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### EFFECT OF MIXING METHODS ON PROPERTIES OF IMPRESSION MATERIALS

*Swetha.G<sup>1</sup>, Jayalakshmi Somasundaram\*<sup>2</sup>, Leslie Rani<sup>3</sup>*

<sup>1</sup>Saveetha Dental College, Saveetha Institute of Medical And Technical Sciences,  
Saveetha University, Chennai, Tamil Nadu

<sup>2</sup>Chief Scientist White Lab- Material Research Centre Saveetha Dental College and  
Hospitals, Saveetha Institute of Medical And Technical  
Sciences, Saveetha University Chennai, Tamil Nadu.

<sup>3</sup>Lecturer Department of General Pathology Saveetha Dental College and Hospitals, Saveetha  
Institute of Medical And Technical Sciences, Saveetha University Chennai, Tamil Nadu

<sup>1</sup>151801011.sdc@saveetha.com, <sup>2</sup>jayalakshmisomasundaram@saveetha.com, <sup>3</sup>leslieranis.sdc  
@saveetha.com

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Mixing methods, Properties, Rheology**

#### **ABSTRACT :**

The contemporary dentistry has a large group of impression materials accessible for making impressions in fixed prosthodontics, Implant dentistry and operative dentistry. With genuine material choice and control, exact impressions can be acquired for fabrication of tooth & implant supported restorations. This article plots the effects of the different mixing methods on the various properties of impression material. A systematic search strategy was employed using keywords to search the literature in medical databases. Pub med & Google scholar, Semantic scholar, Elsevier and Medline studies were considered. Among the mixing methods automix is beneficial, especially in removing voids, Mechanical mix has improved properties than hand mix and is most preferred. Handmix can be utilized in clinics and dental schools. Mixing methods decide the properties of impression materials. Automix is the best method with

## INTRODUCTION

Imagine creating a fixed or removable dental prosthesis directly in the patient's mouth and exposing it to outrageous temperatures and harsh chemicals, and working in a restricted cavity. Impression making is the beginning of this procedure by making a negative type of the teeth and tissues into which gypsum or other die materials can be delivered to make the working analogs. This procedure is as much an art as it is a science. Painters and artists who make delightful centerpieces cannot achieve this without understanding the properties and taking care of attributes of the paint or mud that they use. Essentially, dental professionals ought to comprehend the properties of the materials and manipulate these materials securely and effectively to catch the exact replica of the oral tissues. (Ariga *et al.*, 2018)

Modern dentistry has an array of excellent impressions on material available for making impressions. Impression materials are utilized to record intra oral structures for the manufacture of definitive restorations. (Jyothiet *et al.*, 2017) An impression is an "imprint" or negative similarity of the teeth and edentulous regions, made in plastic material which gets solidified or set while in contact with the tissue. Accurate impression materials & impressions are required in making any (Kannan and Venugopalan, 2018) prosthesis ('The Glossary of Prosthodontic Terms: Ninth Edition', 2017) (Ajay *et al.*, 2017) (Venugopalan *et al.*, 2014) (Ashok and Suvitha, 2016). Articles report that there is significant association between marginal discrepancy and the material of impression. (Ganapathy *et al.*, 2016) (Ranganathan, Ganapathy and Jain, 2017) and it is important to disinfect the impression materials. Dental impressions are among the things that are considered potentially infectious. Dental impressions ceaselessly are tainted with patent salivation or blood, Such fluids can contain viral and bacterial pathogens, including HIV and hepatitis A, B, and C infections. (Selvan and Ganapathy, 2016) (Vijayalakshmi and Ganapathy, 2016). Based on the effects of imbibition, spraying techniques using Aloe vera juice as a disinfectant material can be used as an alternative because it has a lower imbibition effect so that dimensional stability is better. (Subasree, Murthykumar and Dhanraj, 2016) The accuracy of these final restoration gently depends greatly on the impression material and technique with proper selection and manipulation.

Exact impression can be acquired for creation of tooth and implant supported restorations (Christensen, 1997) (Duraisamy *et al.*, 2019) (Ganapathy, Kannan and Venugopalan, 2017) Accurate impressions rely upon distinguishing the applications that do or don't fit every material qualities relies upon the subjective choice of the operator. Impression materials can be characterized by their composition, setting reaction, setting properties, and uses, however a regularly used classification is based on the setting properties. (figure 1). At present, the most well known sorts of impression materials for removable, fixed, and implant prosthodontics are irreversible hydrocolloids, polyethers, and PVSs. Although, Some of the impression materials are easy to manipulate, all the manipulative factors (water/powder ratio, spatulation) affect the strength of the set materials. It is important to follow manufacturers directions on mixing (Cook, 1986; 'HeraeusKulzer Benelux', 2006). Elastomeric

impression materials normally comprise separate base and catalyst pastes, which are blended preceding impression making.

Automix systems, as disposable intraoral syringes, dispensers with joined cartridges, or automatic mixing machines, have gotten mainstream and have supplanted hand mixing. Automatic mixing is simpler than hand mixing and yields an impression material with less voids and improved homogeneity. It has been demonstrated that automixed alginate has improved elasticity and surface detail reproduction that is even similar with elastomeric materials. (Ashok *et al.*, 2014) Automixing of impression materials likewise influences their rheological properties, creating materials that are less viscous and flow better, a property that is clinically applicable and desirable in many clinical situations (Subasree, Murthykumar and Dhanraj, 2016). Mechanical mixing proved having better properties than hand mix (Inoue *et al.*, 2002) However it is noted that the working time of automatic mix is markedly reduced (Koski, 1977); they easily produce fine paste low in air bubbles. It posts superior properties (Stackhouse, 1983)

A study performed by Kilinc and his team found that regular set alginate had better mechanical properties when mechanically mixed (Kilinc *et al.*, 2003) Many unacceptable impressions are the result of errors in other stages (Donovan and Cho, 2001). This article outlines the effect of mixing methods in different properties of the impression materials so the best method with better properties can be seen and proper investment.

## **MATERIALS AND METHODS**

A systematic search strategy was employed using keywords to search the literature in medical databases. Pub med & Google scholar semantic scholar, elsevier and medline studies were considered if it has employed different methods to improve properties. Total of 50 records were identified after excluding duplicates and articles that didn't meet the criteria. 35 studies were obtained.

## **DISCUSSION**

### ***Mixing methods***

Mixing is the process by which two or more components are mixed together in order to get a homogenous mix (Phillips and Skinner, 1991)

### ***Hand Mix***

***Hand mix*** is a manual process that requires a rubber bowl, spatula and water + powder. This is one of the ancient methods followed in dentistry. (Reisbick, Garrett and Smith, 1982) The mechanical and physical properties of materials under investigation are likely to be affected due to resultant porosities during hand-spatulation which may consequently decrease the reliability of data. There can be a change in water powder ratio or base catalyst ratio resulting in inferior properties. The SEM of hand-spatulated impression material highlights greater porosity, which is expected due to incorporation of air during mixing. The presence of any imperfection or deformity may act as a weak inclusion and lead to stress concentrations thus accelerating failure. Moreover, it has been suggested in the previous study that nanoparticles are

likely to agglomerate and may lead to a decrease in the strength of the material. (Ginjupalliet *al.*, 2016)

### **Mechanical Mix**

*Mechanical* mixing method was later introduced around the 1970's. This method lowered viscosity compared hand mix and gave materials with improved properties (Nallamuthu, Braden and Patel, 2012)

### **Auto Mix**

The *automix is the advanced* form of mixing material designed around additional response vinyl polysiloxane material and utilized an encased idea hypothetically equipped for maintaining a strategic distance from all the dangers of spatula mixing strategy (Craig, 1980). Furthermore study can be done with comparing all three mixing methods

### **Mechanical Properties**

In **oral** cavity restorative materials undergo chemical, thermal and mechanical challenges. (Basha, Ganapathy and Venugopalan, 2018) These challenges can cause deformation of materials. The mechanical properties of a material define how materials respond to mechanical challenges. (Abuzenada, 2006) It is in the physical sciences that deals with energy, forces and their effects on the body. (Wang *et al.*, 2003) The manipulative factors affect the strength of set material (Phillips, 1959) It is important to follow the manufacturer's direction of mixing. (Faria *et al.*, 2008)

### **Elastic recovery**

When an impression is removed from the mouth, the material should withstand the forces produced. This same impression must have the ability to be accurately poured in appropriate model material. The accuracy of an impression material is related to strain in compression. elastic recovery, compressive strength, tear energy (Walter, 1971) Concerning accuracy and dimensional stability, the elastomeric materials have been exceptional than hydrocolloids (Reisbick, Garrett and Smith, 1982). Mechanical blending technique has improved elastic recovery and compressive strength, yet had no impact on the strain in compression (Frey, Lu and Powers, 2005) Study by Chong reasoned that the automixed elastomers produce a mix with no voids than hand mixing. (Chong, Soh and Wickens, 1989) An impression material being free will help it in improved properties. But study by Culhaoglu, Says that the vacuum mixer has best performance over all in reducing the number of porosities in mixed alginate. (Culhaoglu *et al.*, 2014) Further study should be done in comparing automix and vacuum mix on mechanical properties of impression materials.

### **Tensile Strength**

Tensile strength is the maximum stress that a structure can withstand without sustaining a specific amount of plastic strain or stress at the point of fracture (Cook *et al.*, 1984) Tear strength becomes significant when impression materials are made of areas with undercuts. The higher the strength, Less likely the materials to be torn. The Stiffness should be low so that the impression material can be easily removed from the patient's mouth. (Vrijhoef

and Battistuzzi, 1986; Cohen *et al.*, 1998). The results of the article say, Mixing technique has statistically significant influence on tensile strength (Dreesen *et al.*, 2013) Hand mix has lowest tensile strength while for automix the tensile strength was significantly higher (Dreesen *et al.*, 2013) A study by Culhaoglu *et al.*, also concluded that the automix has higher tensile strength (Culhaoglu *et al.*, 2014)

### ***Surface characteristics***

Accurate reproduction of the prepared tooth or edentulous arch is of clinical significance in the manufacture of fixed or removable prosthesis. It is needed upon an accurate void free cast or die. Mistakes in the replication procedures will at last adversely affect the fit and adjustment of final restoration (Vijayalakshmi and Ganapathy, 2016).

### ***Wettability***

Wettability is the aftereffect of molecular interactions between the adhesive and the substrate, similarly as the cohesion powers of the adhesive, particularly its surface tension. (Sakaguchi and Powers, 2012) The contact angle of a substrate framed against the surface of dental impression materials has been a built up proportion of surface wettability. The impression materials shaping a contact point under  $90^\circ$  are depicted as hydrophilic and those framing a contact edge more than  $90^\circ$  are hydrophobic in nature. Smaller the contact point, lesser the voids framed during the pouring of the impression. It has been hypothesized that contact edges that estimated or surpass  $90^\circ$ , increment the likelihood for ensnarement of air bubbles during the pouring of the impression. There was no statistical difference found in the mixing technique and its effect of the wettability of polyther. (Lepeet *et al.*, 2002)

### ***Imbibition***

Imbibition is absorption of water molecules from the surrounding. (Pratten and Craig, 1989) Gain (imbibition) or loss of water (syneresis) in the impression material is joined by dimensional changes and detail replication of clinical significance. The imbibition for mechanically mixed was lower than that of hand mixed materials of polyester and polyvinyl siloxane. But the new generations of the hydrophilic addition silicone shows higher wettability on mixing methods. (Lang *et al.*, 1995). All the mixing method produces voids, the automix impression produces free voids rather than hand mixing.

### ***Rheology***

**Rheology** is the study of deformation and flow characteristics of matter (Phillips and Skinner, 1991) Dental specialists are exposed to control materials with flow or deform when exposed to pressure the study of flow of attributes of materials in the reason for the study of rheology (Eyre, van Noort and Ellis, 1989) The high standard of a dental impression may be influenced by different factors.

### ***Dimensional stability***

A requirement for a perfect impression material is not only to register all the details of the prosthetic field, but also to transmit them to the technical laboratory in the very same dimensions. (Ganapathy, Kannan and

Venugopalan, 2017) et al in their study says, The dimensional stability of impression materials is one of the variable that adds to the precision or to the inaccuracy of dentures; their accuracy may be also influenced by the modifications occurred during preparation or by the impression techniques. (Ganapathy, Kannan and Venugopalan, 2017) The impression is a very important clinical phase because its precision and integrity may influence the quality of denture. The denture is perfect when the model fits in with the clinic situation

#### ***Working and Setting time***

The working and the setting time of pastes mixed by the automix method markedly shortened compared with handmix or mechanical mix. Coefficient of the viscosity was the smallest for paste obtained by automix, telling that mixing method exceeding affects the setting reaction of pastes and their rheological properties (Wanis, Combe and Grant, 1993) and also it increases the temperature of the paste

#### ***Viscosity***

There is a decreased rate of viscosity of the paste in automix, significant difference between the automix method but not between Hand mix and machine mix (Wilson, 1966) but it changes with filler (Lee and Lee, 2012). The overall is given in [Table 2]

**Table 1:** Classification of impression materials.

<b>ACCORDING BEHAVIOR AFTER SETTING</b>		
<b>NON ELASTIC</b>	<b>ELASTIC</b>	
Either fracture or permanent distortion during removal from under cut	Recovered after from undercut	
<ul style="list-style-type: none"> <li>● Plastic impression.</li> <li>● Impression compound</li> <li>● Zn-oxide / Eugenol</li> </ul>	HydroColloid <ul style="list-style-type: none"> <li>● Agar</li> <li>● Alginate</li> </ul>	Elastomers <ul style="list-style-type: none"> <li>● Polysulfide</li> <li>● Poly ether</li> <li>● Addition silicone</li> <li>● Condensation silicone</li> </ul>
<b>ACCORDING TO SETTING REACTION</b>		
<b>Chemical Reaction(Irreversible)</b>	<b>Physical Reaction(Reversible)</b>	

Soft→Hard		Hard ← heating-cooling → soft	
<ul style="list-style-type: none"> <li>• Plastic impression</li> <li>• Zn-oxide / Eugenol</li> <li>• Alginate</li> <li>• Elastomers</li> </ul>		<ul style="list-style-type: none"> <li>• Impression compound</li> <li>• Agar</li> </ul>	
<b>ACCORDING TO THEIR USES</b>			
<b>COMPLETE DENTURE</b>	<b>PARTIAL DENTURE</b>	<b>CROWNS AND BRIDGES</b>	
<ul style="list-style-type: none"> <li>• Plastic impression</li> <li>• Zn-oxide / Eugenol</li> <li>• Alginate</li> <li>• Impression compound</li> </ul>	<ul style="list-style-type: none"> <li>• Alginate</li> <li>• Elastomers</li> </ul>	<ul style="list-style-type: none"> <li>• Elastomers</li> </ul>	

**Table 2 :Over all performances of mixing methods**

Sl. no	PROPERTIES	HAND MIX	MACHINE MIX	AUTOMATIC
1	<b>Tensile strength</b>	Low	Higher than hand mix	Higher
2	<b>Elastic Recovery</b>	Low	Low	High
3	<b>Wettability</b>	No difference	No difference	No difference
4	<b>Imbibitions</b>	High	Less	High
5	<b>Voids</b>	High	Moderately Low	Free of voids
6	<b>Dimensional Stability</b>	Low	High	High
7	<b>Paste temperature</b>	Normal	Increased	Increased

8	<b>Working &amp; settling Time</b>	More	Less	Less
9	<b>Viscosity</b>	No change	No change	Decrease

### SUMMARY

Clinicians have an excellent set of impression materials and techniques in use of fabrication of restorations. Obtaining maximum accuracy of impressions is critical to provision of precise restorative dentistry. Mixing methods of impression materials have a significant role in properties of materials. Three methods are used in dentistry till date and all are effective in their own way. However automix seems to be most impervious to different properties of the impression materials.

### FUTURE SCOPE

Furthermore, studies can be done with articles from various other platforms. Use of nano technology in improving material property & technique.

### CONCLUSION

Mixing methods decide the property of the impression material from this review. Automix is the best method with most efficient properties but is expensive. Mechanical mix is little less to the performance of automix but is both economical and good properties and the most preferred method

### AUTHORS CONTRIBUTION

Swetha. G carried out execution of the work, data collection and drafting of the manuscript. Dr. Jayalakshmi Somasundaram, carried out the concept and design of the study, validation of the data collection, revision and proofreading of the manuscript. Dr. Leslie rani, revise and proofread the manuscript. All authors contributed equally. All authors read and approved the final manuscript.

### CONFLICT OF INTEREST

None

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