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

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In Part III of this series, possible errors 169 through 243, all of which may be committed during the fabrication of a removable partial denture, are presented. Suggestions for avoiding the problems and solutions for correcting them are described. (J Prosthet Dent 2001;86:277-88.)

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

SET-UP AND TRIAL PLACEMENT OF THE REMOVABLE PARTIAL DENTURE

169. *Error*: Failing to evaluate the trial tooth arrangement on the removable partial denture (RPD) in the mouth.

Problem: The last opportunity to evaluate decisions made up to this point is when the teeth are set in wax. If the RPD is not tried in the patient's mouth at this time and corrections are not made, future changes will be difficult (if not impossible) and much more expensive.[1]

Solution: It is a good practice to arrange the teeth on the framework and try them in the mouth regardless of whether the anterior teeth are involved. It is far easier and less expensive to alter the tooth arrangement or change the teeth before the RPD is processed.[2-7]

170. *Error*: Failing to seal the denture bases to the cast after the final wax-up is completed and before processing.[1]

Problem: Considerable vibration is required when the RPD is invested in a flask in preparation for processing the acrylic resin. The vibration is necessary to flow the stone mix around the RPD. If the metal and wax borders are not sealed well, stone may flow varying distances under the edges of the base and set. Because the framework will not be removed before packing the resin, there is no way to detect or remove this stone.[2] A defect will be created in the processed resin where the stone is incorporated into the resin.

Solution: Seal all borders of the RPD (both metal and wax) to the cast by flowing pink baseplate wax around the borders.

171. *Error*: Carelessly removing the indexed definitive cast from the mounting stone on the articulator.[1]

Problem: If the mounting stone on the articulator is broken, it may not be possible to remount the cast and RPD to correct processing errors.

Solution: If preliminary steps are accomplished without error, separating the indexed cast from the articulator mounting stone will not be problematic (see Part II, solutions to errors 79 through 83).

FLASKING THE RPD

172. *Error*: Investing the dry cast.

Problem: A dry cast will dehydrate the investing stone and reduce its crushing strength. The stone then will be susceptible to crushing when the resin is packed during processing, increasing the vertical dimension of occlusion and consequently necessitating substantial correction of the occlusion after processing.

Solution: Soak the definitive cast assembly in slurry water for 10 minutes before investing.[3]

173. *Error*: Using dental plaster to invest the RPD for processing.[3]

Problem: When plaster is used in the place of stone to invest a partial or complete denture, the force of packing and polymerizing the resin may crush the plaster, particularly when a hydraulic press is used. Plaster has a crushing strength of 1300 to 1500 psi. Most hydraulic presses are capable of applying more than 5000 psi very rapidly. If the investing plaster is compressed or crushed, it will cause an increase in the vertical dimension of occlusion, which will be evident when the completed dentures are placed in the mouth. This may be more evident if the occlusion has not been corrected on the cast that has been remounted in the articulator. In the past, plaster was used because it made retrieval of the completed denture easier. With the advent of pneumatic chisels, retrieval is no longer as difficult as when the stone had to be cut by hand with a saw and plaster knife.

Solution: Dental stone has a crushing strength of 3000 to 5500 psi and is less likely than plaster to be crushed. Use dental stone to invest the cast assembly in the flask. If plaster is used for investing, the base of the cast must touch the metal bottom of the flask. Seat the cast forcefully to make certain that it is in contact

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with the metal base of the flask and that a layer of plaster is not left between the cast and the flask. The stone cast can withstand the pressure of packing.[2]

174. *Error*: Overfilling the bottom half of the flask when investing the RPD.

Problem: If the investing stone mix flows onto the wax and denture teeth, the stone will be very difficult (if not impossible) to remove, particularly from the stippling and around the teeth, without scraping and deforming the wax that has been carved, smoothed, and polished.[3]

Solution: Control the amount of stone put into the bottom half of the flask. Fill it only ⅔ full to prevent overflow onto the wax and denture teeth. It is much easier to add more of the stone mix than to remove the stone from the wax[3]; thus, it is better to use too little rather than too much stone in the bottom of the flask.

175. *Error*: Failing to secure the RPD framework on the cast when preparing to pack the resin.[4]

Problem: If the framework is invested to pull in the top half of the flask with the denture teeth, a processing error will result, causing an increased vertical dimension of occlusion. The resulting error will manifest as an increase in the thickness of the resin between the denture base and the framework. The only way to seat the RPD in the mouth will be to reduce the intaglio surface of the denture base resin that fits the edentulous ridge, an almost impossible task.[4]

Solution: Invest the RPD so that the framework is held securely on the cast in the bottom half of the flask. Cover the entire exposed framework with investing stone in the lower half of the flask, leaving only the denture teeth and wax denture base exposed, and ensure that all undercuts are eliminated. Any increase in vertical dimension will result in only the denture teeth that contact prematurely in occlusion. This increase can be corrected by grinding the denture teeth after the casts are remounted in the articulator after processing (see solution to error 226).

176. *Error*: Trimming the stone teeth on the cast when half-flasking the assembly (completing the investment in the lower half of the flask).

Problem: If the stone teeth on the cast are trimmed during the flasking process in an effort to eliminate undercuts, it may not be possible to remount the cast properly in the articulator or to know how much to reduce the teeth in height to connect the processing error.

Solution: Do not alter the teeth on the cast during investing. Pile up the investing stone to cover the stone teeth on the cast and, at the same time, eliminate the undercuts. Be certain to use a stone separating medium on the cast (see errors 179 and 180).

177. *Error*: Leaving undercuts in the investing stone after the RPD is half flasked.

Problem: If undercuts are present, the investing stone will break when the flask halves are separated; at the least, the undercuts will make separation of the flask halves difficult.[2]

Solution: Inspect the investing stone carefully, and remove the undercuts. If this is not possible, fill them with wax to prevent the cast and stone investment from breaking. During the boil-out process, the wax will soften and the flask can be separated without incident. The waxed areas will leave spaces when the wax is eliminated. Depending on their location, they may fill with resin when packing; removing this resin, however, should be easy during the finishing process.

178. *Error*: Creating steep surfaces that are almost parallel to each other.

Problem: Friction between 2 nearly parallel surfaces may be strong enough to break the stone when the flask is separated, even if no undercuts are visible or exist.

Solution: Coat steep, nearly parallel surfaces on the heels of mandibular casts and other parallel surfaces with a thin film of wax to prevent the surfaces from binding against each other and breaking. The wax, which will create a slight space between the 2 surfaces and thus prevent friction and breakage, will soften when the flask is heated to separate the halves [2]

179. *Error*: Applying yellow-colored (stone-to-stone) separating medium.[3]

Problem: Most stone-to-stone separating media are very good for preventing dental stone from adhering to dental stone. However, some of the older colored separators will stain contacting acrylic resin as it is polymerized.

Solution: Most stone-to-stone separators are available in a clear solution. Avoid separators, pencils, or other materials that have pigment that could stain the resin.[3]

180. *Error*: Failing to apply separating medium to all gypsum surfaces in the lower half of the flask.

Problem: A fresh mix of investing stone will adhere to previously set stone, making separation of the flask halves problematic.

Solution: After undercuts in the lower half of the flask are eliminated or blocked out with wax, use a small paint brush to apply clear separating medium to the exposed stone (not covered with wax). The separating medium will soak into the stone and dry almost instantly; begin the next step immediately if desired. Be aware that stone coated with separating medium, including the preferred wax-based liquid stone-to-stone separating medium, is not waterproof.[3]

181. *Error*: Failing to soak the invested lower half of the flask in slurry water before proceeding with investing.

Problem: If a mix of investing stone is poured into the upper half of the flask seated on the lower half with the invested lower assembly, it will absorb water from the mix being poured and create a softened layer of stone. Separating medium will not prevent the second pour

from absorbing water, but it will prevent the stone from adhering to new mixes of stone.

Solution: After separating medium has been painted on the exposed stone investment in the lower half of the flask, soak the lower half assembly in slurry water for 5 to 10 minutes before pouring the upper half.[3]

182. *Error*: Failing to apply a coat of surface tension reducer to the wax and denture teeth before pouring the top half.[3]

Problem: Wax naturally has a high surface tension and does not wet readily. If surface tension reducer is not applied before pouring the upper half, air trapped during the investing process may create nodules of resin on the processed RPD around the teeth and in the interproximal spaces.

Solution: Apply a coat of surface tension reducer to the teeth and wax of the RPD in the lower half of the flask, and allow the reducer to dry before starting the next step.

183. *Error*: Failing to paint a layer of stone over the wax and teeth as a part of the flasking procedure.

Problem: Vibrating a mix of stone into the upper hall of the flask, even when surface tension reducer has been used, may still trap air around the teeth and cause nodules of resin to form on the processed RPD.[3]

Solution: When the stone mix for filling the upper half of the flask has been made, use a fairly stiff brush to paint some of the mix around the teeth and over the wax to eliminate air pockets. Continue to fill the top half of the flask ⅔ full of the mixed stone.

184. *Error*: Failing to fill the upper half of the flask approximately ⅔ full of stone and then expose the occlusal surfaces of the denture teeth.[3]

Problem: If the operator fills the top half of the flask with stone, forgets to expose the teeth to make a trough for the stone, and then closes the lid, no harm will result; however, it will take longer to recover the RPD. It sometimes is not as necessary to use a separable cap of stone for an RPD as for a complete denture; when such a cap is necessary, however, it must be applied properly.

Solution: In most instances, after the top half of the flask is ⅔ full of stone, the teeth will be covered. Before the stone sets, use the fingers to expose the occlusal surfaces of the teeth, and taper the stone from the occlusals of the teeth to the rim of the flask to make a trough. Then allow the stone to set.

185. *Error*: Failing to coat the second pour of investing stone with a separating medium.

Problem: If the trough is not painted with a separating medium before the cap is poured, the stone cap may not separate when the RPD is deflasked. The cap then must be cut away.[3]

Solution: Make certain to coat the trough in the top half of the flask with separating medium.

186. *Error*: Failing to wet the stone trough before pouring the cap.

Problem: Because separating medium is not waterproof, if the trough is not wet with slurry water before the mix of stone is added for the cap, the set stone in the top half of the flask may dehydrate the small amount of stone mix in the cap. This will make the stone in the cap weaker and may allow the denture teeth to be forced into the cap during packing; an increase in the pin opening on the articulator will result.

Solution: Fill the set stone trough (see solution to error 184) with slurry water, and allow it to sit for about 10 minutes. Then pour the water off and blot the surface before adding the stone mix for the cap (see error 185).

187. *Error*: Making the sides of the trough too smooth.

Problem: If the cap comes off with the lid of the flask when the resin is being packed, the separating medium is only doing its job.

Solution: To prevent this from happening yet be able the remove the cap easily when deflasking, cut 2 to 4 small undercut notches in the sides of the trough before adding the stone mix for the cap. Each notch should be approximately 6 mm long and 1 mm deep.[3] The notches will fill with stone and hold the cap in place, but they will easily break when a knife blade is forced between the 2 layers of stone.

188. *Error*: Wiping off all of the stone that extrudes through the holes in the lid when the top of the flask is filled and the lid is placed.[3]

Problem: As the stone mix in the cap sets, it shrinks. If the excess stone has been removed, the stone in the cap may be porous and therefore weak. Packing pressure may cause an increase in the vertical dimension of occlusion by forcing the teeth into the stone cap.

Solution: Porosity in the stone cap can be avoided by leaving stone around one of the holes in the lid and wiping another hole clean. As the setting starts, the stone in the hole that has been wiped clean will shrink, leaving a small void. Force some of the stone into the hole with the excess stone around it until the stone comes out of the hole with the small void. Continue this until the stone can no longer be forced out of this hole. This procedure will eliminate porosity.[3] Trim the remainder of the extruded stone when it sets. Do not lift the lid.

ELIMINATING WAX

189. *Error*: Having only 1 container of boiling water for wax elimination.

Problem: Because it quickly becomes contaminated with wax, a single container of boiling water cannot be used to thoroughly clean all of the wax from the flask. Repeatedly cleaning the container and heating more boiling water causes long delays in the wax elimination process.

Solution: Have 2 containers of boiling water: one with detergent for heating the flask before opening it

and for removing the bulk of wax, and the other with wax-free clear water for final cleanup.[2,3] Do not allow wax or detergent to get into the wax-free water container. If 1 of these materials does contaminate the water, a new container of wax-free clear slurry water should be prepared.[2,5,6] If even a trace of wax contaminates the stone investment, it will prevent the irreversible hydrocolloid separating medium from working as it should.[5]

190. *Error*: Failing to use a holder to lower the flask into the boiling water.[5]

Problem: If the flask is put into boiling water without a holder, it will be very difficult to remove it in the allotted time.

Solution: Purchase a flask holder or make one out of a metal clothes hanger.[5,6]

191. *Error*: Failing to closely monitor the time the flask is in the boiling water.[5]

Problem: Five minutes in boiling water is the optimum time for softening the wax enough to remove it in a semisolid form to prevent it from soaking into the stone investment.[5] If left longer than 5 minutes, the wax will become totally fluid and penetrate the stone investment. It then will be very difficult to completely remove the wax residue from the stone investment. Wax absorbed by the investing stone interferes with the application of the irreversible hydrocolloid separating medium, which is intended to prevent the resin from adhering to the stone.[5]

Solution: A 5-minute boiling period is sufficient if the water is boiling vigorously when the flask is placed in it and if only 1 flask at a time is boiled-out.

192. *Error*: Delaying the opening of the flask when it is removed from the boiling water.[2,6]

Problem: If the hot flask is not opened as soon as it is removed after 5 minutes in boiling water, the wax will continue to melt, and the opportunity to remove the wax in its semisolid state will be lost. This not only raises the risk of allowing the wax to absorb into the stone but also flushes more wax into the container of boiling detergent water and makes it more difficult to clean this mold and subsequent molds.[2,6]

Solution: At the end of the 5-minute period, remove the flask from the boiling water, and open the flask immediately (see errors 190 and 191).

193. *Error*: Using high-sudsing detergent in the first boil-out container (see solution to error 189).

Problem: The abundant bubbles that regular, high-sudsing detergent forms make it very difficult to use because the bubbles obscure one's vision.

Solution: Use low-sudsing liquid detergent. If low-sudsing powder detergent is used, make certain that all the granules are dissolved before the detergent is applied[2,6] (see solution to error 196).

194. *Error*: Using tap water in the boil-out containers.

Problem: Cleaning water made with tap water will dissolve and erode some of the stone in the cast and investment. Because of the elevated temperature, erosion will occur faster than with room temperature water.

Solution: Add a few small pieces of set stone to both containers of boiling water to make slurry water.[2,3]

195. *Error*: Merely flushing the investing stone with detergent water.

Problem: Flushing the investment with detergent water is not enough, especially if some of the wax has melted and soaked into the investing stone. Scrubbing the cast and framework in the lower half of the flask, as well as the teeth and stone investment in the upper half of the flask, will remove any wax film left on the stone.[2,3]

Solution: Scrub the investment in each half flask with a low-sudsing liquid detergent and a medium stiff brush.[2,3]

196. *Error*: Applying powdered detergent directly to the flasks.

Problem: If dry powder detergent is used directly in the flasks, it will be difficult to get rid of all of the granules.[2,3]

Solution: Use a low-sudsing liquid detergent. If a powdered detergent is used, completely dissolve the powder in water before using it to scrub the stone investment in the flask halves.

197. *Error*: Using the same ladle in both the detergent water and clear water containers.

Problem: Using the same ladle in both containers will contaminate the clear boiling water by carrying wax and detergent residue into the clear water container[2,3] (see solution to error 189).

Solution: Do not use the same ladle for both containers. Buy 2 ladles, each with the capacity to hold approximately 16 ounces of liquid; use 1 only for the detergent water and the other only for the clear water.

198. *Error*: Using the wrong type of ladle or not using the right type of ladle correctly.

Problem: Because wax floats on water, if hot water with wax scum on it is poured over the lip of a ladle, the invested RPD will be recontaminated with wax.[2,3]

Solution: Drill a hole approximately ¼ in. in diameter through the side wall of the ladle near the bottom. When using the ladle, let wax-free water run out of the hole. Stop before the top of the water level reaches the hole to prevent the floating wax from running out of the hole.[2,3]

199. *Error*: Failing to clean the wax from the outside of each half flask after it is removed from the boiling detergent water for the last time.

Problem: A coat of molten wax always remains on the outside of the flasks after they are flushed with detergent water. If the flask is placed directly in clean boiling water, the clean water will be contaminated with wax.

Solution: Before transferring the flask from the boiling detergent water to the clear water, wipe the outside of the flask with a clean towel. CAUTION: These flasks are very hot. Always handle them with a thick towel or protective gloves.[5,7]

200. *Error*: Delaying the transfer of the half flask into the second container of boiling clear slurry water.

Problem: If the flask is permitted to cool before it is transferred to the clear boiling water, any remaining residue may solidify, making it much more difficult to remove.[2,3]

Solution: Flush wax out of the flask into the container with detergent, and wipe residue off of the outside of the flask (see solution to error 199). Then transfer the flask to a clean holder, and immediately flush the flask with the clear boiling water in the second container.

201. *Error*: Failing to allow each half flask to drain and cool after it has been cleaned.[2,3]

Problem: If the liquid is not drained out of the flask, any wax residue that may have inadvertently gotten into the clear boiling water may recontaminate the stone investment.

Solution: It is difficult to stand the flask halves on their sides to let the water drain while they cool. A simple draining and cooling rack that will hold the flasks can be made of wood.[2,3]

202. *Error*: Failing to allow the flask halves to cool sufficiently before applying irreversible hydrocolloid separating medium[2,3] (also known as tin foil substitute or gypsum/resin separating medium).

Problem: If irreversible hydrocolloid separating medium (tinfoil substitute) is applied when the stone is hot and steaming, bubbles will form under the coating. The separating medium will peel off of the investing stone and thereby be rendered ineffective.

Solution: Allow the flasks to cool until they can be handled comfortably with bare hands but are still well above room temperature. The warmth of the flask will help the separating medium set.

203. *Error*: Failing to observe beading of the separating medium while painting it on the investing stone.

Problem: If the irreversible hydrocolloid separating medium will not paint on evenly over the investing stone and cast, an invisible film of wax may remain on the stone. The separating medium will not cover this contaminated surface uniformly, and the wax will not be thick enough to prevent resin from adhering to the stone.[2,3] Because the wax will dissolve slightly in the resin monomer, the monomer will force the wax deeper into the stone and allow resin to adhere to the stone.

Solution: Repeat the cleaning and scrubbing process, making certain that there is no wax in the container with the clear boiling water.

204. *Error*: Applying multiple coats of separating medium.

Problem: Adding multiple coats of irreversible hydrocolloid separating medium usually causes the previous coats to peel off.[2,3]

Solution: Irreversible hydrocolloid separating medium chemically reacts with the investing stone. After enough medium has been applied to react with the exposed stone, additional coats will only build up on the surface. Apply only 1 coat of separating medium if the investing stone is free of wax.[2,3]

205. *Error*: Carelessly applying irreversible hydrocolloid separating medium.

Problem: Any irreversible hydrocolloid separating medium on the teeth or metal of the framework may prevent resin from bonding properly. Even if the resin holds the teeth, other problems may occur. The irreversible hydrocolloid medium will remain and dry around the denture teeth and the metal framework as the RPD is processed. As the patient wears the RPD, the irreversible hydrocolloid separating medium will dissolve gradually, and the space left will be filled with food and bacteria, causing a thin black line to form around the teeth and parts of the framework covered by resin.

Solution: Use a fairly small, pointed brush to apply the separating medium to the investing stone between and around the teeth and under and around the framework.[8-11] Avoid getting the separating medium on teeth and the metal resin retention areas of the framework.

206. *Error*: Using inappropriate types of resin retention on the RPD framework.

Problem: Two basic methods for attaching the denture base resin and denture teeth to the framework are open retention and solid metal retention. Each has its own unique use, so the dentist should decide which is best for the specific patient. The open method places denture base resin next to the denture-bearing soft tissue; the solid method places metal next to the tissue (Note 1). If the wrong retention method is used, the resin may fracture prematurely, the soft tissues may become inflamed, or the patient may require a reline sooner than expected.

Solution: The dentist should use the information in error 207, error 208, and Note 1 as well as his/her own experience to select the type of retention that best fits the patient's oral condition[9] and to write an appropriate work authorization form for the laboratory.

207. *Error*: Using open retention when it is not indicated.

Problem: The ladder type of open retention is universal and can be used over most ridges, but it is especially indicated for immature, "green" ridges (namely, when the teeth have been extracted for fewer than 3 years). If the ridge is mature, a solid metal base should be used. The mesh type of open retention can be used for the same conditions as the ladder type, but it is least desirable for resin retention. It is very weak unless

Note 1. Methods for attaching denture base resin and denture teeth to the removable partial denture framework

Two basic methods for attaching the denture base resin and denture teeth to the metal framework are open retention and solid metal retention. There are 2 types of open retention: ladder and mesh. Both types of open retention require that a relief pad be placed over the edentulous ridge on the cast when the undercuts are blocked out. Both also permit the metal to wrap around the metal straps so that the acrylic resin is next to the soft tissue of the alveolar ridge and the metal retention straps are enclosed in the resin. Ladder-type open retention is preferred for use on immature ridges because the widely spaced ladder bars permit relatively easy access for painting irreversible hydrocolloid separating medium on the cast without contacting the metal and because, after it is in service, the RPD can be easily relined at chairside.

Laboratory personnel commonly use mesh-type open retention in the absence of instruction from the dentist because it can be applied quickly. If the technician does not reinforce the mesh around the edges, it will be more apt to break than ladder-type retention or solid metal retention. Because the openings in the mesh are small, there is inadequate access to the cast; it is impossible to paint the irreversible hydrocolloid separating medium under the mesh without getting it on the metal or having the medium puddle in some places.[9] When the irreversible hydrocolloid coating dries, a thin layer remains on the metal and prevents the resin from contacting the metal. The dentist and patient may not be aware that anything is amiss because the irreversible hydrocolloid separating medium is usually pink in color, like the resin. As the patient wears the RPD, the irreversible hydrocolloid coating will gradually dissolve and be replaced by food and bacteria, leaving a black color surrounding the mesh (see error 205).

Solid metal retention is the preferred choice for mature ridges where the extraction site has healed and recontoured and thus does not require relining soon. This method has several advantages over the open retention methods: It is stronger; is less likely to fracture (because the resin is placed on top of the metal to give it more support); and does not require internal finish lines, a relief pad, or placement of irreversible hydrocolloid separating medium underneath the metal. There are many options for holding the resin onto the solid metal base, including beads, nail heads, braided posts, reinforcement for reinforced acrylic resin pontics (RAP), flat back-facing retention, and retention for tube teeth; all can be cast along with the base. With the advent of new materials, resin may be bonded directly to a smooth metal denture base with or without an electro-etched surface on the base. Additional advantages of having metal rather than acrylic resin in contact with the edentulous soft tissue–bearing area include better fit, greater cleansability, increased strength, and thermal stimulation of the soft tissue through the metal base.[2]

it is expertly reinforced during the waxing of the framework. It is not possible to paint the cast with separating medium without contacting the metal (see error 205 and Note 1).

Solution: Choose resin retention areas thoughtfully. Use open retention when there is a need for frequent relines, but switch to a new RPD with a solid metal base when the ridge matures. Avoid the use of mesh retention.

208. *Error*: Using solid metal retention over an immature ridge.

Problem: Solid metal retention should be reserved for well-healed ridges, as it is difficult to reline at chairside when an immature ridge is healing and shrinking.

Solution: As extraction sites heal and the edentulous ridge resorbs, the RPD should be relined frequently. An RPD with open retention is easier to reline at chairside. The patient can be kept comfortable with chairside relines for several years, if necessary, until the ridge matures.[8] At that point, a new RPD with solid metal retention should be used (see error 207 and Note 1).

MIXING AND PACKING ACRYLIC RESIN

209. *Error*: Packing resin into the flasks before allowing them to cool to room temperature.

Problem: If the flask is too warm when the resin is packed, some of the liquid in the resin will volatilize. As a result, the resin will become stiff and granular, and it will not flow well when packed.

Solution: After coating the stone in the warm flasks with irreversible hydrocolloid separating medium, allow them to cool to room temperature before packing the resin.[6]

210. *Error*: Mixing acrylic resin liquid and powder in an unsealed container while preparing a packing mix.

Problem: If the resin mix is granular and does not smooth out by the time it should be ready to pack, it usually indicates a lack of control of the mix. This may occur if the manufacturer's instructions for liquid-to-powder proportions are not followed or if some of the liquid evaporates before it can penetrate the granules of powder. An uncontrolled mix will not flow properly during the packing process.[3]

Solution: Keep the correctly proportioned mix of acrylic resin in a tightly sealed jar until it is ready to pack.

211. *Error*: Handling the resin mix with bare hands.

Problem: Acrylic resin liquid is a solvent. If it is handled with bare hands, oil and dirt on the hands may dissolve and be incorporated into the mix, leaving dirty streaks in the processed resin.

Solution: Handle the mix with clean 4 × 4-in. polyethylene sheets that are 0.001 in. (0.035 mm) thick or with polyethylene gloves to prevent contamination of the resin. Remember that acrylic resin liquid can cause adverse skin reactions in some people. Always avoid skin contact with the liquid as well as breathing the vapors.[3,6]

212. *Error*: Failing to test the acrylic resin mix to determine when it is ready to pack (Note 2).

Problem: Packing the resin too soon will result in an underpacked or incompletely filled mold, and the mix may stick to the polyethylene sheet when trial packing. If the resin is packed too late, it will be stiff and will not flow well, and an excessive amount of pressure will be required to close the flask.[3]

Solution: Place the mix in a sealed jar for approximately 10 minutes. Then open the lid, and stir the mix with a stainless steel cement spatula. If the resin is sticky and adheres to the side of the jar, wait a few more minutes, and check it again. When the resin does not adhere to the side of the jar, it is ready to pack.

Note 2. Denture base resins

There are many brands and types of denture base resins. Those referred to in error 212 are for conventional pressure packing. Even these resins may require the resin to be packed sooner than recommended in the solution to error 212. There are injection materials, chairside reline materials, soft lining materials, vinyl materials, repair materials, premixed materials, and materials made especially for microwave processing. Follow the manufacturer's recommendations for each product carefully, and be familiar with the working properties of the type and brand of products that you use.

213. *Error*: Underfilling the mold in the first trial pack.

Problem: If the estimated amount of resin taken out of the mixing jar is not enough to fill the mold at the first trial pack, more resin from the jar must be added. Moreover, if the added material is stiffer than the first pack because it has had longer to set, it may force the teeth into the stone cap or cause the investment to break.

Solution: It is better to overfill the mold slightly than to add more resin after the first closure of the flask. Make a rope of the ready-to-pack resin large enough to slightly overfill the desired space, and force it into the mold with covered fingers until the mold is overfilled. Then proceed with the first closure.[3,9]

214. *Error*: Neglecting to place a polyethylene sheet between the 2 flask halves when trial packing the resin.[2,3]

Problem: If a polyethylene sheet is not placed between the 2 flask halves, the resin may be pulled away from both halves when the flask is opened. The resin may adhere enough to the stone in one part of the flask to pull the bulk of the resin out of the other part of the flask.

Solution: A polyethylene sheet prevents the acrylic resin from adhering to the stone and irreversible hydrocolloid separating medium. Always insert a sheet of polyethylene (4 × 4 in. and 0.001 in. thick) between the halves of the flask before it is closed for trial packing procedures.[2,3]

215. *Error*: Using a hydraulic press to close the flask when packing acrylic resin.[3,9]

Problem: A hydraulic press closes the flask so rapidly that the excess resin does not have time to flow out of the mold; tremendous pressure thus builds. This may increase the vertical dimension of occlusion or fracture the stone investment.

Solution: A hydraulic press is capable of applying approximately 20 times more pressure than the flask and investing stone can withstand.[3] Use a hand press for trial packing. It will not be possible to apply as much pressure, and the slower operation will allow the excess resin to flow out of the mold.

216. *Error*: Using a hand press improperly.

Problem: Even when a hand press is used, the flask in the press can be closed too rapidly and thus not allow the acrylic resin to flow out of the mold. Pressure buildup may result in an increased vertical dimension of occlusion.

Solution: To eliminate excess pressure, close the hand press until it meets resistance. Wait a minute for the resin to flow before giving it another turn. Repeat this until the hand press cannot be turned any more. Allow time for the resin to flow before opening the flask to trim the flash.[2]

217. *Error*: Trimming the flash with a sharp knife during trial packing.

Problem: A sharp instrument cuts into the stone investment and dislodges flakes, which may become imbedded in the acrylic resin.[10]

Solution: Use a hand instrument (such as an unheated No. 7 wax spatula) to scrape the flash away without cutting the investing stone.[3,9]

218. *Error*: Inadequate trial packing.

Problem: If a considerable amount of flash is present after the RPD is processed, the packing may not have been performed satisfactorily. This usually increases the vertical dimension of occlusion.[3] Causes of poor trial packing may include too few trial closures or failure to apply adequate packing pressure because the hand press was not in good working order.

Solution: Examine the hand press periodically to determine that it is in good working order and closes easily. Apply a small amount of waterproof grease to the threads. The trial packing process must continue until no more flash appears, which usually takes 3 or 4 closures.[3]

219. *Error*: Failing to recoat the exposed stone in both halves of the flask with irreversible hydrocolloid separating medium after the final trial pack.[2]

Problem: After several trial packs with the polyethylene sheet between the halves of the flask, the irreversible hydrocolloid separating medium will have been partially removed. Failure to recoat the stone

may allow the stone investment to adhere to the acrylic resin as the resin polymerizes.[2]

Solution: Recoat the exposed stone investment surfaces with irreversible hydrocolloid separating medium, but cover only the stone investment. If the irreversible hydrocolloid separating medium covers the acrylic resin in either of the flask halves, the resin will not adhere to itself in those areas. It is not necessary to wait for the coat to dry before closing the flask.

220. *Error*: Failing to remove the polyethylene sheet from between the flask halves when they are assembled for processing.[3]

Problem: If the polyethylene sheet is left between the halves of the flask when the RPD is processed, the framework and base will separate from the teeth.

Solution: Remember to remove the polyethylene sheet before processing.[3]

PROCESSING THE ACRYLIC RESIN

221. *Error*: Failing to allow the packed flasks in the compress to set on the bench before heating.

Problem: If packed flasks are placed in hot water too soon or are brought to boiling too quickly, the liquid will have a tendency to boil and develop porosity in the denture base resin.[7]

Solution: After the flasks are packed and clamped in the hand press, allow them to set on the bench for 30 minutes to 1 hour before placing them in the polymerization unit in room temperature water. Then slowly bring the water temperature to 160°F.[2]

222. *Error*: Failing to end the polymerization cycle in boiling water.

Problem: Acrylic resin can be polymerized at a temperature of 160°F. However, the residual monomer will not be eliminated without boiling. If the patient is sensitive to liquid monomer, he/she may experience a reaction to any residual liquid.[3,6]

Solution: Hold the packed flask at a temperature of 160°F for at least 4 hours; then raise the temperature to boiling and hold for at least 30 minutes[3] (see solution to error 221).

223. *Error*: Removing the flasks from the press before allowing them to cool to near room temperature.[3]

Problem: The flasks and RPD should cool gradually rather than be forced to cool quickly by contact with cold water. Rapid cooling may induce stresses that will strain and warp the RPD.

Solution: After removing the press from the boiling water, let it sit on the bench until it cools enough for the flasks to be handled easily with bare hands. At this point, the flasks can be immersed in tap water to complete the cooling before they are opened.[3] If time permits, the flasks may be left in the press in the water until the entire cooking apparatus cools to near room temperature.

DEFLASKING AND POLISHING THE RPD

224. **Error*: Prying open (between the top and bottom halves of the flask) the flask in which the RPD is processed.

Problem: Flasks in which most RPDs are processed can be pried open between the top and bottom halves of the flask, but this is a dangerous procedure. If the denture teeth bind in the upper half of the flask, the framework may be distorted.

Solution: Remove the investment and the partial denture in 1 piece with the use of a flask ejector. Then remove the investment in smaller pieces.

225. **Error*: Hurriedly removing the investing stone in large pieces.

Problem: Prying loose large pieces of the stone investment may warp the framework or bend a clasp. If the framework is warped at this stage, the only remedy is to start over with a new impression and new framework.

Solution: Cut the investment into smaller pieces with a saw, knife, or pneumatic chisel. Be careful not to nick the metal or plastic or cut into the denture teeth. If the resin is nicked, it may be necessary to polish it out or repair the nick with autopolymerizing resin. Depending on their depth and location, some nicks in the metal may be polished out without weakening the framework.[2,8,9] If the denture teeth are damaged, they can be replaced.

226. *Error*: Removing the RPD from the cast before processing errors have been eliminated.[3]

Problem: After processing, the denture teeth are almost always in hyperocclusion. When the RPD is removed from the definitive cast on which it was processed, the cast is usually destroyed; thus processing errors cannot be eliminated on the articulator. If the RPD has been removed from the cast or cannot be replaced in the articulator to adjust the occlusion, adjustment must be accomplished intraorally. Failure to correct the occlusion on the articulator will cause extra chairside work and patient discomfort.[2,9]

Solution: After the RPD is recovered but before it is removed from the cast, remount it in the articulator and correct any processing errors. This will make the final intraoral occlusal adjustment much easier (see solution to error 240).

227. **Error*: Carelessly removing the RPD from the cast.[4]

Problem: If an RPD is removed from the cast by prying before the clasps are freed, it will be easy to bend the clasps or warp the framework.[2,8]

Solution: Before trying to remove the RPD from the cast, use a knife or a bur to cut off the stone teeth that the clasps engage; then carefully pry the denture base resin free from the cast.

228. *Error*: Carelessly using an arbor band to trim the resin.[2,8,9]

Problem: Using an arbor band in a bench lathe is usually the fastest way to remove flash and shape the denture base, but this procedure makes it easy to scratch the metal. If the metal is scratched at this stage, the scratches will have to be finished out with a rubber wheel, and the metal will have to be repolished with polishing compound.[2,8] The repolishing process may damage the resin by overheating it: Polishing compound may be embedded in the resin, or the resin may be overfinished because it is softer than the metal.

Solution: Use the arbor band, but be careful not to scratch the metal. The exercise of extra care can prevent errors that will require significant time for repolishing.

229. **Error*: Carelessly using a cloth wheel and pumice.

Problem: If the finisher uses a large-diameter cloth wheel with pumice and is inattentive while polishing an RPD with polymer denture teeth, the facial and lingual contours of the denture teeth themselves may be destroyed. When the loss is considerable, the damaged teeth must be replaced.

Solution: Use wheels and cones that are appropriate for the situation. It is especially important to use a smaller cloth wheel or cone on the lingual aspect of the maxillary RPD. Areas that cannot be reached with a cloth wheel or cone can be pumiced with a prophy angle and cup.

230. *Error*: Using a cloth wheel that has not been prepared correctly (Note 3).

Note 3. Breaking in a new cloth wheel

Put a new cloth wheel on a sturdy bench lathe, and turn the lathe on high speed. Run the new cloth wheel against the backside of a knife blade; a solid-handle stainless steel dinner knife is the ideal tool for this procedure. Because it is a messy job to fray the cloth wheel (lint and small pieces of cloth fly off), it is necessary to use the lathe pan and turn the vacuum on. After several turns of the cloth wheel against the knife blade, strings will appear at the periphery of the cloth wheel. Cut these off with scissors, or singe them off by slowly hand rotating the mandrel with the cloth wheel over a small flame. Repeat the procedure as long as strings appear. The cloth wheel is broken in and ready for use when strings no longer appear.

Problem: Using a cloth wheel that has not been broken in properly may result in injury to the operator and damage to the RPD. A new cloth wheel has strings of the material protruding from it. The strings can become tangled in the clasps or other parts of the RPD, snap the RPD from the operator's hands, and throw it with great force.

Solution: Always use cloth wheels that have been broken in properly or are worn down.

231. **Error*: Carelessly using a cloth wheel when polishing an RPD base.

Problem: It is very easy for a large cloth wheel to catch the edge of the denture or become tangled in a clasp arm, jerking the RPD out of the hands and throwing it forcefully. The damage to the operator's fingers and the RPD can be severe.[8,9]

Solution: Be alert to the possibility that clasps and other parts of the RPD may become caught in the cloth wheel. As much as possible, cover the clasp tip with a finger and/or use the wheel so that it rotates away from the clasp tips.

232. *Error*: Using coarse pumice to polish the denture base resin.

Problem: Coarse pumice leaves scratches that must be removed by some other polishing agent. Time is thus wasted.[7]

Solution: Flour of pumice will cut just as fast as coarse pumice, and the former leaves a smooth finish.

233. *Error*: Using a cloth wheel to polish around the denture teeth.

Problem: It is difficult to adequately polish around the necks of denture teeth with a cloth wheel or a lathe-mounted bristle brush without damaging the contours of the teeth.

Solution: Use a prophy cup or brush and flour of pumice to polish around polymer denture teeth in interproximal areas and other areas that cannot be reached with a cloth wheel.[7] These tools are relatively easy to use and will not damage the polymer teeth.

234. *Error*: Using the same cloth wheel with various polishing materials.

Problem: It is a mistake to use different types of polishing materials on the same wheels and brushes. The polishing always reverts to the scratches made by the residue of the coarsest material used, making it much more difficult to achieve a highly polished surface. Polishing metal leaves a black residue, which will be carried by the wheels to other parts.

Solution: Make a set of cloth wheels, cups, brushes, felt wheels, and cones for each of the various applications. For example, have 1 set for pumicing acrylic resin and another for restorations with metal components. Make another set for the brown cutting compounds. Make yet another set for high shine, with white polishing compound for acrylic resin and rouge for metals. Keep the sets in small boxes or bins marked appropriately. Polishing is much easier and quicker when this procedure is followed.

235. *Error*: Using detergent alone to clean the RPD after polishing.

Problem: Detergent alone will not adequately cut or remove polishing compound from the RPD. Remaining

residue will prevent the RPD from achieving its full luster.

Solution: Use a warm solution of tincture of green soap and ammonia with a soft brush to remove the polishing compound and to bring out the luster on both the metal and plastic (see Part II, errors 161 and 163). After cleaning, always rinse the RPD thoroughly with clean water. Store the RPD in water to prevent the acrylic resin from drying out and warping.[2]

FITTING AND ADJUSTING THE RPD TO THE MOUTH

236. *Error*: Failing to evaluate the denture border when first evaluating the completed RPD intraorally.

Problem: An undercut in the soft tissue denture base area can be very difficult to locate and judge for adjustment. If the RPD is seated too rapidly or firmly, the patient may experience pain.[12]

Solution: The plastic part of the denture base is the only concern at this time. The framework should have already been evaluated and fitted to the patient's mouth.[12] Flow a bead of white disclosing wax around the resin borders of the RPD. Carefully seat the RPD in the mouth until the patient can feel pressure caused by the borders, and then remove the RPD and look at the areas where pink plastic shows through the white wax. These areas of the border should be trimmed (see error 237).

237. *Error*: Excessively trimming the denture base where pink resin shows through the disclosing wax.[8,13]

Problem: Grinding more or less of the denture base than necessary will not give the desired results.[12] Failing to identify the correct areas will prolong the fitting process. Removing too much resin will leave spaces under the denture base or shorten the borders, thus reducing tissue support and contributing to food collection under the denture base.

Solution: Remove only the denture base border that shows through the wax. The denture base will show through the white wax only where the base is binding on the ridge. It is very specific. Add more disclosing wax to the area and continue the procedure until the RPD can be seated without wiping off the wax or hurting the patient. Several repetitions of the procedure usually are needed to seat the base properly. The inside (sharp) edge must be rounded slightly before each application of wax to prevent injury to the patient.

238. **Error*: Failing to determine that the denture borders are overextended.

Problem: An overextended RPD border may not make the patient's mouth sore, but it may place constant pressure on the teeth in contact with the RPD. Just as with an orthodontic appliance, light steady pressure can move these teeth.

Solution: Flow a bead of disclosing wax around the borders of the RPD base, and hold the base in place intraorally while manually muscle trimming the borders by pulling on the cheeks. On the lingual aspect of the mandibular RPD, have the patient protrude the tongue and extend it into each cheek. All movements should be made to the maximum extent.[12] Trim the borders until the plastic denture base does not show through the disclosing wax.[2]

239. *Error*: Not polishing areas that have been adjusted.

Problem: If the borders are not polished, they may abrade and injure the soft tissue.

Solution: Take time to smooth and highly polish the edges of the denture base.

240. *Error*: Failing to adjust the occlusion intraorally.

Problem: Even if the RPD was remounted after processing and the occlusion was adjusted to remove processing errors, the occlusion must be adjusted intraorally (see error 226). Mounting inaccuracies or flaws in the casts may cause errors in the final occlusion.[13] If the occlusion is left high on an RPD, the patient will keep biting the RPD until it seats, thereby damaging the teeth and supporting tissues.

Solution: Adjust the occlusion first in the centric relation position, then in protrusive, right lateral, and left lateral excursions. Use 0.0005-in. thick shim stock to finalize the occlusal contacts (see Part II, Note 1).

241. **Error*: Failing to show the patient how to seat and remove the RPD.[13]

Problem: If the patient does not seat the RPD correctly, he/she may warp the RPD or be injured by it.

Solution: Demonstrate how to place the RPD in the patient's mouth so that it is centered on top of the teeth and how to push the RPD into place with the fingers. Warn the patient about the destruction that may result if he/she bites on the RPD to seat it.[13]

242. **Error*: Failing to tell the patient how to care for the RPD.[13]

Problem: Studies have shown that more clasps are bent and RPDs distorted from being dropped in an unprotected washbasin than from any other cause. The second most common reason for loss of RPD use is accidental disposal of the RPD.

Solution: Instruct the patient to partially fill his/her sink basin with water when cleaning the RPD; if the RPD slips out of his/her grasp, the water will break its fall. Also instruct the patient to place the RPD, when it is out of the mouth, in a special and easily recognizable container filled with an appropriate cleansing solution. A drinking glass is not recommended because someone may discard the contents of the glass without realizing that it is being used for RPD storage.

243. *Error*: Failing to make a follow-up appointment for the patient.[13]

Problem: If the patient is allowed to decide when a

follow-up appointment is needed, he/she may postpone it for as long as possible. Patients often wait until something really hurts before coming in for a follow-up appointment. By this point, irreversible damage may have occurred.[13]

Solution: Schedule the first follow-up appointment for the day after the patient receives the RPD. When the patient returns for that visit, thoroughly examine the entire mouth, both with the RPD in place and with it out of the mouth. Look for red spots or cuts in the soft tissues. Move each tooth contacted by the RPD to determine whether any teeth are sore. Use white disclosing wax inside the clasps and on the intaglio of the denture base to find areas of the denture that require correction. Most potential problems can be eliminated before the patient is aware that a problem exists.

DISCUSSION

Parts I through III of this article were not written to place blame on anyone in particular for errors that may occur during the fabrication of an RPD. A single person usually is not responsible for committing all of the errors that affect the fit of an RPD. Instead, everyone who participates in the production process must share in the success or failure of the restoration.

The dentist and dental assistant, both before and after the commercial laboratory procedures, are responsible for completing the appropriate mouth preparation, making the impressions, pouring the casts, making jaw relation records, surveying and designing the diagnostic casts, indexing the casts, mounting the casts in an articulator, creating the work authorization order, accepting the framework, fitting the framework to the patient's mouth, intraorally evaluating the tooth arrangement and waxed RPD, fitting the completed RPD to the patient's mouth, instructing the patient about proper RPD care, and providing follow-up services.

Laboratory personnel responsibilities include (but are not limited to) accepting the work from the dentist; transferring the design to the definitive cast; surveying and blocking out the definitive cast; duplicating the cast to make the investment cast; waxing the framework; investing, burning out, and casting the framework; finishing and polishing the framework; inspecting the framework for quality; arranging the denture teeth; waxing, processing, and finishing the denture base; and inspecting the RPD before returning it to the dentist.

Some errors in and of themselves will not have a noticeable effect on the final product. However, errors do have an accumulative effect: the more that are made, the greater the inaccuracy, and the more that are eliminated, the better the result.

It probably is not possible to eliminate every potential error; nonetheless, the goal should be to strive to eliminate all of them and provide a better service for the patient. Some errors that are serious enough to require a new impression are subtle and may not be evident until the framework is completed and the dentist finds that it will not fit the mouth. Other errors can be detected when they are made. The sooner an error is discovered, the sooner the process can be started anew. Early recognition of errors saves time and money.

Parts I through III of this article are by no means a complete listing of all errors that can be made when an RPD is fabricated. Nor does this article cover all kinds of impression materials, investments, and metals for casting frameworks or all of the various methods for making RPDs. The 243 potential errors described are a generic set intended to illustrate the principles and practices that may be applied to the fabrication of an RPD with the use of any procedure.

SUMMARY

The secret to a successful RPD is attention to minute details. It takes no longer to do it right the first time than to correct mistakes down the road. To paraphrase an old saying, the most important step in making a removable partial denture is the step being done at any given moment. Our hope is that this article will help eliminate some of the errors that can be made by those who handle the materials used during the fabrication of an RPD and perform the procedures required for that process. The dental team's ultimate goals should be to produce RPDs that are a credit to the dentist and technician, improve the patient's well-being, and satisfy the patient's needs.

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Noteworthy Abstracts of the Current Literature

Rehabilitation of patients with severely resorbed maxillae by means of implants with or without bone grafts: A 3- to 5-year follow-up clinical report.
Widmark G, Andersson B, Carlsson G, Lindvall AM, Ivanoff CJ. *Int J Oral Maxillofac Implants* 2001;16:73-9.

Purpose. The prognosis for implants in the atrophic or resorbed maxilla is lower than in areas with less bone loss. Grafting procedures may allow the use of implants, but they are frequently associated with further degradation in prognosis. This study compared the treatment outcome of patients who received maxillary tissue-supported or implant-supported prostheses. Implant-supported prostheses were further divided into groups of patients with or without bone grafting.
Material and methods. Forty-three patients with severe maxillary resorption were assigned to 1 of 3 treatment groups: bone graft and implant placement (graft group; n = 16), modified implant placement without grafting (trial group; n = 20), and optimized dentures (no implant group; n = 7). Patients were evaluated annually for a period of 3 to 5 years to assess implant survival, bone loss surrounding implants, resorption of grafted bone, and responses to a questionnaire. Grafting procedures primarily used 1-stage techniques (n = 68), although some implants were placed into consolidated grafts (n = 33). Grafts were harvested from iliac crest donor sites. Implants in the trial group were placed with threads covered by bone chips, guided tissue regeneration, novel implant positions, and small implant sizes.
Results. At 12 months of clinical loading, the implants in the graft group demonstrated an 82.2% cumulative survival rate; implants in the trial group showed 95.8% cumulative survival at the same period. Implant losses in both groups occurred during years 1 to 3 but reached a steady state after that time. The cumulative survival rate for the graft group at years 4 to 5 reached 74.1%; the trial group demonstrated 86.7% survival at that time. No differences were seen in marginal bone loss for the 2 implant groups. All patients in each group expressed a willingness to undergo the same treatment again.
Conclusion. The results of this study are consistent with previous findings that demonstrate a higher risk of implant failure in patients with severe maxillary resorption. Implant loss diminished with time, resulting in a steady state of implant survival. 33 References. —*SE Eckert*