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ELASTOMERIC IMPRESSION MATERIALS:-A COMPARATIVE REVIEW

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ABSTRACT The use of many impression materials is acceptable in dentistry. In order to create final restorations, intraoral features are recorded using impression materials. Any dental prosthesis must be constructed using precise impressions. For the best cast, it is necessary to correctly represent the relationship between the fixed and movable oral components. Dentists are helped in the design and construction of detachable and fixed prostheses by creating a cast in gypsum materials using an impression of the dental anatomy. The impression materials and methods have a significant impact on how accurately these final restorations will be. The more popular impression kinds are used to create master and diagnostic casts. Casts used for diagnosis are utilised to help in treatment planning. Complete dentures, removable partial dentures, crowns, fixed partial dentures, and implants are all made using master casts. Identification of the applications that fit or do not fit the properties of each material is necessary for accurate impressions. A successful outcome can be hampered by the usage of materials without proper awareness of their qualities. The operator's subjective decision, based on personal tastes and prior experience with specific materials, frequently determines the impression material selection.

KEYWORDS : Dental impression materials, elastomers, physical properties, dental prosthesis, review

INTRODUCTION

According to the polymer constituent, elastomers—rubber-based polymers used in dental impressions—can be divided into four groups: polysulfide (PS), polyether (PE), polyvinyl syloxane (PVS), and condensation silicone (CS). High tear resistance, accurate detail replication, and inexpensive cost are all characteristics of polysulfides. Polyethers have a high cost, great detail reproduction, and moderate tear resistance. In contrast to condensation silicones, which have weak tear strength and exhibit more distortion, PVS offers excellent tear strength, a reasonable working time, and excellent elastic recovery.

The success of indirect restorative operations is influenced by the fit and retention of dental prostheses, which are impacted by the dimensional changes of the impression materials. Humidity, the amount of time between mixing and pouring, and the thickness of the layer of material in the tray all have an impact on the dimensional behaviour of imprint material. Additionally, due to their linear thermal expansion coefficient and the temperature difference from the mouth cavity to the outside environment, impression materials contract. Volumetric changes are also influenced by the kind of tray, how well the materials adhere to the tray, and the kind of polymer used to make the elastomers. Depending on whether the impression process is used in single or double phases, the results will vary.

A perfect imprint material should have, among other things, long-term dimensional stability that enables the creation of accurate cast models at any time. The materials frequently employed to make dental imprints, however, exhibit changes in their dimensional behaviour. Their dimensional stability may be impacted by the emission of water and ethanol as byproducts of the polymerization of polysulfide and condensation silicone, respectively, and polyether hydrophilic behaviour. It exhibits the best dimensional behaviour since PVS polymerization produces no byproducts.

Criteria used in evaluating impression materials

Properties and handling characteristics

In this section, numerous modern impression materials' qualities and handling traits are covered. Flow properties, which produce a more bubble-free image, are explored in relation to the hydrophilic versus hydrophobic nature of materials. Due to their enhanced physical and mechanical qualities, polyvinyl siloxanes and polyethers have recently become more popular among dentists [1,5-7]. These 630 RUBEL characteristics Improved dimensional accuracy, stability, wettability, good elastic recovery, flexibility, ease of handling, tear strength, ability to create many casts from a single imprint, and superior ability to reproduce detail are just a few of the benefits of the author's personal copy.

Dimensional accuracy

Dimensional precision is typically time-dependent for elastomeric impression materials including polyvinyl siloxane, polyether, and polysulfide, with greater accuracy happening right after polymerization is finished but decreasing when the impression is stored for a long time [5,7-9]. For one to two weeks, polyvinyl siloxane and polyether imprint materials maintain their dimensional accuracy [5,7,8]. If poured within 1 to 2 hours of taking the impression, polysulfide impression material has correct dimensions [5,7].

Hydrophilic versus hydrophobic nature of impression materials. The hydrophilic characteristics of elastomeric

impression materials vary significantly. The hydrophobic properties of polyvinyl siloxanes are a drawback [6,7,10-13]. Because of their chemical makeup, polyvinyl siloxanes are hydrophobic. Around the siloxane link, they have hydrophobic aliphatic hydrocarbon groups [2,3,13,14]. More hydrophilic materials include polysulfides and polyethers. They include functional groups that interact with water molecules chemically and via hydrogen bonds [13,15]. Moisture causes impressions to have voids or pitted surfaces, which results in a worse quality reproduction of the detail. Even with the new "hydrophilic" polyvinyl siloxane imprint materials, this effect has been documented. The wettability of these hydrophilic polyvinyl siloxanes has improved [1, 4, 19, 20], although they are only therapeutically usable in dry environments [17]. The choice of the best material is made simpler by comparing the many types of impression materials based on their hydrophilic versus hydrophobic nature, wettability, the level of detail reproduced, their dimensional stability, their rigidity, their tear strength, and their contact angle. An impression material's hydrophilicity refers to its capacity to function in a moist environment while still producing accurate impressions. A substance is said to be hydrophilic if it can withstand some moisture.

Elastic recovery

When removed from the mouth, a set impression must be sufficiently elastic to return to its original proportions without suffering from substantial distortion [2]. The best elastic recovery is found in polyvinyl siloxane, followed by polyether and polysulfide [2,8].

Flexibility

When set, flexible impressions are simpler to remove from the mouth. The most rigid imprint materials are frequently poly ethers [2]. Because polyvinyl siloxanes are somewhat stiff, they can flow easily to capture fine details depending on the material's viscosity [8]. When the amount of distortion and removal time are both increased, the accuracy of the impression is likewise impacted. Depending on the kind of elastomeric imprint material employed in these situations, permanent deformation happens [2,8,14].

Tear strength

The resistance of a certain material to ripping after setting is referred to as the tear strength of an impression material [2,3,25]. This could be a crucial factor in the case of subgingival margins. Hydrocolloids are thought to have relatively low tear strengths, whereas polyethers are thought to have the highest tear strengths [2,3]. Despite having a strong resistance to ripping, polysulfide impression materials flex and do not fully recover elastically [2,14].

Contact angle (and ability to reproduce detail)

Dental stone can flow readily through impression materials with low contact angles, and casts are created largely bubble-free. For accurate casting, pouring techniques and attention must be more careful with materials with high contact angles [2]. Surfactants may be necessary to reduce the contact angle of polyvinyl siloxane compounds before casting. The contact angles of hydrocolloids, polyethers, and polysulfides are relatively small.

Types and characteristics of specific impression materials

Polyethers

A base paste made of a long-chain polyether copolymer with reactive terminal groups and alternating oxygen atoms and methylene groups (O-[CH2]n) makes up polyethers. Triglycerides, plasticizers, and fillers are also included. A cross-linking agent (aliphatic cat ionic initiator), filler, and plasticizers are included in the catalyst paste. Imine-ringed side chains that contain polyethers react with a reactant that opens the rings, lengthens the chain, and causes chain cross-linking to create polyether rubber (IMPRESSION MATERIALS 635 Author's own copy) [2,14]. In the presence of some saliva or blood, polyether impression materials are moderately hydrophilic and take precise impressions. They may capture a full arch impression more readily than polyvinyl siloxanes because of their low wetting angle [2]. For 1 to 2 weeks after impressions are taken, they are dimensionally stable, have good detail reproduction, and allow multiple pours of precise casts as long as the imprint is not torn. They can be more challenging to remove than polyvinyl siloxanes since they are hard compounds [2, 14]. They have a high tear strength, which makes it possible for the dentist to remove the imprint without tearing it and still obtain good subgingival detail. This substance sticks to itself and can be used to create correctable impressions or create border moulds. Newer polyether formulations, such "soft" polyethers, are simpler to remove, maintain correct stiffness for a variety of applications, and capture fine detail even in damp environments [36]. Soft polyether materials don't start setting before the working time is up because to their snap-set characteristic. Once it does, it sets right away [23,36]. It is extremely attractive for clinical and laboratory application due to these qualities. Polyether has the ability to flow into sensitive areas with little pressure applied, resulting in accurate impressions and less corrections and remakes in dental procedures. They perform slightly better than polyvinyl siloxanes and better than hydrocolloids [2]. Due to their mild hydrophilicity, these materials must be disinfected with extreme care in order to avoid swelling. Before pouring the castings, spray with the disinfectant for 10 minutes, then immediately rinse and dry [34]. This substance has a bitter taste, however it is currently flavoured to mask it. The setting times are brief (4-5 minutes), and latex gloves are not used to change or contaminate the set.

Polyvinyl siloxanes

The most common type of silicones are addition silicones, which link a vinyl siloxane in the base material with a hydrogen siloxane using a platinum catalyst [1,2,8]. As a result, no reaction by-products are produced. The platinum scavenges the hydrogen that is produced by the process. Changing the amount of silica filler results in either a putty or a less viscous wash material, depending on the desired viscosity. For fixed partial denture impressions, vinyl polysiloxane silicones—also known as addition silicones, polyvinyls, vinyls, and polyvinyl siloxane—are thought to be state-of-the-art. They are the type of impression material that fixed prosthetics employ the most frequently [8]. They can be trimmed and poured in any die material, and once set, they are essentially inert. However, they are contaminant-prone before they set. Anything that prevents 636 RUBEL the addition silicones from setting requires a little amount of catalyst (a compound of platinum). Author's personal copy the catalyst, which prevents the substance from cross-linking, results in the impression's surface remaining tacky [2]. Sulfur or sulphur compounds are frequently the cause of polyvinyl siloxane contamination [2,8]. In the dental office, this is typically seen as rubber dams or latex gloves. Small levels of sulphur cause significant deformation and prevent the crucial surface from being placed adjacent to the tooth [3]. To get rid of impurities, clean the preparation and nearby soft tissues with 2% chlorhexidine [2]. The interior of the tray, the mixing spatula or mixing pad, the end of a mixing tip, the retraction cord, the teeth and nearby gingiva, should not be touched when wearing latex gloves. Wearing polyethylene gloves over latex gloves or skipping the latex gloves altogether while taking impressions are the two ways to prevent latex contamination. Because of the sulfur-containing stabiliser used in the production process, some vinyl gloves may also have the same effect [3]. In addition to silicone impression materials, sulphur compounds can poison the platinum-containing catalyst, which will slow or prevent polymerization in the contaminated area of the imprint [2]. The vapour that polysulfide impression material emits has reportedly been

implicated in contamination. Avoid keeping polyvinylsiloxane impression materials next to polysulfide impression materials when storing them. The oxygen-inhibited layer that forms on the surface of resin materials right after curing is another source of contamination. Around freshly installed composite restorations, this thin layer keeps impressions sticky [8]. Additionally, polyether and polysulfide impression materials produce a chemical layer in the mouth that prevents polyvinyl siloxanes from adhering. The set is inhibited if you produce an impression with one of these two sorts of substances before choosing to make an impression with polyvinyl siloxane [1,8]. Materials made of poly vinyl siloxane are similarly thermally sensitive [8]. They set more quickly the warmer it is. It is advised to store this material in a cool environment, out of the sun, as if it is overheated it may not return to its typical setting time even after cooling (refrigerator or cool space). The material sets more slowly when cooled. When using a substance that has been stored in a refrigerator, it is best to let it warm up to room temperature first; otherwise, it takes longer than usual to set. When the material is cold, it becomes thicker and more challenging to express and combine [8]. Most imprint materials need a base to catalyst ratio of 1:1. The setting time is also sped up by adding more catalyst. Prior to inserting the mixing tip when using automix cartridges, it is advised to extrude 0.25 inches of material to remove any contaminants or material that has been exposed to the environment for an extended period of time. If you pour castings too soon, the stone will catch the hydrogen out-gassing bubbles that some polyvinyl siloxane compounds exhibit, resulting in a cast with pitted areas [3]. Although it is best to study the instructions for pouring particular brands of polyvinyl siloxanes before pouring stone, it is said that the newer materials contain a proprietary component that reduces hydrogen bubbles. After the impression material is taken out of the mouth, the newer materials are allegedly able to be poured in 5 minutes. Before pouring the gypsum casts and dies, it is advised to wait at least 30 minutes for the setting reaction to be finished [3]. After the impression has been left overnight, epoxy dies should not be poured [2]. Gypsum products set up significantly more quickly than epoxy die materials, which accounts for the disparity in the delay between the two materials. Gypsum and epoxy die materials can be poured against items that contain a hydrogen absorber, such as palladium, as soon as it is practicable [2]. When you spit and introduce air to the impression, bubbles may form. More often than not, hand spatulation produces more bubbles than automixing cartridges.

This is definitely accurate when comparing manual sputtering to automixing with regard to any impression material. In general, polyvinyl siloxanes are hydrophobic. A little hydrophilicity is present in Aquasil (Caulk/Dentsply) [4,9,36]. Accurate impressions can be hampered by saliva or blood moisture. The presence of moisture results in a loss of detail at the impression margins [3]. It has a slightly higher wetting angle than hydrocolloid, polyether, or polysulfide, which makes it a bit trickier to get a precise full arch impression. If there are no tears in the material, it has an excellent capacity to replicate detail and is dimensionally stable, allowing for successive pours of precise casts for a few weeks after impressions are created. It may be removed more easily than polyether polymers and is relatively stiff. They have a tear strength that is superior to hydrocolloid but inferior to polyether [2,14]. They can be sterilised using cold water without risk of distortion and can be utilised with the majority of disinfection methods [34]. Keep in mind that most silicones emit hydrogen when they set, and many need to be de-gassed for 30 to 60 minutes before a master cast can be poured. Otherwise, the cast will become porous on the surface. Because of the stone's somewhat high contact angle and greater ability to trap air bubbles, stone pouring must be done with more caution [2]. This substance comes in many flavours and is not particularly unpleasant to the palate. Additionally, the setting time is rather brief (4–5 minutes). However, contamination from glove latex proteins may prevent this material from setting. The majority of the materials in this category don't stick to themselves once they've dried, thus they can't be utilised for correctable impression techniques or border moulding. Because it sticks to itself after setting, Aquasil is an exception. There have been no reports of any disinfectants damaging poly vinyls once they are set, and they are generally inert after that. They can be trimmed and poured with any die material for casts and are unaffected by high ambient room temperature.

Polysulfides

Two paste techniques are available for the supply of polysulfide impression materials. A polysulfide polymer (side/terminal chain SH groups), titanium dioxide, zinc sulphate, copper carbonate, or silica make up the base. Lead dioxide is the main ingredient in the catalyst for the accelerator 638 RUBEL, together with deodorants, sulphur, magnesium stearate, and dibutyl or dioctyl phthalates. By varying the base's addition of titanium dioxide powder, the viscosity can be changed. It hardens by the oxidation of the SH groups, which lengthens the chain, creates cross-links, and confers elastomeric characteristics [2,14]. In general, polysulfide impression materials are low to moderately hydrophilic and accurately imprint when exposed to saliva or blood. Compared to polyvinyl siloxanes or polyethers, the material's low wetting angle makes a full arch impression easier. Although its dimensional stability is relatively fair, it reproduces detail with great results [5,7-9, 14,37]. If it is not too thin in some places, it can allow for more than one pour. It is not a stiff material, and unlike poly yethers and polyvinyl siloxanes, impressions are simpler to remove. Unlike hydrocolloids or polyvinyls, it typically captures a subgingival margin upon impression without tearing on removal. Due to its hydrophilic nature, it distorts during cleaning if done incorrectly and may swell if submerged in water or a disinfectant for an extended amount of time. Before pouring in dental stone, it is advised by researchers that it be sprayed with disinfectant for 10 minutes, rinsed, and dried right away [2,26]. It is quite bitter tasting and not very pricey. Gloves made of latex have no effect on it. Unfortunately, it doesn't stick to itself, therefore border moulding and correctable impression techniques cannot use it.

Tissue conditioners (polyethyl or methyl methacrylates)

A liquid containing an aromatic ester-ethyl alcohol mixture (up to 30%) and a powder containing poly (ethyl methacrylate) make up tissue conditioners. Soft elastomers are tissue conditioners. Due to the elimination of alcohol, they show a weight reduction of 4.9% to 9.3% after 24 hours. The loss of alcohol causes tissue conditioners to stiffen over the course of a few days. Specific viscoelastic qualities are included in the formulation of tissue conditioners. The molecular weight of the polymer powders and the power/liquid ratio have an impact on the viscoelastic characteristics [2]. Typically employed as tissue conditioners, temporary soft liners, and functional impression materials, polyethyl and polymethyl methacrylate flow for a while to adapt to tissues after they have attained their set. They make good functional impression materials because of their long flow periods. All of them are made of polyethyl or polymethyl methacrylate materials and a plasticizer with an alcohol basis [23]. Each material is distinct because to the plasticizer, which also provides a varied post-set flow period. Plasticizers leave an accurate image when exposed to saliva or blood because they are somewhat hydrophilic. They can quickly and easily acquire entire arch imprints because to their low wetting angle. Because they imitate detail in a moderate manner, they are appropriate for both full and partial dentures. They have average dimensional stability and typically offer one pour per imprint. Because of their low rigidity, they must be supported by robust trays to prevent distortion. IMPRESSION MATERIALS 639

Author's personal copy borders. They can be moved around very easily. These materials have a poor tear strength and, if not handled carefully, typically rip upon removal [2]. These materials work fantastically for relining or rebasing removable prosthesis [23]. Dealing with these many tissue conditioners and other sorts of imprint materials has learning curves, just as working with any material. Their self-adhesion, border moulding, and correctable impression process are exceptional. Since they are alcohol-based, they are easily distorted by alcohol-based disinfectants like Lysol [2,3,25,34], but they do not distort when exposed to water. They generally have a neutral flavour.

Summary

Dental professionals have used impression materials for a variety of purposes, such as creating dental prostheses, acting as temporary liners, and functioning as bite registration materials. The irreversible hydrocolloids, polyethers, polyvinyls, and polysulfides are the materials that have drawn the most attention due to their physical and handling characteristics. A significant component of the market is made up of polyvinyls (additional silicones) and polyethers, which are used to create impressions for fixed partial dentures, detachable appliances, and implant prostheses. When employed according to the right guidelines, hydrophilic addition silicones and polyethers flow readily, necessitate fewer retakes, and yield more bubble-free casts. The polyvinyl siloxane compounds must be made hydrophilic by adding surfactants because they are naturally hydrophobic (water-repellent). Due to the need for moisture to migrate to the surface when these surfactants come into contact with it, the hydrophilicity cannot fully develop throughout the working and setting times, which can lead to voids and erroneous impressions. They need a dry field to work in. Due to the hydrophilic nature of polyether, moisture does not significantly hinder the creation of void-free imprints. Because they display more changes over time after setting, which may influence accuracy in detail reproduction, condensation silicones, polysulfides, and irreversible hydrocolloids have characteristics that make them more sensitive to handling considerations and mix-and-pour processes. After setting, the polyvinyls and polyethers are more resistant to deformation. All have unique cleaning procedures that must be performed in order to prevent material distortion before pouring moulds, but polyvinyls appear to be the most resistant to various disinfection procedures.

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