Predictable Elastomeric Impressions in Advanced Fixed Prosthodontics: A Comprehensive Review

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Despite advances in dental material technology, the predictable procurement of accurate impressions for the fabrication of complex fixed prosthodontic restorations remains an elusive objective. The technical challenges and potential negative sequelae are exponentially magnified in advanced applications that involve multiple abutments and preparatory phases. A protocol for consistently achieving accurate impressions with the use of polyether impression materials and automatic instrumentation is presented and illustrated with multiple clinical examples. The technique is capable of yielding reliable results in extensive cases and requires minimal support from auxiliary personnel.

Key Words: impression, polyether, tissue, prosthodontic, tray material

The technical complexity inherent in fixed prosthodontic treatment is compounded by the necessity of utilizing an indirect approach, where fabrication occurs extraorally at the dental laboratory and the completed restorations are subsequently retrofitted in the oral cavity. One fundamental aspect in the fabrication of indirect restorations is the procurement of an accurate impression from which a refractory model can be created to precisely replicate the intraoral environment. Although numerous materials and techniques have been advocated, predictable impression making remains a challenge for a majority of practitioners particularly in cases that involve multiple abutments.

For the clinician involved in complex reconstructions, the ability to consistently attain accurate impressions acquires added significance due to the additional time and effort involved in preparation for the impression procedure, as well as the increased expenses associated with remakes that result from inaccuracies. This article illustrates a protocol that will yield accurate impressions on a consistent and predictable basis. The principles discussed are applicable to simple as well as extensive restorations.

Review of Material Properties

Elastomeric materials currently set the standard for definitive impressions in fixed prosthodontic applications. While several materials are available, addition reaction silicones (or “poly(dimethylsiloxanes)” and polyethers are used with the greatest frequency. While not an elastomer, reversible hydrocolloid may be utilized due to its inherent hydrophilic nature and unmatched wetting ability. Although this material is relatively inexpensive, it exhibits low tear strength and a lack of dimensional stability that requires the impression to be poured immediately. In addition, accurate multiple pours cannot be obtained with reversible hydrocolloids.

Figure 1. Case 1. Maxillary full-arch impression recording twelve abutments. Treatment was required for severe retrograde wear as a result of bruxism.
hydrocolloid.1 Mercaptan-based polysulfides are used infrequently as a result of their highly unpleasant odor and taste as well as difficult handling characteristics. Although accurate restorations can be produced from this material, it does not rival the physical properties of alternative elastomers.1

As a group, addition reaction silicones are currently the most popular category of impression material. They are available in different viscosities and can accommodate several techniques. These materials are extremely accurate and exhibit adequate tear strength, dimensional stability, and neutral odor and taste. Disadvantages include their hydrophobic nature and susceptibility to inadequate polymerization as a result of latex contamination. In addition, methylmethacrylate acrylics and ferric sulfate hemostatic agents are reported to inhibit the setting of polyvinylsiloxanes.1-3 While surfactants have been added in attempts to improve their wetting ability, true hydrophilic polyvinylsiloxanes are yet to be developed.

Condensation reaction silicones have decreased in popularity as a result of their poor dimensional stability and elastic recovery. Significant volumetric changes during polymerization require that a two-step putty tray and wash technique be utilized in order to maintain a minimum thickness of the low-viscosity material. This elastomer offers no advantage over the polyvinylsiloxanes and its use is difficult to justify.1

Polyether impression materials (Espe, Norristown, PA) are often utilized as a result of their inherent hydrophilic nature and enhanced wetting ability. Polyethers also exhibit favorable accuracy, elastic recovery, dimensional stability, and high tear strength. These materials are also characterized by a higher degree of stiffness, which requires a greater effort during removal, and an unpleasant taste. Since polyethers are available in different consistencies, they can be utilized with either a monophase or a dual-viscosity technique.1,3

### Rationale for Material Selection

In order to be utilized in fixed prosthetic applications, an impression material must fulfill specific physical requirements. The ability to store the impression prior to model fabrication and to subsequently produce multiple accurate pours from an individual impression are also important requirements.
considerations in contemporary restorative practice. In the intraoral environment, tolerance to moisture, wetting ability, and flow characteristics significantly impact the material’s ability to accurately record surface detail. The impression material should ensure the patient’s comfort and satisfy practical clinical considerations (e.g., easy handling, convenient setup and cleaning, and expense). Since polyethers satisfy these requirements and exhibit wetting ability unsurpassed by other elastomers, they constitute the author’s material of choice. Although satisfactory results can be achieved with alternative materials, evidence has suggested that polyethers display the most consistent accuracy for full-arch applications.4-7

A high-viscosity tray material (Permadyne Penta H Tray, Espe, Norristown, PA) and a light-bodied syringe-able polyether (Permadyne Garant, Espe, Norristown, PA) are specifically utilized by the author in a one-step dual-viscosity technique with the aid of an automatic mixing system (Pentamix, Espe, Norristown, PA). This unit provides a void-free, even material with extended working periods when compared to manually mixed polyethers. In addition, the higher viscosity polyether tray material exhibits superior rheological characteristics that result in unmatched predictability. Accurate, wrinkle-free impressions can be consistently achieved even in full-arch applications and under less-than-optimal circumstances (Figures 1 through 4).

Soft Tissue Preparation

Achieving an accurate final impression is one of the most technically demanding aspects of fixed prosthodontic treatment. Its procurement cannot solely depend on the selection of materials or procedures, but rather on a protocol that encompasses adequate tooth preparation and soft tissue management. The principles that govern tooth preparation for various types of fixed restorations have been extensively covered in the literature and are not within the scope of this article. It must be stated, however, that proper tooth reduction, and finish line placement in particular, may directly affect the accuracy of the impression (Figure 5).8 While the location of a finish line may vary within the sulcus, it must never impinge upon the biologic width. Clinical judgment must be exercised to identify situations where surgical crown-lengthening procedures are indicated.
Concomitantly, periodontal health must be accomplished so that adequate moisture control and predictable postimpression gingival margin levels can be maintained (Figure 6). This is not only limited to the treatment of periodontitis and the incorporation of a proper oral hygiene regimen, but also includes surgical procedures necessary to increase the quantity and improve the quality of the mucogingival tissues.

**Gingival Retraction Technique**

Once the aforementioned requirements have been satisfied, the impression procedure is initiated with tissue retraction. This process has been previously described as a prepacking or double-cord impression technique. Nonimpregnated knitted cord (Ultrapak, Ultradent, UT) is soaked in a 21.3% buffered aluminum chloride hemostatic solution (Hemodent, Premier, Norristown, PA), which is an effective chemical agent for tissue displacement and bleeding control. A thin initial cord (Ultrapak 00 or 0, Ultradent, UT) is atraumatically packed into the sulcus around the circumference of the preparation. Any excess is trimmed to avoid overlapping (Figure 7). This cord provides hemostasis as well as vertical (and to a lesser degree horizontal) displacement of the tissue. It is allowed to remain in place lining the sulcus during the impression procedure, thus protecting the sulcular epithelium from tears.

The tissue retraction achieved by the placement of the first cord may expose the finish lines, which may then be reprepared to the level of the retracted gingival margin depending on specific aesthetic and functional requirements (Figure 8). Caution must be exercised at this stage to avoid excessive tissue injury as well as to prevent catching the cord with the diamond bur. The second retraction cord (which is also impregnated) is then carefully packed into the sulcus and allowed to remain in place for 5 minutes. Sufficient excess cord must be preserved to facilitate its removal, which will occur immediately prior to taking the impression (Figure 9). In the presence of gingival health, cord packing procedures should not elicit bleeding as long as they are performed atraumatically and avoid tearing of the connective tissue attachment.

The diameter of the second cord is selected according to the thickness of the soft tissue wall and the degree of lateral displacement required. It should generally be of the maximum thickness that can be atraumatically accommodated within the sulcus. Once packed into place, the secondary retraction cord should be visible from the occlusal aspect along the full extent of the

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**Figure 10.** Readily visible second cord layer ensures adequate lateral tissue displacement.

**Figure 11.** Case 3. Maxillary anterior segment prepared for definitive impression following orthodontic therapy.

**Figure 12.** Polyether impression demonstrates detailed recording of finish lines as well as distinct material margins.

**Figure 13.** Completed metal-ceramic restoration displaying porcelain shoulder margins. Splinting was required for postorthodontic retention.
preparation (Figure 10). This is an indication that adequate lateral displacement of the soft tissues has been achieved, which results in impression margins of sufficient thickness. These margins provide increased tear resistance upon removal and prevent distortion during pouring (Figures 11 through 13).13

Impression Tray Considerations

A rigid stock impression tray (Mastertray, Teledyne Water Pik, Fort Collins, CO) of adequate size is selected and beaded with utility rope wax on a study model to control and limit the flow of the elastomeric material. The wax also serves as a soft tissue stop during seating of the loaded impression tray to ensure that adequate material thickness is preserved. A polyether adhesive (Espe, Norristown, PA) is applied to the tray and allowed to dry for 60 seconds.

Although it is generally accepted that accuracy is enhanced with the use of custom trays,14,15 polyethers utilized in conjunction with stock trays achieve or exceed results obtained with alternative materials.16 It must also be noted that all published reports have utilized Impregum (Espe, Norristown, PA), primarily in a monophase technique, as the comparison polyether. The author has experienced no clinically discernible difference in accuracy between custom or stock trays when utilizing the recommended technique. Second only to the silicone putty materials in viscosity and stiffness, the high-viscosity polyether tray material (Permadyne Penta H Tray, Espe, Norristown, PA) is an accurate space filler that effectively supports the syringeable material and captures surface detail when used with stock trays, while retaining the desirable physical characteristics of polyethers.

Mucosal Tissue Management

The corresponding area is thoroughly rinsed and dried, and the prepared teeth are isolated. An analysis of the requirements for adequate management of the mucosal tissues is essential in the achievement of accurate impressions. Anatomical and physiological considerations (e.g., degree of mucosal hydration, character of salivary secretion, vestibular depth, and tongue position) determine the proper selection and strategic placement of isolation aids. When bilateral or full-arch impressions are necessary, the anticipated behavior and deformation of the oral tissues upon tray insertion must be clearly understood. The biomechanical considerations are such that a path of insertion must be predetermined for proper placement and seating of the impression tray.
Impression Procedure

A sufficient quantity of high-viscosity tray material is loaded into the impression tray utilizing the mixing unit. The light-bodied polyether (Permadyne Garant, Espe, Norristown, PA) is then dispensed into an intraoral impression syringe with an automix gun and cartridge system. Although both materials may be cooled to prolong the total working period when necessary, a minimum temperature of 65°F should be maintained to avoid an increase in viscosity, which may affect the automatic mixing systems.

The secondary retraction cord is subsequently removed from around the teeth and the preparations are dried once again. The light-bodied polyether is then syringed around the finish lines until the preparations are completely covered. During application, the nozzle tip should remain immersed in the material without breaks in continuity to avoid entrapment of air bubbles. In instances where soft tissue collapse has occurred following removal of the secondary cord, a gentle stream of air may be applied to force the material into potentially difficult areas. The impression tray loaded with the high-viscosity polyether is immediately inserted and seated until liberal amounts of excess material flow over the flanges and through the perforations of the tray. The increased hydraulic pressure that results from the high-viscosity tray material's rheological characteristics enhances the ability of the low-viscosity material to capture surface detail (Figures 14 and 15).

It is necessary to avoid movement of the impression tray, which must remain in place for 7 minutes. Complete polymerization is essential to prevent deformation of the material during removal and to ensure adequate elastic recovery. Although additional force may be required, removal of polyether impressions from the mouth can be accomplished with relative ease by applying pressure on the handle of the tray while simultaneously stretching the oral mucosa. Once a break in adhesion occurs, the impression can be gently manipulated out of the mouth. A water spray may be utilized to moisten the mucosal tissues and any absorbent isolation aids, which further facilitates the removal of the impression while preventing soft tissue abrasions.

The impression is rinsed, dried, and thoroughly inspected with magnification aids to verify its accuracy. Once deemed satisfactory, it is sprayed with a disinfectant solution, positioned upside down to prevent pooling of the disinfectant, and allowed to dry. Although reports
have shown no adverse effects on the accuracy or dimensional stability of polyethers, immersion techniques are not utilized by the author for disinfection.\(^{17}\)

**Refractory Models and Dies**

Following disinfection, the impression is forwarded to the dental laboratory for fabrication of refractory models. Care must be exercised to ensure the production of an accurate, void-free model. In the selection of gypsum materials for die fabrication, it is important to remember that dental stones exhibit a range of linear expansion of approximately 0.04\% to 0.3\% after setting.\(^{18}\) Such a degree of variation in expansion — which occurs in all dimensions — may result in significant model distortion, even with the use of an extremely accurate impression material.\(^{19}\)

Triple pouring the definitive impression is recommended in cases with multiple abutments. The first pour is utilized as the working master model, the second pour serves as a spare master model, and the third pour is kept unsectioned as a solid model on which metal frameworks can be assembled and interproximal contacts adjusted (Figure 16).

Each individual die must be inspected and trimmed under magnification. It is recommended that the restorative dentist perform this task in complex cases. Comparing the finish lines on the dies against the definitive impression may be of aid during this process. Once identified, the finish lines should be marked with pencil and the dies trimmed short of them so that a portion of the intact tooth surface remains on the die. This aids the technician in establishing proper emergence profiles during fabrication of the restorations (Figure 17).

**Discussion**

The ability to consistently obtain accurate impressions during the first attempt possesses obvious practical value for patient and clinician. These advantages are compounded when dealing with more extensive and technically demanding cases.

The previously detailed guidelines may be modified as necessary to address the specific requirements of the prescribed restorations. A second retraction cord, for example, may not be necessary where supragingival or slightly subgingival finish lines are indicated (eg, nonesthetic areas, all-ceramic margins) (Figures 18 through 21).\(^{10}\) Although it is obviously more difficult to capture margins placed more subgingivally, clinicians are frequently
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confronted with situations that require further extension into the sulcus (e.g., short clinical crowns or subgingival caries and restorations). The former does not, however, preclude the need for surgical crown lengthening when indicated. Alternatively, extensive reconstructions and periodontal prosthetic patients who require splinting with a metal-ceramic framework and metal margins demand more subgingival placement in aesthetically sensitive regions (Figures 22 through 25). These cases invariably benefit from the application of the double-cord impression technique.

Since proper cord placement should not impinge upon or tear the connective tissue attachment, minimal or no bleeding will be elicited, provided that adequate soft tissue health is present. The hemostatic agent (Hemodent, Premier, Norristown, PA) utilized with this technique generally controls bleeding, except for instances that exhibit severe gingival inflammation. In situations where compromised tissue health must be accepted due to existing systemic conditions or physical handicaps, judicious use of an electrosurgical or laser unit may be incorporated as an adjunct to the achievement of hemostasis.

The degree of tissue retraction following cord placement is dictated by the relationship between the osseous crest and the gingival margin. In the presence of adequate gingival health, this retraction will be proportional to the amount of supracrestal tissue present. Numerical parameters that define the relationship between the different anatomical structures comprising the dentogingival and dentoalveolar complexes have been previously described in the literature. The variability in these dimensions, introduced by the existence of different periodontal biotypes, must also be taken into account. Although these factors have been considered primarily in crown-lengthening surgery, they may also be applied as guidelines in predicting ultimate gingival margin levels following cord retraction procedures.

Conclusion

Indirect restorations depend on an accurate impression in order to achieve clinical success. Complex situations that involve multiple abutments can be properly recorded when care is exercised in the selection of impression materials and techniques. This article has reviewed a series of clinical considerations that must be addressed in association with indirect restorations, and has demonstrated the use of a protocol that allows accurate impressions to be achieved with success and consistency.

References

CONTINUING EDUCATION (CE) EXERCISE NO. 15

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article “Predictable elastomeric impressions in advanced fixed prosthodontics: A comprehensive review” by Ernesto A. Lee, DMD. This article is on Pages 497-504.

Learning Objectives:
of this article is to illustrate a protocol that will yield accurate impressions on a consistent and predictable basis. Upon reading and completing this exercise, the reader should have:
• An understanding of the basic principles involved in obtaining impressions for simple and complex restorations.
• An awareness of the advantages and disadvantages of several impression-taking protocols.

1. Polyvinylsiloxanes are the most popular group of elastomeric impression materials and are also known as:
   a. Addition reaction silicones.
   b. Condensation reaction silicones.
   c. Polyethers.
   d. Polysulfides.

2. Which of the following reasons is most important for ensuring that the dies are trimmed short of the finish lines, allowing a portion of the unprepared tooth surface to remain?
   a. The finish lines are protected during the fabrication of the restoration.
   b. The technician can more easily establish the desired emergence profile.
   c. The technician has a more ample working area for fabrication of the restoration.
   d. The finish lines will not be damaged during the die ditching process.

3. Soft tissue preparation prior to taking definitive impressions may include any of the following procedures EXCEPT ONE:
   a. Implementing an adequate plaque control regimen.
   b. Finish line selection.
   c. Free gingival grafts.
   d. Scaling and root planing.

4. Which of the following advantages is provided by the presence of adequate periodontal health during impression procedures?
   a. Ability to place the finish line further into the attachment apparatus.
   b. Increased degree of tissue retraction.
   c. Predictable postimpression gingival margin levels.
   d. Prolonged duration of tissue retraction.

5. The double cord impression technique recommended by the author utilizes:
   a. Aluminum chloride and nonimpregnated knitted cord.
   b. Electrocautery and plain braided cord.
   c. Epinephrine impregnated braided retraction cord.
   d. Ferric sulfate impregnated cord.

6. If, following placement of the first cord layer, the finish line becomes exposed, the clinician should:
   a. Modify the type of finish line to conserve tooth structure.
   b. Not become concerned and accept a possible supragingival margin.
   c. Place the finish line according to restoration and site-specific considerations.
   d. Reprepare the finish line to a more subgingival level.

7. The most important benefit of obtaining adequate lateral tissue displacement with retraction cord is:
   a. Decreased dentinal hypersensitivity.
   b. Increased access and visibility.
   c. Improved periodontal and gingival health.
   d. Increased resistance to tearing of impression margins.

8. Successful results can be achieved utilizing plastic stock trays with the recommended technique because:
   a. Polyethers are superior in accuracy.
   b. The elastic recovery of the material compensates for tray flexure during removal.
   c. Stock trays provide superior accuracy.
   d. The tray material is an effective spacer exhibiting high rigidity and dimensional stability.

9. One of the advantages of polyether impression materials compared to polyvinylsiloxanes is:
   a. Higher tear strength.
   b. Increased accuracy.
   c. Lower cost.
   d. Superior wetting ability.

10. Each of the following are advantages of the addition reaction silicones as impression material EXCEPT ONE:
    a. Hydrophobic properties.
    b. High tear strength.
    c. Dimensional stability.
    d. Neutral odor and taste.