

A review of 243 errors possible during the fabrication of a removable partial denture: Part I

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Everyone who participates in any step of the fabrication of a removable partial denture must share in the success or failure of the restoration. Some seemingly innocuous deviations can be accumulative and cause serious problems, so everyone should review the procedures that they use on a regular basis. Parts I through III of this article present a personal and generic (but by no means comprehensive) list of errors that can occur when a removable partial denture is fabricated. Results that can be attributed to these errors are identified, and a possible solution for each error is described. This information is useful to the entire dental team: the dentist, dental assistant, office manager, and dental technician. The articles also include 18 notes that may be beneficial to personnel in the office and/or in the laboratory. (J Prosthet Dent 2001;86:251-61.)

Good technique pays off. These words are not merely a motto to hang on the wall in the laboratory but words of wisdom.¹ Good technique demands that everyone involved give adequate attention to all details required for safe and efficient operations. This means that good dentistry depends on the integrity, knowledge, and skills possessed by the entire dental team, which includes the dentist, dental nurse, dental assistant, office manager, and dental technician. A great force working against good technique is the habit of taking shortcuts. Shortcuts are risky attempts to save time by modifying a proven procedure. A proven procedure is one that accomplishes an operation efficiently while reducing the possibility for errors to a minimum. A procedure that may be “accepted” or “approved” is not always a proven procedure.

Increased chairtime required for adjusting misfit dentures, dissatisfaction and pain experienced by patients, and remakes resulting from shortcut practices indicate that they rarely save time. One of Murphy’s Laws² says that there is never enough time to do it correctly in the first place, but always plenty of time to do it over. It is a good idea for everyone involved in a dental practice to frequently review the procedures used. Many seemingly innocuous deviations can creep into one’s technique without notice. These deviations can add up to serious problems.

The results of many errors made during the fabrication of removable partial dentures (RPDs) may not be recognizable when they occur. This article, therefore, has 3 aims: (1) to advise personnel involved in the fabrication of RPDs of potential errors, (2) to call attention to results that can be attributed to these errors,

and (3) to identify steps that can be taken to avoid these errors. The errors are listed in the order that they would occur during the fabrication of an RPD.

IMPRESSIONS: ERRORS, PROBLEMS, AND SOLUTIONS

Currently, irreversible hydrocolloid impression material (irreversible hydrocolloid) seems to be the material of choice for making RPD definitive impressions. It therefore is the impression material referenced in this article. Errors for handling it are described. The advantages of irreversible hydrocolloid seem to outweigh the advantages of other impression materials; it has only a few disadvantages.

The advantages of irreversible hydrocolloid compared with other impression materials include the following: First, the use of irreversible hydrocolloid does not require specialized equipment or customized trays; this is not the case with agar and other elastomeric materials. Satisfactory results can be obtained with the use of non-water-cooled stock metal trays modified by application of impression compound and cotton fibers.¹ Second, the setting time of irreversible hydrocolloid is easy to control by adjusting the water temperature.¹ Third, most impression cleanup is much easier with irreversible hydrocolloid than with polysulfide elastomeric materials. Fourth, irreversible hydrocolloid does not stain clothing like elastomerics. Fifth, irreversible hydrocolloid can be mixed more easily than some of the elastomeric materials. Sixth, because irreversible hydrocolloid materials are more elastic than the elastomeric materials, full-arch impressions are easier to remove from the mouth. As a result, loose and mobile teeth are less apt to be extracted when the impression is removed, and isolated teeth are less apt to break when the cast is separated from the impression. Seventh, irreversible hydrocolloid is not as easily displaced by saliva as some of the elastomeric materials

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and zinc oxide–eugenol when a thin layer is used as the final impression. Eighth, the time required for irreversible hydrocolloid to set in the mouth is less than that required for several other materials. Ninth and finally, irreversible hydrocolloid is less expensive than most other materials.

The disadvantages of irreversible hydrocolloid include the following: First, it cannot be stored after removal from the mouth. For best results, the impression must be poured within 12 minutes of removal from the mouth. Second, irreversible hydrocolloid has a tendency to adhere to the teeth when they are not properly treated.¹

DIAGNOSIS/TREATMENT PLANNING

An asterisk indicates that the error is serious. If the error is committed, new impressions may have to be made.

1. *Error:* Making RPDs using a 2-appointment system: one appointment for diagnosis, mouth preparations, and definitive impressions and a second for insertion of the partial denture.

Problem: The more one learns about the chemical and physical properties of dental materials and the procedures for using them, the more certain one becomes that the 2-appointment system for making RPDs is inadequate.

Solution: Use the first appointment to make an assessment of the patient's needs and to begin to develop a diagnosis. Make a primary determination of the condition of the patient's mouth, take radiographs, and make impressions for diagnostic casts. At the second appointment, after the records have been evaluated and diagnostic casts have been designed, obtain the patient's acceptance of the diagnosis, treatment plan, and prognosis. When an RPD is the treatment of choice, make mouth preparations and impressions for definitive casts. A third appointment may be scheduled, when necessary, to make jaw relation records. In some instances, it may be reasonable to combine the second and third appointments. Use the fourth appointment to verify the fit of the metal framework before the denture teeth and plastic base material are added. If the framework does not fit at this stage, any further work performed on the RPD will be wasted. Schedule a fifth appointment to deliver the denture and adjust the occlusion and denture base. Give the patient instructions essential to successful function and maintenance of the denture. A sixth, mandatory follow-up appointment is needed for refinements of the denture to make it optimally functional. More appointments may be necessary in some instances.

2. *Error:* Not making a set of diagnostic casts for each patient.

Problem: If diagnostic casts are not studied carefully with the aid of a surveyor, an erroneous diagnosis may be reached.

Solution: After only an intraoral examination, a patient may appear to have a simple problem when, in fact, the situation is very complicated. Always make diagnostic casts and evaluate them thoroughly before committing to treatment.

3. *Error:* Failing to analyze the casts and compare teeth on the diagnostic cast with those on the definitive cast.

Problem: When the teeth on the diagnostic cast are measured and compared with the same teeth on the definitive cast and the dimensions are not the same, a discrepancy is indicated.³

Solution: The teeth on the diagnostic and definitive casts should always be compared with each other. When they are not the same, a determination must be made before continuing. If it is determined that the teeth on the definitive cast are of the same dimensions as those in the mouth, continue making the frameworks. If not, start over with a new impression for the definitive cast.

4. *Error:* Using irreversible hydrocolloid that is past its expiration date, even if it has been stored at relatively low temperatures (40°F–90°F) in its original, unopened container.⁴

Problem: Setting time is affected as irreversible hydrocolloid deteriorates with age. Because of loss of elastic properties, the tear resistance and elasticity of the set material may be greatly reduced.

Solution: Note the expiration or "use before" date on each container of irreversible hydrocolloid.⁴ Discard if the date has been exceeded, or at least test a sample mix (Note 1).

Note 1. Test for deterioration

A simple initial setting time test can be used to determine whether irreversible hydrocolloid has been adversely affected since its date of manufacture.^{3,5}

1. Make a test rod by flattening and polishing both ends of a 6-in. length of standard 1/4-in. diameter polymeric (plastic) stock. Polymeric stock is usually available from a local plastics supply company.
2. Make a mix of irreversible hydrocolloid exactly according to the manufacturer's directions (specifically, those related to the use of distilled water, temperature of mixing water and equipment, water/powder ratio, method of mixing, and length of mixing time). Leave the mix in the mixing bowl.
3. At 10-second intervals, lightly touch the unset irreversible hydrocolloid material with a polished end of the test rod. Wipe the rod off, and repeat the procedure until the irreversible hydrocolloid does not stick to the rod. The loss of tackiness indicates that the mixture has reached its initial setting time. Record the time. If the test shows that the time does not vary more than 15 seconds from the initial setting time stated in the manufacturer's instructions,^{3,5} then the irreversible hydrocolloid has probably not undergone any significant deterioration since its date of manufacture.⁴

5. *Error:* Using irreversible hydrocolloid that has been frozen, even when it is stored in its original, sealed container.

Problem: Freezing may alter the setting time of the material drastically.

Solution: In the winter, when temperatures in some parts of the country are considerably below freezing, irreversible hydrocolloid should be tested before use.

6. *Error:* Using irreversible hydrocolloid that has been stored in temperatures over 100°F.

Problem: Heat will make the setting erratic.

Solution: Store irreversible hydrocolloid in a controlled temperature between 40°F and 90°F.

7. *Error:* Using irreversible hydrocolloid that has been stored in defective packaging or in an unsealed container after being opened for first use.

Problem: Moisture contamination due to water uptake from the atmosphere can accelerate or retard the setting time and cause rapid deterioration of physical and chemical properties of the irreversible hydrocolloid.⁴

Solution: Test the irreversible hydrocolloid before using it (Note 1).

8. *Error:* Using irreversible hydrocolloid that has been contaminated by particles of gypsum.

Problem: Even a speck of gypsum can contaminate an entire container of irreversible hydrocolloid under certain conditions.⁴

Solution: Use prepackaged irreversible hydrocolloid (enough for the fabrication of 1 impression) to eliminate this error, even though it is more costly than a can of irreversible hydrocolloid or bulk irreversible hydrocolloid. If bulk irreversible hydrocolloid is used, separate and weigh amounts for individual use; then seal each portion in an airtight container such as a specimen containers. In addition, use a dedicated mixing bowl and spatula only for mixing irreversible hydrocolloid. When in doubt about the deterioration of the irreversible hydrocolloid, test it before use (Note 1).^{5,6}

9. *Error:* Using a mix of irreversible hydrocolloid that is too thin.

Problem: A thin mix of irreversible hydrocolloid is difficult to control in the impression tray. The irreversible hydrocolloid may flow out of the tray and cause voids in the impression.⁶ Moreover, the irreversible hydrocolloid may not be confined in the tray enough to create the pressure required to force the material into the gingival crevices and stippling in the soft tissues; thus, the anatomy may not be copied adequately. Irreversible hydrocolloid may flow out of the tray and stimulate the patient's gag reflex.^{5,6}

Solution: Read and follow the manufacturer's instructions concerning the proper water/powder ratio for irreversible hydrocolloid.

10. **Error:* Using a mix of irreversible hydrocolloid that is too thick.

Problem: A thick mix of irreversible hydrocolloid may set before it is fully seated in the mouth. When this happens, the irreversible hydrocolloid will set under pressure. When irreversible hydrocolloid sets as pressure is applied, it is always distorted.⁶ The irreversible hydrocolloid may not flow into the interproximal spaces between the teeth or pick up the anatomy of the soft tissues. This error may also result in the creation of drag marks in the impression and on the cast during seating of the impression. The marks will not fill in because the material is too stiff to flow after it is seated.

Solution: Follow the manufacturer's instructions for water/powder proportions by weight rather than by volume.

11. *Error:* Using tap water for mixing with irreversible hydrocolloid powder.

Problem: Depending on the source of the tap water, it may contain many different chemicals; these include compounds of calcium, carbon, chlorine, potassium, iron, lead, copper, sodium, sulfur, and magnesium. Any of these may alter the optimum properties of the irreversible hydrocolloid. It is not easy for the user to predict how these compounds, acting alone or in combination with others, may affect the setting time or other behavioral characteristics of the irreversible hydrocolloid.⁶

Solution: Always use distilled or deionized water for mixing irreversible hydrocolloid.

12. *Error:* Attempting to control the setting time of irreversible hydrocolloid by altering the water/powder ratio.^{5,6}

Problem: If the mixture is thin one time and thick another time, a standardized procedure cannot be established for seating the impression tray. The resulting inconsistency can cause unreliable results, in addition to other problems (see errors 9 and 10).

Solution: Control the water temperature to vary the setting time of irreversible hydrocolloid mixes. Always use the manufacturer's recommended water-to-powder ratio. Use water heated to more than room temperature to make the irreversible hydrocolloid set faster; use water chilled to lower than room temperature to increase the working time.⁷ A 10°F increase or decrease in the water temperature will increase or decrease the working time by approximately 40 seconds.

13. *Error:* Making a mix of irreversible hydrocolloid by adding the water to the powder.^{5,6}

Problem: If the water is added to the powder, some remnants of unmixed irreversible hydrocolloid material may be incorporated into the mix and cause an inaccurate impression.

Solution: Always add the irreversible hydrocolloid powder to the liquid and mix thoroughly.

14. *Error:* Failing to adequately mix the irreversible hydrocolloid.

Problem: If irreversible hydrocolloid is not mixed long or thoroughly enough to completely saturate all of the powder with water, pockets of dry or partially wet irreversible hydrocolloid can cause distortions.

Solution: Hand mix the irreversible hydrocolloid thoroughly for 60 seconds. Alternately, vacuum mix the irreversible hydrocolloid for 15 seconds with at least 25 inches of vacuum.

15. *Error:* Allowing partially mixed irreversible hydrocolloid from around the top of the mixing bowl to be incorporated into the mix as the tray is loaded.

Problem: Any dry irreversible hydrocolloid particles will absorb water when the impression is washed. The dry particles expand as they get wet and set. If a pocket of dry or partially wet irreversible hydrocolloid is in contact with a tooth or other critical area when the impression is made, the dry material will expand after the impression is removed from the mouth and washed, resulting in inaccuracies.^{5,6}

Solution: Make certain that partially mixed or dry irreversible hydrocolloid powder is not incorporated into the mix for the impression.

16. *Error:* Using an impression tray that is too small.

Problem: If an impression tray that is too small is used, the border of the tray may impinge on and distort the soft tissues. The resulting casts may show evidence of distortion. Also, the irreversible hydrocolloid impression cannot be removed from the mouth without distortion, tearing, or the irreversible hydrocolloid pulling loose from the tray.¹

Solution: Use the next larger tray size.

17. *Error:* Using an impression tray that is too large.

Problem: If an impression tray is too large, the irreversible hydrocolloid material may slump away from the soft tissues, especially from palatal surfaces. It also may be difficult to seat the maxillary tray because the posterior flanges will bump into the ascending ramus of the mandible when the mouth is opened wide. Definitive casts obtained from these defective impressions cannot be used to produce snugly fitting palatal major connector castings.¹

Solution: Always select a tray that clears the soft tissue by ¼ in. when it is tried in the mouth.

18. **Error:* Failing to release seating pressure from a solid rim lock impression tray after the impression is in place in the mouth.

Problem: When a solid rim lock tray for making an irreversible hydrocolloid impression is used, the seating pressure must be released after the tray is in place but before the irreversible hydrocolloid sets. Irreversible hydrocolloid setting under pressure will cause a distorted impression.⁶

Solution: Release the pressure required to seat the impression as soon as it is seated.

19. **Error:* Continuously applying pressure when seating an impression in a perforated tray.

Problem: When a perforated tray is used, pressure buildup is not as critical because the perforations¹ allow the irreversible hydrocolloid to escape and release the pressure. But when seating pressure is applied continuously, the tray may bottom out on some of the teeth, resulting in the teeth showing through the impression material. If this happens, the impression will be distorted and must be remade.¹

Solution: Release the seating pressure after the impression is fully seated in the mouth. Support the tray with only enough pressure to keep it in place.

20. **Error:* Failing to detect movement of the impression during setting of the irreversible hydrocolloid.

Problem: If the impression tray moves after the impression is seated in the mouth, during the approximately 30-second period required for the irreversible hydrocolloid to change from the fluid to the solid state, the impression will be distorted. It is difficult for some patients to keep from swallowing or moving their tongue during the setting period. Dentists must detect the timing of any movement while supporting the tray and must decide whether the movement occurred during the 30-second setting period. If movement does occur during the setting period, the impression should be remade because it will always be distorted. Distortion of this type is impossible to detect by inspection of the completed impression.

Solution: If movement is suspected, the only safe course of action is to remake the impression.¹ The dentist must make a habit of lightly supporting the tray during impression making until the initial set of the irreversible hydrocolloid has occurred (Note 2).

Note 2. Verify fit of the framework

Separation of the irreversible hydrocolloid from the tray is often very difficult or impossible to detect. The possibility of this error (and error 20) make it necessary to verify the fit of the framework before the teeth and denture base material are added. If the framework fits the cast perfectly but does not seat properly in the mouth, then the dentist has committed an error and a new impression must be made.¹ (see Part II, errors 165 and 166).

21. **Error:* Failing to take steps to prevent the irreversible hydrocolloid impression from separating from the tray.

Problem: Mixed irreversible hydrocolloid placed in a bare metal tray will not adhere to the tray uniformly when the irreversible hydrocolloid sets.

Solution: An effective tray adhesive must be used to prevent separation and hold the impression material securely (Note 2).

22. **Error:* Using wax to build up the interior surfaces and borders of the tray.

Problem: If wax is used to build up the interior surfaces and borders of the tray to ensure a uniform thickness of irreversible hydrocolloid, tray adhesive will not keep the irreversible hydrocolloid from separating from the tray. Tray adhesive softens the wax and allows easier separation.

Solution: Use modeling plastic impression compound, not wax, to build up the interior surfaces of the tray. Imbedding cotton fibers in the compound can enhance adhesion.⁵⁻⁷ Use the adhesive recommended by the manufacturer to hold the irreversible hydrocolloid in the tray. After the cast is made, separate the cast, remove the bulk of the impression material and compound, and then soak the tray in methanol or isopropyl alcohol to dissolve the tray adhesive. These solvents will not damage a metal tray.

23. Error: Failing to block out a tray with modeling plastic impression compound and trim it for a clearance of ¼ in. around the teeth.

Problem: If the tray is blocked out with modeling plastic impression compound but not trimmed sufficiently (to leave ¼ in of clearance between the compound and teeth when the tray is seated in the mouth), the irreversible hydrocolloid will be distorted. Insufficient bulk of irreversible hydrocolloid will not permit it to recover from the deformation caused when the irreversible hydrocolloid springs out of the undercuts during removal of the impression from the mouth.^{5,6}

Solution: After the compound is trimmed, check the clearance by seating the diagnostic cast in the tray. Trim more if necessary.

24. Error: Failing to properly load the irreversible hydrocolloid into the tray.

Problem: Failing to load the tray by forcefully adding small increments of irreversible hydrocolloid may allow the completed impression to loosen from the tray in some areas and result in a distorted cast.^{5,6}

Solution: By placing the irreversible hydrocolloid in the tray in small increments, it can be forced into the rim locks, perforations, and cotton fibers to make it hold better.

25. Error: Placing irreversible hydrocolloid in the tray in large amounts.

Problem: When irreversible hydrocolloid is placed into the tray in large amounts, it is possible to trap air. Trapped air may prevent the irreversible hydrocolloid from coming into contact with the tray adhesive and cotton fibers, which are intended to hold the irreversible hydrocolloid in the tray.¹

Solution: Place the irreversible hydrocolloid mix in the tray in small increments, and be careful to not trap air.

26. *Error: Not allowing enough time for the impression material to flow before it sets.

Problem: When irreversible hydrocolloid starts to set before it is fully seated in the mouth, it can no longer flow adequately; it therefore cannot capture the

anatomy of the teeth and soft tissues accurately. Moreover, pressure will be exerted on the setting irreversible hydrocolloid, causing distortion.⁵⁻⁷

Solution: Seat the impression with enough working time remaining to allow at least 15 seconds of irreversible hydrocolloid flow after the loaded tray is fully seated in the mouth. If more working time is needed, use cooler water to mix the irreversible hydrocolloid. Cooling the water by an extra 5°F will increase the working time by approximately 20 seconds.¹

27. Error: Failing to remove debris and plaque from the teeth before the impression is made.

Problem: The resulting cast will not be an accurate copy of the mouth. The impression will record the coating of debris and/or plaque on the teeth. There is no way to tell the thickness of this material by looking at the cast.³

Solution: Routinely clean the teeth with a lubricating prophylactic paste before making an impression (Note 3).

Note 3. Formula for lubricating prophylactic paste

50 g silicone compound
50 drops USP oil of peppermint
20 drops liquid petrolatum (mineral oil)
40 g flour of pumice
Blend thoroughly, and use sparingly on a rubber cup to remove debris and plaque from the teeth. This paste will coat the teeth with a thin film of silicone and prevent the irreversible hydrocolloid from adhering to the teeth.

28. Error: Removing plaque with regular prophylactic paste.

Problem: Removing plaque with regular prophylactic paste usually removes the pellicle from the teeth, resulting in adherence of the irreversible hydrocolloid to the teeth.^{5,6}

Solution: Use a prophylactic paste made of flour of pumice and silicone compound to remove plaque from the teeth before making the impression.⁶

29. Error: Failing to remove the pumice in the prophylactic paste from the teeth.

Problem: When the pumice is not completely removed from the teeth, the same result occurs as when the plaque is not removed¹ (see error 27).

Solution: Use a strong spray of air and water to remove the remaining prophylactic paste from the mouth. The spray will remove the pumice but will not remove a thin coating of silicone from the teeth. The coating is intended to replace the pellicle and prevent the irreversible hydrocolloid from adhering to the teeth.⁶

30. Error: Failing to paint the teeth with irreversible hydrocolloid just before seating the loaded impression tray in the mouth.

Problem: Air may be trapped in critical areas such as rest seat preparations, occlusal surfaces, the palatal vault, and proximal areas.⁶

Solution: Use some of the irreversible hydrocolloid mix from the mixing bowl to paint (with your fingers) a thin layer of irreversible hydrocolloid into critical areas of the mouth. Alternatively, some of the excess irreversible hydrocolloid mix may be loaded into a 60-mL disposable syringe and injected over the occlusal surfaces, facial and lingual surfaces, and palatal vault just before the loaded impression tray is seated.

31. *Error:* Using excessive finger pressure to paint irreversible hydrocolloid around the teeth when making an impression.

Problem: Using too much finger pressure to paint irreversible hydrocolloid on the teeth sometimes causes it to stick to the teeth, even when the prophy lubricating formula is used. The thin coating of silicone left by the prophy paste formula can be wiped off when heavy pressure is used, allowing the irreversible hydrocolloid to adhere to the teeth. The sticking is always on a prominent, smooth surface of the teeth when this happens.⁶

Solution: Use very light finger pressure and minimal rubbing to apply the irreversible hydrocolloid. The use of a 60-mL syringe also can minimize this risk.

32. *Error:* Removing the impression from the mouth before it has set sufficiently.

Problem: If the impression is removed from the mouth before it has set sufficiently, it will lack adequate strength and tear resistance, and a loss of detail will result.

Solution: The gel strength of irreversible hydrocolloid doubles during the first 4 minutes after the initial set.⁵ Test the material for final set before removing the impression from the mouth (Note 4).

Note 4. Test for final set of irreversible hydrocolloid

There are 2 reliable ways to determine when to remove an impression from the mouth: (1) When the irreversible hydrocolloid material remaining in the mixing bowl is no longer tacky, set a timer for 1 minute. At the end of the timed interval, remove the impression. (2) The most reliable method is to leave some of the mix of irreversible hydrocolloid in the mixing bowl to set. When it is no longer tacky, remove a piece from the mixing bowl, fold it over onto itself, and squeeze it between a thumb and forefinger. If the material breaks cleanly, the impression is ready to remove from the mouth. If it mashes slightly, leave it longer and test the mix again.¹

33. *Error:* Leaving an impression in the mouth too long.

Problem: When an impression is left in the mouth too long, it has an increased tendency to adhere to the

teeth. Moreover, the time allowed to pour the impression in stone is shortened.¹

Solution: Do not rely only on clock time to indicate when to remove the impression from the mouth. Use a method that accurately measures the set of the material (Note 4).

34. *Error:* Attempting to remove the impression without breaking the seal.

Problem: Trying to remove the impression without breaking the seal may dislodge the impression from the tray and/or distort it beyond recovery.⁷

Solution: Break the seal by inserting a finger between the peripheral roll of the impression and the mucobuccal fold of the soft tissue. Simultaneously, remove the impression by applying unseating pressure to the handle of the tray.

35. **Error:* Removing the impression from the mouth slowly or with a rocking motion.⁷

Problem: Removing the impression from the mouth slowly or with a rocking motion may distort the impression to such a degree that it cannot recover its original shape.

Solution: Break the seal around the periphery with a finger (see solution to error 34), and then remove the impression with a quick snap.

36. **Error:* Failing to inspect the impression thoroughly after it is removed from the mouth.

Problem: Defects may exist in critical areas and not be discovered until the cast is inspected, necessitating a recall of the patient for a new impression.

Solution: Before the impression is washed, use magnification and a bright light to thoroughly inspect the impression for defects. Look for voids and other defects in the impression that would affect placement of the metal framework. Compare the impression with the diagnostic cast to see whether the location of the defects would interfere with any of the planned component parts such as rests, a palatal bar, or a clasp. If the defects might interfere, it is best to remake the impression immediately.⁷

37. *Error:* Failing to clean the impression before making the cast.

Problem: If the impression is poured without removing debris, the cast will be defective in those areas in which the debris is lodged. Blood, mucous, and other proteinaceous materials will inhibit setting of the stone.

Solution: Rinse the impression in tap water to remove debris.

38. *Error:* Failing to wash the inside of the impression with unset dental stone powder (calcium sulfate).

Problem: Because irreversible hydrocolloid inhibits the setting of stone and has other chemical reactions with stone, the resulting cast surface may not be as smooth as it could be.⁷

Solution: Scrubbing the surface of the impression

with unset stone powder (calcium sulfate) and water allows the surface to react with the scrubbing stone. When the powder is washed away, the resulting clean, partially nonreactive irreversible hydrocolloid surface produces a much better surface on the cast (Note 5).

Note 5. Procedure to clean the impression

After the debris is rinsed from the impression, sprinkle unset dental stone powder into the impression, wet the powder slightly, and lightly scrub the entire anatomic surface of the impression with a soft camel-hair brush. Add more water if necessary to make a thin stone paste; continue scrubbing, and twirl the brush in the impressions of the teeth. After brushing for approximately 30 seconds, rinse all the stone out of the impression.⁷

39. Error: Failing to remove all of the scrubbing powder from the impression.

Problem: Leaving some of the stone scrubbing powder in the tooth sockets will result in a defective cast.

Solution: Hold the impression under a gentle stream of running water, and twirl the bristles of the brush in the sockets left by the teeth in the impression until all traces of scrubbing stone are gone.¹

40. Error: Failing to suspend an irreversible hydrocolloid impression by the tray handle.⁶⁻⁸

Problem: If an untrimmed irreversible hydrocolloid impression is rested on a countertop, the part resting on the flat surface may be distorted due to pressure from the weight of the impression and tray. An inaccurate cast may result.

Solution: Put the tray handle in a holder so that the impression does not touch the bench top.

41. Error: Placing the impression in a bowl of water before pouring.

Problem: An impression submerged in a bowl of water before being poured will contact the sides of the bowl. Irreversible hydrocolloid is pressure sensitive. If any unsupported part of the impression material touches a solid surface, the pressure may distort the impression.⁵

Solution: Always suspend an irreversible hydrocolloid impression by the handle of the tray in a container full of liquid to prevent distortion. Suspension in liquid equalizes the pressure on the impression. Place a stiff wire across the mouth of the container of liquid, and suspend the tray from the wire by placing a paper clip through the hole in the handle.

42. Error: Failing to treat the impression with a 2% solution of potassium sulfate before forming the cast.

Problem: Even when the irreversible hydrocolloid has been scrubbed with stone (calcium sulfate), enough reactive irreversible hydrocolloid may remain to affect the surface of the cast.

Solution: A 2% solution of potassium sulfate, which

can be purchased from a pharmacy or chemical supply company, will further condition the surface of the irreversible hydrocolloid and improve the surface of the cast.⁶ (The same claim is made for zinc sulfate and aluminum sulfate.) Immerse the impression in a 2% potassium sulfate solution for at least 60 seconds while preparing to form the cast. A pharmacist can help determine the proper proportions of distilled water and potassium sulfate to mix for a 2% solution. Calcium sulfate is recommended as a part of the impression cleaning procedure (see solution to error 38).

43. Error: Delaying the pouring of an irreversible hydrocolloid impression and/or attempting to store it.

Problem: When an impression is left uncovered for more than 12 minutes^{3,7} before pouring, the irreversible hydrocolloid starts a process known as "syneresis" in which contraction causes the liquid to separate from the gel. During this process, the irreversible hydrocolloid shrinks very rapidly, which results in a defective cast.⁸

Solution: Clean and pour the impression immediately.

44. Error: Leaving the impression in water or other liquid for more than 12 minutes before pouring it.

Problem: When the impression is left in water for more than 12 minutes before it is poured, the irreversible hydrocolloid absorbs water and expands unevenly and therefore is inaccurate. Thicker areas will expand more than thinner areas.

Solution: Do not try to store an irreversible hydrocolloid impression. Pour it within the required total time of 15 minutes measured from the beginning of mixing.^{4,6} This allows 3 minutes for mixing the irreversible hydrocolloid and making the impression.

45. Error: Leaving an impression for more than 12 minutes in a humidor with 100% humidity.

Problem: The irreversible hydrocolloid may not shrink or expand in a humidor at 100% humidity, but humidity cannot stop syneresis (see error 43) or the release of strains built up in the impression procedure. Thus, the impression will be inaccurate.^{9,10}

Solution: Rather than attempting to store the impression in a humidor, take time to pour it immediately.

46. Error: Wrapping an impression in a wet towel.

Problem: If an impression is wrapped in a wet towel, parts of the impression may be distorted by pressure caused by contact with the towel; at the same time, these parts will expand by absorbing moisture from the towel. Parts not in direct contact with the wet towel, such as impressions of the ridges, will be in 100% humidity and may not shrink or expand. Nevertheless, the entire irreversible hydrocolloid impression will undergo syneresis and release of strains, which will cause distortion to progress very rapidly 15 minutes after the start of irreversible hydrocolloid mixing¹⁰ (see errors 43-45).

Solution: Time the impression from the mixing of the irreversible hydrocolloid and water. For best results, make certain that the impression is poured within 15 minutes from the beginning of the mix, even if that means that the first impression must be poured before making the second impression. Never wrap an irreversible hydrocolloid impression in a towel.¹⁰

47. *Error:* Failing to remove excess liquid from the impression before pouring the cast.

Problem: Excess liquid left in the impressions of the teeth when the cast is poured will combine with some of the stone mix and change the liquid-to-powder ratio. The result will be soft teeth on the cast in those specific areas.

Solution: Shake the impression to remove the gross liquid; then use a gentle stream of air, if necessary, to remove more liquid. Any puddles of liquid left at this point can be blotted gently with the corner of a tissue. The surface of the impression should not be dry but should have a wet, glistening appearance without puddles of liquid.^{1,4,9}

48. *Error:* Using too much air pressure to blow excess liquid from an impression.

Problem: Using too much air pressure to blow excess liquid from an impression may lift the impression from the tray. If the irreversible hydrocolloid impression is loosened in the tray for any reason, it can never be returned accurately to its original position. A new impression must be made.^{7,9}

Solution: Use a gentle stream of air from a controlled source such as a dental unit. Avoid using a laboratory air source with full air pressure.

DENTAL STONE CASTS: DIAGNOSTIC AND DEFINITIVE

49. *Error:* Failing to store dental stone in an airtight container^{7,10} (Note 6).

Note 6. Test for setting time of stone

To test the various brands and types of dental stone, follow the manufacturer's instructions precisely (especially those related to volume, powder/water ratio, temperature, and distilled water). Make a mix as soon as a new container is opened. Mix the materials 30 seconds mechanically or 60 seconds by hand. Record the time from the start of spatulation until the material reaches its initial set (loss of gloss). To check the batch at a later date, repeat this procedure to determine whether the time corresponds. If moisture has been absorbed, the setting time will have increased.^{1,9} If the setting time has increased, all the other physical properties will be affected.

Problem: Dental stone kept in an open bin or an unsealed container, with or without a lid, will soon absorb moisture from the air. The powder may even

become filled with soft lumps. This will affect the accuracy and setting time of the material.

Solution: Weigh bulk stone in increments of 100 and 200 g; keep individual portions in their own airtight containers. Alternately, purchase preweighed dental stone (enough to pour a single cast) in individually sealed packages.

50. *Error:* Using a wet or damp utensil to dip stone from a bulk stone container.

Problem: Using a wet utensil will transfer a damaging amount of water into the container and cause hydration of the stone powder.

Solution: Do not use stone directly from the original bulk container. Take out enough for 1 day's use, and reseal the original container.

51. *Error:* Using too much water in a mix of stone (Note 7).

Problem: A thin mix of stone is difficult to control and will make a softer cast when it is set.⁶

Solution: Precisely measure the water and stone. Avoid estimating the amount needed.

Note 7. Quick and easy water measure

A simple and quick way to measure water is to use a plastic syringe marked in mL increments. Because syringes come in all sizes, it is easy to find one that meets your needs. Pour more distilled water than is needed to mix with the powder into a small, open container. Place the tip of the syringe into the water, and withdraw a few more milliliters of water into the syringe than required for the mix. Remove the syringe from the container of water and hold it with the tip point upward, tapping the barrel a few times to dislodge any air bubbles that may have adhered to the walls of the barrel. With the tip still pointing upward, push the plunger to expel the air and excess water until the plunger rests on the mL mark that matches the amount of water required for the mix. Dispense the measured amount of water into a damp mixing bowl, add the powder, and proceed with mixing. Measuring water in this manner is much faster and more accurate than using a graduated cylinder. For greatest accuracy, the powder should be weighed on a beam balance, a scale, or an electronic weighing device.

52. *Error:* Using too much powder in a mix of stone.

Problem: A thick mix of stone is difficult to pour because it does not flow well and may trap air.³ More importantly, the setting expansion of the stone is affected, resulting in a cast that is not dimensionally accurate.³

Solution: Always use the exact amount of powder (by weight) and water recommended by the manufacturer to make a smooth, creamy mix with the correct consistency.^{4,7}

53. *Error:* Vigorously drying the impression before introducing the stone mix (Note 5).

Problem: When the surface of the impression is dried excessively before the impression is poured, it is usually the result of applying a stream of air for too long in an attempt to remove all liquid from the tooth impressions. The dried areas will shrink, and the cast will not have a smooth surface; an inaccurate cast will result.

Solution: When removing excess liquid, do not blow air on the impression so long that the surface begins to look chalky. The surface should be glistening but not covered with puddles of liquid.

54. **Error:* Overvibrating the impression to speed the flow of the stone mix into the impression.

Problem: Overvibrating can trap small bubbles at the leading edge of the stone mix as it flows in the impression. Overvibrating may even loosen the impression from the tray or cause unsupported parts of the impression to break off (Note 8).

Note 8. Procedure for making casts

Add small increments of mixed cast material (stone) to the impression in the same place until the tooth impressions are filled and the ridge is covered. Control the direction of stone flow by holding the impression tray against the vibrator and tilting the tray. Do not allow the impression material to touch the vibrator. Observe the leading edge of the stone mix as it flows from one tooth impression to another. The leading edge of stone must be thin, and it must flow down one side of the tooth impression, across the articulating surface, and up the other side to fill the socket. If the stone jumps across, air will be trapped and a void in the cast will result. Continue adding small amounts of stone until all teeth and critical areas are full and the stone flows out the other side of the impression. Only then may the remaining stone mix be added more rapidly to fill the impression. Caution: Do not overvibrate. Use a vibrator that has light, sharp, rapid vibrations. Avoid large vibrators that have a rolling vibration.

Solution: Stone mixed to the manufacturer's recommendations will flow easily with light vibration.

55. *Error:* Adding a stone mix to the impression too rapidly.

Problem: Air may be trapped between the stone and the impression, resulting in air voids in the cast.

Solution: Add the stone mix in small increments; vibrate each addition before adding more.

56. *Error:* Introducing the stone mix onto the palatal surface of the impression and allowing the mix to flow in all directions at the same time.

Problem: It is impossible to control the leading edge of the stone mix when it is introduced in this manner. It will almost always trap air in some of the tooth impressions and other critical areas, causing voids in the resulting cast (Note 8).

Solution: Add the stone mix to the palate only after the tooth impressions have been filled.

57. *Error:* Immediately inverting the first pour of the impression onto a patty of the same mix of stone to form the base of the cast (not using a double-pour procedure when making a definitive cast).

Problem: If the impression is inverted immediately, before the stone has reached its initial set, the occlusal surfaces of the teeth on the cast will be soft and rough and exhibit small craters around the rough areas. When the impression is inverted, the occlusal surfaces of the teeth are at the highest point in the impression. Any vibration, or even the passive action of gravity, causes the heavier stone to settle and the liquid to rise. As the liquid collects at the upper areas of the impression where the teeth are located, the powder-to-liquid ratio is changed; the occlusal surfaces and cusp tips of the teeth on the cast thus become soft and rough. After the stone sets and the cast is separated from the impression, the liquid is not visible because it absorbs into the stone.^{3,10}

Solution: Always use a double-pour procedure when fabricating definitive casts.^{3,10}

58. *Error:* Not covering all of the impression material in the first pour of stone.^{3,10}

Problem: If all the impression material is not covered with the first pour of stone, a line of demarcation will form between the 2 pours as the base is added. The result will be a defective cast.

Solution: When the first stone mix is poured, make certain that it covers all the intaglio surface of the impression (namely, all parts of the impression that touch the oral tissues).

59. *Error:* Separating the cast from the impression too soon.

Problem: Irreversible hydrocolloid is an inhibitor of the setting of stone; stone in contact with irreversible hydrocolloid will set more slowly than stone from the same mix that is not in contact with irreversible hydrocolloid. If the cast is separated from the impression too soon, a thin layer of stone may adhere to the impression. If the cast lacks definition around the teeth, it cannot be used. If the cast is separated from the impression and it appears that some of the dye used in the stone has been left in the impression, dentists should be aware that this is usually not dye, but leftover stone.^{3,10}

Solution: It is best to rely on measured time as an indication for separation.⁸ Separate the cast from the impression at a specific time rather than rely on how the stone feels. Separate the cast from the impression 45 minutes to 1 hour after the first pour.⁶

60. *Error:* Leaving the cast in contact with the water-rich impression material too long.

Problem: If the cast is left in contact with the water-rich impression material for too long, the impression material will attack it.⁹ The cast will be dissolved slightly, and the resulting framework will fit the teeth in the mouth too tightly.

Solution: Do not leave the poured cast in the impression for more than 1 hour.

61. Error: Leaving the exposed surface of the first pour too smooth (without retention for the second pour).

Problem: When the first pour separates from the second pour (base) as the stone sets and dries or separates as the wax is boiled out in preparation for packing the resin, it is usually the result of inadequate retention on the exposed surface of the first pour.

Solution: Creating mechanical retention on the exposed surface of the first pour can prevent this separation. To create small nodules, add small increments of the stone mix to the base of the first pour before it sets.¹⁰

62. Error: Making the base of the cast too thin.

Problem: If the base of the cast is too thin, the cast will be weak and unable to withstand the rigors of subsequent procedures. The cast may break when transported to the laboratory, when clamped in the surveyor table, or as the resin is being packed.

Solution: Use a reliable method to ensure that the thickness of the base will be known when it is added (Note 9).

Note 9. Predetermining the base thickness

It is easy to judge the thickness of the base by following this procedure. When the first pour has set after the pieces of the stone mix have been added (see solution to error 61) and the assembly is still in the tray, place the tray upside down on a flat surface to determine whether the retention added to the first pour is too thick. If it is, thin it appropriately with a cast trimmer. When the stone mix is added for the base, the thickness established in the first pour will determine the thickness of the completed base. This is another advantage of a double-pour procedure. It permits an advance determination of how thick the base will be when it is added.³

63. Error: Making the base of the cast too thick.

Problem: If the base of the cast is too thick, the cast may not fit in the duplicating flask or allow the lid to be seated. At this point, the base must be reduced on the cast trimmer, which introduces the possibility of eliminating the indexing. The cast can no longer be remounted accurately in the articulator.^{3,10}

Solution: If it is possible that the base is too thick, try it in the flask and, if necessary, thin the base on the cast trimmer before it is indexed (see Part II, solution to error 73).

64. Error: Attempting to increase the thickness of the base by adding more stone after the original base sets.

Problem: If a base is poured too thin and an attempt is made to add more stone after the original base sets, it will almost always separate.¹

Solution: Pay attention to the thickness when the original base is made. It must be between $\frac{1}{8}$ and $\frac{3}{8}$ in. at the thinnest part. If extra thickness must be added, add mechanical retention to the base by cutting definite undercut irregularities in the base. Be careful not to break the first original base or penetrate through it to the tissue surface. Doing so may make the cast unusable.

65. Error: Failing to wet the cast before shaping the base on a cast trimmer.

Problem: If the base of a cast is too thick or too large in diameter, it should be trimmed to useable dimensions on a cast trimmer. If the cast is not wet before trimming, the cast will absorb moisture from the trimming sludge. The grindings may adhere to the surface of the cast; they cannot be removed with a brush and water without abrading the cast (see error 70). Moreover, failing to wet the cast before adding stone to it (see error 64) may allow the new addition to separate, even if mechanical retention has been made in the original base of the cast.

Solution: Wet the cast before trimming it on a cast trimmer.

66. Error: Failing to wet the cast before mounting it in an articulator.

Problem: If an attempt is made to mount a dry cast, the mounting stone will be dehydrated by the cast; a layer of soft, weak stone between the cast and the bulk of the mounting stone will result. This problem could cause premature separation of the cast from the mountings and a soft surface on the mounting stone that could flake off, making remounting inaccurate.

Solution: Soak the cast in slurry water for several minutes before mounting it in an articulator (Note 10).

Note 10. Slurry water recipe

Slurry water is a supernatant liquid made by placing pieces of set stone left over from pouring impressions in a rust-free container filled with tap water. (Do not use casts or stone that have been in contact with an impression made in an oral cavity.) Allow the stone pieces to set for 48 hours, stirring the solution occasionally. The resultant supernatant solution is slurry water.¹⁰

67. Error: Failing to wet the cast before adapting brown or pink shellac baseplate material to it.

Problem: If a cast is not wet before a shellac baseplate is adapted to it, the baseplate material will likely adhere to the cast.

Solution: Wet the cast in slurry water before adapting shellac baseplate material to it, or use an alternate material such as a thermoplastic, vacuum-formed material.

68. *Error:* Failing to wet the cast before duplicating it.

Problem: If the cast is not wetted before it is duplicated, type 1 (reversible) and type 2 (irreversible) duplicating materials will adhere to it. The result will be a rough surface on the duplicate cast.

Solution: To prevent type 1 or 2 duplicating materials from adhering to the cast, wet the cast in slurry water.

69. *Error:* Wetting the stone cast in tap water or distilled water rather than slurry water.^{3,7}

Problem: Casts are soluble in tap water, distilled water, and deionized water^{3,8} (see Part II, error 91).

Solution: Always wet the cast with slurry water before all procedures that require a wet cast (see errors 65-68 and 70-71).

70. *Error:* Failing to thoroughly wet the cast before trimming.

Problem: If the cast has been dipped in slurry water but not thoroughly wetted before the base is shaped on a water grinder, the grindings will still stick to the cast.

Solution: Soak the cast in slurry water for 15 to 30 minutes before trimming it on a water cast trimmer. Alternately, a cast may be placed in a bell jar in a container of slurry water and placed under vacuum for 5 minutes.

71. *Error:* Failing to rinse the cast frequently during the trimming procedure.

Problem: Even if the cast is wet with slurry water when the base is shaped on a water cast trimmer, the grindings may stick to the cast if it begins to dry before an attempt is made to remove the grindings.

Solution: To prevent the grindings from adhering to the cast, rinse the cast in slurry water after each cut is

made. When this is performed, the cast will be clean at the end of grinding.³ Casts are not soluble in slurry water.^{1,7}

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