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Evaluation of Surface Detail Reproduction of Alginate Impression Material Incorporated with Different Ratios of Sodium Hypochlorite

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Abstract

Background and objectives: Alginate impression material considered widely used material for primary registration of oral tissue because it is accurate and simple to use. The objective of this study is to evaluate the antimicrobial efficacy of varying ratios of sodium hypochlorite as disinfection solution for alginate against Gram+ve streptococcus microorganisms and to measure the surface detail reproduction of alginate after disinfection.
Methods: This experimental study was carried out in Hawler Medical University, Erbil College of Dentistry from December 15, 2022, to September 1,2023.40 samples of alginate were prepared, ten samples for each tested ratio (1%,3%,5%) of sodium hypochlorite and ten samples for distilled water as control group using stainless steel dies made in accordance with American Dental Association Specifications No. 18. The surface detail was evaluated after the alginate setting. Besides, three samples of each percentage were assessed for antimicrobial activity.
Results: The samples of 1%, 3% sodium hypochlorite groups showed Owens score 1 for recording of 75 µm and 50 µm lines with no significant difference with control group. However, for line 20 µm recorded mean score 2 for 1%, 3% samples which is considered significant according ADA 18 specifications. By raising the sodium hypochlorite ratios, the number of colonies decreased from 6% to 0% in terms of antibacterial activity.
Conclusions: Surface detail reproduction were not dramatically impacted when sodium hypochlorite was added to the alginate as a disinfect. While they have a clear impact on the alginate impression's control group.

Keywords: Alginate impression, Antimicrobial, Sodium hypochlorite, Surface detail reproduction

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Introduction

Alginate, a hydrocolloid impression material that is elastic and irreversible, is an essential component in indirect restorations. One of the most popular dental materials is alginate, which is an easy, affordable, and necessary component of dental practice. To create the perfect cast, an exact duplicate is required.[1] The earliest elastic materials to be used in dentistry were hydrocolloids, which come in three varieties: the reversible one (agar-agar), the irreversible one (alginate), and the synthetic (polysulfides, polyethers, silicones).[2] Because of its elastic nature, alginate is the most widely utilized irreversible hydrocolloid. They were frequently employed in orthodontic and prosthetic applications to make the prior impressions of a temporary fixed prosthesis, brightening situations, a study model, a detachable prosthesis, and sports mouth protection.[3,4] Regarding the history of alginate it was created by the US Navy as a change in agar during World War II due to lack of raw materials to replace the reversible hydrocolloid.[5,6] The widespread acceptance of alginate is due to its faster reaction at higher temperatures and elastic properties that allow it to withdraw from the underworld, as well as the low irrigation angle makes the substance hydrophilic that ease the accurate impression of saliva or blood.[7] The most often used form of alginate is available as a powder that is combined with water. Paste-type substance is capable of producing the highest surface quality. According to studies, a paste-type substance would be more suitable for fulfilling the alginate impression requirements.[8] Hydrocolloids are responsible for the greatest harbor of bacteria due to their hydrophilic nature,and the oral cavity is the host of many microbial substances, and it is shown that the oral fluid can be impressed.[9] Therefore, they are able to make cross infection during dental treatments, dentists and their assistants, dental laboratory technicians can be exposed to the blood of various patients, saliva and oral cavity microorganisms. Many studies have evaluated a variety of methods to disinfect the impression materials. The application of antimicrobial methods involves two techniques for irreversible hydrocolloid impressions: spraying and immersion, which do not eliminate the antimicrobial agent's surface. which are not considered ideal because they change physical dimensions, incorporation of the agent to the impression material solution instead of water.[10-12]To reduce the risk of the infection caused by the pathogens of the oral cavity, dental impressions must be disinfected with effective disinfectants, but the disinfectant selected should not adversely affect the stability and physical properties of the impression material.[13,14] The presented study objective is to evaluate the effect of different ratios of sodium hypochlorite (NaOCL) as antimicrobial agents and surface detail reproduction of alginate impression material when disinfectant incorporated to it.

Materials and methods

The experimental study included 40 prepared samples for surface detail reproduction with a different ratio of sodium hypochlorite (1%, 3%, 5%, NaOCL) mixed the Alginate impression material powder 10 samples for each ratio. A stainless-steel mold that was manufactured in accordance with the American Dental Association (ADA) specification number 18 was used for surface detail reproduction. The die, as shown in figure (1), consists of three parallel lines 25mm in length horizontally and two vertical lines bisecting the three parallel lines. The parallel lines have a width of 50µm, 20 µm and 75 µm from the top respectively. The mold's surface was cleaned with alcohol before the material was added, and oil gel was used to lubricate the metal ring so that it would split when the substance.

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Figure(1): stainless steel die

Using an alginate automated mixer, alginate powder and distilled water were mixed in accordance with the manufacturer's instructions. The mixture was put on a metal ring in a water bath that was thermostatically controlled to maintain a temperature of 35 ± 1°C. A glass plate was then placed over the stainless-steel stamp and a weight of 1 Kg was added. Three minutes after the manufacturer specified time, the sample was taken out. This was according to ADA Specification No. 18 Alginate Impressed Material and ISO 1563: 1990 Dental Alginate Impression Material.[15,16]All samples were prepared at the same environmental conditions at 23.0 ± 1.0°C for corresponding clamminess as stated by ADA specification no. 18 and 19.[16,17]Depending on the reproduction of the details, the samples have been tested immediately after the separation from the die at daytime light and recorded whether 20 µm, 50 µm and 75µm lines are fully restored over the entire 25 mm distance between the cross line.[15,17] The surfaces were evaluated by the Rating System of Owen,[18] that is:

Score 1: Line replicate and intense obviously over whole length between the marks.

Score 2: Line obvious over more than half of length, or line blurred over less than half of length, the line become visible well over the whole length, but not clearly.

Score 3: Line appear obvious over less than half of length, or line blurred over more than half of length, or line visible over whole length but blemished not sharp.

Score 4: Line is not replicate over whole length; abrupt, impaired, pitted.

The samples were divided into four groups according to sodium hypochlorite ratios to water percentages: Group A, powder of alginate will be mixed with 1% of sodium hypochlorite and 99% of water. Group B, powder of alginate will be mixed with 3% sodium hypochlorite and 97% of water. Group C, powder of alginate will be mixed with 5% sodium hypochlorite and 95% of water. Group D, control group alginate mixed with 100% water. For antimicrobial activity, after recording scores for all groups, 3 specimens were selected (one sample from each group). Then the samples placed in clear aseptic closed container and were transported to the laboratory (Within one hour) under aseptic conditions for testing gram positive microorganism. The samples were processed for microbiological examination, culturing on suitable media for growth of S. mutans which was taken from laboratory sources for microbial strains by using American Type Culture Collection (ATCC) strand. Afterwards, the alginate samples were cultured on a blood agar and the plate will grow under anaerobic condition using candle jar to provide CO2 rich atmosphere. Microbial colonies were diagnosed and identified using a microscopic and an automated biochemical analysis system (VITEK-2 machine) for confirmation. The principle of use of VITEK 2 system (bioMérieux Clinical Diagnostics; VITEK 2 YST ID and VITEK® 2 GP ID card) were followed according to the instructions of manufacturers and previous researches.[19,20] The study was approved from the ethics and

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scientific committee of Kurdistan higher council of Medical Specialties. Statistical package of social science (SPSS), version 23 and Microsoft Excel were used for data analysis.

Results

Surface detail reproduction test results found that all groups were able to record the 75 µm and 50 µm line with Owens score 1 except for group 5% that fail to record any scores. The chosen baseline for comparing procedure among the groups was the replication of the 20-um line, and hence come the major difference between the groups, were 1% and 3% samples showed score 2,4 for the line 20 µm for 50% and 60 % of tested samples respectively. The data obtained indicates that the requirements for an irreversible hydrocolloid material were satisfied, since all tested groups were able to replicate the groove of 75-µm and 50-µm, Figure (2) that is deemed adequate for the materials of alginate impression in accordance with ISO 21563 and the ADA 18 specification.

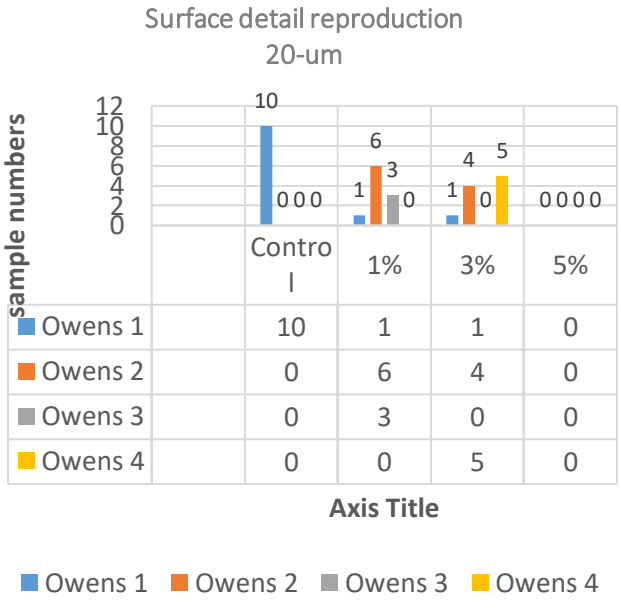

Figure (2): surface detail reproduction of 20-um difference between four tested groups.

The selected samples from tested groups sent for culture sensitivity test showed that 1% and 3% samples revealed growth of *S.mutans* strains seen on the agar plate. While for 5% tested sample no any colony was appeared on the agar plate when comparing to sample with distilled water which contain 6 strains of colonies before sodium hypochlorite disinfection was added as control group.

Discussion

Dental impressions can be sanitized using a variety of methods, some of which have been tried and tested with varying degrees of success. These methods include chemical cleaning through immersion or spraying with a chemical cleaner, using microwave and ultraviolet radiation, etc. Numerous studies have shown that chemical disinfection is the most efficient technique.[21,22] Undoubtedly one of the first and most popular disinfectants is sodium hypochlorite. Numerous studies have suggested it as an efficient disinfectant for alginate impressions in concentrations of 0.525%, 1%, and 2 %.[23-24]In this study, were the efficacy of disinfection control and surface detail reproduction of different ratio of sodium hypochlorite were compared with each other and with control group of distal water shows that alginate was able to record score 1 for line 75µm and 50 µm for 1% and 3% successfully. while the 20 µm lines were not sharply recorded, and the 5% group fall to record scores this regarding the result of obtained by the current study for detail reproduction. One of the key elements in this equation is the composition of alginate; trisodium phosphate is added to decelerate the oxidization between the powder and water, and any variation in its concentration caused by the addition of disinfectant materials has a significant impact on the equation's correctness.[25]The hydrophilic nature of the material, which makes it unstable in environmental humidity and temperature,[26] may be the cause of this

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behavior. Even at 100% humidity, water desiccation (syneresis) induces contraction and related water exudation onto the impression surface, causing the colloidal skeletal network to constantly constrict,[27] which increases the material's susceptibility to dimensional change in a daily environment. High filler content alginate will also affect dimensional stability in contrast to lower weight molecular polymer chains and alginic polymer.[28]Based on the results obtained by the surface detailed reproduction of the current study there was no statistically significant changes in the surface detail reproduction when disinfected with sodium hypochlorite solution this result was supported by the previous study done by Shambhu and Gujjar [29] who toke 70 impression by alginate and used stain steel die for recording 50 µm and 70 µm line for evolution of surface detail reproduction after disinfected by immersing in sodium hypochlorite solution. In a study of Altaf et al investigate the effect of sodium hypochlorite disinfectant on the linear dimensional stability of alginate impression material were sixty alginate impression were made of stainless steel die and randomly divided into two groups ,were one group of 30 control group impression rained by tap water, whereas the 30 experimental group of impression were immersed in 0.525% sodium hypochlorite solution for 10 minutes the result the distance between C and D lines on the die were measured in the cast of both group the result showed mean value difference between two groups was 0.01 which mean does not causes significant on dimensional stability of alginate impression material.[30] Regarding bacterial growth showed greater reduction of colonies number as the percentage of sodium hypochlorite increased when measured in blood agar plate in laboratory from 6 colonies to zero colonies according to the control group and different ratio (1%,3%,5% Naocl) respectively when added to alginate impression materials. This study's limitation was the use of a single disinfectant type and its concentrations. The impact of other disinfectants on alginate impression needs to be investigated for future investigation.

Conclusions

Within the limits of this in vitro study, it can be inferred that the alginate impression material can serve as a route for bacterial contamination during dental procedures. As a result, cleaning the alginate impression by submerging it in various sodium hypochlorite concentrations did not produce significant impact on the surface detail reproduction of alginate impression.

Conflict of interest

The authors declare no conflict of interest.

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