Received: 20th February 2015 *Accepted: 15th April 2015* *Conflict of Interest: None*

Source of Support: Nil

Original Research

Clinical Evaluation of Different Pre-impression Preparation Procedures of Dental Arch

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How to cite the article:
Arora N, Arora M, Gupta N, Agarwal M, Verma R, Rathod P. Clinical evaluation of different pre-impression preparation procedures of antagonistic dental arch. J Int Oral Health 2015;7(7):80-84.

Abstract:
Background: Bubbles and voids on the occlusal surface impede the actual intercuspation and pre-impression preparation aims to reduce the incidence of air bubbles and voids as well as influences the quality of occlusal reproduction and actual clinical intercuspation in the articulator. The study was undertaken to determine the influence of different pre-impression preparation procedures of antagonistic dental arch on the quality of the occlusal reproduction of the teeth in irreversible hydrocolloid impressions and to determine most reliable pre-impression preparation method to reduce the incidence of air bubbles.

Materials and Methods: A total of 20 subjects were selected having full complement of mandibular teeth from second molar to second molar with well demarcated cusp height. 200 impressions were made with irreversible hydrocolloid material. The impressions were divided into five groups of 40 impressions each and each group had one specific type of pre-impression preparation. All the impressions were poured in die stone. A stereomicroscope with graduated eyepiece was used to count the number of bubbles on the occlusal surface of premolars and molars. The mean and standard deviations were calculated for each group. Mann–Whitney *U*-test was applied to find the significant difference between different groups.

Results: Least bubbles were found in the group in which oral cavity was dried by saliva ejector and fluid hydrocolloid was finger painted onto the occlusal surfaces immediately before the placement of impression tray in the mouth.

Conclusion: It was found that finger painting the tooth surfaces with fluid hydrocolloid immediately before the placement of loaded impression tray in the mouth was the most reliable method. The oral cavity can be cleared more easily of excess saliva by vacuum suction rather than by use of an astringent solution.

Key Words: Antagonistic arch, air bubbles and voids, alginate, pre-impression preparation

Introduction

Irreversible hydrocolloid has long been one of dentistry's most serviceable products. Ease of use and low cost, coupled with good clinical and physical properties, make these materials a popular choice for impression making in both the dentate and edentulous patient, in the process of orthodontic appliance construction and for study casts.[1]

Irreversible hydrocolloid impression materials have undergone continuous improvement since their introduction in the early 1940's.[2] The recent past has witnessed subtle changes in the physical characteristics of these materials, including the development of the "dustless" powders, the incorporation of antimicrobials and a product containing a two-color change indicator system.[1] Alginate impression material has as much dimensional accuracy as the other impression materials.[3] Unfortunately, a proportion of alginate impressions are not of adequate standard to allow the production of quality dental cast, as the properties of the material have been abused.[4] Extensive research indicates that much of the fault lies with the manipulation and not with the material.[5] The simplicity of the procedure leads the dentist into using careless techniques.[3] The best method to take full advantage of the accuracy of these materials is to follow a series of exacting procedures according to manufacturer's directions supplied with the respective materials[6] and to pour the cast immediately after the impression is removed from the mouth.[5]

In fixed and removable prosthetics, the cast of the antagonistic arch articulates with the partially edentulous one that requires rehabilitation. The antagonistic cast must accurately reproduce the occlusal morphological features to simulate the actual clinical intercuspation in the articulator. Routine clinical practice uses irreversible hydrocolloid for the impression of the antagonistic arch because it is the most practical material. Bubbles and voids on the tooth surface are a major limitation to the satisfactory use of this material. Air bubbles are incorporated into the material during mixing, while voids are associated with moisture or debris on the oral tissues.

Pre-impression preparation aims to reduce the incidence of air bubbles trapped between hydrocolloid impression and tooth surfaces. Accordingly, the purpose of this study was to clinically evaluate the influence of different pre-impression preparation procedures of antagonistic dental arch in the quality of occlusal reproduction in irreversible hydrocolloid impressions and to determine the most reliable pre-impression preparation method to reduce the incidence of air bubbles.

Materials and Methods

The study comprised of 20 subjects consisting of 16 male and 4 female of age group between 20 and 30 years. The ethical clearance for the commencement of the study was undertaken from the ethical committee of the concerned institute and an informed consent was obtained from the study subjects. The inclusion criteria for the selection of study subjects was good oral health along with complete tooth arches, correctly aligned and in organic occlusion. The mandibular dentulous perforated stock metal trays were selected and a total of 200 impressions were made. The mandibular arch was selected according to patient's comfort and the operator's convenience. Impressions were divided into five groups of 40 impressions each including the control group. For each subject five different pre-impression preparations were carried out. Two impressions were made for each preparation in a subject in a day. After each impression, subject was made to rinse mouth thoroughly and relax for 15 min before the commencement of next impression. A total of 10 impressions were made from each subject.

Pre-impression preparation was divided into five groups. In Group I, the oral cavity was dried by saliva ejector and fluid hydrocolloid was finger painted onto the occlusal surfaces immediately before the impression tray was placed in the mouth (Figure 1). In Group II, the fluid hydrocolloid in the impression tray was smoothed with a wet finger. In Group III, the oral cavity was not dried before the impression and the fluid hydrocolloid was finger painted onto the occlusal surfaces as done for Group I. In Group IV, the patient rinsed mouth with an astringent mouth wash followed by a water rinse before the impression. Group V was the control group in which the oral cavity was not dried and the impression was made directly without any painting or smoothing of the hydrocolloid.

Each impression was made with irreversible hydrocolloid material with proper w/p ratio and handmixed for 45 sec with tap water at room temperature (21°C to 25°C). The mixed material was loaded into sterilized tray. After the material was set, the tray was removed with a vertical movement. Any hydrocolloid that overlapped the tray in the retromolar pad region was cut away with a scalpel to avoid the risk of distortion during the manipulation of the impression. The impression was washed under tap water and then sprayed with 2% glutaraldehyde as disinfectant. Finally the impression was thoroughly rinsed with cold running water, dried without dehydrating its surface and was poured immediately in improved dental stone. Standard proportions and mixing time were used. The mixture was poured into the impression under slight vibration. After 40 min, the cast was removed from the impression. The base was poured with plaster of paris using rubber base former. The cast was retrieved, numbered and set aside. Stereomicroscope with graduated eyepiece was used to count the number of bubbles that produced positive defects in the dental stone on the occlusal surface of premolars and molars (Figure 2). Bubbles were classified into three sizes:

Type 1: Bubbles of 0.5 mm or less in diameter.
Type 2: Bubbles between 0.5 and 1.0 mm in diameter.
Type 3: Bubbles more than 1.0 mm in diameter.

The values (in units) for bubble diameter obtained for each cast using the stereomicroscope were converted to millimeters by using the following formula:

$$\text{Readings in mm} = \frac{\text{Number of units}}{\text{Eyepiece magnification} \times \text{Zoom magnification}}$$

Where,

Eyepiece magnification = 10
Zoom magnification = 1

Figure 1: Finger painting occlusal surface with fluid irreversible hydrcolloid before seating loaded impression tray.

Figure 2: Occlusal detail of gypsum cast. Many small bubbles caused by air trapped between hydrocolloid and tooth surface can be seen.

The number of bubbles of each size found in each of the casts were calculated. The data was subjected to one-way analysis of variance test. The comparison between the groups was made through Mann–Whitney *U*-test (a non-parametric test).

Results

This study demonstrated that bubbles were found in all the five groups, however a variation was found in the number according to type and method of pre-impression technique. Type 1 i.e., bubbles of 0.5 mm or less in diameter were found in each of the casts of five groups and the minimum number of bubbles were found in Group III and maximum in Group V (Table 1 and Graph 1). Type 2 i.e., bubbles between 0.5 and 1.0 mm in diameter were found minimum in Group I and III and maximum in Group V (Table 2 and Graph 2). Type 3 i.e., bubbles more than 1.0 mm in diameter were found minimum in Group I and maximum in Group V (Table 3 and Graph 3). One-way analysis of variance test was used to derive the values of *P* (Table 4), which showed that minimum number of Type 3 bubbles were found in Group I (Table 3), followed by Group I and Group III for Type 2 bubbles (Table 2) and Group III for Type 1 bubbles (Table 1). Mann–Whitney *U*-was applied to find the significant difference between Group I and III for Type 1 and Type 3 bubbles, which showed that for Type 1 bubbles ($U = 2.8347$, $P < 0.01$), there was a significant difference, but for Type 3 bubbles ($U = 0.7181$, $P > 0.05$), there was no significant difference. Type 3 bubbles in Group II and Group IV did not show significant difference from Group V (control group).

Table 1: Statistical analysis for Type 1 bubbles (0.5 mm or less in diameter).

	Group I	Group II	Group III	Group IV	Group V
Mean	6.7	4.8	3.4	11.2	17.1
SD	2.7101	1.3984	1.5055	5.2451	6.3500
Min	4	3	1	5	6
Max	12	7	6	20	23

SD: Standard deviation

Table 2: Statistical analysis for Type 2 bubbles (0.5-1.0 mm in diameter).

	Group I	Group II	Group III	Group IV	Group V
Mean	1.8	5.3	1.8	7	11.1
SD	0.7888	1.8288	0.7888	1.7638	3.4140
Min	1	3	1	4	5
Max	3	8	3	9	18

SD: Standard deviation

Table 3: Statistical analysis for Type 3 bubbles (more than 1.0 mm in diameter).

	Group I	Group II	Group III	Group IV	Group V
Mean	0.7	3.7	0.9	6	5.3
SD	0.8233	0.9487	0.5676	1.6997	2.0575
Min	0	2	0	3	3
Max	2	5	2	8	10

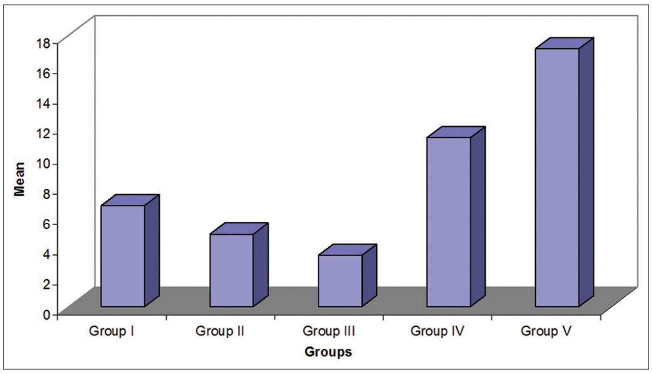
SD: Standard deviation

Discussion

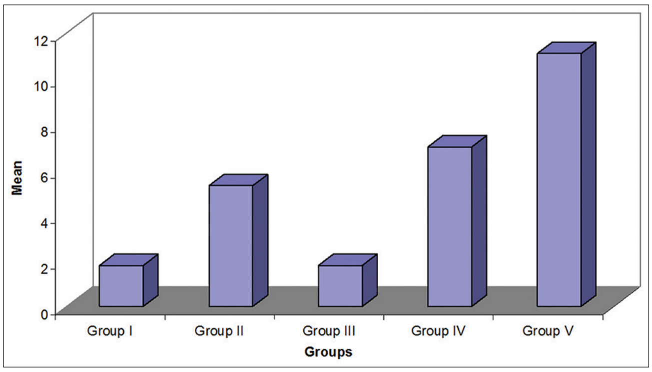
Irreversible hydrocolloid impression material commonly known as alginate, is the most widely used and possibly the most versatile of the impression materials available. The ease of handling, the relative inexpensiveness, the dimensional accuracy, the lack of need of additional equipment and the cleanliness of the material contribute to its popularity.[7]

Table 4: *P* values.

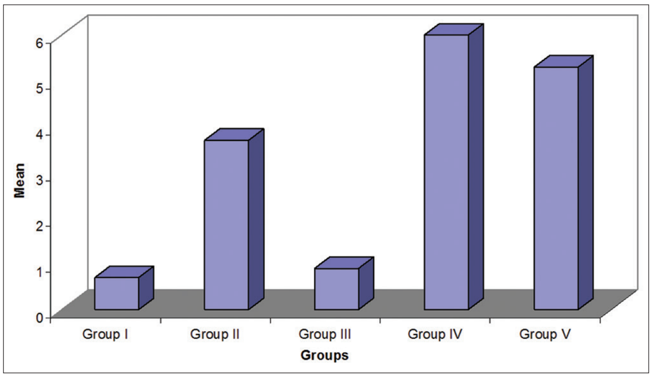
	Type 1 bubbles	Type 2 bubbles	Type 3 bubbles
P values	2.22E-09	3.7E-14	6.65E-13



Graph 1: Representing the means of the five groups for Type 1 bubbles.



Graph 2: Representing the means of the five groups for Type 2 bubbles.



Graph 3: Representing the means of the five groups for Type 3 bubbles.

However, it is one of the most abused impression materials used by dentists. Knowledge of the physical properties and working characteristics of irreversible hydrocolloid is essential if the material is to be used successfully.

The literature reports several studies of irreversible hydrocolloid as an impression material since it was introduced in 1943 by Schoonover and Dickson. Researchers carried out extensive studies to find the effect of various factors on accuracy of alginate impressions that includes water temperature,[7] method of dispensing hydrocolloid,[8] device versus handmixing of irreversible hydrocolloid,[9] influence of type of tray and tray size,[10] removal time,[7] compatibility with dental stones[11] as well as effect of long term storage on properties of the material.[12]

One of the limitations of hydrocolloid is the presence of voids and bubbles on the impression surface. Voids are associated with moisture or debris on oral tissues. If impressions are made after thorough or vigorous polishing of teeth, sticking of alginate to teeth surfaces is more likely to occur. Therefore, only light cleaning of teeth should be accomplished immediately before impressions are made. If thorough cleaning is necessary, the impression making should be deferred until a later appointment. Excess saliva in the oral cavity must be eliminated. However tooth surfaces must be left slightly damp to avoid adherence of alginate. Adequate control of saliva can be accomplished by packing the mouth with gauze pads or saliva ejector before making the impression. Drying with compressed air is contraindicated because the degree of drying achieved in this manner contributes to sticking of alginate. If repeated impressions are made of an arch, there is a greater tendency for sticking to occur. The film that protects the enamel from sticking of alginate is apparently lost during repeated attempts to make impression. If the alginate sticks to the teeth the impression and the cast will be inaccurate.

Pre-impression preparation aims to reduce the incidence of voids and air bubbles trapped between hydrocolloid impression and tooth surfaces. This study compared five different pre-impression preparations to obtain correct contact between the impression material and tooth surfaces. After casting in dental stone, these bubbles become positive defects and impeded correct intercuspation.

A total of 200 impressions of lower dental arch were made with five different pre-impression preparation procedures in 20 subjects. Two impressions were made for each preparation in a subject in a day. Saliva ejector and astringent mouth wash was used for moisture control and finger painting the occlusal surface with hydrocolloid and finger smoothing hydrocolloid surface was used to reduce the air bubbles and voids. Thus the procedure prevented any sticking of alginate to tooth surfaces which can also result in inaccurate impressions.

Alginate impressions were removed from the mouth with a sudden jerk, with the force directed as closely as possible along the long axis of the teeth. Impressions were not removed from the mouth for at least 2-3 min after initial gelation to allow the development of additional strength. Clinically, the initial set of alginate was determined by a loss of surface tackiness.

Casts were poured with Type 4 dental stone within 12 min after being removed from the mouth to avoid any measurable distortion. The impressions were not stored in anything during the 12 min period. Stone casts were analyzed to count the number of bubbles that produced positive defects on occlusal surface of premolars and molars. These bubbles were classified into three sizes.

The bubbles >1.0 mm in diameter (Type 3) have more of an effect on the correct intercuspation of the casts and they are more difficult to cut away from the occlusal surfaces. The quality of an antagonist cast depends primarily on the incidence of this type of defect, rather than on the incidence of those of smaller size.

In this study, the larger bubbles (Type 3) were less in Group I followed by Group III. Group II and Group IV did not show any significant difference from Group V (control group). Compared with the control group (Group V), in which there was no pre-impression preparation, the procedures used for Group I and III produced casts with significantly increased occlusal quality. The two preparation procedures both involved finger painting fluid hydrocolloid onto the occlusal surfaces before the impression tray was placed in the mouth, with the addition of drying the oral cavity with saliva ejector in Group I. Occlusal painting of hydrocolloid therefore appears to be the most reliable method to avoid the incorporation of large amounts of air between the hydrocolloid and the tooth surfaces. One possible explanation for the reduction in the number of bubbles may be attributed to finger painting which compact the impression material on the occlusal surface, eliminating air bubbles incorporated during mixing and voids associated with moisture or debris on the oral tissues.

Smoothing the hydrocolloid without painting the fluid material onto the teeth (Group II), was recommended by Morris *et al.*[6] and Lim *et al.*[13] They concluded that surface moistening technique was associated with fewer bubbles incorporated on impression surface. Lim *et al.*[13] also concluded that it does not add a substantial time factor to the procedure of preparing the irreversible hydrocolloid impression material prior to impression making. The technique added about 10 sec to the pre-placement timing. The reduction in the number of bubbles may be due to the addition of water to the impression surface which may have acted as a spreading factor reducing the contact angle. It may also be due to the stroking motion of the wet finger, eliminating superficial air bubbles incorporated during mixing.

The present study was in concrescence with Lim *et al.*[13] that pre-impression preparation procedure does not add any substantial time factor prior to impression making. However, on the contrary, the surface moistening technique was not proved to be superior to non-surface moistening technique. Smoothing the hydrocolloid without painting the fluid material onto the teeth (Group II), did not significantly improved occlusal precision compared with the control group. This may be attributed to the inability of hydrocolloid impression material to eliminate air bubbles incorporated between tooth surfaces and impression material during placement of tray. It may also be due to moisture or debris on the oral tissues resulting in air bubbles and voids on impression surface.

Saliva can also be controlled for most patients by rinsing the patient mouth with astringent mouthwash followed by a rinse of cold water. However, in this study, Astringent mouthwash used before the impression was made (Group IV) gave no advantage over the control group.

Vassilakos *et al.* investigated the effect of plasma treatment on the wettability of impression materials and void formation in die stone casts concluded that plasma treatment produced high-energy impression surfaces that result in void-free die stone casts from the addition type silicone materials Vassilakos *et al*[14].

Air bubbles and voids present on impression surface are potentially affected not only by the pre-impression preparation procedure but also by the mixing technique. In a study carried out by Reisbick *et al.*[9] vacuum mechanically mixed, irreversible hydrocolloid yielded the best results because the air was actually removed. In the present study, hand mixed irreversible hydrocolloid was used, which was the limitation of the study.

Conclusion

Preimpression preparation effectively influences the presence of large occlusal defects caused by air bubbles and incomplete contact between hydrocolloid and tooth surface. The most reliable procedure consist of finger-painting the tooth surfaces with fluid hydrocolloid immediately before the loaded impression tray is placed in the mouth. The oral cavity can be cleared more easily of excess saliva by vacuum suction rather than by use of an astringent solution.

Clinical significance

The cast must accurately reproduce the occlusal morphological features to simulate the actual clinical intercuspation in the articulator. Voids and bubbles influence the quality of occlusal reproduction in irreversible hydrocollide impression material. Thus, pre-impression preparation aims to reduce the incidence of air bubbles trapped between hydrocollide impression and tooth surface. More accurate the occlusal reproduction of dental arches, the least number of occlusal discrepancies will be developed in the prosthesis.

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