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Repairing Porcelain-Metal Restorations with Composite Resin

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COURSE OBJECTIVES

At the completion of this program the participant: will be able to:

- describe the indications for crown and bridge repair
- list materials and techniques that can be used to adhere to exposed metal of a fractured porcelain-metal restoration
- list the materials and techniques that can be used to adhere to fractured porcelain of a porcelain-metal restoration
- describe the techniques for crown and bridge repair with direct composite resin

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WHY TAKE THIS COURSE?

The use of porcelain-metal and all-ceramic restorations to restore teeth that have had many restorations over the patient's lifetime is a routine procedure. Learn about the materials and techniques you can use for aesthetic management of these restorations.

PATIENT CARE—While repairs can be durable, the patient needs to understand all the implications of treatment before committing to the intraoral repair.

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CUT ALONG DOTTED LINE

Our increasing population of older individuals is comprised of patients who have received extensive, comprehensive dental care. ey grew up in an era of non- uoridation which has lead to numerous restorations. at, and the combined advances and successes of periodontal and endodontic treatment, have allowed our patients to keep there teeth longer. Practitioners are seeing more patients without missing teeth who are educated to the value of treatment to maintain an intact dentition. With this in mind, the use of porcelain-metal and all-ceramic restorations to restore teeth that have had many restorations over the patient's lifetime is a routine procedure.

With the increased usage of crowns and xed partial dentures, the clinician is faced with the dilemma of the aesthetic management of these restorations. Porcelain is an inherently brittle material. Over time, the fatigue and catastrophic accidents can create stresses that lead to porcelain fracture. When a porcelain-metal restoration or an all-ceramic restoration fractures in normal function or due to trauma, some patients cannot a ord replacement of the restoration and seek some form of maintenance and repair. In some cases, the desire to repair xed prosthodontic restorations is a personal one. When a xed partial denture replaces many teeth, the patient may not want to undergo the complicated procedure of removing the defective restoration. ey may also forego subsequent treatment visits to include a new provisional restoration with the use of local anesthetic, followed by an impression that requires gingival retraction procedures that will leave the so tissue uncomfortable for days. Future visits include the metal framework try-in, porcelain try-in and adjustment and cementation. For some patients, a less durable procedure with fewer dental appointments is a way to x the problem, or at least provide a temporary x without having to undergo the number of visits and levels of discomfort they had in the past.

PORCELAIN AND COMPOSITE RESIN FRACTURES:

Ceramic, porcelain-metal and the newer bonded -to-metal composite resin restorations may need repair due to fractures of the substrates or wear of the veneering materials. Metal, ceramic and composites undergo stress fatigue due to occlusal and functional forces over time. In the case of ceramics and composites, they are inherently brittle materials. Once a crack initiates in the surface, it will propagate until the restorative material breaks away from the tooth or metal understructure.[1] Fixed prosthodontic restorations can also fracture due to trauma, carelessness or hard substrates within food bitten on by the patient, e.g., biting a pen or pencil or food having a hard foreign object, and parafunctional grinding habits.[2,3] In some cases, the reason for restoration fracture may be due to poor and inadequate laboratory techniques during fabrication of the restoration. ere may be poor metal design by the laboratory of the coping or bridge substructure leaving unsupported porcelain or inadequate porcelain over the metal substructure. Metal may be incompletely or improperly prepared for bonding porcelain to the metal or the ceramic may be red too many times during restoration fabrication, creating a weakened ceramic structure.[4] While laboratory errors can contribute to porcelain fractures, the challenge of the practitioner is to provide the laboratory with an impression of adequately prepared teeth so that a proper metal coping can be fabricated. Sometimes, the practitioner does not adequately reduce a tooth for ceramic or ceramic-metal restorations. is can lead to poor metal design, or for an all-ceramic crown, insu cient porcelain thickness that will be subject to fracture in normal function.

TREATMENT PLANNING

When a porcelain-metal or all-ceramic restoration fractures, the patient will frequently either call the dental office or show up as a walk-in emergency. Ozcan and coworkers reported on the reasons and locations of metal ceramic restoration fractures.[5] Of 153 patients with 289 fractured porcelain-metal restorations, 255 of the fractures were on fixed partial dentures and 34 on single crowns. Meanwhile 65% of the fractures were in the anterior region; 60% were on facial surfaces including a cusp or incisal edge; 27% at the buccal gingival area; 5% incisal edge only; and 8% involving occlusal porcelain. The fractures were predominantly in the maxillary arch (75%), predominantly on the facial surface. Implant-supported, porcelain-metal prostheses are at a greater risk of porcelain fracture when the opposing occlusion is another implant supported restoration.[6] It was recommended that patients with a history of occlusal parafunctional habits have occlusal appliances fabricated to protect the restorations.

Whenever a patient presents with porcelain fracture of a porcelain-metal or all-ceramic restoration


FIG. 1


FIG. 2


FIG. 3A


FIG. 3B

Figure 1: Fractured marginal ridge on a porcelain-metal crown. **Figure 2:** Fractured facial surface of a porcelain-metal crown abutment of a four-unit fixed partial denture exposing the metal understructure. **Figure 3A:** Preoperative view of fractured porcelain on pontic of 3-unit bridge. **Figure 3B:** Note the lack of occlusal clearance.

single-crown or multiple-unit xed partial denture, the patient should be told that the most predictable outcome would be replacement of the fractured restoration.[7, 8] Replacement allows the clinician to control all factors that will contribute to restoration success, tooth preparation, occlusion, gingival health, laboratory fabrication (you have a history with your dental laboratory), and cementation. If the porcelain fracture is small and not in the esthetic zone, polishing the porcelain to remove rough edges so the patient is comfortable, is the next best choice.[3, 7, 9] Fractured porcelain for a single crown, in this author's opinion, should lead to a treatment plan for a new replacement crown. For the emergency for that day, fabrication of a new provisional restoration is the best course of treatment. For multi-unit xed partial dentures, the decision to replace the entire restoration is a more involved one. As earlier stated, multiple-unit xed partial dentures are expensive restorations to replace, and are more complex from a clinical standpoint.[10] In Ozcan's study of repairing anterior and posterior fractures of porcelain with adhesive composite resin, repairs of fractures of porcelain in the posterior region are less successful than anterior repairs. [5] If a patient has a fracture of occlusal porcelain or a proximal marginal ridge, which also includes the proximal contact, replacement of the restoration is the best choice. (Figure 1) Occlusal fractures are usually due to thin porcelain, and any repair will also be too thin to withstand occlusal forces. For posterior teeth, in these circumstances, polishing the porcelain or replacement is the best solution. In some cases, porcelain fractures leaving a signi cant surface of metal exposed are di - cult to achieve predictable repair. (Figure 2) Anterior repairs with an adhesive composite resin are more predictable for success if occlusion and adequate surface area for retention of the repair is achieved.[3,5,6]

When a patient presents with a fractured restoration the clinician needs to evaluate the reparability of the restoration and the cause of the fracture. (9, 11) If the cause of the fracture is a single traumatic event, the decision to repair or replace the restoration is very straightforward. Many times, the fracture is due to stresses over long periods of time. Higher success with composite resin repairs of porcelain-metal restorations will occur if there is control of opposing occlusion to minimize stresses on the porcelain repair, the repair is on surfaces not subject to shear stresses, the restoration has intact margins and the preparation of the site to accomplish the repair does not weaken the entire restoration, leading to other problems, e.g, preparation of an abutment crown for a porcelain repair will not weaken the connector of a xed partial denture.

Patients must be part of the decision-making process. As stated earlier, the patient must understand that when porcelain has fractured, the best course of treatment is the remake of the restoration. If the fracture is small, and can be managed esthetically and functionally by minor recontouring and polishing with abrasives, this is the next best choice for treatment. If the restoration is in the esthetic zone, repair of the fracture would be a third choice. Through informed consent, the patient should be told of the limited durability of the repair when compared to restoration replacement. These choices must be noted in the patient record. For the patients on which I have done porcelain repair, I always remind them, during subsequent recall appointments,of the status of the repair: how long it has been in place and expected continued longevity, before the need for remaking the restoration or remaking the repair. Anterior repairs will have greater success and longevity than posterior repairs.

While porcelain repair with direct placement composite resin for small fractured areas is the most com-


FIG. 4


FIG. 5A


FIG. 5B

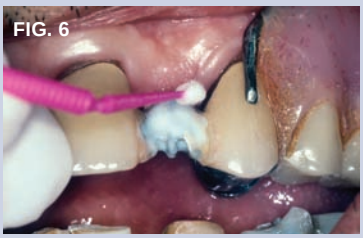
FIG. 6


FIG. 7


FIG. 8

Figure 4: The mandibular canine has been recontoured to provide for adequate occlusal clearance for the composite resin repair. **Figure 5:** Preparation of the exposed metal creating undercuts in the metal. A. Facial view B. Incisal view **Figure 6:** Application of GoldLink 2 metal bonding agent. **Figure 7:** Application of TetraPaque resin opaquer. **Figure 8:** Use of dead soft metal matrix on gingival area of pontic to shape the composite resin repair.

mon method for repair, there are other techniques that have been described. For more extensive repairs, the practitioner may choose repairing the restoration using a laboratory-fabricated porcelain veneer or a porcelain-metal overlay crown.(7)

SURFACE TREATMENTS OF METAL AND PORCELAIN FOR REPAIR:

Di erent surface treatments will be necessary to establish a bond between the existing crown or bridge and the type of repair material being used. ese di erent treatments depend on the size and type of fracture, and whether or not the repair is bonding to metal, metal/porcelain, or porcelain.

CHEMICAL METAL BONDING:

Over the years laboratories have used a wide variety of cast metals to fabricate crowns and xed partial dentures. ese metals may have a high gold (noble) content or be a base metal with high concentrations of nickel and chrome with no noble alloy present. It is almost impossible to know which metal has been used in an existing restoration that needs a repair. Chemically adhering to metal substrates with composite resin has been investigated. A research project tested a metal bonding agent, GoldLink (Den-Mat, Santa Maria, CA) for bonding to ve di erent metal substrates, including a high noble alloy, a three different palladium alloys and a base metal alloy.(12) e ndings indicated that GoldLink was able to adhere to all metal substrates. A 4-Meta-containing metal adhesive, C&B Metabond (Parkell, Farmingdale, NY) has been well investigated and has been demonstrated to adhere to all types of metal alloys as well.(13-15) e use of a phosphate ester containing composite resin, Panavia (Kuraray, CA) has been shown to bond to base metal. Newer metal bonding agents such as M-Bond (J. Morita, Irvine, CA), Metal Primer II (GC America, Alsip, IL), MonoBond Plus (Ivoclar Vivadent, Amherst, NY) and Z-Prime (Bisco, Schaumburg, IL) have been introduced.

CHEMICAL PORCELAIN BONDING:

Dental porcelains are chemically very similar. The ability to adhere composite resin to porcelain is based upon the chemical coupling agent, silane, used to surface treat glass particles used as fillers in composite resins.(16) Investigations of porcelain-silane bonding with a variety of porcelain repair agents have been reported.(16-20) Shear bond strengths of composite resin to silane-treated porcelain in laboratory studies has exceeded the cohesive strength of porcelain.(21) Silane coupling agents are also referred to a ceramic primers. They include Silane Bond Enhancer (Pulpdent), Silane Coupling Agent (Dentsply Caulk), Versa Link Silane Porcelain Bonding and Repair (Ivoclar Vivadent), CerinateP-rime (Den-Mat, Santa Maria, CA), Clearfil Porcelain Bond (Kuraray, New York, NY) and Rely-X Ceramic Primer (3M-ESPE, Maplewood, MN). Other manufacturers provide silane in their porcelain veneer cementation kits.

SURFACE ROUGHENING OF METAL AND PORCELAIN:

Surface treatments of metal and porcelain with air abrasion to microscopically roughen the surfaces to be repaired is beneficial.[19, 22-24] Relatively inexpensive air abrasion units, microetchers (Mini Etcher II, Danville Engineering, San Ramon, CA; MiniEtcher, DenMat, Santa Maria, CA) can be used to create high-velocity stream of aluminum oxide particles that microscopically roughen both metal and ceramic surfaces to prepare them for bonding. Recently introduced was an air abrasion unit that can be used for crown and bridge repair and for tooth preparation for preventive resin restorations that is significantly less expensive than large stand-alone air abrasion cavity preparation units. The RONDOflex (Kavo, Lake Zurich, IL) fits on the Kavo coupler for their high speed handpiece and is a multiuse instrument. In the past, all air abrasive particles functioned similarly. Some recent research has shown that a unique particle for air abrasion, CoJet (3M-ESPE, Maplewood, MN), containing a silanized silica coating on aluminum oxide particles, leaves a coating of silica on both metal and ceramic surfaces that enhances the bond of the repair using composite resin.[25]

Another method to microscopically roughen porcelain to enhance micromechanical retention of composite resin to porcelain is to etch the porcelain with either hydro uoric acid[11, 24-28] or 1.23% acidulated phosphate uoride.[11, 28] Hydro uoric acid (HF) is a very caustic chemical and should be used carefully in the oral cavity. When used, the so tissues adjacent to the restoration being treated must be protected and isolated with either a dental dam or a light-cured resin-based paste. Typically, intraoral-use hydro uoric acids are of low concentration in the 6%-10% range and in a gel formulation to allow for controlled placement. Typical etching of porcelain with an intraoral hydro uoric acid gel is 30 seconds to 10 minutes, depending on the type of porcelain being etched.[11] During etching, it is important to keep the surface being etched moist with gel over the time of etching. When using 1.23% acidulated phosphate uoride the etching time is 5-15 minutes. e main advantage of acidulated phosphate uoride is that this acid agent is safe to the oral tissues.[11] A comparison of HF etching to air abrasion of porcelain has shown that air abrasion provides an equivalent adhesion for a porcelain repair. Also, the use of air abrasion is considered safer to the so tissue, hence the recommendation for a barrier protection to the gingival tissues when using a porcelain HF etchant.[11] With the use of diamonds and burs, metal and porcelain can be roughened to enhance bonding. It is important that whenever porcelain is prepared with a diamond abrasive, copious water spray is used to cool the diamond. If the diamond heats the porcelain, it can cause heat-checking of the porcelain which initiates microcracks in the ceramic surface that can lead to further fractures of the porcelain. When preparing the fracture site for composite resin repair, it is important the site be enlarged by at least three to four times the original fracture surface area.[4] is increased surface area is critical for a more predictable, longer-lasting repair. In the case of repairing only metal, composite resin retention can be enhanced further by creating mechanical undercuts in the metal. Because adhesives are used to seal the composite resin repair, these undercuts can perforate through the metal portion of the crown into the tooth without any ill e ects. A new class of burs has been designed to cut even the hardest of crown and bridge

Figure 9: Placement of nanohybrid composite resin.
Figure 10: Completed composite resin repair of the lateral incisor
Figure 11: Fractured incisal edge of pontic of 8-unit fixed partial denture.


FIG. 9


FIG. 10


FIG. 11


FIG. 12


FIG. 13


FIG. 14


FIG. 15

Figure 12: Etching the porcelain with a 1.23% acidulated phosphate fluoride gel for 10 minutes total.
Figure 13: Etched porcelain surface. Note the amount of porcelain preparation to assure retention of the repair.
Figure 14: Application of adhesive.
Figure 15: Completed porcelain repair with nanohybrid composite resin.

metals. ese metal cutting burs include the Great White series (SS White Burs, Lakewood, N.J. and e-cutters (Brasseler USA, Savannah, GA).

CASE REPORT 1:

The patient presented with a 3-unit porcelain-metal fixed partial denture that included a maxillary central incisor and canine abutment with a lateral incisor pontic that had been fabricated 18 months previously. Four months ago, porcelain fractured from the lateral incisor leaving the metal exposed. A composite resin repair had been attempted, but at this visit, it had fractured away. The canine of the bridge was an abutment for a clasp and rest seat for a partial denture fabricated after the bridge was cemented. Refabrication of the fixed partial denture would have led to the remake of the removable partial denture. The patient was on a fixed income and wanted to have the repair attempted again.

Evaluation of the site revealed a very tight occlusion that had contributed to the porcelain fracture and the subsequent composite resin repair fracture. (Figure 3) e opposing mandibular canine was reshaped to allow for adequate room for a composite resin repair of the fractured site.(Figure 4) When the last repair was attempted, very little had been done to enhance retention of the composite resin to the metal. Without weakening the connectors of the xed bridge, metal was air abraded with CoJet Sand (3M-ESPE, Maplewood, MN) using a Minietcher (Den-Mat, Santa Maria, CA). e air abrasion particles can be problematic and need to be suctioned when using the air abrasion unit. A unique air abrasion particle suctioning device (SandTrap, Clinician's Choice Dental Products, New Milford, CT) minimizes the amount of abrasive that gets in the patient's mouth and on the instruments, countertops and any other devices in the operatory even when using a high-speed evacuator.

e tip of the MiniEtcher is inserted and oriented to the surface being abraded within the SandTrap, while another ori ce in the SandTrap had a saliva ejector attached to evacuate the particles. Additional retention was developed in the metal by placing undercuts in the incisal areas of the metal pontic, using a Great White #1 metal cutting bur (SS White Burs, Lakewood, NJ). (Figure 5)

One problem frequently seen when doing repairs of exposed metal is how to avoid a graying out of the composite resin repair. is is best accomplished by using a composite resin opaquer that can mask the metal in a thinness that helps avoid overbulking of the composite resin repair. Most opaquers need a thickness of at least ½ millimeter to adequately opaque metal. A study investigated the masking e ectiveness of 57 di erent resin color modi ers or opaquers.[29] By placing the di erent opaquers over a gray metal they could measure thickness required to adequately opaque the metal. One opaquer tested, TetraPaque (Den-Mat, Santa Maria, CA), was able to opaque the metal with excellent masking ability with a thinness of less than 0.2 mm.

e air-abraded porcelain and metal was cleaned with a phosphoric acid etchant for 10 seconds, rinsed and dried from the surface. e phosphoric acid does

not etch the porcelain surface, but leaves residual hydrogen ions that enhance silane porcelain primer bonding. A silane porcelain primer was applied to all exposed porcelain surfaces with a BendaBrush (Centrix, Shelton, CT) for 30 seconds and dried from the surface. e air-abraded and prepared metal was covered with an opaque metal adhesive bonding agent, e.g., (GoldLink 2, Den-Mat, Santa Maria, CA or CB Metabond, Parkell, Farmingdale, NY) (Figure 6) and a resin opaque, e.g., Kolor Plus Opaquer Shade A3 (Kerr, Orange, CA) or TetraPaque, (Den-Mat, Santa Maria, CA) using a BendaBrush Micro (Centrix, Shelton, CT).(Figure 7) e surfaces were light cured with a high power quartz halogen curing light (Optilux 501, Ker,, Orange, CA) for 10 seconds.

For this case, another challenge was creating the tissue surface side of the pontic when repairing it with composite resin. To control the contour of the pontic adjacent to the gingival tissue, a dead so stainless steel matrix strip (Den-Mat, Santa Maria, CA or Pulpdent, Watertown, MA) was cut to form a trapezoidal shape. is trapezoidal shape is perfect for adapting the matrix under the pontic and into the embrasure spaces. e narrow portion of the trapezoid is slid from facial to lingual under the pontic. e wider wings of the trapezoid are then stabilized into the gingival embrasures with wooden wedges.(Figure 8) e composite resin was placed on the facial surface being certain the metal was opaque.(Figure 9) If there is shine through, a more opaque composite may be needed. e completed restoration utilizing a nanohybrid composite resin was esthetically acceptable and was able to match the appearance of the glazed porcelain on the adjacent teeth. (Figure 10) e composite resin was nished and polished using nishing burs (ET burs, Brasseler USA, Savannah, GA) followed by a silicone abrasive points and cups (Enhance Finishers, fDentsply Caulk, Milford, DE) and composite resin polishing disks (So ex Disks, 3M-ESPE, Maplewood, MN). At three years the restoration was still functioning acceptably.

CASE REPORT 2:

A 68-year-old male patient presented with a fractured porcelain-metal 8-unit xed partial denture on the pontic of tooth #9. (Figure 11) When presented the treatment choice of remaking the xed partial denture, which was highly recommended due to age of restoration (15 years), presence of recession and intact margins, the patient requested a second alternative- a composite resin repair. e fracture site was prepared, creating additional surface area (3 times greater) than the fracture site on the facial and lingual surface using a medium grit diamond with a high-speed handpiece with water spray. To create additional retention to the site, the porcelain was etched with 1.23% acidulated phosphate uoride (Nupro topical APF gel, Dentsply, York, PA) for 5 minutes, rinsed from the porcelain, dried and reapplied. (Figure 12) ere was no need for a so tissue barrier to protect the gingival during the etching process with the uoride gel. e gel was rinsed from the porcelain again and dried. e etched porcelain had a dull appearance. (Figure 13) e porcelain was treated with a silane for 30 seconds and air dried. An adhesive resin (Prime and Bond NT, Dentsply Caulk) was painted on the etched porcelain surface, air thinned and light cured for ten seconds on the facial surface and 10 seconds on the lingual surface.(Figure 14) e porcelain fracture site was then restored with a nanohybrid composite resin (Filtek Supreme Plus, 3M-ESPE). (Figure 15)

CONCLUSION:

In the past, crown and bridge repair was not very successful. With the latest technologies of air abrasion, porcelain and metal bonding agents, the durability of porcelain repair is more predictable.[30] While repairs can be durable, the patient needs to understand all the implications of treatment before committing to the intraoral repair of fractured porcelain, knowing that, in most circumstances, remaking the crown or xed partial denture is the better choice. For this article, two di erent techniques for roughening of the porcelain and metal to create micromechanical retention were presented (air abrasion and porcelain etching). As part of the treatment planning process, the clinician should evaluate the reason for the porcelain fracture. If occlusion contributed to the fracture, it may be necessary to evaluate and adjust the occlusion in all dynamic movements to minimize the risk of fracture of the composite repair.

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TEST QUESTIONS

1. Typically, when porcelain fractures from a porcelain metal crown or bridge, the reason is

a. Exposure to hot and cold beverages and food have a cumulative e ect on porcelain fracture.
b. Fatigue and/or traumatic fracture of the restoration. ***
c. e reasons for porcelain fracture are not known.
d. None of the above.

2. According to this article, when porcelain fractures, some patients cannot a ord to replace the restoration. In some cases, the patient may not want to undergo the extensive and complicated procedures of removing the defective restoration, and then subsequent treatment visits for the fabrication and cementation of the restoration.

a. Both statements are true.
b. e rst statement is true, the second is false.
c. Both statements are false.
d. e rst statement is false, the second is true.

3. Porcelain is an inherently brittle material. Once a crack initiates in the surface of the porcelain

a. If not stressed again, the crack with self-heal.
b. It will spread along the surface but will not cause further problems.
c. It will propagate until the restorative material breaks away from the tooth or metal understructure.
d. It should be polished to heal the crack.

4. Reasons for porcelain fracture in crowns and bridges can be due to

a. Trauma when a patient falls and the crown hits a hard object.
b. e patient biting on hard substances, like a pen or pencil.
c. Poor metal design by the laboratory technician for a porcelain-metal restoration
d. Parafunctional grinding habits.
e. All the above can contribute to porcelain fracture.

5. According to this article, the options that should be o ered to a patient to repair a porcelain-metal xed partial denture (bridge) to obtain the most predictable outcome would be to replace the restoration, for small fractures polishing the porcelain to remove rough edges, and for anterior fractures in the esthetic zone a porcelain repair. is article recommends that when porcelain fractures on a single crown, the best option is replacement of the crown.

a. Both statements are true.
b. e rst statement is true, the second is false.
c. Both statements are false.
d. e rst statement is false, the second is true.

CUT ALONG DOTTED LINE

6. In this article, a clinical study by Ozcan evaluating porcelain repair reported that
a. No porcelain fractures were seen, porcelain fractures are a very rare event.
b. When porcelain repairs are done in the posterior and anterior region, the repairs in the posterior region are less successful than anterior repairs.
c. Porcelain fractures were only seen in the anterior region.
d. Porcelain fractures were only seen in the posterior region.

7. When porcelain fractures are seen on occlusal surfaces of posterior teeth it is usually due to
a. A traumatic fall or automobile accident.
b. Poor restoration design leading to thin porcelain on the occlusal surface.
c. Porcelain fractures on the occlusal surface are never seen.
d. Fracture of the facial or lingual porcelain that pulls the occlusal porcelain o the restoration.

8. Repairing porcelain-metal restorations with composite resin requires surface treatment that will help create a bond between the existing crown or bridge and the repair material being used. ese di erent treatments depend on the size and type of fracture and whether or not the repair is bonding to metal, metal/porcelain, or porcelain.
a. Both statements are true.
b. e rst statement is true, the second is false.
c. Both statements are false.
d. e rst statement is false, the second is true.

9. Chemical bonding to metal is
a. Not possible.
b. Is not a recommended procedure when doing crown and bridge repair.
c. Uses specialized chemical metal bonding agents to adhere composite resin to metal.
d. Will not work unless porcelain is bonded to as well.

10. Chemical bonding to porcelain
a. Is a process using specialized chemical porclein bonding agents to adhere composite resin to porcelain.
b. Is not possible.
c. Is not a recommended procedure when doing crown and bridge repair.
d. Will not work unless metal is bonded to it as well.

11. e chemical bonding agent for porcelain is a
a. Polyvinyl siloxane
b. Hydrogenated ester
c. Silane.
d. Sodium uoride.

12. Microscopically roughening the surface of porcelain can be done
a. Using a paint-on resin gel.
b. Using a intraoral-use hydro uoric acid gel.
c. Using an air abrasion unit.
d. Both b and c.

13. Porcelain can be etched to make it microscopically rough and retentive with a
a. Hydro uoric acid gel
b. Phosphoric acid
c. Lactic acid
d. Acidulated phosphate uoride.
e. Both a and d.

14. When using hydro uoric acid to treat porcelain it is advised in this article to protect the gingival tissues adjacent to repair site with all the following EXCEPT
a. Petroleum jelly.
b. Dental/rubber dam
c. Paint-on light cured resin paste.

15. Typically hydro uoric acid used intraorally is a concentration in the range of _____ and in a gel formulation to allow for controlled placement.
a. 1-2%
b. 6-10%
c. 35-50%
d. 65-85%

16. When repairing porcelain according to this article, the fracture site must be
a. Polished before starting
b. Covered with a resin adhesive to initiate the procedure.
c. Prepared so the site is enlarged by at least three to four times the original surface fracture.
d. Nothing needs to be done to the site, just do the repair.

17. When repairing only metal for a porcelain-metal restoration, this article recommends that retention be enhanced by creating mechanical undercuts in the metal. Because adhesives are used to seal the composite resin repair, these undercuts can perforate through the metal portion of the crown into the tooth without any ill e ects.
a. Both statements are true.
b. e rst statement is true, the second statement is false.
c. Both statements are false.
d. e rst statement is false, the second statement is true.

18. A unique air abrasion particle suctioning device that minimizes the amount of abrasive that gets in the patient's mouth is named
a. SuctionHog
b. SandTrap
c. Instant Powder-away
d. ere is no such device.

19. In this article, for the rst described case of porcelain repair, the management of the contour of the pontic adjacent to the so tissue was accomplished using a
a. Mymar matrix strip cut in an elliptical shape.
b. dead so stainless steel matrix strip cut to form a trapezoidal shape.
c. A piece of rubber dam shaped like a ve-pointed star.
d. Flowable composite syringed into the space but not light cured.

20. As described in the conclusion of this article, while repairs can be durable, the patient needs to understand all the implications of treatment before committing to the intraoral repair of fractured porcelain and that, in most circumstances, remaking the crown or xed partial denture is the better choice. For patients that demand a single crown with fractured porcelain be repaired, the patient should be told this is the best and most predictable option.
a. Both statements are true.
b. e rst statement is true, the second is false.
c. Both statements are false.
d. e rst statement is false, the second is true.

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ANSWER KEY

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