Impressions in Fixed Prosthodontics

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COURSE AUTHOR

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COURSE OBJECTIVES

Upon completion of this course, the participant will have developed a clearer understanding of product classification, material properties, preparatory considerations, tray selection, mixing techniques and disinfection. This course was written for dentists, hygienists and dental assistants.

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Impressions in Fixed Prosthodontics

A satisfactory impression must precisely reproduce the prepared tooth and adjacent structures to permit the fabrication of a successful prosthesis. Reproduction of sufficient tissue cervical to tooth preparation margins is critical to ensure appropriate axial contours in the completed restoration. As prosthesis complexity increases, accurate reproduction of teeth elsewhere in the arch becomes more important. For instance, reproduction of the lingual concavity of the maxillary anterior teeth influencing a patient's anterior guidance is critical when undertaking a complex posterior reconstruction, but is of less concern when fabricating a simple posterior restoration.

The most current available elastomeric impression materials are capable of highly accurate reproduction of prepared teeth and surrounding structures. Indications and manipulation vary, however. With the intent to assist the practitioner to make informed choices leading to predictable results, this course classifies available impression materials, discusses relevant material science considerations by material, reviews preparatory procedures for successful impression making such as tissue management, tray selection and mixing techniques, and concludes with a review of recommendations for disinfection.

PRODUCT CLASSIFICATION

ANSI/ADA specification #18 lists minimally required physical properties for aqueous impression materials, whereas ANSI/ADA specification #19 lists applicable product requirements for ADA certification of non-aqueous elastomers of varying viscosities.

Aqueous elastomeric impression materials contain water. Two products are presently in use: the irreversible hydrocolloids (alginate) and the reversible hydrocolloids (agar).

Non-aqueous elastomeric impression materials are subdivided into four major categories: polysulfide rubber materials, condensation silicones, polyethers, and addition silicones. In addition to the former, photo-activated polyether urethane impression materials were developed, but due to inherent deficiencies, failed to gain market share. (The advantages and disadvantages of the currently available choices are summarized in Table I.)

MATERIAL PROPERTIES

Irreversible Hydrocolloid

The water-soluble alginates consist of sodium or potassium salts of alginic acid. These react with calcium sulfate and form insoluble calcium alginate. Other ingredients include diatomaceous earth (a filler providing desired consistency), sodium phosphate, and similar compounds to control the setting rate and to extend the working time of the material. After these are consumed in the initial phase of the chemical reaction, gel formation begins. The reaction rate can be influenced by varying the temperature of the mixing water. Higher temperatures and extended spatulation are convenient ways to accelerate setting. Because set alginate consists largely of water, it is subject to imbibition and syneresis resulting in distortion. Therefore, these impressions should be poured at once.

Zinc oxide is added to some products to control setting time, and potassium titanium fluoride may serve as a hardener assisting the development of a dense and presumably more abrasion-resistant gypsum surface. Small quantities of glycols are sometimes added to render the material dustless. Additionally, quaternary ammonium compounds are added by some manufacturers for their anti-bacterial and anti-fungal effects. Nevertheless, additional disinfection procedures are needed to ensure appropriate levels of protection for dental personnel.

Reversible Hydrocolloid

Reversible hydrocolloids are derived from agar, a polysaccharide. If poured immediately, the material results in casts of good accuracy and surface detail. Agar changes from gel to solid at 210°F. It remains in that state as it cools to 122°F and forms a gel on further cooling.

Reversible hydrocolloid is available in multiple viscosities. Typically, a heavy-bodied tray material is combined with a more fluid syringe material. Temperature change is controlled with a conditioning unit and water-cooled trays.

The reversible hydrocolloids lack dimensional stability as water is readily released or absorbed (again through syneresis and imbibition). Accuracy improves when the material is used with as much bulk as realistically feasible. Therefore, using the largest size tray that can still be conveniently inserted is recommended.

A typical reversible hydrocolloid consists of 80-85% water and 12-15% agar. Small quantities of potassium sulfate, borax, and alkylbenzoate may also be present. Although efforts have been made to add silicone polymer to these materials to improve tear strength, reduced levels of cross-linking adversely affect its dimensional accuracy.

Polysulfide Rubberbase

The polysulfides were introduced about forty years ago. Because of their improved dimensional stability and tear strength, especially by comparison to the hydrocolloids, their introduction was applauded by the profession. Nevertheless, this material should be poured as soon as possible after impression making. Otherwise, clinically significant dimensional change results.

Water is a by-product of the polysulfide polymerization reaction. Its evaporation results in a slight contraction of the polymerized material, which can be minimized through the use of a custom tray

Table I: Impression Materials: Advantages and Disadvantages by Product Type

	Advantages	Disadvantages
Irreversible Hydrocolloids	Easy manipulation Short working time Patient acceptance Low cost	Pour only once with reasonable accuracy Limited accuracy/detail reproduction
Reversible Hydrocolloids	Hydrophyllic nature Long working time Low cost	Special equipment needed/cost Special trays require watercooling Requires advance preparation Must be poured immediately
Polysulfide Polymer	High tear strength Comparatively easy to pour Accurate through third pour if poured immediately	Poor patient acceptance (odor) Long setting time Distortion over time Hydrophobic Should be poured within one hour
Condensation Silicone	Short setting time Easy use	Hydrophobic Low dimensional stability More difficult to pour than polysulfide
Addition Silicone	Excellent dimensional stability Short setting time Automix cartridges	Hydrophobic H2 release of some materials More difficult to pour than polysulfide
Polyether	Excellent dimensional stability & accuracy Short setting time Automixing available Suitable for implant impressions	Imbibition Short working time Rigidity can cause cast fracture
Polyether Urethane	Can vary working time No mixing required (premixed) Dimensional accuracy High tear strength	Special transparent tray required Potential for incomplete polymerization Higher viscosity Rigidity

Adapted in part from: Rosenstiel S.F., Land M.F., Fujimoto J. Contemporary Fixed Prosthodontics, 2nd Edition, Mosby-Yearbook, Inc. 1995, p. 307

as this reduces material thickness. Polysulfides are typically dispensed as two paste systems and are available in low, medium, and high viscosities. The relatively high viscosity of the pastes precludes development of an automix cartridge that is available for many other products. Different viscosities can be combined; they polymerize simultaneously. A chemical bond of adequate strength has been shown to result.

Its high tear resistance makes polysulfide useful for impressions of deep sulcular areas and pinholes. Although accurate enough to index Fixed Partial Denture components on a third pour (provided that pours are made immediately after impressing at about 30 to 45 min. intervals), the material is less dimensionally stable than either the addition silicones or the polyethers. Patients dislike its sulfide odor (reminiscent of the smell of rotten eggs) and long setting time (8-10 min.). High humidity and temperature significantly shorten the working time of the polysulfides. Temperatures near 77°F, not unusual in warmer regions, especially when combined with high humidity, cause accelerated polymerization. Should this occur prior to insertion, serious distortions may result after impression removal due to the relaxation of intraorally compressed and prematurely formed polymer chains.

Composition and Polymerization: the base material consists of approximately 80% polysulfide polymer, 17% zinc sulfide, and titanium dioxide, which contributes to the white color of the material. Additives may include stearic acid, dibutyl phtalate, and selected pigments. The catalyst contains up to 70% lead-or copper-dioxide, and 30 to 35% of dibutyl or dioctyl-phtalate, as well as small amounts of sulfur and magnesium stearate. Polymerization of the original polysulfides was based on lead-dioxide PbO_2, resulting in the gray-dark-brown color of the resulting polymer. Subsequently, hydrated copperoxide $[Cu(OH)_2]$ and cumene-hydroperoxide have been used in single-mix polysulfides (the copper-based materials having a green color) with reduced setting times, leading to improved product acceptance.

However, the lead-based products are slightly more accurate and dimensionally stable. Upon polymerization, the impression is sticky, and incompletely mixed portions can stain clothing permanently. The polysulfides are less costly than the more recently developed addition silicones and polyethers. Some brands of polysulfide have working times exceeding any of the more recently developed elastomeric impression materials. This helps explain why a significant number of experienced practitioners continue to use polysulfide for complex impressions that mandate optimally extended working time.

Condensation Silicone

Being virtually odorless and of neutral taste, the condensation silicones overcame several disadvantages associated with polysulfide. They are less affected by changes in humidity and temperature, and their shorter intraoral setting times (5 to 7 min.) contributed to improved patient acceptance. On the negative side, tear strength is modest by comparison to the polysulfides, and condensation silicones exhibit the least dimensional stability of the non-aqueous elastomeric impression materials.

Silicone impression material is available in four viscosities ranging from very high to low. When the new very high viscosity material evolved, usually referred to as "putty" consistency, it led to changes in impression technique using combinations of putty tray and light body wash materials. This facilitates subgingival impression making as increased hydraulic pressure results during seating of the impression tray because of the rigidity of the putty. Spacers, such as polyethylene sheets, are available to create the necessary room for the lower viscosity wash material.

Care must be taken to prevent contamination of the putty surface prior to placement of the wash material as incomplete adhesion may occur between the two layers. Also, it is important to avoid inadvertent compression of the polymerized putty when reseating the impression tray with the wash material.

Condensation silicones are extremely hydrophobic, which results in poor wetting characteristics. Thus, moisture control is critical when making impressions, and pouring bubble-free impressions is difficult. Accordingly, routine use of surfactants has been recommended.

Composition and Polymerization: the base material contains polydimethyl siloxane with copper carbonate or silica carbonate as a filler in addition to plasticizers and pigments. Typically, the catalyst contains tin octoate and alkylsilicate. Thickeners may be added to give the mixed material the desired viscosity. Some additives limit material shelf life. Because the condensation polymerization reaction forms ethyl alcohol as a by-product, its evaporation causes dimensional contraction of the impression, which necessitates immediate pouring.

Polyether

The polyethers were initially developed in Europe in the late 1960s. These two-paste systems have a polymerization mechanism that does not produce a volatile by-product. Accordingly, these impression materials have excellent dimensional stability. Polymerization shrinkage is very low, although thermal expansion is comparatively high. The polyethers are available in three viscosities that can be varied through addition of modifiers, albeit at the expense of dimensional stability. The material is dispensed in tubes and automix cartridges, and a bulk-dispensing mixing machine is available as well.

Working time and setting time of the polyethers is short. This is an advantage when simple procedures are performed, but limits their application for complex multi-abutment fixed partial dentures.

Provided the material is stored dry, accurate casts can be produced even after three pours and for up to two weeks after making of the initial impression. Combined with the short intraoral setting time (3 to 5 min.), these characteristics have made polyethers a popular choice for many prosthetic procedures.

The stiffness of set polyether can be advantageous or a hindrance. For example, when making impressions for implant supported prostheses, accurate repositioning of impression transfer copings is facilitated; conversely, in the presence of even moderate tissue undercuts, impression removal can be nearly impossible and cause fracture of stone casts. Single teeth and mandibular incisors are especially prone to fracture.

Through imbibition, the polyethers absorb moisture, which results in significant expansion. This hydrophillic nature of the material before, during, and after setting results in lower contact-angles by comparison to the addition silicone impression materials. While this may suggest that the material is slightly more tolerant of intrasulcular moisture than silicones, the difference is probably not of clinical significance.

Allergic hypersensitivity to polyether has been reported including complaints of burning, erythema, and itching.

Composition and Polymerization: The base material typically consists of the polyether polymer, pigments, and filler materials such as silica and glycol ether. The catalyst contains sulfonate esters, plasticizers, thinners, and pigments. The polyether polymer is of low molecular weight and has terminal imine groups that react with the catalyst, resulting in polymerization to a rubber.

Addition Silicone

Polyvinyl siloxane, also known as addition silicone, was introduced in the 1970s. Although chemically similar to condensation silicone, addition silicones have far superior dimensional stability equivalent to, or even exceeding that of, the polyethers.

The material is available in consistencies ranging from putty to light body, and is dispensed in tubs, tubes, and automix cartridges. Although monophase material is available, its use reportedly increases the prevalence of bubbles. Usually, two viscosities are used in a putty/wash technique.

Once set, the addition silicones are less rigid than the polyethers, making cast removal easier and fracture less likely to occur. Addition silicones, particularly the putties, reportedly are subject to setting inhibition caused by some brands of latex gloves. Clinically, if a tacky surface remains on the impression, this may result from contact between gloved hands and surrounding tissues. Cleansing of the area and coating of the tissue with a varnish such as Cavilax® can prevent this. With putty systems, it is important to select glove brands that do not affect the setting reaction, or alternatively, to knead the materials without gloves.

Addition silicones are hydrophobic. Surfactants have been added to some materials, resulting in more hydrophilic properties.Wettability then is comparable to that of the polyethers, although without the dimensional change. Hydrophillic addition silicones have demonstrated improved wetting by type IV stone. The dimensional stability of the material over time allows multiple pours of reliable accuracy to be made.

Adverse soft-tissue responses comparable to those for polyethers have also been reported for addition silicones.

Composition and Polymerization: The base material consists of polysiloxane, a low molecular weight polymer with silane groups, fillers, plasticizers, and pigments. The catalyst contains a low molecular weight polymer with a vinyl terminal group, plasticizers, pigments, and fillers. As no by-products result from the polymerization reaction, dimensional stability is excellent. Compared to the other materials, working time is shortened by elevated temperature. If hydroxyl groups are present, as in some of the earlier materials, porosities may result on the surface of poured casts because Hydrogen gas is released as the result of a secondary chemical reaction. Although this problem can be overcome by delaying the pouring of the impression for several hours, addition of scavengers that bind hydrogen has resolved this problem in the more recent formulations.

Light-Activated Impression Materials

With the increased use of light-activated restorative materials, light-activated impression materials were developed during the late 1980s. The apparent advantage of such materials was their "unlimited" working time, eliminating one of the primary challenges in clinical impression making for complex multi-abutment fixed partial dentures. Generally, these light activated polyether urethane dimethacrylates were polymerized with any hand-held visible light source as in use for composite resin. Polyether urethane dimethacrylates are hydrophobic, constant, viscous materials that possess excellent tear strength characteristics. However, serious problems encountered with uniformity of cure led to inconsistencies in dimensional accuracy, which contributed to their limited acceptance and availability.

PREPARATORY CONSIDERATIONS

Elastomeric impression materials do not tolerate or displace moisture, which can cause voids in the impression. Therefore, saliva flow must be minimized. When tooth preparation margins extend subgingivally, mechanical, chemical, or surgical means of tissue displacement are used to gain access.

Tissue Health

Successful tissue management is essential to good impression making. The effects of tooth preparation trauma can be managed as long as properly contoured and finished provisional restorations are fabricated, and the patient practices adequate plaque control. However, plaque retention will lead to localized inflammation, and hemorrhage is likely during subsequent procedures.

Moisture Control

Isolation: A number of options are available to ensure the necessary dry field of operation. In its simplest form, absorbent cotton rolls are combined with the use of

Table II: Medications with antisialagogue effects

MEDICATION	DOSAGE[1]	
Atropine sulfate	0.25-1.0 mg	1-2 hrs preoperative
Methantheline bromide	50-100 mg	30-45 min preoperative
Propantheline bromide	5-30 mg	30-45 min preoperative
Scopolamine hydrobromide	0.4-0.8 mg	30-60 min preoperative
Glycopyrrolate	1-2 mg	30-60 min preoperative
Clonidine[2]	0.2-0.4 mg	1 hr preoperative

[1] Dosages should be verified for each product independently in accordance with the manufacturers' recommendations. Ranges are reported, as recommended dosages vary.

[2] Clonidine is an antihypertensive that has been shown to be safer than use of Anticholinergics. However, blood pressure should be monitored and the practitioner should be cognizant of possible side effects.

minimize salivary output, medication with an antisialogogue effect may be prescribed. It is important to be aware of contraindications to their use. Anticholinergics (atropine, dicyclomine, and methantheline) are typically used for this purpose, but caution is urged with lactating females, elderly patients, or patients with glaucoma, hypertension, coronary problems, congestive heart failure, a history of prostate hypertrophy, and several other conditions. Because the primary development of these drugs was to remedy other medical conditions (e.g., peptic ulcer), their dental efficacy is not well documented. It should also be noted that certain medications such as MAO inhibitors, antihistamines, and tricyclics could have a potentiating effect on the antisialogogue. Finally, patients should be cautioned regarding possible side effects such as blurred vision and drowsiness. (Table II lists medications and dosages that have been recommended to curtail saliva production.)

Tissue Displacement

The majority of posterior extracoronal restorations require the tooth preparation to be extended intrasulcularly. This necessitates the gingival tissues be displaced to allow access for the impression material. Such displacement is typically achieved through insertion of a knitted, braided, or twisted cord, often impregnated with a chemical agent. Alternatively, especially in the presence of inflamed or hypertrophied tissue, partial excision with a scalpel or electrosurgery provides the necessary access.

Mechanical Tissue Displacement

Mechanical tissue displacement results when a cord is inserted into the sulcus, stretching the periodontal fibers through exertion of sustained pressure. Cord placement is easier with braided or knitted cords, although larger sizes of these "tube-shaped" cords can actually prove to be problematic. Knitted cords tend to be slightly more flexible, and thus easier to place than the braided varieties. Among the twisted types of cords, some resemble a strand of wool (Gingipak®), and these can be flattened after moistening, making them easier to insert than other twisted displacement cords, which have a tendency to unravel. Cords should always be moistened prior to their removal. Dry cords may adhere to the crevicular tissues and actually initiate additional hemorrhaging on removal.

Use of Chemicals in Tissue Displacement and Hemostasis

Often, mechanical pressure by itself does not suffice, and improved displacement results when cords are impregnated with certain chemical compounds. Impregnated cords are available, and dipping the cord in an astringent can increase dosage. Solutions such as Hemodent® (Premier), GingiAid® (Gingi-Pak Laboratories), or Hemogen-L® (Van R) contain aluminum chloride ($AlCl_3$) which is known to cause a transient ischemia, shrinking the gingival tissue. The exact mechanism is poorly understood, but histological observation suggests that Aluminum may migrate into the connective tissue and cause swelling of collagen fibers, which exerts pressure on the capillaries. This effectively reduces the blood supply to the area. Nevertheless, after cord removal, sulcus enlargement does not last much longer than 30-45 seconds, and impressions should be taken immediately. Residual crevicular seepage can be controlled through use of a dual cord technique, the initial cord remaining in place at the base of the sulcus during the impression procedure.

Ferric sulfate [$Fe_2(SO4)_3$] is useful when uncontrolled bleeding is encountered. The availability of ferric ions effectively accelerates the formation of a coagulum. Rubbing the bleeding site with the "wick" of the dispenser while providing a constant flow of solution will result in coagulum formation. After about one minute, the site is washed and dried, and the procedure is repeated. For most situations this will result in adequate hemostasis to proceed with the impression.

Aluminum sulfate [Al2(SO4)3] impregnated cords like Pascord ® (Pascal) and Gingibraid A (Van R) are also useful to control bleeding and seepage, and exhibit good tissue compatibility. However, it has been suggested that these materials may interfere with the polymerization of the addition silicones which would limit their application.

Epinephrine impregnated cords are available, but the manufacturers cannot control dosages per length of cord. Therefore, these should be used cautiously because tachycardia has been reported as a side effect. Injection of an anesthetic solution containing epinephrine into the interdental papillae adjacent to the tooth preparation in combination with non-impregnated cord placement is often sufficient to gain hemostasis.

The chemicals used for hemostasis are dispensed in buffered solutions of low pH as they are not stable in neutral or alkaline solutions. The practical implication is that if tooth structure has been exposed to these materials for any extended time (> 2 min.) the smear layer will be removed and the surface etched. Nonacidic hemostatic agents are available. Tetrahydrozoline (Visine®, Pfizer) has been shown to be as effective as Aluminum chloride in effecting hemostasis. (Selected products are listed in Table III.)

Electrosurgical Tissue Excision

Minor tissue removal is rapidly accomplished with monopolar electrosurgery, in which a high-frequency current (1,000,000 to 4,000,000 Hz) is used to effect cellular breakdown. Although a somewhat jagged cut results by comparison to incisions with conventional scalpel blades, postsurgical hemorrhage is minimal provided that the tissues are not seriously inflamed. The potential for permanent gingival recession should not be underestimated. Depending on the tex-

ture and thickness of the free gingival tissues, recession between 0.5mm and 1.0mm is a common occurrence. Use of an unmodulated, alternating current is recommended, as deep tissue trauma is reduced. Contact with underlying bone must be avoided as osseous resorption can occur. Bipolar electrosurgical units are gaining acceptance due to their improved safety since the current is confined to the tissue between two electrodes which are typically 1mm to 2mm apart. While monopolar units are considered superior in cutting, bipolar units are very effective in electrocoagulation (hemostasis) and free of the hazards of remote mucosal and osseous necrosis.

Electrosurgery Contraindications and Precautions

- Contraindicated in patients with cardiac pacemakers
- Contraindicated in patients with TENS units
- Contraindicated in patients with an insulin pump
- Contraindicated in patients having received radiation therapy
- Contraindicated when dealing with thin attached gingival tissues
- Do not use metal instruments (risk of electric shock)
- Local anesthesia is mandatory
- A cutting stroke should not be repeated within 5 seconds

Sulcular enlargement is easily accomplished using either a thin straight wire electrode, or a slightly tapered titanium tip. Contouring and sculpting of tissues, as in an edentulous space, is conveniently accomplished using a loop electrode. The electrode should not be held stationary at any time. To prevent serious tissue damage, a continuous cutting movement should be maintained while current is being supplied to the instrument. If difficulty is encountered moving the electrode through the tissues, it is likely that more current must be used. Conversely, the amount of current must be reduced if sparking is observed.

Throughout the sulcular enlargement process, care must be taken not to make contact with adjacent metallic restorations or alveolar bone, as pulpal damage or osteonecrosis respectively, will result. Cleaning the electrode between cutting strokes by wiping it with alcohol will result in a smoother tissue surface. If it is necessary to perform an additional cutting procedure in the same location, a delay between cutting strokes of at least 5 seconds is necessary to permit heat dissipation.

Retraction cord can be placed immediately following electrosurgical sulcular enlargement, and, as minimal bleeding is present, elastomeric impressions can be made. It is recommended that the sulcus be irrigated with hydrogen peroxide prior to initial cord placement.

Table III: Selected Hemostatic Agents

Hemostatic Agent	Active Ingredient
Astringedent (Ultradent Products, Inc. Salt Lake City, UT 84124)	15.5% $Fe_2(SO_4)_3$
Stasis (Gingi-Pak Laboratories Camarillo, CA 93010)	21% $Fe_2(SO_4)_3$
Cranbery Styptin (Van R Dental Products, Inc. Oxnard, CA 93033)	20% $AlCl_3$ in buffered glycol
Hemodent (Premier Dental Products Co. Norristown, PA 19401)	21.3% $AlCl_3$ aqueous/glycol
Gingi-Aid 25% (Gingi-Pak Laboratories Camarillo, CA 93010)	25% $AlCl_3$ N.F.
Hemogin-L (Van R. Dental Products, Inc. Oxnard, CA 93033)	25% $AlCl_3$ aqueous
Orostat 8% (Gingi-Pak Laboratories Camarillo, CA 93010)	8% racemic epinephrine HCl aqueous
Visine (Pfizer)	Tetrahydrozoline HCl 0.05%

om: Land M.F., Couri C.C., Johnston W.M. Smear layer instability caused by hemostatic agents J Prosthet Dent 76:5; 477-82 1996

TRAY SELECTION

Full-Arch Impressions

Elastomeric impression materials distort due to thermal contraction, relaxation of stresses induced during removal, and dimensional change associated with the polymerization reaction. Except for the hydrocolloids, custom trays increase accuracy because they reduce material volume and provide improved support for the material, effectively minimizing the impact of these concerns. By comparison, a hydrocolloid impression is subject to less dimensional change when it is used in the thicker layer provided by a large stock tray due to its lower surface area/volume ratio.

Custom trays can be made from autopolymerizing acrylic resin, thermoplastic resin, or photopolymerized resins. Autopolymerizing resin trays distort after initial fabrication. Therefore, trays should be fabricated at least 9 hours prior to the appointment. Should it be necessary to use a tray sooner, boiling the tray for about 5 minutes and cooling to room temperature will prevent further distortion from occurring.

After softening in a water bath, the thermoplastic materials are manually adapted to a diagnostic cast. A vacuum former with a heating element can also be used. No apparent difference in accuracy results as a function of the selection of tray material, although the photopolymerized materials tend to result in trays with reduced rigidity. As these thermoplastic resins are comparatively less susceptible to moisture related distortions, they are useful when electroplated die systems are to be fabricated.

Nevertheless, distortions can result even after slight flexing of the tray. Therefore, when using stock trays, thicker trays should be selected with resin thicknesses of 2mm to 3mm to ensure rigidity, com-

parable to the recommended thickness for a custom tray. Optimal impression material thickness is 2mm to 3mm for the polysulfides and silicones, whereas the polyethers require slightly greater material thickness (3mm to 5 mm) to facilitate removal.

Suitable stock trays can mimic custom trays through the use of a putty impression, which is permitted to polymerize prior to making a subsequent wash impression with a lower viscosity material. Vents should be created with a scalpel blade in the putty material to allow for escape of excess wash material and to prevent hydraulic pressure buildup. This can lead to compression of the putty, which upon rebounding results in a distorted and useless impression.

Dual-Arch Quadrant Impressions

In addition to disposable quadrant impression trays, dual-arch impressions are popular since a single procedure captures both the prepared tooth and its antagonist. Disposable (e.g., Triple Tray, ESPE) and non-disposable, autoclavable metal dual arch trays are available. An advantage of the metal tray is its rigidity, compared to the flexible plastic trays, which derive their rigidity from the impression material.

Distortion does occur with flexible trays, usually due to flexing of the tray during the polymerization reaction of the impression material. Upon removal, the tray rebounds to its original shape, causing the distortion. Therefore, it is important to ensure that the tray fits passively prior to dispensing of the impression material.

The dual arch technique works well with polyether and addition silicones, but the condensation silicones and polysulfides have too much flexibility to recommend their use for this technique. Provided that care is taken during tray try-in, and the patient is guided in to the exact position at which the restoration is to be fabricated, this technique will lead to predictable results for simple fixed prostheses such as single crowns.

MIXING TECHNIQUES

Spatulation

Impression materials dispensed in tubes require spatulation on disposable mixing pads. Depending on the specific material, one or both pastes may adhere tenaciously to the spatula. Wiping the spatula clean and continuing to mix will minimize the presence of streaks of unmixed base or catalyst.

Automix Technique

Most silicone and polyether impression materials are available in automix cartridges. Before each use, it is important to bleed the cartridges prior to attaching the mixing tip. Automixing has been shown to result in fewer voids. The viscosity of the polysulfides precludes automixing.

Direct syringe tips that fit onto the end of the automixing tube are available. Access is occasionally a problem, as is precise control of the syringe tip due to the size of the cartridge gun assembly. Smaller cartridges with shorter, narrower diameter mixing tips have somewhat minimized this problem. Alternatively, the automix can be dispensed into conventional impression syringes if desired.

Mixing Machines

Within the last few years, a mixing machine was introduced for use with polyether impression materials. Among its advantages is reduction of voids in the resulting mix and instant dispensing into syringe and tray. Rather than rely on small cartridges, larger bulk packages of impression pastes are available.

Reversible Hydrocolloid

The preparatory, mixing, and dispensing steps for a reversible hydrocolloid impression are unique by comparison to the other elastomeric polymers. The reversible agars are immersed for approximately 10 minutes in a boiling tank. The material can then be stored for several hours in a storage tank at approximately 150°F. After loading of the tray, it is stored in a tempering bath at approximately 115°F for several minutes. The wash material is typically not tempered, but dispensed into the syringe directly after removal from the storage tank. The following sequence is representative:

a. Select the largest size water-cooled impression tray that can conveniently be used, and create stops in the tray with compound to prevent over-seating.

b. Load heavy body material from the storage bath, squeeze some wash material onto the tray material, and submerge in the tempering bath. Load the impression syringe and place it in the storage tank.

c. Remove retraction cord and inject the light-bodied impression material as needed.

d. Remove the tray from the tempering tank, use gauze to wipe off the surface layer, and insert. Support the tray throughout the setting cycle while circulating cold water through the tray (usually 6 to 8 min.).

e. Remove the tray with a quick movement - do not 'tease' the tray from the mouth - wash, disinfect, and pour immediately in Type IV stone.

SPECIAL CONSIDERATIONS

Occasionally, the impression technique is slightly modified, such as when making impressions of pin holes or post spaces for post and cores. Prefabricated plastic impression pins are recommended for use with pinholes, and all elastomeric impression materials have sufficient body to retrieve such patterns.

For post and cores, reinforcement of the post space in the impression is necessary to prevent distortion of the poured cast. A few years ago, a thermoplastic material be-

came available that is convenient to rapidly fabricate well-adapted post patterns for custom cast post and cores with flared canals. After adaptation, the patterns are coated with the applicable adhesive to assist in their retention in the elastomer. Removal of conventional prefabricated patterns from poured casts is typically uneventful. Removal of thermoplastic patterns requires that the poured cast is soaked in warm slurry water to facilitate separation.

DISINFECTION

Upon removal, impressions must be rinsed, dried, and disinfected by the recommended procedures for the material being used. Glutaraldehyde solutions or iodophor sprays are the recommended disinfectants. The most commonly recommended techniques for the various impression materials are listed in Table IV. Hydrophillic materials such as the hydrocolloids, polyether and some of the hydrophyllic addition silicones should not be soaked, but rather sprayed and stored for a suitable period of time in a plastic bag. Provided that a compatible disinfection protocol is selected for a given impression material, disinfection has no clinically significant effects on the accuracy or surface reproduction of the currently available elastomeric materials.

Spray disinfection is an expedient technique that can safely be used with the aqueous materials and the hydrophyllic non-aqueous elastomers. Suitable materials include the iodophors (1:213 dilution), and the chlorines (1:10 dilution). A typical exposure time of 10 minutes is recommended.

Immersion disinfection can be accomplished with 2% acidic glutaraldehyde (1:40 dilution), 2% phenolic buffered glutaraldehyde (1:16 dilution), 2% neutral or alkaline glutaraldehyde (not diluted), or complex phenolic compounds. A 10- to 30- minute immersion time accomplishes satisfactory disinfection.

If an impression is to be sterilized rather than merely disinfected, far longer immersion times are needed, ranging to as long as 10 hours. Water imbibing materials obviously do not lend themselves to such prolonged immersion, and should be avoided when sterilization must be accomplished.

FINAL NOTE

Elastomeric Materials

Impression trays must be supported in accordance with manufacturer's recommendations while the material sets. Premature impression removal is a common cause of distorted impressions. When used in accordance with recommended guidelines, predictable success can be obtained with any of the available materials.

Table IV: Recommended Disinfection Protocols

	Gluteraldehyde 2% (10 min. immersion)	Phenolic Gluteraldehydes	Iodophors (1:213 dilution)	Chlorine (Bleach, 1:10 dilution)	Complex Phenolics
Irreversible Hydrocolloid[1]	No	No	Yes	Yes	No
Reversible Hydrocolloid[1]	No	Yes	Yes	Yes	Uncertain
Polysulfide	Yes	Yes	Yes	Yes	Yes
Silicones	Yes	Yes	Yes	Yes	Yes
Polyether[2]	No	No	No	Yes	No

[1] Minimize soak time. Repeated dipping in gluteraldehyde followed by rinsing is advocated. Pouring should be delayed for approximately 10 minutes; A comparable spray/rinse cycle using sodium hypochlorite may be substituted.
[2] Prolonged soaking will result in distortions due to imbibition. Repeated spraying with chlorine dioxide or 1:10 hypochlorite followed by rinsing is advocated. Pouring is then delayed by approximately 10 minutes.

Adapted in part from: Merchant VA, Update on Disinfection of Impressions, Prostheses, and Casts. CDA Journal 20:10, 31-5, 1992

Self-Test

1. Which of the following has superior tear strength?

A. Polysulfide rubber base
B. Condensation silicone
C. Polyether
D. Addition silicone

2. Antiocholinergics should not be used:

A. in patients with heart disease
B. in patients with glaucoma
C. to control excessive salivation
D. A and B

3. Which of the following are hydrophobic?
1. Reversible hydrocolloid
2. Polysulfiude polymer
3. Condensation silicone
4. Addition silicone

A. 1, 3 and 4
B. 2 and 4
C. 2, 3 and 4
D. all of the above

4. Condensation silicones have greater dimensional stability than the addition silicones.

A. True
B. False

5. An advantage of condensation silicone impression materials include:

A. High tear strength
B. Long working time
C. Short setting time
D. Low cost

6. Which of the following may be used for tissue displacement and/or hemostasis?
1. $AlCl_3$
2. Al2(SO4)3
3. $Fe_2(SO4)_3$
4. FeCl3
5. Epinephrine

A. 1 and 3
B. 1, 3 and 5
C. 2 ,4 and 4
D. all of the above

7. High humidity increases the working time of polysulfide rubber impression material significantly.

A. True
B. False

8. Which of the following has a long setting time?

A. Polysulfide rubber base
B. Condensation silicone
C. Polyether
D. Addition silicone

9. Which of the following impression materials may exhibit setting inhibition caused by some brands of latex gloves?

A. Polysulfide
B. Condensation silicone
C. Polyether
D. Addition silicone

10. A custom tray improves the accuracy of an elastomeric impression by limiting the volume of the material.

A. True
B. False

11. In order to make a successful elastomeric impression, which is most important?

A. Have the patient swallow repeatedly
B. Moisture control
C. Use of a cartridge system
D. Disinfection

12. Which of the following should not be immersed for a prolonged time?

A. Irreversible hydrocolloid
B. Reversible hydrocolloid
C. Polyether
D. None of the above should be immersed

13. When using an acrylic custom tray impression material, volume affects accuracy. Which of the following variable(s) result(s) in dimensional change?

A. Polymerization shrinkage of the elastomer
B. Choice of autopolymerizing resin
C. Thermal contraction
D. A and C

14. A disadvantage of polysulfide impression material is:

A. Imbibition
B. Low tear resistance
C. Stability only fair
D. Poor wetting

15. A disadvantage of polyether impression materials is:

A. Unpleasant odor
B. Messy
C. Imbibition
D. Low stability

16. Which of the following impression materials is rigid and can cause cast fracturing?

A. Irrversible hydrocolloid
B. Polysulfide polymer
C. Addition silicone
D. Polyether

17. Polyether impressions should not be soaked for a prolonged time because after a few minutes, which of the following occurs?

A. Distortion occurs due to by- product formation
B. Distortion occurs due to elastic rebound and relaxation of the elastomer
C. Distortion occurs due to water sorption
D. None of the above

18. Ridigity of the impression tray is important to prevent distortion because even slight flexing of an impression tray will lead to distortions sufficient to prevent fabrication of a successful restoration.

A. Statement true, reason true
B. Statement false, reason false
C. Statement true, reason false
D. Statement false, reason true

19. Which of the following can result in distortion of elastomeric impressions?

A. Delay in seating the impression tray
B. Use of the heavy body/light body technique
C. Flexing of the impression tray
D. A and C

20. The use of a custom tray will compensate for the slight expansion that occurs during polymerization of hydrocolloid impression material.

A. True
B. False

21. Contraindications for electrosurgery include patients with all of the following except?

A. Peptic ulcer
B. Pacemakers
C. Thin attached gingival tissues
D. Insulin Pump

22. For which of the following is the routine use of surfactants recommended because of the extremely hydrophobic nature of the material?

A. Polysulfide
B. Irreversible hydrocolloid
C. Condensation silicone
D. Polyether

23. Which of the following materials requires increased bulk to obtain increased accuracy?

A. Addition silicone
B. Condensation silicone
C. Reversible hydrocolloid
D. Polysulfide

24. Which of the following medications are specifically marketed as an antisialogogue?
1. Clonidine
2. Glycopyrrolate
3. Atropine sulfate
4. Propantheline bromide

A. 1 only
B. 2 and 3
C. 2, 3, and 4
D. all of the above

25. Which of the following can have potentiating effects on antisialogogue effect?

A. Antihistamines
B. Tricyclics
C. MAO inhibitors
D. All of the above

26. A custom tray made from autopolymerizing resin should be made at least how many hours prior to its use?

A. 1 hour
B. 2-3 hours
C. 6 hours
D. 9 hours

27. Which of the following additives to irreversible hydrocolloids assists in the development of a dense and presumably more abrasion-resistant surface?

A. Zinc oxide
B. Potassium titanium fluoride
C. Sodium phosphate
D. Lead dioxide

28. Addition silicone impressions can be disinfected with which of the following?

A. 10- minute immersion 2% gluteraldehyde
B. Chlorine (bleach 1:10 dilution)
C. Iodophors (1:213 dilution)
D. All of the above

29. Allergic hypersensitivity to impression materials may manifest themselves as:

A. Burning
B. Itching
C. Erythema
D. All of the above

30. When performing electrosurgical tissue excision, repeated cutting in the same area requires a delay of at least ____ second(s) between strokes to permit heat dissipation.

A. 1
B. 2-3
C. 5
D. 10

Please circle your answer.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	TRUE		FALSE	
5.	A	B	C	D
6.	A	B	C	D
7.	TRUE		FALSE	
8.	A	B	C	D
9.	A	B	C	D
10.	TRUE		FALSE	
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D
14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	TRUE		FALSE	
21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D
26.	A	B	C	D
27.	A	B	C	D
28.	A	B	C	D
29.	A	B	C	D
30.	A	B	C	D

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