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Review Article

Redefining accuracy: The art & science of fixed prosthodontic impressions

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Abstract

The success of a dental restoration largely depends on the accuracy of the impression. Impressions serve as negative replicas of the oral structures and must be made with utmost precision to capture fine details. Achieving an accurate impression involves the selection of an appropriate impression material and a technique that is minimally technique-sensitive yet capable of reproducing the required detail.

Numerous authors in the literature have evaluated the accuracy of various impression techniques, highlighting their respective advantages and disadvantages. Ongoing research continues to explore the optimal combination of impression materials and techniques to enhance clinical outcomes. This review discusses the different impression techniques used in fixed partial dentures.

Keywords: Dual phase impression, Fixed partial dentures, Fixed prosthodontics, Impression techniques, Monophase impression, Putty wash impression

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1. Introduction

A successful dental restoration primarily depends on the accuracy of the dental impression. An impression is an imprint or negative replica that enables the duplication of oral and surrounding tissues. This duplication allows for various treatment procedures—such as the fabrication of prostheses, mock surgeries, and tissue modifications—to be performed with reduced chairside time.

All prosthodontic treatments follow a structured sequence of clinical and laboratory steps, during which different types of impressions are required. In fixed partial prosthodontics, obtaining an accurate impression to create a precise cast—ultimately resulting in a well-fitting prosthesis—is of paramount importance.[1]

Numerous impression techniques have been developed to achieve the highest possible level of accuracy. The precision of an impression depends not only on the materials used but also on the technique employed. Each technique has its own advantages and limitations.[2] Commonly used impression procedures involving elastomeric materials include the single mix (monophasic) technique, one-step putty-wash technique, two-step putty-wash technique, and multiple mix technique.

Failures in impression techniques may occur due to several factors, such as dimensional changes caused by thermal expansion, material shrinkage, or internal stresses.[3]

2. Methodology

A comprehensive literature search was carried out across electronic databases including PubMed, Scopus, Google Scholar, and ResearchGate to identify relevant publications on fixed prosthodontic impression techniques. Articles published between 1950 and August 2025 were reviewed. The search employed keywords such as “fixed prosthodontic impressions,” “impression materials,” “impression techniques,” “custom trays in fixed prosthodontics,” and “accuracy of impressions.” Only peer-reviewed articles, clinical trials, systematic reviews, meta-analyses, and standard reference textbooks in prosthodontics were considered. References from selected studies were further screened to identify additional relevant sources. Duplicate reports and articles lacking scientific rigor were excluded to maintain authenticity and quality of evidence.

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3. Discussion

An impression technique is a multistep procedure that involves several critical components to accurately record oral tissues. These steps include:

3.1. Choice of impression material

Meticulous selection of impression material is essential, taking into account both physical and chemical properties. The selection of impression material also depends on the impression technique employed.[4] Addition polymerized silicone materials offer several advantages, such as excellent accuracy and dimensional stability, high resistance to dimensional changes following disinfection or sterilization, the absence of unpleasant taste or odor, and the availability of a wide range of viscosities suitable for various techniques. They also provide wettability comparable to polyether and feature automixing capability, which reduces the risk of void formation, while the use of small-diameter syringe tips further enhances precision. Furthermore, these materials impose no time restrictions for pouring the cast.

Tear resistance, viscosity appropriate for the technique, and clinician preference remain key factors in material selection. Although hydrophilic materials are popular, they should not be considered a substitute for proper moisture control and hemostasis. Increasing surfactant levels in these materials enhances hydrophilicity but significantly reduces tear strength and slightly compromises dimensional stability. However, addition silicones demonstrate superior tear resistance and stability following disinfection.

3.2. Choice of impression tray (The Carrier)

An impression tray is a receptacle into which the impression material is placed to make a negative likeness. According to GPT-10, it is defined as "a device used to carry, confine, and control impression material while making an impression." Trays may be stock, custom-made, light-cure, or autopolymerizing, and are available in prefabricated or individually fabricated forms. The dentist must carefully select the appropriate tray based on the material being used.

3.3. Choice of tray adhesives

Elastic impression materials must adhere firmly to the tray to ensure an accurate and undistorted impression. If the material separates from the tray upon removal, it can result in dimensional inaccuracies, leading to a distorted die, wax pattern, or casting.[6] Tray adhesives enhance the bonding between impression material and tray, thereby preventing displacement or distortion during removal. They are available primarily in two forms: spray-on adhesives such as COLTENE and KERR Universal VPS, and paint-on adhesives such as SILI SPRAY. Tjan and Whang[7] reported that the combination of tray perforations and adhesive provides optimal retention for impression materials.

For specific materials, different adhesives are recommended. Alginate adhesives are available as liquids or sprays and contain polyamide or diethylenetriamine polymers, ester gum, and rosin in isopropyl alcohol, or a combination of isopropyl alcohol and ethyl acetate. Polysulfide adhesives[8] consist of butyl rubber and styrene/acrylonitrile dissolved in volatile solvents such as chloroform or ketone. Silicone adhesives[8], on the other hand, are composed of polydimethyl siloxane or related compounds like silicone and ethyl silicate. Hydrated silica forms of ethyl silicate chemically bond with the tray, while a chemical bond is also established between the tray material and polydimethyl siloxane.

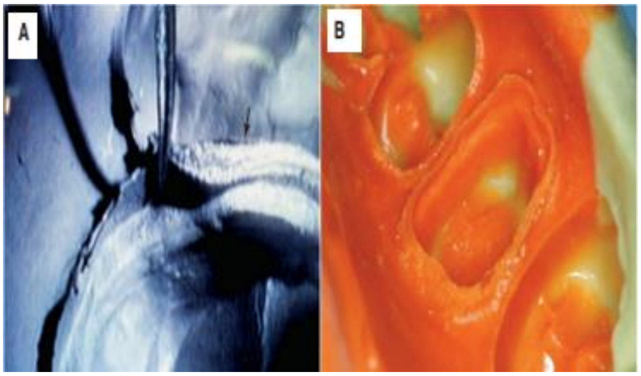

Figure 1: Impression evaluation. **A:** Low magnification of elastomeric impression. On the left, an adequate cuff is formed by material extending beyond the preparation margin. On the left side (arrow), the impression does not extend adequately; **B:** This impression reproduces an adequate amount of the unprepared tooth structure cervical to the preparation margin.

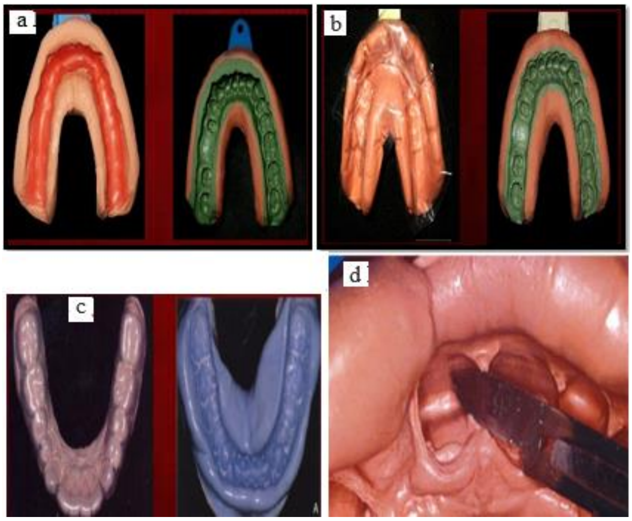

Figure 2: a: Preliminary impression using spacer; **b:** Polyethylene Sheet; **c:** Vaccum formed resin; **d:** Relieved by scalpel

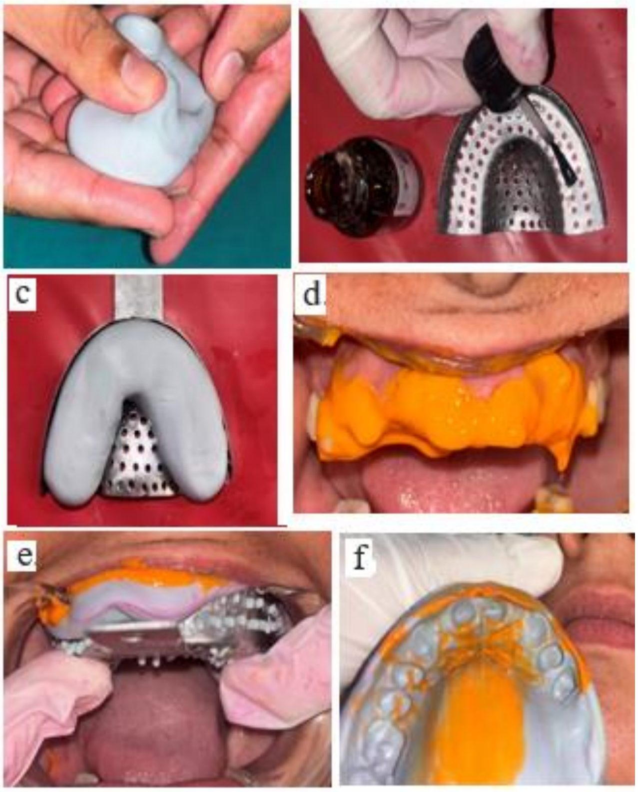

Figure 3: Single mix; **a:** Heavy Body Kneading; **b:** Tray Adhesive technique; **c:** Heavy Body Material in Stock Tray; **d:** Light body; **e:** Tray placement in oral cavity; **f:** Final impression made

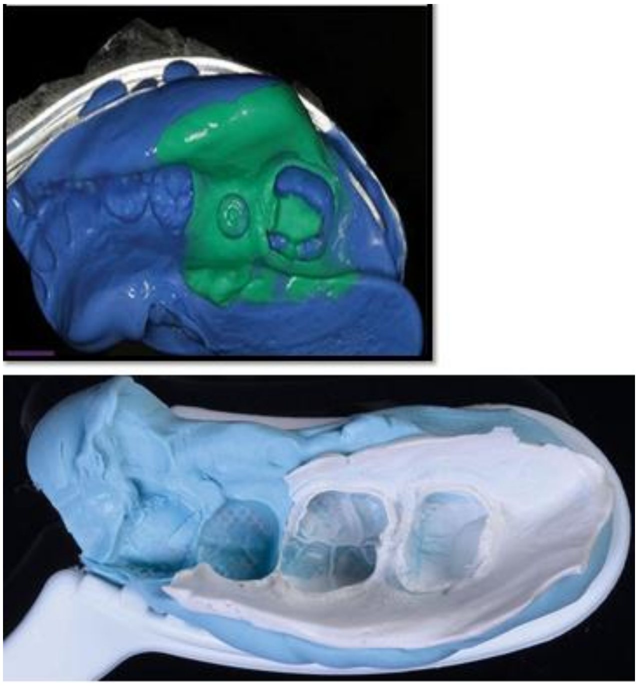

Figure 4: Segmental impression

From a practical perspective, adequate retention of impression material in the tray is crucial for accuracy and consistency.[9] Complete adhesive application is a critical step, and retention improves significantly when adhesives are used with perforated trays. The size, position, and orientation of tray perforations, whether parallel or perpendicular to the tensile axis, also influence mechanical retention and must be carefully considered when selecting or designing trays. Further research into optimizing mechanical retention is warranted. For optimal clinical results, manufacturers should specify the most compatible combinations of impression material, tray, and adhesive.

3.4. Method of fluid control and soft tissue management

Effective fluid and moisture control is essential for capturing accurate impressions. Tissue management ensures that all tooth preparation margins are clearly visible and recorded, regardless of whether conventional or digital impression techniques are employed. This is a critical factor in achieving excellent marginal fit in laboratory-fabricated restorations.

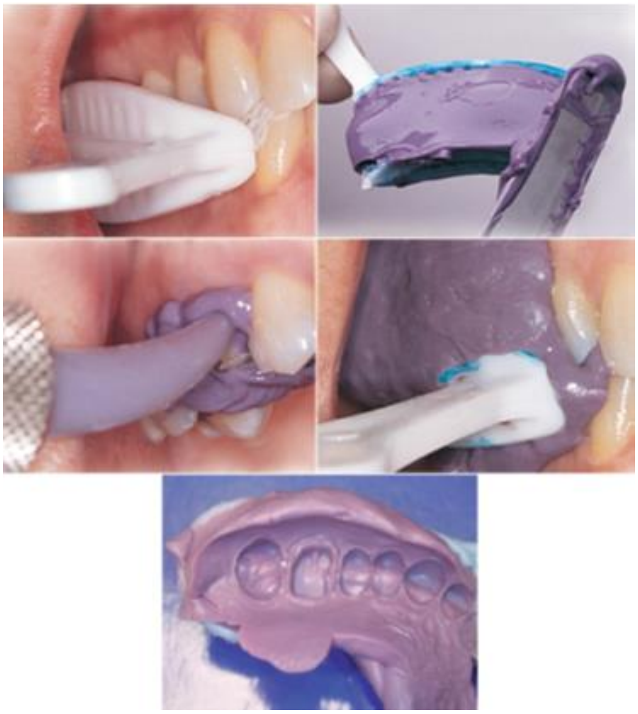

Figure 5: Dual arch impression technique

Fluid control can be achieved using a variety of approaches, including the placement of retraction cord in the sulcus, cotton rolls in the vestibule to manage saliva, Dry-Angles placed on the cheek, a saliva ejector, suction managed by a dental assistant, or the Isolite system, which provides suction, illumination, and tongue displacement.[10]

Gingival displacement, or retraction, may be performed through several methods.[11] Mechanical approaches include the use of copper bands, matrix bands and wedges, gingival protectors, and rubber dams. Chemicomechanical methods primarily involve the use of retraction cords. Surgical approaches include gingettage and electrosurgery.

Table 1: Disinfection of impression materials

Impression Material	Common Disinfectant	Concentration	Immersion/ Spray Time	Notes
Alginate (Irreversible Hydrocolloid)	Sodium hypochlorite	0.5%–1%	10 min (immersion)	Avoid >10 min to prevent distortion; spraying preferred.
	Glutaraldehyde	2%	10 min (immersion)	Effective without significant dimensional changes.
Agar (Reversible Hydrocolloid)	Iodophor or Sodium hypochlorite	1:213 (Iodophor)	10 min	Avoid alcohol-based agents to prevent surface cracking.
Elastomers (PVS, Polyether, Polysulfide)	Sodium hypochlorite	1%	10 min	Stable; rinse post-disinfection.
	Glutaraldehyde	2%	10–15 min	Does not affect dimensional stability.
Zinc Oxide Eugenol Paste	Sodium hypochlorite	1%	10 min	Compatible; minimal effect on accuracy.
Compound Impression	Sodium hypochlorite or Iodophor	1%	10 min	Avoid excessive heat during drying after disinfection.
Addition Silicone (PVS)	Iodophor or Glutaraldehyde	1:213 or 2%	10 min	Spray disinfection or short-term immersion is best.

3.5. Impression techniques in fixed partial dentures

After selecting the impression material, tray, tray adhesive, and soft tissue management method, the final step is choosing the most appropriate impression technique, taking into consideration the various factors that influence accuracy.

3.5.1. Classification I: According to tylman[2]

Tylman[2] classified impression techniques into several categories. Stock tray techniques, also known as putty-wash techniques, may be carried out using either a double-mix or single-mix approach. Custom tray impressions generally use a single-mix technique. Closed bite, double arch, dual quad, triple tray, Accubite, or triple tray techniques are also described. Other recognized approaches include the copper band technique and hydrocolloid techniques, which may be performed using the laminate or wet field method. Finally, the matrix system is also included in this classification.

3.5.2. Classification II: According to shillingburg[12]

Shillingburg[12] categorized impression techniques based on the type of impression material used. Impressions using hydrocolloids may involve the laminate or wet field technique. Polysulfide impressions may be obtained with either the stock putty-wash double-mix method or a custom tray technique. Condensation silicone impressions may similarly be made with the stock putty-wash double-mix or custom tray technique. Polyether impressions are commonly made using custom trays or the closed bite technique. Polyvinyl siloxane impressions may involve stock putty-wash methods—double mix or single mix—custom tray techniques, or automix systems. In addition, Shillingburg described specific impression techniques for pin-retained restorations.

3.5.3. Classification III: According to rudd and morrow[13]

Rudd and Morrow[13] organized techniques according to impression materials as well. For silicones, the options include custom tray and two-stage (putty-wash) techniques. For polyethers, the custom tray method is most common. For polysiloxanes, putty-wash or two-stage, custom tray, and copper tube impressions are described.

3.6. Impression making with hydrocolloids

3.6.1. Reversible hydrocolloids[2,12]

Reversible hydrocolloids are supplied as semi-solid gels in polyethylene tubes, which are liquefied by immersion in boiling water using a hydrocolloid conditioner. At this stage, the material becomes a liquid (sol) that is too hot for intraoral use and therefore requires cooling through two phases: storage and tempering. Since only one accurate cast can be obtained from a reversible hydrocolloid impression, clinicians typically use either sectional (quadrant) impressions for making dies or full-arch impressions for working casts.

For tray selection, it is important to try in the tray to confirm a proper fit. Adhesive plastic strips are placed inside the tray to prevent teeth from pushing through. In full-arch trays, two stops are placed at the rear and one at the front, whereas in quadrant trays, stops are placed both anteriorly and posteriorly, ensuring that they contact unprepared teeth. Patient preparation involves confirming adequate anesthesia; if impressions are made at a later appointment after tooth preparation, re-anesthetizing the area is necessary. Isolation is achieved by placing retraction cord and inserting a large gauze pack in the mouth.

The impression is made by filling the tray with material from the storage bath and placing it in the tempering bath for

10 minutes until the temperature reaches 110–115°F (44–46°C), ensuring patient comfort. A cartridge of hydrocolloid is then withdrawn from the storage bath, inserted into a syringe, and expressed to confirm free flow. Syringe material can be handled in three ways: loading sticks into Teflon syringes, boiling and storing them with tray material; using pre-packaged injection cartridges (carpules) and anesthetic syringes; or employing a black poly tube that fits the Teflon syringe cylinder. Importantly, the retraction cord is removed before seating the tray.

The advantages of reversible hydrocolloids include less complex equipment requirements for liquefaction and storage and elimination of the need for water-jacketed trays or tubing. However, disadvantages include fast gelation of syringe material, potential separation between syringe and tray material, and low tear strength, which may cause tearing during removal, particularly when subgingival anatomy is involved.[14]

3.6.2. Wet field technique[8,15,16]

The wet field technique requires a special conditioning unit equipped with thermostatically controlled water baths. Instead of injecting syringe material into the sulcus, the preparation sites are bathed in warm water while the syringe material is applied generously to the occlusal surfaces. When the tray is seated, the viscous tray material forces the light-bodied syringe material into the sulcus. However, this technique is indicated only for tooth preparations without internal features such as grooves, boxes, or isthmuses.

3.6.3. Impression making with irreversible hydrocolloid (Alginate)

When using alginate, the mandibular impression should be made first, as it generally causes less discomfort and helps build patient confidence. While holding the tray with the left hand, the dentist uses the right hand to remove gauze pads from the patient’s mouth. A syringe is used to deliver alginate into the facial and lingual vestibules, followed by application to the occlusal surfaces. The right index finger is used to press the material into interproximal spaces and occlusal depressions. The loaded tray is then seated immediately, while lips and cheeks are pulled apically and outward at a 45° angle to properly form the peripheries.

For the maxillary impression, the operator should be positioned slightly behind and to the right of the patient. The patient rinses first with an astringent mouthwash followed by cold water, and moisture control is achieved with gauze pads. Alginate is delivered into the vestibules, onto the occlusal surfaces, and onto the palate using a large-diameter syringe. Skipping the palatal application often results in voids in the impression. Once placed, the material is wiped into interproximal areas and occlusal depressions, and the loaded tray is inserted, stabilized over the premolar areas, and held with light bilateral pressure. Alginate typically sets within two to three minutes.

3.6.4. Laminate technique (Agar–Alginate Impression Technique) \[Schwartz, 1951][15-17]

The laminate technique is a modified impression method that combines reversible hydrocolloid (agar) and irreversible hydrocolloid (alginate). In this method, tray agar is replaced with chilled alginate, which bonds to the syringe-injected agar. Agar sets through temperature change, while alginate sets through chemical reaction. Syringe agar in cartridge form is first heated in boiling water for six minutes, then stored in a 65°C water bath for ten minutes before use. Regular-set alginate is mixed with 10% more water than usual and placed into the tray.

The procedure involves injecting heated agar around the prepared tooth, followed by prompt seating of the alginate-loaded tray. The alginate sets in approximately three minutes, while the agar gels as it cools from the alginate, bonding the two materials together. The impression is removed in about four minutes. The advantages of this method include fine tissue detail provided by agar, elimination of the need for water-cooled trays, better compatibility with gypsum materials, reduced setting time, avoidance of bulky equipment, and cost-effectiveness since only syringe material requires heating. Disadvantages include the occasional unreliability of agar–alginate bonding, possible displacement of agar due to the viscosity of alginate, dimensional inaccuracy limiting its use to single-unit restorations, stiffness of the material, difficulty in removal, and low tear resistance.[15]

3.6.5. Recent developments in alginate impression materials[8,12,14]

Several innovations have improved alginate materials. Dust-free alginates reduce inhalation risks by coating particles with glycerin or glycol, increasing density. Siliconized alginates, which combine an alginate sol with a calcium reactor, incorporate silicone polymer to enhance tear resistance, though dimensional stability remains poor. Low-dust alginate formulations introduced in 1997 by Schunichi and Nobutakwatanate include alginate with gelation regulators and fillers such as sepiolite and tetrafluoroethylene resin, achieving reduced airborne dust. Antiseptic alginate materials, patented in 1990 by Yamamoto and Abinu, incorporate antiseptics such as glutaraldehyde or chlorhexidine gluconate, sometimes microencapsulated or clathrated in cyclodextrin for controlled release. Another innovation, CAVEX color change alginates, features color indicators to guide working and setting times: violet to pink for the end of mixing, and pink to white for tray removal. These alginates offer improved dimensional stability of up to five days, good tear resistance, dust-free handling, smooth surface reproduction, and excellent compatibility with gypsum.

3.7. Impression techniques using elastomeric impression materials

3.7.1. Polysulfide impressions[10, 12]

For impressions using polysulfide, syringe material is injected immediately into the sulcus after gauze removal. The syringe tip should be kept just above the gingival crevice, advancing smoothly around the preparation to push material ahead of the tip and ensure complete coverage. Gentle air is directed to spread the material uniformly into grooves, boxes, and the gingival crevice. However, excessive or prolonged air use should be avoided in patients with thin gingiva, as it may cause interstitial emphysema. The tray is then seated slowly until stops hold it in position, and light, steady pressure is maintained for 8–10 minutes. Setting is confirmed when the material rebounds completely after probing with a blunt instrument. Removal should be performed quickly in a straight line to minimize distortion, after which the impression is rinsed and carefully evaluated for voids or inaccuracies.

3.7.2. Condensation silicone impression technique[12]

The putty-wash double mix technique uses a relieved putty impression. A pre-operative putty impression is first made, and plastic sheets may be placed over the teeth to prevent ingress into the gingival embrasures. The putty is then removed from the area of tooth preparation using a bur or scalpel, and the relieved space is relined with a low-viscosity wash material.

For the preliminary impression procedure, the patient is seated in a supine position with the operator at 9 o'clock and the assistant at 3 o'clock. The tray size and shape are selected based on the arch and material compatibility. Adhesive (polysiloxane with ethyl silicate) is applied to the tray interior and allowed to dry. For a full-arch tray, two scoops of putty base are mixed with six drops of accelerator per scoop, first using a spatula and then kneading by hand for 30 seconds until streak-free. The material is shaped into a cylinder, a polyethylene spacer is placed, and the tray is seated. After the initial set of approximately two minutes, the tray and spacer are removed, excess material is trimmed, and the tray is set aside for final use. This impression can be made with a spacer (**Figure 2**a–c) or relieved with a scalpel or scraper (**Figure 2** d).

For the final impression, the quadrant is isolated, a retraction cord and gauze are inserted, and a thin-wash silicone is mixed in the proportion of 8 inches of base to 8 drops of accelerator for full-arch trays or 4 inches for sectional trays. Mixing should be done using circular and figure-eight motions to avoid voids. One-third of the mixture is loaded into a syringe, while the remainder is placed into the tray. After removing gauze and the retraction cord, the material is injected into the sulcus, with the tip kept above the gingival crevice, and applied circumferentially around the preparation before seating the tray from posterior to anterior, allowing excess material to extrude. The tray is held in place without pressure for six minutes to prevent stress-induced deformation, after which it is removed quickly and directly. The impression is then rinsed, dried, and inspected, ensuring that the material extends 0.5 mm beyond the visible finish line.

3.7.3. Polyvinyl siloxane (PVS) techniques[12]

The double mix technique requires simultaneous mixing of syringe and tray materials for approximately 45 seconds, ensuring streak-free consistency before loading and following the same tray seating and removal protocol as condensation silicones.

The single mix (simultaneous/squash technique)[15] involves gingival retraction with a cord, followed by simultaneous mixing of putty (heavy body) for the tray and light body for syringe injection. After cord removal, light body is injected around the preparation, and the putty tray is squashed over it. However, this technique presents problems such as hydraulic distortion of putty and inaccurate marginal capture due to poor control of light body thickness. Disadvantages include uncontrolled light body thickness, impaired flow from putty viscosity, and possible displacement of the light body due to the stiffness of putty (**Figure 3**).

The automix system[8,12] requires ensuring that the retraction cord is damp before removal. The impression material is injected beginning at an interproximal region and pushed ahead of the tip, while the assistant simultaneously loads the tray with medium or heavy body material. The tray is then seated firmly, held for seven minutes, and removed quickly in a straight motion. The impression is rinsed, dried, and inspected.

The controlled putty-wash technique[12] involves placing putty over provisional restorations, allowing it to set, and then removing the restorations to leave a precisely dimensioned wash space. If thin margins prevent adequate light-body bulk, putty is cut away to the finish line, and vents are created in the putty to direct excess wash material outwards. Large embrasures are blocked out with utility wax. This method allows accurate seating with minimal distortion, uses provisional restorations and unprepared teeth as landmarks, reduces chair time, and ensures enhanced dimensional stability through escape channels.

3.7.4. Copper band impressions[7,12]

In this method, 4–5 retention holes are drilled into the copper tube approximately 2–3 mm above the base. The internal surface is coated with adhesive, filled with heavy-body PVS (not putty), and seated over the tooth. Excess material is compressed, and after setting, the band is removed using a Backus towel clamp. The impression is evaluated and poured into a die if adequate.

3.7.5. Segmental impression technique[15,16]

The segmental impression technique involves loading a segmental tray with low-viscosity material, removing the retraction cords only in the active segment, injecting the material, and seating the tray. The procedure is repeated for all segments, followed by a final overimpression using a stock tray. This method is particularly advantageous in extensive cases or when moisture control is difficult, and it also allows simultaneous implant and tooth impressions.

3.7.6. Hydraulic and hydrophobic impression technique[15,16]

This technique is designed to capture margins without gingival retraction. A preliminary unrelieved putty impression is made, relined with high-flow light-body VPS, and seated while the patient bites into the tray. The hydraulic pressure forces the light body into the sulcus and occlusal areas.

3.7.7. Polyether impression technique[12]

The closed bite double arch method[10,19,20] begins with mixing low-viscosity impression material according to manufacturer's instructions using circular and figure-eight motions while minimizing spatula lifting to prevent voids. The syringe is loaded at a slight angle, excess is wiped off, and the dispensing tip and plunger are attached. During cord removal, forceps are used to grasp approximately 2 mm of exposed cord and tease it occlusally until fully removed. The site is checked for seepage, hemorrhage, or debris. Impression material is injected into inaccessible regions such as distolingual finish lines and interproximal areas, ensuring extrusion ahead of the orifice. High-viscosity elastomer is mixed and overfilled into the tray, with the crossbar positioned distal to the last tooth for quadrant trays. The tray is seated over the maxillary arch, and the patient is instructed to close slowly. Closure is confirmed by observing interdigitation on the opposite arch.

3.7.8. Forming the matrix

Immediately after tooth preparation and before retraction, a matrix carrier should be selected or fabricated. This carrier may be premade with vacuum-forming equipment or created directly with wax. It must provide 3–4 mm of space between its walls and the prepared teeth, 2–3 mm of clearance from adjacent unprepared teeth, extension of one tooth beyond the prepared teeth on either side, and 2–3 mm extension beyond the gingival margin onto the ridge. It should also include soft tissues under planned pontics or precision attachments.

Once the carrier is ready, it is filled with polyether or PVS occlusal registration material and positioned over the prepared teeth, ensuring 1–2 mm thickness of the occlusal wall over unprepared teeth. After polymerization, the matrix is removed and trimmed with a scalpel, maintaining half to two-thirds of a tooth beyond the preparation for orientation, while removing excess from the facial and lingual extensions. The matrix should accurately record the occlusal surfaces, axial walls, and gingival crests, but the finish lines are not the primary target at this stage. If the crevice is not registered or voids are present, the matrix must be remade. When the impression is to be taken later, the matrix should be labeled and stored; if the procedure continues in the same appointment, the matrix refinement should be carried out.

3.7.9. Completing the impression

The impression may be completed in the same appointment or at a subsequent visit after refining the matrix. The interim restorations are removed, and the preparations are thoroughly cleaned. The refined matrix is then seated on the teeth, and a stock tray that accommodates both the matrix and the unprepared teeth is selected. Tray adhesive is applied if PVS is used, although no adhesive is required for polyether matrix impressions unless a non-perforated tray is used. A moist retraction cord, either with a hemostatic agent or water, is placed around each tooth with 2–3 mm protruding for retrieval. Any blood in the sulcus must be rinsed away beforehand, as dried blood will not be removed by the matrix.

A high-viscosity material is mixed and loaded into a conventional syringe, which is dispensed into the occlusal depressions of the matrix and applied around the soft tissue side to avoid air entrapment, without using vent holes. After cord removal, additional light body may be injected around the preparations to flush debris, a step that is particularly valuable for smaller teeth. The filled matrix is seated with light vertical pressure, aligned with adjacent teeth, and care is taken to avoid excessive force. Proper design ensures definitive seating through vertical stops. A medium-viscosity mix is then prepared for the stock tray and seated over the matrix. Notably, this reverses the traditional viscosity sequence, with the medium body in the tray and the high body in the matrix.

Following complete polymerization, the impression is removed and inspected. The matrix may be visible, which is acceptable, as it becomes an integral part of the impression. Once the impression is deemed satisfactory, the procedure can proceed to the formation of the master cast.

3.7.10. Monophase impression technique[7]

The monophase technique is similar to the dual-phase method, except that a medium-viscosity (regular body) elastomer is used for both syringe and tray. A custom tray with a 3 mm spacer is employed in this approach. However, the surface reproduction may be inferior to that of light body materials, and polymerization shrinkage is greater due to the lower filler content. This method is suitable only where very high accuracy is not critical.

3.7.11. Disinfection of impression materials[21]

For disinfection procedures, **Table 1** provides detailed protocols applicable to various impression materials.

Recent high-quality syntheses indicate that, in most fixed prosthodontic scenarios, restorations derived from digital impressions achieve marginal and internal fit that is comparable to conventional elastomeric impressions. A 2024 *Journal of Prosthetic Dentistry* review reported no clinically meaningful differences in fit across workflows, a finding that is consistent with multiple meta-analyses published since 2019.[23-25] However, for full-arch situations—particularly those involving implant-supported prostheses—the evidence is more nuanced. A 2025 *Journal of Clinical Medicine* systematic review and meta-analysis, which included studies up to December 2024, found that although methods were heterogeneous, clinical accuracy with intraoral scanners (IOS) was generally within acceptable thresholds and often similar to conventional impressions. Nevertheless, variability tended to increase with full arches and multiple implants.[26]

Full-arch digital implant impressions remain particularly challenging due to the scarcity of landmarks and the potential for error accumulation. Contemporary reviews show that while digital and conventional full-arch implant impressions demonstrate mixed but broadly acceptable accuracy, factors such as scanner type, scan body geometry and location, and scan strategy have a significant influence.[26] Photogrammetry systems have emerged as promising alternatives for multi-implant arches, demonstrating superior trueness and precision compared with IOS, particularly in cases with non-parallel implants. Recent comparative and in-vitro studies from 2023 to 2025 report improved angular and linear deviation with photogrammetry, though robust clinical outcomes data remain limited.[27-30]

Randomized clinical trials conducted between 2018 and 2019 demonstrated that digital complete-arch scans are faster chairside than conventional impressions, and overall laboratory time is reduced with CAD-CAM workflows, all without compromising the marginal or internal fit of the final prostheses. Patients also generally prefer digital scanning due to enhanced comfort and the reduced gag reflex burden.[31] These findings are corroborated by more recent systematic reviews, which conclude that digital workflows can be cost-efficient, time-optimized, and associated with high patient satisfaction, although the greatest benefits are observed for single-unit restorations and short-span fixed dental prostheses (FDPs).[32]

Several factors influence the accuracy of digital impressions. Scanner-related variables such as brand, calibration, the use of powder, ambient conditions, and scan path significantly affect trueness and precision, with deviations accumulating over longer spans. Additionally, the use of auxiliary geometric aids and optimized scan body design and positioning can enhance accuracy in full-arch implant scans.[26] Peri-implant soft tissue capture is another critical factor; a 2025 systematic review suggests that indirect emergence-profile scanning currently offers the most promising outcomes for implant single crowns, although further randomized controlled trials are needed for validation.[33]

Multiple meta-analyses published between 2019 and 2024 conclude that single-unit crowns and short-span FDPs fabricated from digital impressions achieve marginal gaps well within accepted clinical thresholds, often equivalent or slightly better than those achieved with conventional impressions, particularly in zirconia restorations. Importantly, recent studies highlight that both digital and conventional techniques can meet the target of less than 120 μm marginal discrepancy when executed properly.[24,34,35]

Gingival displacement and tissue management remain critical considerations in impression making. Since 2015, randomized controlled trials have compared displacement cords with aluminum-chloride-based pastes and cordless systems. A multicenter randomized controlled trial published in 2016 and a subsequent 2020 trial both demonstrated that cords and pastes provide clinically acceptable sulcular widening, though cords typically achieve slightly greater horizontal displacement, while pastes may be faster and less traumatic.[36,38] Another 2020 RCT reported comparable final gingival gaps, with cords producing statistically larger gaps that were still within acceptable limits. Systematic reviews and prospective trials published since 2019 support the view that cordless systems are easier, faster, and gentler, although many clinicians perceive cords combined with hemostatics as more predictable. Operator skill remains a key determinant of success, and clinicians must remain mindful that aluminum-chloride agents can alter the smear layer and affect bonding, making careful rinsing protocols essential.[39-42]

Taken together, the practical synthesis for fixed prosthodontics as of 2025 suggests that the best-supported indications for digital impressions include single crowns and short-span tooth- or implant-supported FDPs, offering advantages in accuracy, fit, chairside time, and patient comfort.[24] Areas requiring greater caution are complete-arch and multi-implant cases, where optimizing scanner selection, scan bodies, and scanning strategies is crucial, and where photogrammetry may be considered to enhance precision.[26,29] In terms of tissue management, the choice between cord and cordless methods should be based on sulcus depth, tissue biotype, and operator experience. While cords remain the gold standard for achieving maximal displacement, pastes and cordless systems improve efficiency and patient comfort, with generally acceptable outcomes.[42-45]

4. **Conclusion**

Custom trays generally provide superior accuracy and uniform material thickness compared to stock trays, making them essential for complex cases. Among materials, polyether offers excellent wettability, while PVS remains highly accurate with both one-step and two-step putty-wash techniques, the latter providing better marginal fit. The matrix impression system enhances sulcular detail and simplifies multi-unit cases, combining the strengths of traditional techniques. However, material compatibility and bonding between polymerized and unpolymerized components require further research to prevent delamination.

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None.

6. Conflict of Interest

None.

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