

Evaluation of the Effect of Two Types of Autopolymerizing Acrylic Resin Splints on Dimensional Accuracy in Open Tray Impression Technique

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ABSTRACT

Background and Aim: One of the main goals in the fabrication of an implant-supported prosthesis is to build a superstructure with passive fitness. If this fails, it will lead to the failure of the implant components. This study aimed to investigate the effect of Duralay and Pattern Resin splinting materials on dimensional accuracy in the open tray impression technique.

Materials and Methods: An edentulous acrylic model was developed. In the lateral teeth area, two implants (CMI, Neobiotech Co.) were placed perpendicularly and parallel to each other. The implants were cemented with cyanoacrylate. Pattern Resin (n=10) and Duralay (n=10) were used to splint the impression copings, and the impression was taken using the open tray technique. The main casts (20 pieces) were made with Vel-Mix type IV plaster using a vacuum mixer. The dimensional changes of each group were measured using a multi-axial coordinator. T-test was used to analyze the data.

Result: The mean dimensional changes of implant position transfer at the x-axis were $5.04 \pm 0.37 \mu\text{m}$ for Duralay and $5.58 \pm 0.13 \mu\text{m}$ for Pattern Resin. The mean dimensional changes of implant position transfer at the y-axis were $7.01 \pm 0.49 \mu\text{m}$ for Duralay and $6.78 \pm 0.15 \mu\text{m}$ for Pattern Resin. The mean dimensional changes of implant position transfer at the z-axis were $7.62 \pm 0.71 \mu\text{m}$ for Duralay and $6.86 \pm 0.12 \mu\text{m}$ for Pattern Resin. T-test showed that the difference between the two groups was not statistically significant ($P > 0.05$).

Conclusion: According to the results, Duralay and Pattern Resin were not significantly different regarding dimensional changes in the open tray impression technique.

Keywords: Dental Implant, Dental Impression Technique, Splints, Acrylic Resins

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Introduction:

It is essential to provide a precise template of the implant for passive fitness. The term “passive fitness” in implantology describes a form of prosthesis matching on implants, which does not impose any strain on the various components of the implant, such as the bone around the implant and its components. Passive fitness has been reported in previous studies to be 10 microns.⁽¹⁾

Manufacturing of a superstructure with passive fitness is one of the major goals when fabricating an implant-supported prosthesis. It is essential to obtain a precise template with no dimensional changes before casting to achieve this passive fitness. Failure to obtain passive fitness results in pressure on the implant, and in some cases, failure of the implant and in some cases, failure of the implant components and failure of

the implant components and failure of treatment.⁽²⁾ The forces caused by the non-passive superstructure in the implant can cause bone resorption around the implant, ischemia, non-mineral tissue repair around the implant, mechanical failure, loosening of the implant components, and fracture of the restoration. Therefore, it is necessary to prepare a precise template without any dimensional changes before casting to obtain this passive fitness for the long-term success of implant treatment.⁽³⁾

The dimensional changes in the impression material due to the polymerization reaction are associated with the production of by-products, volatility with the force applied during molding, the impression technique, and the type of splinting material. One of the factors affecting the dimensional accuracy is the impression method that can affect the molding accuracy, especially when angled implants are present. Some studies have shown the accuracy of the open tray technique to be more than that of the close tray technique.⁽⁴⁻⁶⁾ For the first time, Brånemark and colleagues realized the importance of splinting and bonding of impression copings together inside the mouth for greater precision in molding.⁽⁵⁾

Some previous studies have shown that the accuracy of molding with autopolymerizing acrylic resin splints is similar to that without a splint.^(2,4,7) In some studies, the light-cure splinting material or bite registration polyether showed less dimensional changes than acrylic splint or no splint.^(7,8) Other studies reported similar dimensional changes.^(9,10) In some studies, unlike the previous study, the type of splinting material affected the accuracy of the impression; these studies showed that the casts made from impression copings splinted with autopolymerizing acrylic resins were more accurate than those without a splint. Profile projectors or optical microscopes have been used to measure dimensional changes in the mentioned studies.⁽¹¹⁻¹³⁾

Given the inconsistent findings of previous studies regarding the mentioned splinting materials, accurate evaluation of dimensional changes and distortion in the three dimensions seems to be important to prevent the loss of some data. Some

information may not be evaluated when examining linear changes in two dimensions. The profile projector method, which is a linear measurement, is more accurate than the caliper, strain gauge, and microscopic methods, but is less accurate than three-dimensional (3D) measurements, and some data may not be recorded. Our research uses a high precision coordinate measuring machine (CMM) in three dimensions.⁽⁷⁾

Autopolymerizing acrylic resins commonly used for splinting implants include GC Pattern Resin and Duralay. Both resins have a methacrylate base and are available in powder and liquid. The volumetric shrinkage of Duralay is reported to be 9.7% after 24 hours. The microstrain of Pattern Resin for implant molding has been reported to be lower than that of Duralay. Its shrinkage after 24 minutes has been reported to be 0.37%. In another study, volumetric shrinkage was $5.07 \pm 1.36\%$ for Duralay and $5.72 \pm 0.89\%$ for Pattern Resin with no significant differences. Therefore, the present study investigates the dimensional changes of the two types of splints mentioned above with a more precise method.⁽¹⁴⁾ This study aimed to evaluate the effect of two types of conventional dental abutment splinters, namely Duralay autopolymerizing acrylic resin and Pattern Resin, on the dimensional accuracy of implant position transfer using a multi-axial coordinator.

Materials and Methods

In this in-vitro experimental study, an edentulous acrylic model (Moravia, Boyman Boya, Tokyo, Japan) was made. In the lateral teeth area, two implants (CMI, Neobiotech Co., Seoul, Korea) were placed perpendicularly and parallel to each other. The main cast was made with Vel-Mix type IV plaster (Kerr, Romulus, MI, USA) using a vacuum mixer. All implants were secured with cyanoacrylate, and one operator completed all work. To fabricate a two-layer tray, the wax was used as a spacer (thickness=2 mm) on the model along with three stops (one anterior and two posteriors). The trays were made of light-curing acrylic resin with 6-minute polymerization time.

The trays (20 pieces) were trimmed and punctured to increase the retention of the impression material. The main cast also had two guide holes for adaptation of the special tray to the open tray technique.

In this research, we used two autopolymerizing acrylic resins for impression taking. In the first method, the implants were splinted together on the model using GC Pattern Resin (GC. Corp., Tokyo, Japan) and molded in one step using the open tray technique. In the latter case, the implants were splinted together on the model using Duralay acrylic resin (Reliance Dental Mfg. Co., Worth, IL, USA) in the laboratory and molded using the open tray technique.⁽¹⁵⁾ The trays containing polyvinyl siloxane impression material (Monopren, Kettenbach, Eschenburg, Germany) were placed on the main cast and polymerized for 10 minutes before separation. After the guide pins were removed, the tray was removed from the main cast, and the implant analog was attached to the impression copings.⁽¹⁶⁾

The molds were checked for errors such as air bubbles and the presence of impression material in the coping connection area; the procedure was repeated if necessary. The casts were made using Vel-Mix type IV plaster, according to the manufacturer's instructions, trimmed, coded, and simultaneously placed on the mounting plate for measurement. A stylus with a fine tip was placed on the upper surface of the hex implant and the cast base to record using the multi-axial coordinator (Mitutoyo CRYSTA-Apex S544, Japan). The tip of the stylus was inserted at the center of the hex implants, and the measurements were made with respect to the six heads of the hex in the three planes (X-Y-Z). Different vector calculations were then determined in degrees between the implant angles in the main cast and the duplicated cast. The minimum sample size required in each group was 10 samples considering $\alpha=0.05$ and $\beta=0.02$, based on previous studies.^(16,17) Data were analyzed by T-test.

Results:

The study was conducted on two groups of ten, in total, 20 samples. In each sample, the measurement was made at six points. The average dimensional changes of implant position transfer at the x-axis were $5.04 \pm 0.37 \mu\text{m}$ for Duralay and $5.58 \pm 0.13 \mu\text{m}$ for Pattern Resin. The mean dimensional changes of implant position transfer at the y-axis were $7.01 \pm 0.49 \mu\text{m}$ for Duralay and $6.78 \pm 0.15 \mu\text{m}$ for Pattern Resin. The mean dimensional changes of implant position transfer at the z-axis were $7.62 \pm 0.71 \mu\text{m}$ for Duralay and $6.86 \pm 0.12 \mu\text{m}$ for Pattern Resin. T-test showed that the difference between the two groups in the three planes was not statistically significant ($P>0.05$).

Discussion

Our study showed that, in the open tray molding process, the two applied autopolymerizing resin splinters (Duralay and Pattern Resin) were not significantly different in dimensional changes. Molding with Duralay and Pattern Resin renders similar precision.

Precision molding is essential for the 3D recording of the location of the implants as well as the passive fitness of the prosthesis. The results of the present study are comparable to those reported by Rismanchian and Monirifard⁽²⁾ and Choi et al.⁽⁴⁾ These studies have shown that splinting material has little advantage in the precision of molding. In 2018, Saini et al showed that light-cure splinting materials had a smaller dimensional change compared to splinting with acrylic resins or no splint.⁽⁷⁾ But acrylic splinting and no splint exhibited similar results. In the cited study, as in the present study, a coordinate device in three planes was used to measure the distance between the implants. In 2010, Hariharan et al showed that casts made with the polyether-splinted bite registration technique were more accurate than those prepared with the acrylic resin-splinted and non-splinted and bite registration addition silicone-splinted techniques.⁽⁸⁾ Acrylic splinters and no splint had similar results. In 2018, Joseph et al showed that the accuracy of splinting

materials (flowable composite, bite registration paste, Pattern Resin, and acrylic resin) did not differ.⁽⁹⁾ In 2016, Selvaraj et al showed that the accuracy of GC Pattern Resin and Pro-temp TM 4 (bis-GMA) splinting materials were similar.⁽¹⁰⁾ All the mentioned results are in line with the results of the present study.

In some of the studies that follow, unlike the present study, the type of splinting material had an impact on the accuracy of the impression.^(11-13,18) Vigolo et al argued that attaching the impression copings using Duralay splinting material is effective in reducing dimensional changes.⁽¹³⁾ They used the profile projector method for the assessment of their samples. In 2019, Kavadia et al showed that splinting of the impression copings had no advantage for parallel implants, but when the implants are not parallel, splinting of the impression copings increases the accuracy of the casting.⁽¹¹⁾ In their study, microgaps between the prosthesis and the implant analog in parallel and non-parallel implants were reduced with splinting of the impression copings using autopolymerizing acrylic resins, and this decrease was significant in the non-parallel implant with a 25-degree angle. The microgap was evaluated using images taken by an optical microscope. In 2014, Pujari et al showed that castings made from impression copings splinted using an autopolymerizing acrylic resin were more accurate than non-splined casts.⁽¹²⁾ They used the profile projector method for measurements. This difference between the results mentioned and those of the present study may be attributed to the type of device used. In our study, the MMC device with high precision in three dimensions was used.⁽⁷⁾

Dimensional changes of the impression material and the cast can occur in different directions. The CMM used in this study evaluates changes and distortions in three dimensions. When the evaluation is linear or in two dimensions, some information may not be evaluated. The profile projector method, which is a linear measurement, is more accurate than the caliper, strain gauge, and microscopic methods, but is less accurate than the 3D measurements, and

some data may not be recorded.⁽¹²⁾

It is recommended that further research be undertaken to investigate the possibility of increasing the dimensional accuracy of the final cast and approaching the intraoral conditions to increase clinical generalizability. In addition, the use of new splinters and comparison of their dimensional changes are recommended. The results of this study showed that the two types of splinting materials did not show a statistically significant difference; however, Pattern Resin is cheaper with a shorter setting time compared to Duralay.

Conclusion

Considering the limitations of this study, it can be concluded that Duralay and Pattern Resin have no significant effect on the reduction of dimensional changes. Duralay is recommended due to its ease of use and low cost.

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