HNSJ Humanities & Natural Sciences Journal
ISSN: (e) 2709-0833
www.hnjournal.net
Peer-Reviewed Journal
Indexed at: NSP - SJIF
Impact Factor 2022 = 4.91

RESEARCH TITLE

Marginal fit of two CAD/CAM Restorations Using Different Impression Materials

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HNSJ, 2024, 5(11); https://doi.org/10.53796/hnsj511/10

Published at 01/11/2024 **Accepted at 20/10/2024**

Abstract

There are multiple impression materials available in our market. So many investigations are needed to evaluate their accuracy which effect of the marginal fit of the final restoration. there is no significant different between all the investigating materials as regard their accuracy.

Introduction: impression material is used to record the intraoral structure. Ideally the material should be extremely accurate, and virtually distortion free. The accuracy allows to record minute details without taking additional impression. The material is very soft elastic & resistance to tear while removes from the undercut. [1]

Prosthetic restorations that fit poorly may affect the periodontal health and occlusion. The design of the tooth preparation is an important consideration in tooth reconstruction. The use of certain geometric features in preparations for full coverage restorations has been based largely on experience and individual preference. [2]

The dimensional changes of the impression materials may affect the quality of fit and retention of the restoration, which influence the success of indirect restorative procedures.[3,4,6] The dimensional behavior of impression material, is influenced by humidity, the time interval from mixing to pouring, and the thickness of the layer of material in the tray. In addition, impression materials contract with the temperature change from the oral cavity to the external environment due to their linear expansion thermal coefficient [3].

New generation of impression materials keep immersing in dental market every day, so more investigations are needed to study their properties and qualify their uses.

This study was conducted to evaluate which of these materials could provide accurate seating of the final restoration.

Material and method: this study was made to evaluate the accuracy of three different impression materials using two ceramic materials used in this study were zirconia and Lithium disilicate using machinable Computer Aided Design / Computer Aided Manufacturing (CAD/CAM) (CEREC in Lab), impression materials used in this study:

Methodology:

Samples grouping:

The impression materials were grouped as follows:

Group (I**)** Laminated hydrocolloid technique**. Group (**II**)** Addition Silicone impression materials. **Group (**III**)** Polyether impression materials.

For each group, specimens were subdivided into two subgroups according to the ceramic material used:

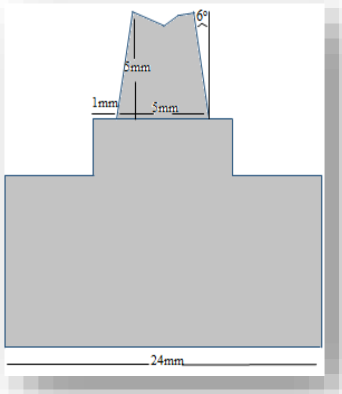
Subgroup (A) Zirconia (15 samples)

from each impression material: 5 non anatomical cad/cam ceramic crowns were fabricated. **Subgroup** (**B)** Lithium disilicate (15 samples) for each impression material: 5 non anatomic cad/cam ceramic crowns were fabricated.

Dies fabrication

For the purpose of standardization, a custom made master die, representing full all ceramic crown preparation was constructed for impression making standardization. A perforated custom made tray was fabricated that could be placed in the same position on the master die for each impression.

The metal master die was prepared by a milling machine to resemble a prepared mandibular second premolar with 5mm height and 5mm width at the base, the occlusal taper was 6°. The occlusal surface was prepared with 2 sloping surfaces, one of which was slightly beveled. The preparation was finished with a 1-mm-wide rounded shoulder finish line. This design was chosen to prevent rotation of the crowns on the die and also to ensure that their placement could be reproduced on the die. four equidistant marks were engraved on the die to oriented the stereomicroscope. the die has a 24mm diameter base to ensure proper handling (Fig1 a, b)



(Fig1a,b) Stainless Steal die.

Custom made perforated tray:

Each custom made perforated tray was cylindrical in shape with inner diameter 7mm (to accommodate with the base of the mater die) and inner height 7mm were made to act as a tray for accommodating the impression materials[56] (Fig2).

Impression making

One impression was made for each material on the same metal die using perforated trays. All fabrication procedures were accomplished according to the manufacturer's instructions for each tested material used.

(1) laminated hydrocolloid technique:

Impressions were taken using agar alginate impression material. The agar was warmed in boiling water for about six min. The agar was stored for at least 10 min at 65°C before being syringed around the preparations. A mix of alginate according manufactures instructions, and was placed in a custom-made perforated tray and it was immediately seated over the agar syringe material. The alginate was set, the combined impression is removed. fig (3)

(2) The polyvinyl siloxane impression:

The single step impression technique was used for the heavy bodied material was injected to the custom made perforated trays. At the same time the light bodied material was injected on the die. The impression tray was then centered over the die and seated, Initially, finger pressure was applied to allowed accurate seating and the escape of any excess material. After complete setting the tray was removed from the die in sharp snap removal parallel to the long axis of the die. fig (4).

(3) Polyether impression materials:

Two equal lines of impression base paste and catalyst were spread on paper pad and mixing was done by a metal spatula in circular strokes for producing homogenous mixed impression. Then load on a perforated tray, and apply the mixture into the die. The impression tray was then centered over the die. After complete setting the tray was removal parallel to the long axis of the die.

Crowns construction:

For each material. crowns were constructed according to the manufacturer's instructions in the shape of non-anatomical cylindrical crowns of 6mm diameter, 7mm height, 2mm occlusal thickness and margin thickness 1mm (fig.6)

All tested crowns were individually seated on the stainless steel die and were examined for vertical marginal fit with respect to the die.

Testing Procedures:

Cervical marginal accuracy: of their seating on the stainless steel die and to hold them in place during the examination with a stereomicroscope. Shots of the margins were taken for each crown using digital camera**fitted on the stereomicroscope using a fixed magnification of 40X (fig20ab).

.*Carl Zeiss stereomicroscope, Germany.

**Olympus Camedia C-5060 digital camera, Japan.

Figure (20 a,b) Olympus camedia C-5060 digital camera fitted on Carl Zeiss Steroemicroscope

Then morphometric measurements were done on an IBM compatible personal computer (PC)*. After that the software **, which was used for image analysis was calibrated, the vertical gap distance was measured for each shot ["6" equidistant landmarks along the cervical circumference for each crown (Mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid- lingual, and disto- lingual line angles). Measurement at each point was repeated five times].Then the data obtained were collected, tabulated and then subjected to statistical analysis.

Vertical marginal gap

The mean values and standard deviation of vertical marginal gap (µm) as function of ceramic and impression materials are summarized in table (5) and graphically drawn in figure (21). The results revealed that e-max cad restoration gave highest marginal gap (62.19) with polyether impression material ,while gave lowest marginal gap with laminate impression techniqe.

Table (5) Vertical marginal gap results (Mean values± SDs) as function of ceramic and impression materials

Variables		***Ceramics***				***Statistics***
		Zr		***e.max***		***t-test***
		Mean	***SD***	***Mean***	***SD***	***P value***
Impression materials	***Laminate***	38.41$^{A}_{a}$	19.87	36.12$^{C}_{a}$	9.44	0.5635 ns
	Addition silicon	41.83$^{A}_{a}$	10.67	46.57$^{B}_{a}$	11.04	0.0718 ns
	Polyether	42.34$^{A}_{b}$	10.14	62.19$^{A}_{a}$	18.99	<0.0001*
Statistics	***ANOVA (P value)***	0.4795 ns		<0.0001*		

Different large superscript letter in the same column indicating statistically significant difference among impression ($p < 0.05$) Different small subscript letter in the same row indicating statistically significant difference among ceramic ($p < 0.05$) *;significant ($p < 0.05$) ns; non-significant ($p>0.05$)

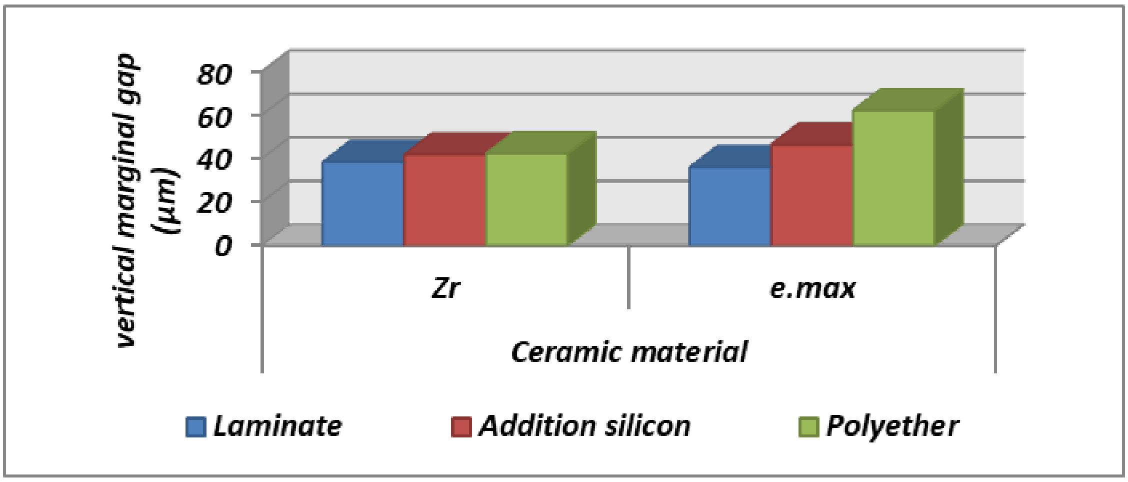


Figure (21) Histogram of vertical marginal gap mean values as function of ceramic and impression materials

Table (6) Two factorial analysis of variance ANOVA test of significance comparing variables affecting vertical marginal gap mean values

Source of Variation	***Df***	***SS***	***MS***	***F***	***P value***
Ceramics	1	3978.95335	3978.95335	13.2411	0.0003*
Impression materials	2	10817.70351	5408.85176	17.6926	<0.0001*
Interaction	2	6141.01819	3070.50909	10.0438	<0.0001*

Effect of ceramic

Regardless to impression materials, totally it was found that ***e.max group*** recorded statistically significant (P<0.05) higher vertical marginal gap mean value (48.29± 9.26 µm) than ***Zr group*** (40.86± 1.63 µm) as indicated by two way ANOVA followed by pair-wise Tukey's post-hoc tests

Table (7) Comparison between total vertical marginal gap results (Mean values± SDs) as function of ceramic

Variable		Mean	SD	Tukey's rank	Statistics (P value)
Ceramic	***Zr***	40.86	1.63	B	0.0003*
	e.max	48.29	9.26	A	

Different letter in the same column indicating statistically significant difference ($p < 0.05$)

*; significant ($p < 0.05$) ns; non-significant ($p>0.05$)

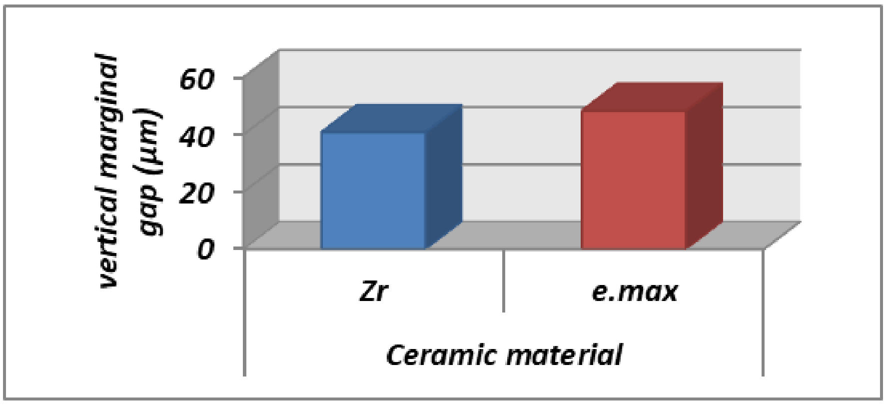


Figure (22) A column chart of total vertical marginal gap mean values as function of ***ceramics***

INTERACTION BETWEEN VARIABLES

Zr group

it was found that Polyether group recorded statistically non-significant (P>0.05) highest vertical marginal gap mean value (42.34± 10.14 µm) followed by Addition silicon group (41.83± 10.67 µm) while Laminate group recorded statistically non-significant (P>0.05) lowest vertical marginal gap mean value (38.41± 19.87 µm) as indicated by one way ANOVA followed by pair-wise Tukey's post-hoc tests

Table (8) Vertical marginal gap results (Mean values± SDs) for Zr group as function of impression materials

Variables		***Ceramic***		***Statistics***
		Zr		***ANOVA***
		Mean	***SD***	***P value***
Impression materials	***Laminate***	38.41^{A}	19.87	0.4795 ns
	Addition silicon	41.83^{A}	10.67	
	Polyether	42.34^{A}	10.14	

Different large superscript letter in the same column indicating statistically significant difference (p < 0.05) *; significant (p < 0.05) ns; non-significant (p>0.05)

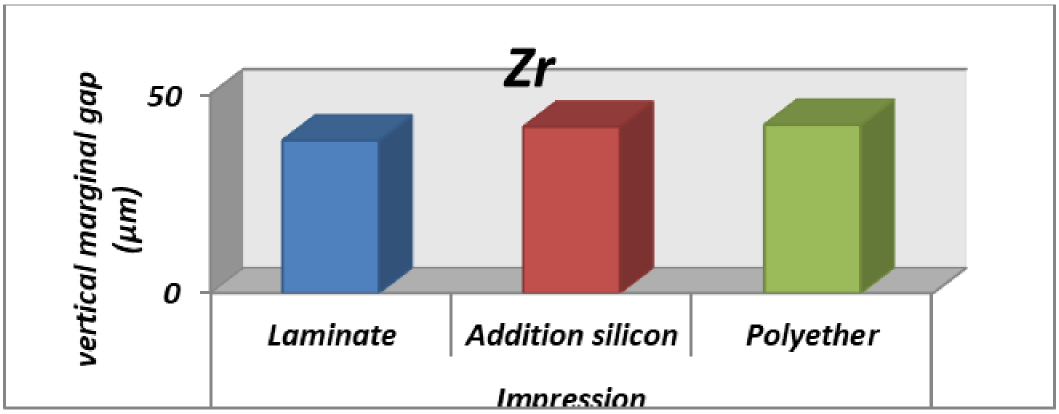


Figure (24) A column chart of vertical marginal gap mean values for Zr group as function of impression materials

e.max group

it was found that Polyether group recorded statistically significant (P<0.05) highest vertical marginal gap mean value (62.19± 18.99 µm) followed by Addition silicon group (46.57± 11.04 µm) while Laminate group recorded statistically significant (P<0.05) lowest vertical marginal gap mean value (36.12± 9.44 µm) as indicated by two way ANOVA followed by pair-wise Tukey's post-hoc tests.

Table (9) Vertical marginal gap results (Mean values± SDs) for e.max group as function of impression materials

Variables		***Ceramic***		***Statistics***
		e.max		***ANOVA***
		Mean	***SD***	***P value***
Impression materials	***Laminate***	36.12^{C}	9.44	<0.0001*
	Addition silicon	46.57^{B}	11.04	
	Polyether	62.19^{A}	18.99	

Different large superscript letter in the same column indicating statistically significant difference ($p < 0.05$) *; significant ($p < 0.05$) ns; non-significant ($p>0.05$)

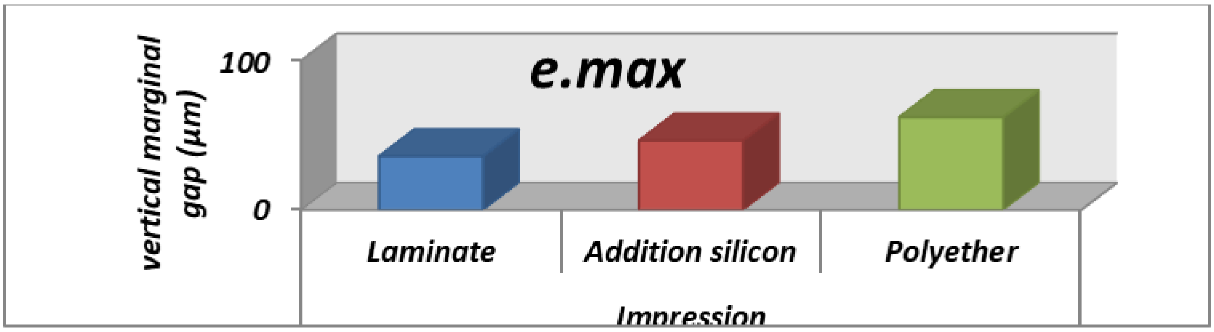


Figure (25) A column chart of vertical marginal gap mean values for e.max group as function of impression materials

Discussion

The transfer of an accurate replication of the patient's hard and soft tissue to the dental laboratory is of critical importance in the fabrication of fixed or removable restoration. Making a definitive impression is a critical step in producing biologically, mechanically, functionally and esthetically acceptable restorations [(84)]. The ability to produce a smooth surface and accurate detail on stone models is one of the most important factors for the impression used in fixed prosthodontics [(59)].

In this study we evaluated the marginal accuracy of different impression materials using two ceramic materials by machinable Computer Aided Design / Computer Aided Manufacturing (CAD/CAM).

In order to achieve this goal, an accurately designed protocol of the methodology was adopted. The in-vitro investigations can help in the estimation of the in-vivo usability of new dental materials and products[(101)]

The introduction of impression technique, laminated hydrocolloid technique, was examined in comparison with other popular accurate impression materials (vinyl polysiloxane and polyether).

A combination between reversible (agar) and irreversible hydrocolloid (alginate) impression system had been introduced in the dental profession recently.This combination is known as 'laminated hydrocolloid technique'.In this technique, reversible hydrocolloid was injected onto the prepared tooth then custom tray loaded with irreversible hydrocolloid was positioned over the reversible hydrocolloid. During this process, alginate gelated by chemical reaction, at the same time, agar gelated by contacting cool alginate rather than cooled water tray [(94)].

The technique simplifies the use of agar and provides an impression surface that allows for preparation of stone casts acceptable for crown and bridge applications. [(7)]

Summary & Conclusion

This in vitro study investigated the marginal accuracy of different impression materials using two ceramic materials by machinable Computer Aided Design / Computer Aided Manufacturing (CAD/CAM).

The results of this study showed:

1. Laminated hydrocolloid agar-alginate impression techniques have significant lowest marginal gap than polyvinyl and polyether.
2. For zirconia copings group it was found that non-significant difference in marginal gap between polyether and polyvinyl impression materials.
3. For e.max cad copings group it was found that there is significant difference marginal gap between polyether and polyvinyl impression materials.

Within the limitation of this study, the following conclusions were drawn:

Laminated hydrocolloid agar-alginate impression technique can be used as secondary impression with high accuracy.

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