A Comparative Study To Evaluate The Accuracy Of Advanced Alginate Materials For Direct Pick Up Impression Of Single Piece Implant: An Original Research

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Abstract

Implant therapy is currently considered to be a successful and acceptable means to restore missing teeth.[1] It is essential for long-term success of any implant prosthesis to achieve a passive fit between the fixture and the superstructure.[4] Minimizing the misfit to prevent possible complications is a generally accepted goal of prosthodontic implant procedure. Since the accuracy of the impression affects the accuracy of the definitive cast, an accurate impression is essential to fabricate a prosthesis with good fit.[4,5,6]

INTRODUCTION

Obtaining an accurate implant level impression is the first step in an attempt to control one of the many variables associated with minimizing implant prosthesis misfit. Conventionally two piece implant system involves complex armamentarium[8] like a healing abutment around which soft tissue have to heal after 2nd stage surgery and they require different prosthetic components, impression copings, splinting of impression coping and implant analogue for laboratory models. Whereas, in case of single\one piece implants[3,8], which comes with an in built abutment, conventional direct pick up impressions can be made after abutment height adjustments intaorally, just like conventional crown and bridgework.

Although vinyl polysiloxanes and polyethers are recognized for their dimensional stability, PVS impression materials have low dimensional change[9], low creep[9,10,13], relatively short setting time[10] and have moderate to high tear strength[16,18,13]. As there are no by-products[14,21,23] to the polymerization reaction, impressions are dimensionally stable and can be poured at the convenience of the operator, making it material of choice for implant impressions.[15,18,19,23]

Alginate is widely used impression material because of its acceptable accuracy[10,12,17], availability, reasonable price and facile handling.[12,22] Recently, manufactures are trying to increase the storage time of hydrocolloid impression materials. Some impression material manufacturing companies have produced a new generation of alginates (extended-pour) and claim that these materials are capable of maintaining their dimensional stability for up to 5 days. Only a few studies[12,22] have investigated the dimensional accuracy of extended-pour alginates.

The purpose of this study was to evaluate whether recent and advanced alginate can be used for making pick up impression of parallel as well as non parallel single piece implants and to compare the accuracy of alginate impression poured at different intervals with that of polyvinyl siloxane impression.

MATERIALS AND METHODS

Following materials were compared during course of the study:

a. Alginate - Normal pour (Zhermack Tropicalgin)
- Three-phase chromatic alginate.
- Thixotrophic in nature.
- Fast working and setting time.

b. Alginate – Delayed pour (Zhermack Hydrogum 5 Alginate)
- Long impression storage (5 days stability).
- Extra fast water absorption of 5 sec.
- Highly dimensionally stable alginate.

c. Polyvinyl siloxane impression material (Aquasil ultra, regular body, Dentsply).
- Setting time of 5 min. 30 seconds.
- Less than 0.50% linear dimensional change.
- Recovery from deformation ≥ 98%.
- Detail reproduction upto 20 microns.

METHODOLOGY

In this in vitro study, a Nissin typhodont mandibular dentulous model was used as master model. The model was customized to make it more suitable for the study. Second premolars, first and second molars from third and fourth quadrant were removed to mimic a bilateral partial edentulous span, the socket of first molar was blocked using autopolymerizing acrylic resin(Fig. 2) .

Four single piece Adin implants were placed in a Nissin typhodont model in the mandibular 2nd premolar and 2nd molar region of 3rd and 4th quadrant. The implants were placed in self polymerizing acrylic resin. Implants in the 3rd quadrant were placed parallel to each other with the help of a dental surveyor at 35(A) and 37(B) position, while the implants in the 4th quadrant were placed at diverging angle of 10-15 degrees at 47(C) and 47(D) position (Fig. 3, 4). The socket 36 and 46 were blocked with self polymerizing acrylic resin. Four acrylic tray stops were prepared with autopolymerizing acrylic resin, for the proper stock tray placement and to avoid overseating of the impression tray and also to achieve the even thickness (3mm) of impression material(Fig. 5).

Customized photo activated acrylic resin trays with 3 mm spacer for material were fabricated for Aquasil ultra impression material (Fig. 6). Multiple escape holes were prepared for excess material to escape out. Before making impression with Aquasil ultra (Monophase), custom tray was painted with a thin layer of tray adhesive (3M, PVS tray adhesive), and air dried for 15 minutes(Fig. 7).

Adequate amount of material was dispensed in the tray and over the abutments. The tray was placed over the model and a load of 500gms was placed over the tray to apply adequate and even pressure over the impression and to avoid errors due to bouncing back of the material (Fig. 8). 30 impressions were made with aquasil ultra. Immediately after making impression the specimens were stored inside a zip lock plastic storage bag and were stored at room temperature(Fig. 9). The impressions were poured at different time intervals i.e after 6 hours, after 24 hours and after 120 hours with type 4 die stone (high strength, low expansion) and casts were removed after 60 minutes(Fig.10).

For alginate impressions perforated metal stock trays were used (Fig. 11). Adequate material with proper water powder ratio as recommended by the manufacturer were mixed using a clean bowl and spatula (30 sec for hydrogum 5 , 45 sec for tropicalgin) and the material was loaded in stock tray and impression was made . A continuous load of 500gms was applied over the impression tray for proper placement of the tray and to avoid the impression tray to bounce back (Fig. 12). Impressions were retrieved after the material was completely set (1 min. 40 sec. for hydrogum 5 & 2 min. 25 sec. for tropicalgin) . Retrieved impressions were wrapped in water saturated towels and stored in zip lock plastic storage packs (Fig. 13) at room temperature. For each material 10 impressions were poured immediately (within 10-15 minutes), 10 impressions after 6 hours, 24 hours and 120 hours with type 4 die stone (high strength, low expansion KALSTONE) using vibrator to eliminate air bubbles entrapment in the final casts and casts were removed when the material was completely set i.e after 60 minutes.

The retrieved casts were left to dry at room temperature for 24 hours. The casts were trimmed and bases were applied with the help of base former (Fig. 14,15,16). The final casts were grouped on the basis of type of impression material used and time of pour as, “A” denoted Aquasil impressions, “H” denoted Hydrogum 5 impressions and “T” denoted Tropicalgin impressions. Subgroups were names as A6 – Aquasil impressions poured after 6 hours, A24 – Aquasil impressions poured after 24 hours and A120 – Aquasil impressions poured after 120 hours . Similarly for Hydrogum 5 impressions subgroups were named as H0 – Hydrogum impressions poured immediately (within 12 minutes) , H6 – Hydrogum impressions poured after 6 hours, H24 – Hydrogym 5 impressions poured after 24 hours , H120 – Hydrogum

impressions poured after 120 hours. T denoted Tropicalgin impressioms , subgroups were denoted as T0 – Tropicalgin impressions poured immediately(within 12 minutes) , T6 – Tropicalgin impressions poured after 6 hours , T24 – Tropicalgin impressions poured after 24 hours, T120 – Tropicalgin impressions poured after 120 hours. The poured casts were scanned digitally (MEDIT -MD-ID200) to evaluate the discrepancies among the impression materials poured at different time intervals. To check discrepancy distance between the implant abutments, distance between the following were measured with digital scanner (Identica, Medit: MD-ID 200).

Inner diameters of the abutments were measured and compared for each impression materials. The data collected, were tabulated and statistically analyzed. Collected data were compared to the measurements of the master model and Aquasil to evaluate accuracy of the different materials.

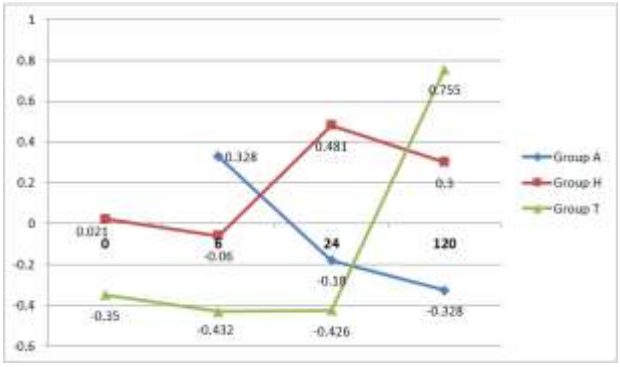
RESULTS

On intergroup comparison of mean of percentage dimensional change of all time intervals between Aquasil group and control model no significant difference was observed between AB (Parallel implants), p=0.353. But a significant difference was found between CD (Non-parallel implants), p=0.003. It was observed that there was expansion in CD, when Aquasil impression was poured after 6 hours with percentage dimensional change of 0.034%. This was followed by shrinkage when the impression was poured after 24 and 120 hours with percentage dimensional change of -0.033% and -0.060%, respectively. The dimensional changes among CD is represented in graph 2. Intra arch comparison of mean of linear dimensions of all Hydrogum impressions with that of control group showed a significant difference in BD (p<0.001).

Similarly, significant difference was observed in AC (p=0.002) when Tropicalgin group was compared to control model. Dimensional changes among AC is represented in graphs 3.

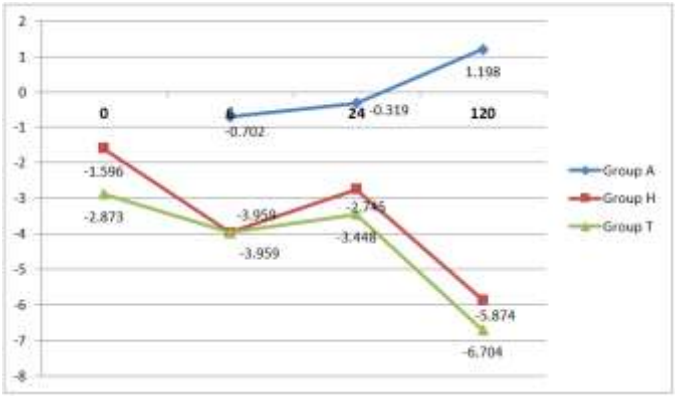
Comparison of mean of inner diameter of all the four abutments (A+B+C+D/4) of control model with that of three groups is given in Graph 5. A significant difference was observed when the mean of inner diameter of control model was compared to the mean of inner diameter at different time interval of Aquasil, Hydrogum and Tropicalgin groups (p=0.048, 0.046 ad 0.042, respectively). Shrinkage with dimensional change of -0.702% at 6 hours and -0.319% at 24 hours and elongation of 1.198% after 120 hours was recorded in Aquasil impressions in comparison to control group.

No significant difference was seen in AB when all the groups were compared at 24 hours interval. Significant values were recorded in AC in Aquasil vs Tropicalgin (p=0.000) and Hydrogum vs tropicalgin (p=0.000).



Graph 2: Showing comparison of C-D dimensional change of all three groups.

Graph 3: Showing comparison of A-C dimensional change of all three groups.



Graph 5: Showing comparison of inner diameter dimensional change of all three groups.

DISCUSSION

Over the past four decades, tremendous progress has been made in the field of impression materials and procedures[23,57]. Various materials have been used to make impressions in fixed prosthodontics[28]. However, recent fixed prosthodontic impressions have domain of the elastic impression materials that produces an accurate negative likeness of oral tissues. The dimensional accuracy of impressions plays a crucial role in the success of fixed prosthesis[24,35].

Irreversible hydrocolloids are one of the most widely[27,29] used impression materials in dental practice. The dimensional stability of alginate is required to obtain reliable gypsum models of the moulded arches. When alginate impressions are exposed to air or water, their dimensional accuracy is affected because of synerisis and imbibition[29,33], leading to inaccurate dimensions of the cast. To overcome this problem, new irreversible hydrocolloids have been developed which are claimed to have increased pouring times, allowing a storage period of up to five days.

This study was conducted to evaluate whether recent and advanced alginate can be used for making pick up impression of parallel as well as non parallel single piece implants and to compare the accuracy of alginate and polyvinyl siloxane impressions poured at different intervals with that of control model. The purpose of placing non parallel implants on one side is to see the distortion in the models poured in impressions made using different materials. Impressions taken were divided into three main groups; Aquasil (A), Hydrogum (H) and Tropicalgin (T). Impressions of these three groups were further divided into four subgroups according to pouring time 0, 6, 24 and 120 hours (except Aquasil, immediately not poured).
On analysing the results of models poured in Aquasil monophase impressions, significant difference was seen in between nonparallel implants (CD). There was distortion at 6 hours (0.034%) followed by shrinkage at 24 (-0.033%) and 120 hours (-0.060%) in CD. Similarly, significant difference was observed on cross arch comparison of mean of Aquasil impressions poured at different interval with that of control model in between AC (p=0.005). Significant distortion was observed in diameters of the abutments in models poured at 6 (0.075%) and 24 hours (0.116%), whereas shrinkage was seen at 120 hours (-0.160%) in AC.

Initial distortion in Aquasil model can be blamed to the storage conditions in which impressions were kept. our study we used a wet cloth and a zip pouch for all the impression materials to maintain humidity in the environment in which impression is kept. Shrinkage in aquasil impressions could be because of shrinkage of the tray[33] used for making impression, improper application of tray adhesive, filler content in impression material or technique with which the impression was retrieved from the model.
However, the dimensional changes for Aquasil impressions were well within the standards of maximal shrinkage value according to ADA specification number 19[26].

Johnson and Craig compared the accuracy of four types of elastometric impression materials with different storage times, and found no significant effect of storage time for the addition silicone impression material[45,65.] Our results were not consistent with their findings. On intergroup comparison of Aquasil impression with that of Hydrogum and Tropicalgin, Aquasil impressions were more accurate as compared to other two alginate groups.

Duseja et al.(2014) observed in an in vitro study that , there was significant shrinkage of both Aquasil Ultra (Monophase)and polyether (Impregum Soft) impression materials over time at room temperature[65]. The dimensional changes at 4 weeks storage were found to be more than 0.5%, which is unacceptable in accordance with ADA guidelines. However, mean percent dimensional changes were found to be satisfactory after 2 weeks storage period. The accuracy of the elastometric impression materials was relatively stable among different storage times and their discrepancies were caused predominantly by the reaction of the components.[45] However, the components of commercial products were usually difficult to investigate.

When Hydrogum impressions were compared to control model, a significant difference was observed in CD (p=0.001). When the impressions taken by Hydrogum were poured immediately and at 6 hours, a significant expansion from the control was observed. Similarly significant shrinkage observed in CD when Tropicalgin impressions were compared to control immediately and at 6 hours. Rohanian et al in 2014 found shrinkage followed by significant expansion in hydrogum 5 when poured immediately and at 24 hours. In Another study by Aalaei in 2017 found that in Hydrogum 5 impressions, the mesiodistal dimension size was insignificant (p=0.26).

Significant shrinkage was observed compared to control in CD when the Hydrogum 5 impressions were poured at 24 and 120 hours with percentage dimensional change of -0.033% and -0.060%, respectively .Similarly Tropicalgin impressions also showed significant shrinkage in CD when poured at 24 and 120 hours. Aalaei et al found 0.10 and 0.11 %age dimensional change mesiodistally in Hydrogum 5 when impressions were poured at 24 and 120 hours respectively. On the contrary Rohanian et al. observed shrinkage of -0.48 % when Hydrogum 5 impressions were poured at 24 hours followed by expansion of 0.48 % when impressions were poured at 120 hours.

The diameter of all four implant abutments were also analysed to observe dimensional changes around the implant abutments. The mean of all four abutments were studied together by calculating mean for the four values. On comparision with the control Aquasil, Hydrogum 5 and Tropicalgin impressions the diameter showed significant shrinkage at all the time intervals when impressions were poured. Chen et al in 2003 studied factors effecting accuracy of elastomeric impressions. They found that the occlusal surface of the stone cast was smaller than that of the master die. In addition, the cervical portion was larger than that of the master die. This showed that the constriction area of the impression material varied in different parts of the stone cast[44].

When change among CD was evaluated, Aquasil and both the alginates showed significant shrinkage when impressions were poured immediately and at 6 hours. Tsagkalidis (2015) concluded in a in vitro study that increase in angulation of the casts caused increase in distortion in the final casts. At 15 degrees of angulation no significant distortion was observed irrespective of the impression technique involved[6,16].

Distortion around angulated implants can be due to distortion caused in the impression material during removal of impression from the impression site. Thickness of impression [28] materials also effect the accuracy of the final cast. Though the distortion in Aquasil impressions is statistically significant but is clinically acceptable.

On intergroup comparision between Hydrogum and Tropicalgin using ANOVA was found to be significant in CD (p=0.043) at 0 hour. A significant difference was observed between CD (p=0.001) between all the three groups at 6 hours. Todd et al (2013) also observed that two different brands of alginate were statistically different from each other but were not significantly different when impressions were poured after various time intervals, stored under same conditions[45].
Significant values were recorded in AC in Aquasil vs Tropicalgin (p=0.000) and Hydrogum Vs tropicalgin (p=0.000); between BD in comparison of Aquasil vs Tropicalgin (p=0.036). Erbe et al. (2012) observed significant increased shrinkage in different alginate impressions at 24 hours .whereas Dhal et al. stated that irreversible hydrocolloid impressions might be stored for 24 hours at 100% relative humidity without compromising the dimentional accuracy[38] of most products.
When all the groups were compared at 120 hours, all the values were found to be significant. Rohanian et al (2014) stated that that the mean antero-posterior measurement at different storage times was equal in Hydrogum 5 (P=0.97). However, in the other two impression materials, these values were found to be significantly different (P=0.003).

When the impressions taken by Hydrogum were poured immediately and at 6 hours, a percentage cross arch dimensional change of 0.333% and 0.298% was seen, respectively. Whereas Tropicalgin impressions when poured immediately and at 6 hours should initial insignificant expansion followed by significant shrinkage respectively. . Farzin & Panahandeh (2010) in a similar study found that cross arch dimensional stability of stone casts made from irreversible hydrocolloid impressions was not influenced by storage time (p= 0.738) and environment temperature (p=0.057) .
At 24 & 120 hours dimensional changes were observed in AC dimensions when hydrogum was compared to the control. Non significant expansion was seen in AC at24 and 120 hours. Todd et al. in his study also observed shrinkage (-2.17) followed by expansion (±0.96) in extended pour alginates at 24 & 100 hours of storage. In a study by Chen et al. (2003) significant expansion was observed at 24 hours among different brands of alginate materials.

CONCLUSION

In the present study following conclusions can be drawn.

1. Elastomeric impression materials should be the material of choice even for direct pickup impression of single piece implant.
2. Advanced alginate materials, when compared to control and Aquasil, displayed significant distortion. Though alginates showed clinically acceptable dimensional changes after 24 hours but initial discrepancies limits its use for implant impressions.

3. When alginates were evaluated for accuracy, numerous dimensional changes were seen at different intervals of time. Thereby, concluding them not to be used as an material of choice for implant impression where accuracy is utmost demanded.
4. When accuracy for parallel and nonparallel implants was evaluated, Aquasil proved to be best among the three. Though Hydrogum5 showed least distortion till 24 hours but its discrepancies among non parallel implants at all intervals makes it unacceptable.
5. Tropicalgin showed significant distortions even when impressions were poured immediately and at all time intervals of delayed pouring, thereby limiting its use as implant impression material.

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