ORIGINAL ARTICLE

EFFECT OF LIGNOCAINE ADDITION ON THE PROPERTIES OF IRREVERSIBLE HYDROCOLLOID IMPRESSION MATERIAL

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Background: Irreversible hydrocolloid impression materials have been a staple in dentistry and useful for the fabrication of dental prosthesis. Gagging is most commonly experienced during maxillary impression making, which may affect the clinical management of the patient. Different techniques have been described to alleviate this problem. One of them is mixing lignocaine local anesthetic solution in irreversible hydrocolloid impression material before making the impression. The objective of this study was to evaluate the effect of lignocaine addition in irreversible hydrocolloid impression on the properties of irreversible hydrocolloid impression materials. **Methods**: Irreversible hydrocolloid was mixed with water (Control group) or water and adrenalin (Lidocaine hydrochloride) (Experimental group). Compressive strength, tear strength and setting time were measured according to ISO1567 and ANSI/ADA specifications 18. The structural analysis of both groups was also evaluated by Fourier Transform Infrared Spectroscopy (FTIR). **Results:** In the experimental group, insignificant decrease was observed in compressive and tear strength of irreversible hydrocolloid ($p>0.05$). There was significant ($p<0.05$) increase in setting time of irreversible hydrocolloid impression material. FTIR analysis indicated no change in chemistry of irreversible hydrocolloid before and after setting. **Conclusion:** Addition of lignocaine in irreversible hydrocolloid impression material may result in control of gag reflex without affecting its mechanical and chemical properties.

Keywords: Irreversible Hydrocolloid; Lignocaine; Gag reflex; Dental prosthesis; FTIR

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INTRODUCTION

Irreversible hydrocolloid impression materials have been extensively used in prosthetic dentistry. These hydrocolloids are elastic materials used to make the impression of intraoral, extra oral tissues[1] as well as for making study and diagnostic casts of completely or partially edentulous patients[2].

Irreversible hydrocolloid dental impression materials were introduced in 1940. They are linear copolymers of (1→4) linked α-L-guluronic acid and. ß-D-mannuronic acid (M). The most common form of irreversible hydrocolloid is supplied in powder form.[3] The main advantage is its ease of use, hydrophilic characteristics and low cost; however, their tear strength is low. They can reproduce sub-gingival contours and anatomy; however, tear upon removal in thin sections. According to ISO 1563: 1990 specifications[4], the minimum compressive strength of irreversible hydrocolloid impression materials should be 0.35 MPa. They have quick setting time that can be controlled with the temperature of water, powder/liquid ratio and sodium phosphate (retarder).[5,6.]

The gag reflex is physiological process that functions to protect the mouth and the pharynx. The process of gagging takes place following internal or external stimuli, which induces rapid contractions of the pharynx in order to protect the airway.[7] Many dental patients avoid visiting the dentist because of an abnormally severe gag reflex. Gagging is usually experienced by patients during impression making for the construction of dental prosthesis. It is also reported during intraoral radiographic procedures, restoration of posterior teeth and during intraoral examination. Therefore, the control of reflex is very important in order to allow the patient to receive dental treatment.[8,9]

Different techniques have been proposed to alleviate this problem, including distraction, relaxation and desensitization techniques; behavioral and psychological therapies; general or local anesthesia and complementary medicine therapies as hypnosis, acupuncture and inclusion of local anesthetic solution in the irreversible hydrocolloid impression material before making the impression. However, Lignocaine as a local anesthesia has been used in clinical dentistry in order to relieve pain.[10–12]

The local anesthetics available in dental cartridges, namely articaine, bupivacaine hydrochloride, lidocaine, mepivacaine, and

prilocaine, belong to the amide class. Lidocaine 2% epinephrine 1:80,000 is a synthetic aminoe thylamide with local anesthetic and antiarrhythmic properties. The chemical formula of lignocaine HCL is $C_{14}H_{22}N_2O$.HCL. It stabilizes the neuronal membrane by binding to and inhibiting voltage-gated sodium channels. Its mechanism of action is inhibition of the ionic fluxes for the initiation and conduction of impulses.[13–15]

The gag reflex in patients may vary from mild to moderate. The patients with mild gag are very commonly encountered in dental practice and can be managed by changing consistency of the impression material or slight modification in the impression technique. However, patients with hypersensitive gag reflex can cause difficulty in carrying out dental procedures especially impression making. Our group recently investigated[12] lignocaine incorporated alginate impression materials clinically and the results showed that irreversible hydrocolloid with single cartilage (2.2 mL) controlled 52.5% of moderate gag reflex cases and 47.5% patients with severe gag reflex, while inclusion of two cartridges resulted in the reduction of 40% of moderate and 60% of patients with severe gag reflex. Similar study was conducted by Kamran, it was reported that incorporation of single cartridge (1.8 ml of 2% lignocaine with 1 part in 100,000 epinephrine) in irreversible hydrocolloid impression material resulted in control of gag reflex in all patients. However, it is important to know the effect of lignocaine on irreversible hydrocolloid impression material's properties.

Therefore, the aim of this study was to incorporate lignocaine solution into irreversible hydrocolloid impression material and investigate its effect on setting time, compressive strength, tear strength, and chemical properties of irreversible hydrocolloid impression material.

MATERIAL AND METHODS

The material used in this *in-vitro* study was a normal setting irreversible hydrocolloid (Cavex CA37 (Holland BV, Haarlem, Netherlands)) and 2% lignocaine HCL solution (Septodont, Dentsply, USA). To prepare the control samples, irreversible hydrocolloid powder was mixed with water according to the ANSI/ADA specification no. (19)[16] for hydrocolloid impression materials. The ratio of powder: liquid was 7 g of powder and 15 mL of water. For experimental samples, 12.8 mL water and 2.2 mL of lignocaine was mixed in irreversible hydrocolloid powder. The preparation of test specimens and test procedures was conducted at 23.0±2 ºC and relative humidity 50±10%.

Exclusion criteria - The samples with porosities were excluded.

For compressive strength, 20-disc shape (n=10) samples (6×2) mm were prepared in Teflon mold for control and experimental groups according to the ANSI/ADA specification no. (18) 1992.[16] The mold was filled with freshly mixed impression material and covered with a glass slab. After two minutes the sample was removed from the mold and tested for compressive strength, Compressive strength was tested at room temperature by using Universal testing machine as shown in figure-1. The cross-head speed was 50 $mm.min^{-1}$ with 100N force. Tear testing was carried out at room temperature by using Universal testing machine. Twenty freshly prepared samples (n=10) were poured into the rectangular mold of 10 mm width × 60 mm length and 3 mm height) and covered with a glass slab. After setting, the glass slab was removed and the samples were removed from the mold. An incision measuring 50 mm was made down the middle of specimen to make a 'trouser test' piece. The sample was held in place with clamps and extended at a constant rate of 50 mm/min[17] as seen in figure-2.

Setting time was measured according to ISO specification 1563.1990.[4] Twenty samples (n=10) were prepared in 6×2 mm^2 Teflon mold. After filling the mold with mixed material, the end of Gilmore needle (weight 50±1 g) was placed in contact with the unset material. The Gilmore needle was released after every 10 s to see the penetration on the surface of samples. When there was no penetration of the Gilmore needle, the time was considered as the final setting time as seen in figure-3.

FTIR analysis of control and experimental group was performed to see any chemical change. The specimens were analyzed before and after setting. FTIR spectra were observed by using a Thermo-Electron Nicolet 6700 FTIR spectrometer. It was equipped with Attenuated Total Reflectance (ATR) accessory. The samples were placed in direct contact with ATR Diamond crystal. The spectral range was 4000–400 cm^{-1} with the resolution of 8 cm^{-1}.[18]

The SPSS 22.0 software program was used for statistical analysis. p-value ≤0.05 considered significant value and it was calculated by using students' t-test.

RESULTS

The data presented in table-1 showed that there was decrease in the mean compressive strength (0.34±0.01 MPa) of experimental group as compared to the control group (0.38±0.01 MPa) however, statistically the difference was insignificant (p>0.05).

The observed tear strength of the experimental group was lower (0.073±0.001 MPa) as compared to control group (0.076±0.001 MPa) as shown in Table 1 Statistically, the difference was insignificant *(p*>0.05). Table-1 showed significant (*p*<0.05) increase in the mean setting time of experimental (3.37±0.002 min) as compared to control group (3.29±0.0004 min). FTIR analysis of control and experimental groups (Figure-4a, 5a) before setting revealed characteristic peak of hydroxyl (OH) group at 3450 cm^{-1}, carbonyl (C=O) group at 1630 cm^{-1}, and carboxyl (COOH) group at 1417 cm^{-1} (Pereira *et al*). An intense band of Si-O-Si was appeared at 1050 cm^{-1} after setting of control and experimental groups as shown in Figure 4b and 5b, whereas, this band was not present earlier. There was change in intensity of different peaks before and after setting of irreversible hydrocolloids. A decrease in intensity of OH peak was observed, before setting, in experimental group (0.26) as compared to control group (0.31).

Figure-1: Compressive strength testing with Universal Testing Machine.

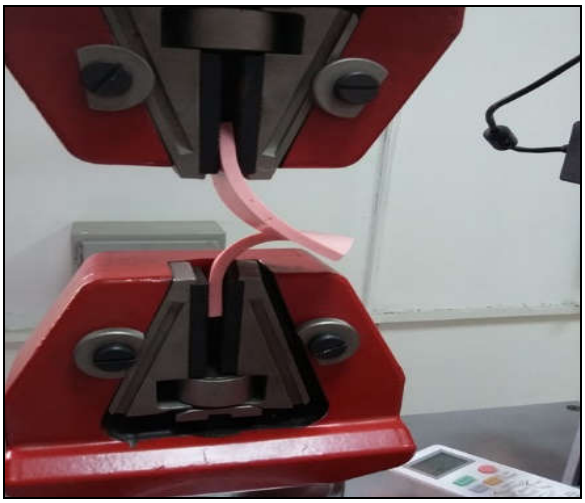


Figure-2: Tear strength testing with Universal Testing Machine

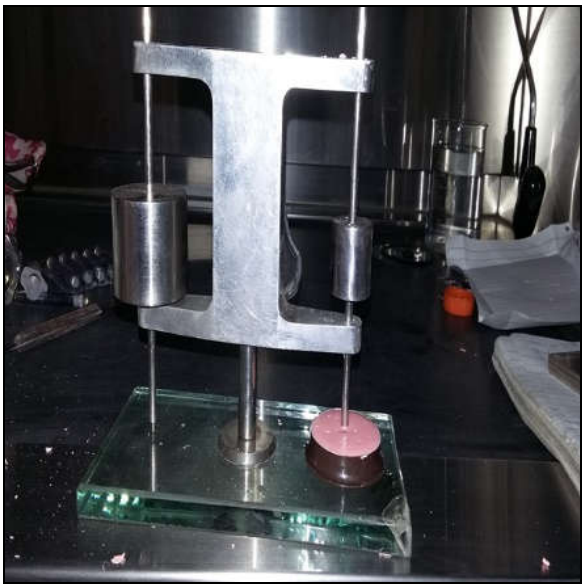


Figure-3: Setting time testing with Gillmore needle

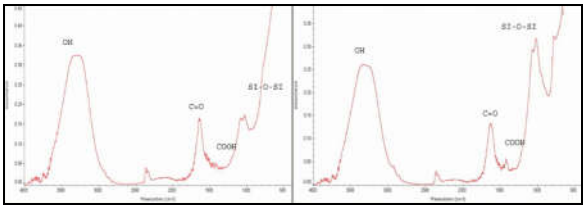
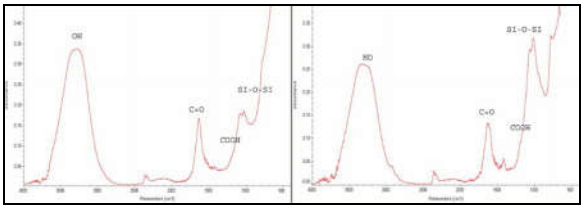


Figure-4 (a): FTIR analysis of control group before setting. (b): FTIR analysis of control group after setting



(Figure-5) (a): FTIR analysis of Experimental group before setting. (b): FTIR analysis of Experimental group after setting

Table-1: Mean values and standard deviation of compressive strength, tear strength and Setting time of alginate impression materials

Test	Groups	n	Mean	SD Mean	*p*-Value
Compressive strength (MPa)	Control	10	0.38	0.01	0.77
	Experimental	10	0.34	0.01	
Tear strength ($N.mm^2$)	Control	10	0.076	0.001	0.36
	Experimental	10	0.073	0.001	
Setting time (minutes)	Control	10	3,37	0.002	0.05
	Experimental	10	3.29	0.0004	

DISCUSSION

Irreversible hydrocolloids are the colloidal solution of polysaccharides. Elastic properties develop in irreversible hydrocolloid impression materials are

due to alignment of long polysaccharide chains. These materials have normal setting time and good compressive and tear strength.[19]

In the present study, there is insignificant decrease in compressive strength of experimental group (0.34 MPa) as compared to control group (0.38 MPa). According to ISO 1563: 1990[4] standards, the minimum compressive strength of Irreversible hydrocolloid impression materials should be 0.35 MPa. The decrease in compressive strength may be due to alteration in crosslinking of polysaccharide chain of irreversible hydrocolloid due to the formation of amide bond between amino group of lignocaine and carboxyl group of irreversible hydrocolloids.

There is statistically insignificant decrease in tear strength of experimental group (0.073 MPa) as compared to control group (0.076 MPa). The decrease in tear strength may be due to the formation of a covalent bond between Nitrogen of amide present in lignocaine with silicon dioxide via O- Si-O.

The results of setting time in the current study revealed that there is significant increase in setting time of experimental group as compared to control group. The increase in setting time may be due to formation of an ionic bond between tri sodium phosphate and Cl^{-1} ion present in lignocaine. It may interfere the process of gelation resulting in increase of setting time.

FTIR analysis revealed a strong band of carbonyl (C=O) group after setting in control and experimental groups due to crosslinking and conversion of sol to gel. Addition of lignocaine resulted in decrease intensity of OH peak in experimental group due to less amount of water (12.8 mL) used for mixing as compared to control group (15mL). No difference in peak positions and assignments were observed for control and experimental groups except the absorbance peak of Si-O-Si was observed at 1050 cm^{-1} after complete setting of samples accomplished. It may be due to formation of hydrogen bonding between H_2O and Silica, crosslinking of Calcium ions and conversion of sol to gel. However, the structural pattern showed similar results and there was no change in peak position and intensity with the incorporation of lignocaine in irreversible hydrocolloid impression material. The result of FTIR and mechanical properties revealed that there is good molecular affinity between irreversible hydrocolloid and lignocaine. The limitation of this study is that only single cartridge of lignocaine was used in the experimental group. Effect of different concentrations of lignocaine and other local anesthetic materials on the mechanical properties of alginate should be investigated.

CONCLUSIONS

Within the limitations of this in vitro study it can be concluded that; there was an insignificant effect of lignocaine addition on compressive strength and tear strength of irreversible hydrocolloid impression material.

There was no difference in chemical properties of experimental irreversible hydrocolloid impression material. The difference in setting time was within the acceptable clinical range, therefore, addition of lignocaine may result in reducing gag reflex of the patients without deteriorating the properties of irreversible hydrocolloid.

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AUTHORS' CONTRIBUTION

AQ: Literature search, study design, data collection & analysis. SH: Data collection, analysis, manuscript editing. NY: Interpretation, proof reading & data acquisition. HK: Analysis, interpretation. AS: Interpretation, proof reading.

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