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Original Article

Evaluation of Pre-Alginate Impression Preparation Methods on the Surface Accuracy of Dental Casts

Wajeeha Parveen, Saad Khan, Aleeha Zahoor, Khadija Irshad, Ayesha Masood, Ayesha Iftikhar

Department of Prosthodontics, Armed Forces Institute of Dentistry/National University of Medical Sciences (NUMS), Rawalpindi Pakistan

ABSTRACT

Objective: To investigate the influence of pre-alginate impression preparation techniques (finger smearing and saliva ejection) on the quality and accuracy of dental casts.

Study Design: Quasi-experimental study.

Place and Duration of Study: Department of Prosthodontics, Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan from Nov 2024 to Apr 2025.

Methodology: An equivalent number of healthy men and women were selected through convenience sampling. Each patient underwent two mandibular impressions with stock trays on the same day. In Group-1 (Test), the oral cavity was dried with a saliva ejector and cotton rolls, and alginate was finger-smeared over occlusal surfaces before tray placement. In Group-2 (Control), patients rinsed their oral cavity with plain water, and after 20 minutes, impressions were taken without drying or finger smearing. Occlusal surface defects were measured and classified as Type A (≤500 µm), Type B (501–999 µm), and Type C (≥1000 µm). Data were analyzed using SPSS software version 23.

Results: In present study, 20 healthy adults (10 males, 10 females) between 20 and 40 years were included. Group-1 had 199 nodules, while Group-2 had 207 nodules. The groups' nodule size distribution differed statistically significantly (p<0.001), and Group-2 had a greater frequency of clinically significant Type C defects, suggesting that pre-impression preparation techniques improved surface accuracy.

Conclusion: Pre-preparation techniques of saliva ejection, drying, and finger smearing substantially reduce large surface defects on casts, thereby improving their quality and ensuring a more accurate fit of dental restorations.

Keywords: Alginate, Dental Cast, Finger Smearing, Impression, Nodules, Saliva Ejection.

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INTRODUCTION

A dental impression is a negative imprint of hard and soft tissues in the mouth from which a positive reproduction, such as a cast or model, can be formed.[1] Taking an accurate dental impression, a technique sensitive step, and making a perfect dental cast have been a major challenge for dentists in the fabrication of dental prosthetics. Clinicians must take care to identify and correct potential complications that will affect the prosthetics fabricated from the impressions.[2] Materials like beeswax, gutta-percha, thermoplastic resins, and plaster of Paris have been used in the past, which needed to be improved for ease of use and accuracy.[3] The ideal impression material, however, has yet to be developed.

Alginate impression material is an elastic, irreversible hydrocolloid most commonly used in dental applications. It is a powder material that contains roughly 15% potassium or sodium alginate, 16% calcium sulphate dehydrate, 4% zinc oxide, 3% potassium titanium fluoride, and 2% trisodium phosphate and 60% diatomaceous earth as a filler along with coloring agents and falvoring agents.[4] It is most commonly used in dental applications including primary impressions, interim restorations, mouth guards, study cast models, opposing dentition impressions, and impressions for orthodontic models and bleaching trays.[4] The popularity of irreversible hydrocolloid is attributed to its low cost, hydrophilic nature, biocompatibility and non-toxicity, ease of manipulation, and ability to record and reproduce detailed anatomical impressions of teeth and their surrounding tissue as compared to other impression materials.[5,6]

Extensive studies have been carried out to find out the effect of various factors on the accuracy of alginate impressions that include water-powder ratios, water temperature, device versus hand-mixing of irreversible hydrocolloid, method of dispensing hydrocolloid, influence of tray type and tray size, removal time, compatibility with dental stones as well

Correspondence: Dr Wajeeha Parveen, Department of Prosthodontics, Armed Forces Institute of Dentistry, Rawalpindi Pakistan

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as the effect of long term storage on properties of the material.[7,8]

Alginate material has low dimensional stability on storage due to loss of water (syneresis) or gain of water (imbibition). It is therefore recommended that irreversible hydrocolloid impression should be poured preferably within 10 minutes and up to 1 hour if kept covered with a wet gauze and stored in a zip-lock plastic bag, without any significant distortion.[4,9,10]

In Pakistan no study has been conducted on the application of finger smearing technique to examine its beneficial effects on the dental impression and cast preparation as recommended by various authors in other parts of the world. This study aims to investigate the effect of pre-impression preparation technique, including saliva ejection, finger smearing, and smoothening of alginate impressions, on the quality and accuracy of the dental casts in our setup.

METHODOLOGY

This quasi-experimental study was conducted in the Department of Prosthodontics, Armed Forces Institute of Dentistry (AFID) Rawalpindi, Pakistan from Nov 2024 to Apr 2025.

Using the OpenEpi online calculator for two independent proportions (95% confidence, 80% power), the sample size was determined by comparing the proportions of clinically significant Type C defects between groups. Assuming a proportion of Type C defects of roughly 0.10 in the pre-prepared group and 0.30 in the unprepared group,[11] a minimum of 88 nodules per group (176 total) were needed to detect a 20% absolute difference between groups.

Inclusion Criteria: Patients with an age range of 20-40 years, good oral hygiene, absence of caries, absence of periodontal disease, absence of oral infections, a completely dentate arch with proper tooth alignment, and absence of limited mouth opening were included using a convenience sampling technique.

Exclusion Criteria: All those Patients who had a history of limited mouth opening, a history of allergy to alginate, unhealed extraction sockets, oral infections, patients with poor oral hygiene, patients with edentulous arches with improper tooth alignment or any comorbidity like diabetes, tuberculosis, asthma, allergy, hypertension, or any chronic illness were excluded.

An approval was obtained from the Ethical Committee/ Institutional Review Board (IERB) of the Armed Forces Institute of Dentistry (AFID), Rawalpindi (Ref. No.918/Trg/008/Jan/2023).

Based on the inclusion criteria, 20 patients, including 10 males and 10 females, were selected for the study. After obtaining informed consent, the patients were subjected to full clinical evaluation. Mandibular impressions were recorded using stock trays employing pre-preparation by finger smearing of alginate impression material as a thin even layer on the occlusal surfaces, followed by the conventional method of alginate impression taking in the same patient, on the same day. It was ensured that the alginate adheres to the tooth surfaces and fills the small crevices between the teeth to help prevent trapping of the air.

Hand mixing of alginate impression material, for 45 seconds, with a proper water to powder (W/P) ratio using tap water at room temperature, was performed by a single operator for all impressions. Stock impression trays with adequate rigidity and sufficient retentive features to hold the set alginate securely were selected. The stock tray may be extended with a green stick or impression compound to ensure that the alginate is supported in important posterior areas.

In Group-1, initially oral cavity was dried up with a saliva ejector, making sure there was no excessive saliva in the oral cavity. The teeth were then dried with cotton gauze to remove any residual saliva. Alginate was first finger-smeared on the occlusal surfaces and smoothened, and then the stock tray was placed in the mouth. The clinical setting of the material was determined with the loss of surface tackiness and impressions were removed after a 1-2 min of delay to allow for additional material strength (Figure-1). After removal of the tray, the material was checked to see if it had been pulled out of the stock tray. If it were so, impression taking was repeated. Excessive impression material was cut off. Impression was disinfected in 1% sodium hypochlorite solution (1% NaOCl), rinsed with cold water, wrapped in a wet paper towel, and dispatched to the Certified Dental Laboratory (CDL) of the institution, and poured immediately within 10-12 minutes. For Group-2, Afterward same patients were advised to rinse their oral cavity with plain water and keep the mouth closed for 20 minutes prior to the next impression, taken without saliva ejection, drying, or any finger smearing and smoothening of the alginate.

Standardized disinfection, storage, pouring, and cast removal techniques were used.

Figure-1A: Mouth preparation prior to impression using a saliva ejector

Figure-1B: Drying by a gauze piece

Figure-1C: Drying by cotton rolls

Figure-1D: Alginate finger smearing

For pouring of dental casts a two-step pouring technique was used. In step 1, dental stone (improved stone) and water were mixed together on a vibrator machine using a standardized water to powder (W/P) ratio of 22-24 ml of tap water per 100 g of dental stone powder (0.22-0.24 ml/g), manually for 30 seconds. The mixture was poured into the impression under slight vibration on a vibrator to remove trapped air bubbles to avoid nodules formation. In step 2, the base was formed by pouring a patty of a mix of plaster of Paris (Gypsum type II, W/P ratio of 45-50 ml of tap water per 100 g of plaster), on a slab, and then inverting the already poured impression tray onto it. The cast was separated, with care, from the base after 40 minutes, labelled for identification, and stored in a plastic bag. Fig-2 B.

Figure-2 A: Stereomicroscope Leica MZ-6, Germany

Figure-2 B: Stone cast poured using experimental impression. Arrow indicates nodules.

Figure-2 C: Close-up of occlusal surface of a molar showing nodular measurements.

For measurements of cast surface nodules, With the help of a magnifying glass, the surface of each dental cast was surveyed for the presence of nodules. All the casts were studied at N-ovative Health Technologies Pvt Ltd, National University of Sciences and Technology (NUST), Islamabad, Pakistan. A stereomicroscope Leica MZ-6, Germany, with a reticule of least count of 13 µm at 100x magnification, was used to measure nodules on the cast surface. The measurement unit used was micrometer (µm). Each nodule was measured in its greatest diameter. The number and size of nodules and blebs on the occlusal surface of all the premolars and molars were measured and recorded in the data sheet for further analysis. Fig-2 C.

The diameters of the nodules were obtained in number of divisions of the reticule and were converted to micrometers using the following equation:

Nodule size (µm) = N x (1300/M) where:

N= Number of divisions observed on the reticule

M= Magnification applied during measurement

Surface nodules on the occlusal surface of casts, as examined with a stereomicroscope were classified according to their sizes into three types:Type A: Nodules ≤ 0.5 mm (≤500 µm) in diameter. Type B: Nodules between 0.5 and 1.0 mm (500-1000 µm) in diameter. Type C: Nodules more than 1.0 mm (≥1000 µm) in diameter.

Data analysis was done by using Statistical Package for Social Sciences (SPSS) version 23 software. Frequency and percentages were calculated for categorical variables, whereas median and interquartile range (IQR) values are calculated for the continuous variables due to the violation of normal distribution assumptions. For the analysis of the data, the overall comparison of the distribution of the nodule sizes between the groups was done using the One-way Kruskal Wallis test. The comparison between Group-1 and Group-2 for different defect types was done using the Wilcoxon Signed-Rank test. The level of significance considered was less than 0.05.

RESULTS

In this study, a total of 20 healthy adults, 10(50.0%) males and 10(50.0%) females with an age range of 20 to 40 years, were included. In Group-1 a total of 199 nodules were identified with an overall mean size of 586.56 µm. Out of 199 nodules, 97(48.7%) were Type A, 77(38.7%) were Type B, and 25(12.6%) were Type C nodules, with mean sizes of 357.29 µm, 734.75 µm, and 1019.72 µm, respectively. In Group-2, a total of 207 nodules were identified. Out of these,

64(30.9%) were Type A, 76(36.7%) were Type B, and 67(32.4%) were Type C nodules, with mean sizes of 348.56 µm, 703.36 µm, and 1430.97 µm, respectively.

The overall comparison between Group-1 and Group-2 showed a statistically significant difference in the size distribution of the nodules for all defect types (p<0.001) (Table-I). This indicates that the pre-impression preparation technique has a significant effect on reducing surface defects in dental casts. In addition, the pairwise comparison showed that there was a statistically significant difference between Group-1 and Group-2 for all defect types (p<0.001). Clinically, Type C nodules, which are greater than or equal to 1000 µm in size, were found in greater numbers in Group-2, indicating that the absence of pre-impression preparation techniques results in poor surface accuracy (Table-II). Type A and Type B, although statistically significant, are small in size and thus are less likely to cause clinical problems in the final restoration. This indicates that pre-impression preparation techniques are effective in reducing clinically significant defects in dental casts.

Table-I: Comparison of Nodule Size (µm) among Different Defect Types

Group	Type	Nodule Size (µm) Median (IQR)	*p*-value
1	Type A	364 (65)	<0.001
	Type B	715 (130)	
	Type C	1014 (13)	
2	Type A	351 (52)	<0.001
	Type B	702 (104)	
	Type C	1469 (104)	

**Kruskal Wallis Test, Group-1: pre-impression preparation with saliva ejection and finger smearing Group-2: conventional technique without preparation.*

Table-II: Pairwise Comparison of Nodule Sizes (µm) among Groups across Different Defect Types (Type A, B, And C)

Types	Study Groups		*p*-value**
	Group-1 (n=199) Median (IQR)	Group-2 (n=207) Median (IQR)	
Type A	364 (65)	351 (52)	<0.001
Type B	715 (130)	702 (104)	<0.001
Type C	1014 (13)	1469 (104)	<0.001

***Wilcoxon-Signed Rank test*

DISCUSSION

The findings of this study show that Pre-preparation techniques of saliva ejection, drying, and finger smearing substantially reduce large surface defects on casts, thereby improving their quality and ensuring a more accurate fit of dental restorations. Previous research indicates that many times the fault lies with the poor operator technique, rather than any inherent problem of the material. With improved handling/manipulation of the material, like smoothening the surface of the alginate impression material with a wet finger and better clinical technique, failures can be avoided.[12] Common defects of dental cast surface include voids, nodules, and porosities.

Interestingly, while an earlier study by Al Qahtani *et al.,* reported that all three nodule types were significantly larger in non-prepared impressions, our results diverged slightly. Although the number of Type A and B nodules was slightly greater in Group-1, the size difference between the two groups, Group-1 and Group-2, was not statistically significant. The Type C nodules, however, were significantly reduced in group-1 (finger smearing) as compared to Group-2 (Adjusted p-value: 0.001). The goal of a prudent approach to impression taking is to reduce the number of larger Type C nodules as these can interfere with the proper fit of cast restorations by creating surface irregularities, impeding full seating of the prosthesis, and potentially leading to localized pressure and patient discomfort. These Type C nodules often require removal during laboratory procedures. However, it has also been suggested that these relatively larger nodules are the most difficult to accurately remove from the diagnostic casts.[11] The significant reduction in Type C nodule size observed in our test group (Group-1) is likely due to improved adaptation of the impression material to the occlusal surfaces achieved through finger smearing.

Nodules and voids on the impression surface are a major limitation to the satisfactory use of irreversible hydrocolloid impression materials in the fabrication of stone casts. It has been reported in the literature that various factors affect the quality of alginate impression.[13] Thus, air bubbles on the impression surface incorporated during mixing, excessive saliva, and debris on the oral tissues when trapped between the alginate impression and the tooth surface are considered to be associated with voids on the alginate impression surface that can lead to the formation of nodules on the surface of the fabricated casts.

Mouth preparation typically involves controlling moisture through saliva ejection with a saliva ejector and drying the area by placing cotton rolls in the mucobuccal folds. Studies have recommended that after mouth preparation, finger smearing of the alginate directly onto the teeth should be performed before inserting an impression tray with alginate material to take a dental impression.[14]

Visual and tactile evaluation of a dental cast enables an operator to locate and describe the type of surface defect, as well as perform a root cause analysis (RCA). These surface nodules typically require manual removal by laboratory personnel to ensure accurate articulation with the opposing occlusal surfaces. To address this issue, various pre-impression mouth preparation techniques have been discussed in the literature. These include rinsing the mouth, gentle tooth cleaning to remove debris, reducing saliva through gauze packing or suction, using astringents, and directly applying the impression material onto occlusal surfaces using finger smearing. Scotti *et al.,* Nandini *et al.,* and Arora *et al.,* have recommended finger smearing of the alginate to achieve an accurate reproduction of the occlusal tooth anatomy and to reduce the incidence of macroscopic defects like surface nodules. [7,15,16]

Alaghari *et al.,* in a review, state that since its early usage, several modifications have been made in the composition of conventional alginates. In our facility, alginate is mixed manually by trained dental assistants using standard formulations that do not contain additional components such as disinfectants, color indicators, or surfactants.[17] Some studies, like McDaniel *et al.,* compared 4 different mixing techniques to study bubble formation in alginate during mixing and suggested the use of vacuum mixing to enhance impression accuracy and resulting cast quality.[18]

In the first phase of our study (Group-1), impressions were captured following pre-treatment involving saliva ejection and finger smearing. Previous studies, like Rubel *et al.,* have indicated that excessive drying during saliva removal can lead to alginate adhesion to tooth surfaces, increasing the likelihood of tearing during impression removal.[19] However, we ensured that over-drying was avoided during the procedure.

For the second phase (Group-2), the same individuals were instructed to rinse their mouths before impression-taking, as drying of the dental arch during the first impression could cause the alginate to stick to the tooth surface during the second impression, affecting the cast quality. However, the act of rinsing alone did not lead to a noticeable reduction in the size of Type C nodules—the category most critical for achieving accurate prosthetic occlusion.

It is worth noting that finger smearing consumes part of the impression material's working time. Previous researchers, such as McCullagh *et al.,* and Lim *et al.,* have recommended only lightly smoothing the surface of the alginate impression material with a wet finger, rather than thorough finger smearing, to save time.[13,20] However, based on our findings, when performed by an experienced operator, the benefits of finger smearing particularly in reducing critical nodule formation appear to outweigh the time-related drawbacks.

As a teaching institution, our department primarily relies on conventional impression-taking techniques for routine patient care. Advanced digital systems such as CAD-CAM (Computer-Aided Design and Computer-Aided Manufacturing) are implemented selectively, depending on case complexity and clinical requirements. CAD CAM is becoming the choice of almost every leading dentist in denture fabrication, whether it is removable or fixed prosthodontics.[21] While CAD-CAM workflows offer digital advantages like speed, comfort, and chairside customization along with precision and accuracy, there are still certain scenarios where traditional methods are considered superior particularly when detailed capture of peripheral soft tissues is needed to achieve an optimal marginal seal for removable prostheses.[22]

LIMITATION OF STUDY

The main limitation of the study was a small sample size.

CONCLUSION

Based on the above results, it is suggested that pre-preparation by finger smearing for the alginate impression taking is better than the conventional method in producing impressions for the high-quality casts that are free of nodules and bubbles, leading to prostheses fabrication with better occlusal contacts and patient (customer) satisfaction.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

WP & SK: Data acquisition, data analysis, critical review, approval of the final version to be published.

AZ & KI: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AM & AI: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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