays after six years: Clinical behavior. Oper Dent 2000;25(6):459–465.

2. Reis B, Walther W. Clinical long term results and 10 year Kaplan-Meier estimation of computer-aided machined CEREC restorations. Int J Comput Dent 2000;3(1):9-23.

3. Reich SM, Wichmann M, Rinne H, Shortall A. Clinical performance of large, all-ceramic CAD/CAM-generated restorations after three years: A pilot study. J Am Dent Assoc 2004;135(5):605-612.

4. Shillingburg HT, Hobo S, Whitsett LD. Preparations for intra-coronal restorations. In: Hobo S, Whitsett L, Jacobi R, et al. Fundamentals of Fixed Prosthodontics. 2nd ed. Hanover Park, IL: Quintessence Publishing; 1981.

5. Puri, S. Predictable preparation, staining, and cementation procedures for chairside CAD/CAM dentistry. Prac Proced Aesthet Dent 2008;20(4):209-214.

6. Sato K, Matsumura H, Atsuta M. Relation between cavity design and marginal adaptation in machine-milled ceramic restorative system. J Oral Rehabil 2002;29(1):24-27.

7. Rosentritt M, Behr M, Lang R, Handel G. Influence of cement type on the marginal adaptation of all-ceramic MOD inlays. Dent Mater 2004;20(5):463-469.

Figure 13: A rubber tip stimulator (ie, Butler Gum, Sunstar Americas, Chicago, IL) was employed to remove residual interproximal cement.

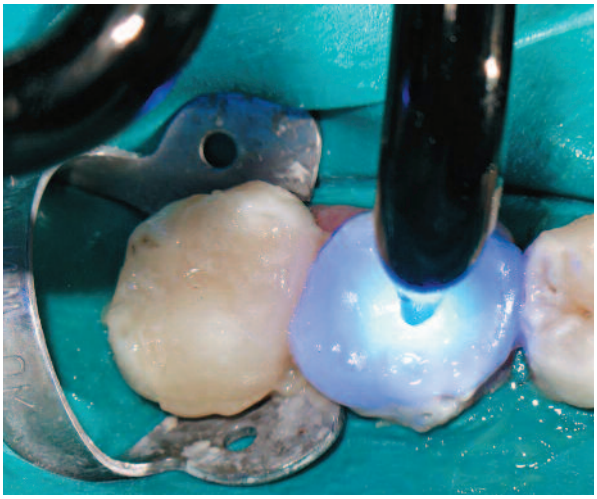

Figure 14: The restorations were tack cured into place to allow final finishing and polishing without jeopardizing the final seat. --

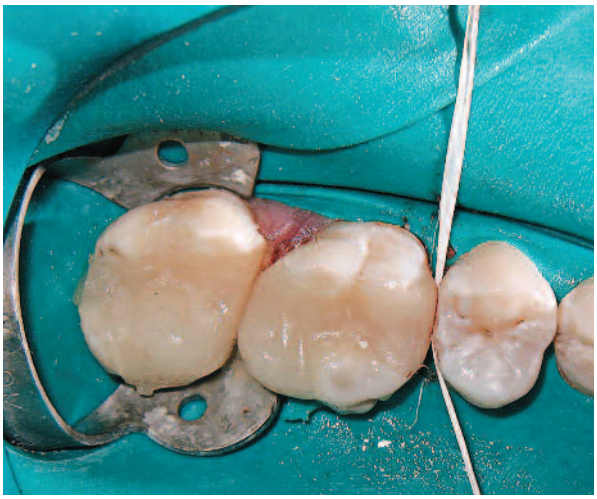

Figure 15: Interproximal cement removal was then finalized using interdental floss to ensure a smooth finish and functional contacts.

Figure 16: The restorations were subsequently cured on the occlusal, buccal, and lingual aspects,. Development of additional occlusal anatomy was not necessary prior to polishing.

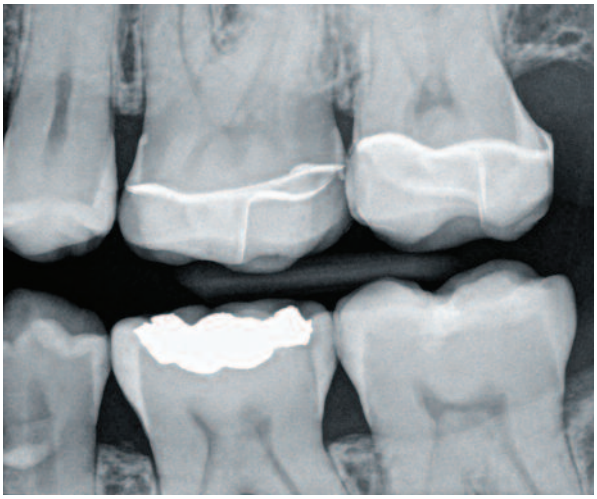

Figure 17: Postoperative radiographic evaluation confirmed the porcelain bond and seating.

Figure 18: Postoperative appearance of the polished restorations demonstrates enhanced aesthetics and optimal integration with the surrounding tissues.

8. Meerbeek B. Mechanisms of resin adhesion: Dentin and enamel bonding. Func Esthet and Restor Dent 2008;2(1):18-25.

9. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for posterior teeth. Int J Periodont Rest Dent 2002;22(3):241-249.

10. Hickel R, Manhart J. Longevity of restorations in posterior teeth and reasons for failure. J Adhes Dent 2001;3(1):45-64.

11. Broderson SP. Complete crown and partial coverage tooth preparation designs for bonded cast ceramic restorations. Quint Int 1994;25(8):535-539.

12. Magne P, Belser UC. Porcelain versus composite inlays/onlays: Effects of mechanical loads on stress distribution, adhesion, and crown flexure. Int J Periodont Rest Dent 2003;23(6):543-555.

13. Conrad HJ, Seong WJ, Pesun IJ. Current ceramic materials and systems with clinical recommendations: A systematic review. J Prosthet Dent 2007;98(5):389-404.

14. Shirai K, De Munck J, Yoshida Y, et al. Effect of cavity configuration and aging on the bonding effectiveness of six adhesives to dentin. Dent Mater 2005;21(2):110-124.

15. Spreafico R. Direct vs. semidirect vs. indirect restorations: Establishing criteria for clinical decision making [interview]. In: Sadan A, ed. Quintessence of Dental Technology 2003. Hanover Park, IL: Quintessence Publishing; 2003.

16. Fasbinder DJ. Clinical performance of chairside CAD/CAM restorations. J Am Dent Assoc 2006;137 (suppl):22S-31S.

17. Gemalmaz D, Ozcan M, Alkumru HN. A clinical evaluation of ceramic inlays bonded with different luting agents. J Adhes Dent 2001;3(3):273–283.

18. Sjögren G, Molin M, van Dijken JW. A 5-year clinical evaluation of ceramic inlays (Cerec) cemented with a dual-cured or chemically cured resin composite luting agent. Acta Odontol Scand 1998;56(5):263–267.