ACCURACY OF THE IMPRESSION TECHNIQUE USING THERMOFORMING POLYMETHYL METHACRYLATE TRAY

Yuko Miyashita, D.D.S., Ph.D., Hiroki Suzuki, D.D.S., Ph.D., Masataka Kishi, D.D.S., Ph.D., Sok-Min Ko*, D.D.S., M.S.D., Ph.D.

Department of Removable Partial Prosthodontics, Tokyo Dental College

*Department of Dentistry, School of Medicine, Ajou University

Statement of problem. Use of the conventional dental impression procedure is problematic in patients who have difficulty opening their mouth, difficulty breathing through their nose or tendency to gag.

Purpose. It is necessary to make individual trays more comfortable for patients during impression taking procedure. It was reported at the KAP Annual Meeting 2001 Seoul that an improved impression technique was suitable for this purpose. In this study, the accuracy of the improved dental impression method for implant was compared with the conventional dental impression method.

Material and methods. An oral simulator was made from clear acrylic resin block which had similar form of edentulous ridge. For setting up the standard, five fixtures were installed on it. Study casts were made using two kinds of impression techniques. One was the conventional method that was taken using silicone impression material and an individual resin tray under connection of inter-fixture relation. The other was the improved method in which was the connection of the impression coping and the thermoformed polymethyl methacrylate tray. In addition, two different study casts were made from the improved impression body. The coordinates of the fixture on the study model were measured by three-dimensional coordinate measuring equipment. Then the distances between each fixture were calculated and compared with that of oral simulator. Accuracy of the each impression method was also assessed.

Results. The differences of inter-fixture dimension between study casts and simulator in the improved impression technique showed 0.014 ± 0.016mm and 0.017 ± 0.022mm, respectively and that of the conventional method was 0.017 ± 0.014mm. There was no significant difference between the improved impression technique and conventional method.

Conclusion. The improved impression technique is useful for multiple support implants.

Key Words

Implant, Impression accuracy, Thermoformed PMMA, 3-D coordinate measuring equipment

When taking the impression to make an implant superstructure, it is important to re-create the positional relation accurately between abutments in the mouth on the working cast. Since the impression taking technique was first demonstrated by Zarb and Jansson,[1] it has been one of the most widely used methods for replicating the implant position in the mouth. Their method was that after curing the impression material the surrounding of impression coping on the individual tray was opened to release the guide pin for removing the impression coping buried together with impression body. Then the opened area was covered with paraffin wax to expose the guide pin. This method can duplicate the reciprocal position of implant perfectly through obtaining the pick-up impression by making a unary block from connecting the impression copings with each other with acrylic resin. However, in the case of full arch edentulism, although an individual tray is used, it is difficult to place the tray inside the mouth accurately. Also distortion of the final impression may be caused by movement of the patients or mucose mobility during the impression taking process. Since it is hard to obtain a uniform thickness with the self curing acrylic resin that is commonly used for individual tray making, it is difficult to maintain the accommodating space for impression material. Also since a blockout for undercut underlying of the cast is required, the tray size is likely to be increased. Fixing the position between implant abutments requires the impression copings need to be connected with each other and for this the tray size is increased to accommodate a pick-up block. In cases with a tray handle and / or when implant site is widely covered, or cases with difficulty of opening the mouth or with gagging reflex, it is difficult for the tray to be inserted inside the mouth and the stress that is given to patient is also very serious.

With the new improved impression technique, it is possible to obtain a uniform tray thickness and impression material accommodating space while reducing the size of the individual tray making for implant impression using the pressure thermoforming polymethyl methacrylate plate. The impression taking technique can be applied to the superstructure procedure on the day of operation when applying the immediate loading technique as well as reducing the patient' s discomfort during taking the impression.[2]

In this method, the preliminary impression is made with alginate. Then the polymethyl methacrylate plate, the first cast, is molded by heating and pressuring after forming a hole for the impression coping to pass through the site where the abutments are located. A completed thermoformed polymethyl methacrylate tray (Fig. 1-A) is positioned inside the patient' s mouth accurately (Fig. 1-B). The positional relation between abutments is then fixed by connecting with Pattern Resin® (Fig. 1-C). After curing the resin, the tray is removed from the mouth by releasing the guide pin of impression coping. The inside of the tray is then filled with silicone impression material (Fig. 1-D). The tray is again inserted in the mouth and the abutments are connected with impression coping. The final impression is taken by removing the tray from the mouth when the impression material is cured. The working cast is completed when the impression coping inside impression body is connected to the lab analog and the plaster is injected directly into the tray (Fig. 2).

Thermoforming is a molding technique that makes a new desired form by using heat and pressure to transform the thermoplastic plate. The pressure thermoforming polymethyl methacrylate plate is commonly used as an operational stent, occlusal splint or denture base plate because of the precise reproducibility of the working cast, dimensional stability, uniform thickness and easy handling[3] Acrylic resin is used as thermoforming resin due to advantages such as transparency, corrosion resistance, high solidity, surface glossiness, and formability. Jagger[4] reported the dimensional accuracy of acrylic resin plate after thermoforming to be 0.37-0.52% of linear shrinkage after 24 hours. This was compared with the results of Mojon[5] where the linear polymerization shrinkage of Pattern resin used for joining impression copings in the pick-up impression technique was 0.3-0.5%. By using the thermoforming PMMA plate, it is likely that impression procedure is simpler and familiar to patients while maintaining the accuracy level of the traditional technique. It is necessary to test the accuracy by measuring the dimensional changes of replicated working cast through each impression technique.

There are many methods used at present to observe the dimensional change. Among the mainly used are the contact method using the 3-D coordinate system and the noncontact measuring methods using hologram, laser, speckle interference, moire phenomenon, stereophotogrammetry, and photogrammetry.[6] Choi et al[7] used a 3D scanner which was a noncontact measuring method to observe the dimensional change after polymerization according to different injection methods of denture base acrylic resin. They calculated the dimensional changes by overlapping the scanned impression images of the denture base produced from the master cast with those before polymerization using an image analysis program. Kim and Yang[8] compared the error rate after measuring the distance between measuring points of the master cast and the replicated cast by using a 3-D measuring microscope which was another noncontact method. However, since measuring points by noncontact methods are determined by the naked eye, error between study individuals or triers is inevitable in measuring the distance between central points.

Therefore, this study was designed to compare the accuracy between impression techniques

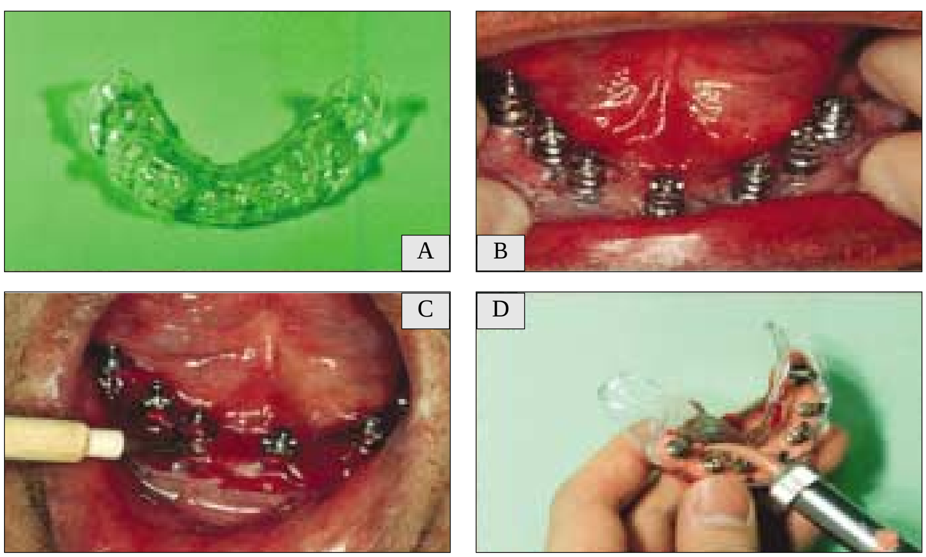

Fig. 1. Improved impression technique.

Fig. 2. Working cast made from improved impression method.

by comparing dimensional changes of the working cast from the implant impression taking technique using the traditional open tray and thermoforming polymethyl methacrylic plate with the contact method 3-D coordinate measuring equipment.

MATERIAL AND METHODS

1. Materials

A. Materials

In this study, the Brånemark implant system from Nobel Biocare was used and individual trays were made with acrylic resin for the light curing tray (Light-platten®, Dreve GmbH, Unna, Germany) in the conventional impression technique. Pressure thermoforming polymethyl methacrylate plate (Biocryl®, Scheu Dental GmbH, Iserlohn, Germany) was used to make individual trays in the new improved impression technique. The working casts were made from alginate impression material (Alginoplast®, Heraeus Kulzer GmbH, Hanau, Germany), and the study casts were made from silicone impression material (Exafine®, GC Co, Tokyo, Japan) and hard stone (New Plaston®, GC Co., Tokyo, Japan) (Table I).

B. Equipments

For the molding of thermoforming plate, a heat and pressure molding machine (Biostar®, Scheu Dental GmbH, Iserlohn, Germany) was used. A torque controller (DEA020; Nobel Biocare, Yorba Linda, CA, U.S.A.) was used to connect abutments with impression coping. Contact 3-D coordinate measuring equipment (Mitutoyo Coordinate Measuring Machine BH303, Mitutoyo Co, Kanagawa, Japan) was also used for measuring coordinates of each abutment of the simulator and the study cast.

2. Methods

A. Making the Simulator

After making a mold with a silicone impression material for the plaster cast, the mandibular arch formed resin block was made by pouring the clear acrylic resin. The part corresponding to the ridge crest of the resin block was formed in an even horizontal plane and the surface was polished. All undercuts and irregularities that might cause the impression distortion were removed. At the median part of the arch, a hole for accepting fixture was made at a right angle to the horizontal plane and was 13mm in depth and 4mm in diameter. Then 4 holes with same size were made on the both sides of this. Five holes all together were at approximately 10mm distance and parallel to each other. Then the implant fixtures (28922, Nobel Biocare, Yorba Linda, CA, USA) were placed into each hole while maintaining same height platform and fixed it with the acrylic resin. By connecting the implant abutments (29181; Nobel Biocare, Yorba Linda, CA, U.S.A.) of 3mm collar height on the implant fixture the simulator was completed (Fig. 3). The simulator was stored at room temperature for releasing of inner stress caused by polymerization of acrylic resin for 1 month.

Table I. Implant components used in this study

Component	Lot Number	Manufacturer
Implant fixture Mk III, 4.0 13mm	28922	Nobel Biocare, U.S.A.
Abutment, Multi-unit RP 2mm	29181	Nobel Biocare, U.S.A.
Impression coping, open tray NP/RP	29089	Nobel Biocare, U.S.A.
Impression coping, closed tray NP/RP	29090	Nobel Biocare, U.S.A.
Guide pin, NP/RP 10mm	29012	Nobel Biocare, U.S.A.
Lab analog, Replica NP/RP	29110	Nobel Biocare, U.S.A.

Fig. 3. Oral simulator used in this study.

B. Making the Study Tray

1) Conventional Impression Tray

The preliminary impression was taken using alginate and closing tray on the simulator. The working cast was completed after connecting lab analogs (29110, Nobel Biocare, Yorba Linda, CA, U.S.A.) and impression coping (29090, Nobel Biocare, Yorba Linda, CA, U.S.A.) on the preliminary impression. On the working cast, after combining the open tray impression coping (29089, Nobel Biocare, Yorba Linda, CA, U.S.A.) to the lab analog with guide pin, each impression coping was connected to pattern resin®(GC Co, Tokyo, Japan) as the width and height of 5mm thickness. Based on this, the open tray for the conventional impression technique was made by blocking out the inside with one sheet of base plate wax to allow the impression material space using acrylic resin for the light curing tray (Lightplast-platten®, Dreve, GmbH, Unna, Germany).

2) Thermoforming Polymethyl Methacrylate tray

The working cast was made by taking the preliminary impression from the simulator with alginate. On this, the pressure thermoforming polymethyl methacrylate tray (hereafter called as thermoforming PMMA tray for convenience) was made for recording the abutment positional relation by heat and pressure molding of 3.0mm thickness PMMA plate (Biocryl®, Scheu dental GmbH, Iserlohn, Germany) using Biostar®(Scheu dental GmbH, Iserlohn, Germany). The thermoforming PMMA tray was completed after making a hole for impression coping to pass through on the area where the abutments were located.

C. Making the Study Cast

1) Study cast from conventional impression technique (C1-C3)

For final impression taking to make the study cast, the spaces between the impression coping on the working cast were connected with Pattern resin® block. After 24 hours when the curing shrinkage of resin was sufficiently completed the impression coping was prepared by separating the connection between copings by cutting the median part of the distance between each impression coping. This prepared coping was set up the simulator using guide pin. Then gaps between the block were connected again with

Pattern resin® and the final impression was completed using individual tray and silicone impression material (Exafine®, GC Co., Tokyo, Japan). After the lab analog (29110, Nobel Biocare, Yorba Linda, U.S.A.) was connected to impression coping in the impression body, the study cast was made by pouring hard stone (New Plaston®, Tokyo, GC Co., Japan).

2) Study cast according to thermoforming polymethyl methacrylate tray (A1-A3 and F1-F3)

After connecting the open tray impression coping to the simulator and then carefully positioning the tray to the simulator for each impression coping to be exposed to the holes formed in the thermoforming PMMA tray, the position relation between abutments was fixed by connecting thermoforming PMMA with impression coping using Pattern Resin®. After polymerization of Pattern Resin®, the tray was removed from the simulator by releasing the guide pin. After filling with silicone impression material (Exafine®, GC Co., Tokyo, Japan) inside thermoforming PMMA tray, the tray was then connected to the simulator again and the impression material was cured. Removing the tray from simulator the final impression by new method was completed.

After connecting the lab analog to the impression coping on the obtained impression body, the study cast method 1 (A1-A3) was produced by pouring the plaster (New Plaston®, GC Co., Tokyo, Japan) directly to the thermoforming PMMA without fixing each lab analog.

After connecting the lab analog to the impression body, which was taken by the same method, and fixing the gap between lab analogs using stainless steel wire and Pattern resin® to steady the positional relation, the study cast method 2 (F1-F3) was produced by pouring the plaster (Fig. 4). By taking three impressions with each impression technique totally 9 study casts were obtained.

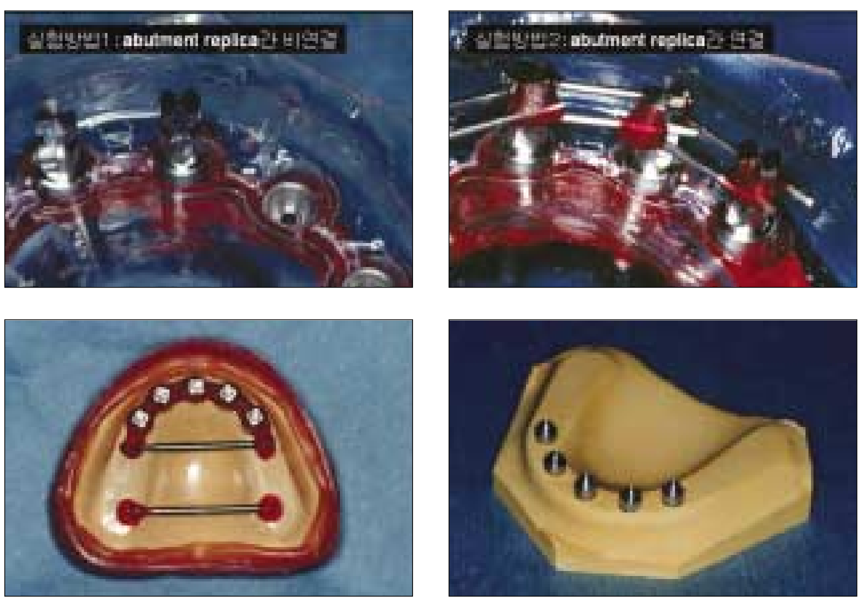

Fig. 4. Working cast for this study.

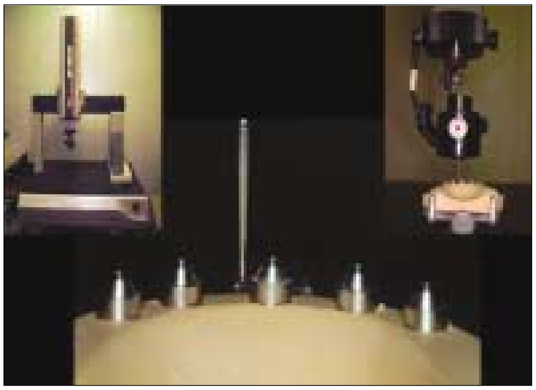

Fig. 5. Three-dimensional measuring equipment.

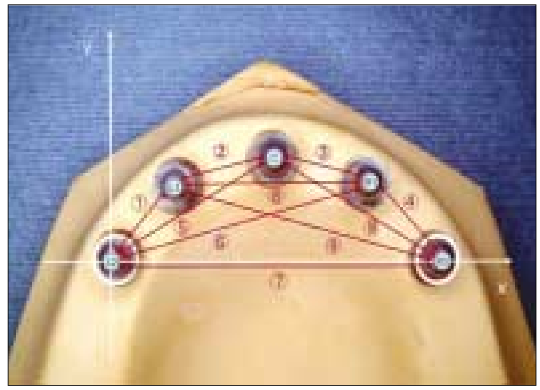

Fig. 6. Measurement of the central point of analogs and the distance between each other.

D. Measuring the study cast

A 3-D coordinate measuring equipment (Mitutoyo Coordinate Measuring Machine BH303, Mitutoyo Co., Kanagawa, Japan) was used for measuring the distances between abutment and lab analog centers (Fig. 5). The central point coordinates of abutment of simulator and lab analog on the study cast were first measured. With the probe in the measuring equipment, the coordinate of central point was obtained by measuring 3 points of the upper end of the abutment cylinder on the simulator and the study casts after performing X-Y axis correction by using L2 coordinate and R2 coordinate. After 5 repetitive measurements for all of 9 study casts, the average value was decided as a central point coordinate.

E. Distance Measuring Between Abutment Centers

From the determined central point of the abutments, the distance between abutment centers of simulator and the distance between lab analog centers of study cast were calculated. Also, by calculating the distance between centers of whole 10 parts the amount of dimensional changes according to each impression technique for simulator was assessed (Fig. 6).

3) Statistics

With every measured value the average value and standard deviation were calculated by using Window SPSS 10.0 program. The amount of dimensional change in the study cast was compared and analyzed with the simulator. Two-way ANOVA ($p<0.05$) was performed for difference study between groups.

RESULTS

In this study, the study cast made by the conventional impression technique which connects the impression copings with each other and takes the impression with the silicone impression material using the individual tray. The study cast method 1 and method 2 used the new improved impression technique, which connects the impression coping and thermoplastic PMMA tray directly. The distances for each between implant centers were measured. The top value represented the distance between lab analogs of study cast. The lower value showed the amount of dimensional change in the study cast for the distance between abutment centers as plus when expanded and as minus when decreased (Table II).

Table II. Dimensional change between master cast and impression methods

	①L2-L1	②L1-C	③C-R1	④R1-R2	⑤L2-C	⑥L2-R1	⑦L2-R2	⑧L1-R1	⑨L1-R2	⑩C-R2
Master	9.289	10.321	9.913	10.494	18.793	26.876	33.487	19.649	28.093	19.679
C-1	9.287	10.320	9.895	10.521	18.803	26.883	33.480	19.677	28.133	19.691
	-0.002	-0.001	-0.018	0.027	0.010	0.007	-0.007	0.028	0.041	0.013
C-2	9.263	10.321	9.904	10.545	18.788	26.907	33.529	19.679	28.133	19.710
	-0.026	0.000	-0.009	0.051	-0.005	0.031	0.042	0.030	0.040	0.031
C-3	9.288	10.366	9.918	10.480	18.854	26.924	33.512	19.663	28.111	19.704
	-0.001	0.044	0.005	-0.014	0.061	0.047	0.025	0.014	0.019	0.025

	①L2-L1	②L1-C	③C-R1	④R1-R2	⑤L2-C	⑥L2-R1	⑦L2-R2	⑧L1-R1	⑨L1-R2	⑩C-R2
Master	9.289	10.321	9.913	10.494	18.793	26.876	33.487	19.649	28.093	19.679
A-1	9.299	10.338	9.900	10.549	18.816	26.935	33.529	19.631	28.080	19.682
	0.010	0.017	-0.014	0.055	0.024	0.059	0.043	-0.018	-0.013	0.003
A-2	9.309	10.324	9.919	10.548	18.812	26.938	33.526	19.652	28.116	19.704
	0.020	0.003	0.005	0.054	0.019	0.061	0.039	0.003	0.023	0.025
A-3	9.237	10.341	9.919	10.510	18.778	26.864	33.484	19.680	28.106	19.684
	-0.052	0.020	0.006	0.016	-0.014	-0.012	-0.003	0.031	0.014	0.005

	①L2-L1	②L1-C	③C-R1	④R1-R2	⑤L2-C	⑥L2-R1	⑦L2-R2	⑧L1-R1	⑨L1-R2	⑩C-R2
Master	9.289	10.321	9.913	10.494	18.793?	26.876	33.487	19.649	28.093	19.679
F-1	9.283	10.339	9.924	10.479	18.838?	26.903	33.542	19.648	28.109	19.711
	-0.006	0.018	0.011	-0.015	0.045?	0.026	0.055	-0.001	0.016	0.032
F-2	9.289	10.343	9.898	10.500	18.838?	26.856	33.508	19.619	28.106	19.715
	0.000	0.022	-0.015	0.006	0.045?	-0.021	0.021	-0.030	0.013	0.036
F-3	9.323	10.335	9.896	10.486	18.844?	26.922	33.574	19.650	28.130	19.680
	0.034	0.014	-0.018	-0.008	0.052?	0.046	0.087	0.001	0.038	0.002

Table III. Average value and dimensional change

	①L2-L1	②L1-C	③C-R1	④R1-R2	⑤L2-C	⑥L2-R1	⑦L2-R2	⑧L1-R1	⑨L1-R2	⑩C-R2
Master	9.289	10.321	9.913	10.494	18.793	26.876	33.487	19.649	28.093	19.679
C	9.280	10.335	9.906	10.515	18.815	26.905	33.507	19.673	28.126	19.702
	-0.010	0.014	-0.007	0.021	0.022	0.028	0.020	0.024	0.033	0.023
A	9.282	10.335	9.912	10.536	18.802	26.912	33.513	19.654	28.101	19.690
	-0.008	0.014	-0.001	0.042	0.009	0.036	0.026	0.006	0.008	0.011
F	9.299	10.339	9.906	10.488	18.840	26.893	33.541	19.639	28.115	19.702
	0.009	0.018	-0.007	-0.006	0.047	0.017	0.054	-0.010	0.022	0.023

Table IV. Average value of the total dimensional change according to impression method

	Impression coping	connection of the each abutment replica	Average value of the total dimensional change
conventional method	connect with each	no	0.017 ± 0.014 mm
New method 1	connect on the tray	no	0.014 ± 0.016 mm
New method 2	connect on the tray	yes	0.017 ± 0.022 mm

The amount of dimensional change in the conventional impression technique showed 0.026mm shrinkage in cast 2 to 0.061mm expansion in the cast 3 when compared with the simulator, but there was no statistical difference for any of the measuring areas (p>0.05).

When making a study cast from the impression body obtained from the impression taking method according to the thermoforming PMMA tray, in the measurement result of method 1 with no connection to the lab analog the dimensional change amount was in the rage of 0.052mm shrinkage in cast 3 and 0.061mm expansion in cast 2 and although whole areas in cast 2 showed the expansion, there was no statistical difference (p>0.05).

In the new impression taking technique, the measurement result of method 2 which made the study cast with connection of the lab analogs, the amount of dimensional change for simulator showed from 0.030mm shrinkage in cast 2 to 0.087mm expansion in cast 3 but there was no significant difference statistically (p>0.05).

Each average value for conventional impression method, method 1 and method 2 was shown (Table III). The amount of dimensional changes in the conventional impression technique for simulator was in the range of 0.01mm shrinkage to 0.033mm expansion and 0.008mm shrinkage to 0.042mm expansion in method 1 and 0.01mm shrinkage to 0.054mm expansion range in method 2 were shown.

Also, in each impression technique when the whole measured area was averaged, 0.0170±0.014mm of expansion in the conventional impression technique, 0.0140±0.016m in method 1 and 0.0170±0.022mm in method 2 were shown (Table IV).

DISCUSSION

Contrary to the natural tooth which shows a physiological mobility[9] of less than 30㎛ vertically and approximately 100㎛ horizontally, in case of implant obtained the osseointegration successfully since it has a minute mobility in the freeplay allowable range of 4㎛ vertically and 10-60㎛ horizontally with bone elasticity and between implant components.[10] The structure of screw-retained prosthesis that compensates for the poor fitness between implant superstructure and implant fixture is tiny and is more likely susceptible to dimensional change after casting in contrast with cement-retained one to be compensated by cement space.[11] Since it has been observed that a superstructure with poor fitness could be the cause of mechanical failure of prosthesis and implant system or biological complications,[12] higher precision is required for implant prosthesis. For accurate prosthesis making, the implant position inside the mouth must replicate accurately to the working cast. Also accurate impression taking through adequate operation as well as material selection according to circumstances should be on the premise when taking the impression.

Even though it is polyether or polyvinyl siloxane rubber impression material which its dimensional stability is recognized as excellent among impression materials being used currently, it is inevitable of the impression body change as time passed.[13] Donovan and Chee[14] reported that more accurate replication was possible if using the individual tray reduced the amount of impression material. However, for patients with difficulty of mouth opening or mouth breathing there are some cases in which it is hard to insert the individual tray inside the mouth and difficult to maintain the tray in accurate position to secure the uniform space for impression material. Tongue movement by the patient can move the tray before the impression material is cured and thus this causing the change in the final impression.

The impression technique using the thermoforming PMMA tray made by heating and pressuring the thermoforming acrylic resin on the working cast has many advantages: tray making is easy, impression material space can be maintained regularly, and it will not be displaced from its accurate position until impression material is cured because tray is directly fixed on the impression coping. In addition, the reduction of tray size can decrease the discomfort for patients with mouth opening difficulty, mouth breathing or gagging reflex.

For the pressure thermoformed acrylic resin plate different materials are recommended depending on the use[15]: for snoring device thermoformed polyurethane (TPU) or copolyester which is few in change and excellent in abrasive wear resistance and elasticity, for orthodontic device polymethyl methacrylate (PMMA) or laminate copolymer (PVC), and for occlusal treatment or implant operational splint copolyester (PET-G) are provided. On the other hand, polystyrene resin is recommended for individual tray making since it is not eroded in chemicals, it is easy to process and has high intensity after molding. Polymethyl methacrylate used in this study is frequently used for pressure thermoforming resin because of high clarity, excellent hardness, luster and good formability.

However, when using acrylic resin for polymerization change and dimensional instability occur due to the inner stress produced upon deflasking and inadequate of denture is caused by accompanying the cooling shrinkage. It has been observed that this inner stress can be occurred identically in the thermoforming resin plate and this can affect on the accuracy after processing.[16] In this study by comparing the dimensional change of study cast replicated by different impression technique, the accuracy of impression taking method for thermoforming resin tray was examined. The dimensional change in the study cast made by conventional impression technique for simulator was in the range of 0.01mm shrinkage to 0.033mm expansion. And after taking an impression, in the method 1 which the study cast was made without connecting lab analogs with each other same as in the conventional impression technique, it showed in the range of 0.008mm shrinkage to 0.042mm expansion. So there was no difference in the dimensional change according to impression techniques. Also, to find the working cast making method which could minimize the stress, the study cast method 1 (A1-A3) made without fixing between analogs after connecting lab analog to impression coping was compared with study cast method 2 (F1-F3) made after fixing the lab analogs to each other. And the effect on the dimensional change depending on the stress inside resin plate produced after heat and pressure molding was observed. However, since the change of average distance between each measured value by comparing with the master cast showed 0.008mm shrinkage and 0.042 expansion in method 1 cast group and 0.010 shrinkage and 0.054 expansion in method 2 cast group, and the average change of total measured area didn't show the significant difference as 0.0140 ± 0.016mm in method 1 and 0.0170 ± 0.022mm in method 2, it is thought that factors like inner stress after heating and pressure molding in polymethyl methacrylate thermoforming resin tray didn't impact largely on the impression accuracy and additional attempts are unnecessary for accurate working cast construction.

Carr[17] whose study compared the accuracy according to implant impression techniques used

3-D measuring microscope to compare the accuracy of direct method that replicated by burying the quadrangle coping inside the impression body with the accuracy of indirect method using tapered coping. The principle of this measurement method was to measure the space position when the minute spring that was attached at the tip of sphere was curving and its accuracy was 0.001 ± 0.003mm. However, the repeatability of data was difficult to obtain because it was hard to contact to the measured point every time. On the contrary, Phillips et al[18] compared three types of impression taking technique fixing tapered and quadrangle coping with acrylic resin by using contact 3-D coordinate measuring equipment and they reported that the dimensional change in impression technique using quadrangle coping was less than the one using tapered coping and the error of contact measuring equipment was accurate as less than 1㎛.

Contact 3-D coordinate measuring equipment which coordinates the position of specific point into the digital values according to the standard point by movable touch probe is composed of measuring probe and frame which supports this and computer and software. This method is to measure the distance between central points by determining the coordinates of each analog after creating the central point coordinate of standard analog automatically when contacting the three random parts outside of column in the lab analog which is the basis with probe. Measuring principle is that one axis of XY plane is formed with the outer arm which can move freely on the granite table and the inner arm which moves by attaching to this outer arm, and an axis of Z plane is formed by locating the sleeve which moves vertically attached with measuring probe. Probe is appropriate for contacting with plane, cylinder and sphere because in its end of metal shaft, the hard sphere is attached. Once a probe is contacted to the specimen, X, Y and Z coordinate of stylus displacement is automatically sent to the computer. The method by this measuring equipment has disadvantages in the extended time need for measurement. It is possible to measure only for rigid materials and it limits the size of measuring objects. Since it is possible to measure the distance between central points of individual into digital values by measuring the central points of column without comparing the measuring points which are randomly decided the error between testers can be minimized.

Even though we tried to locate study abutments and lab analogs on the same level in order to minimize the effect from the vertical factor, in this study the limitation is in that the three dimensional change of impression body and working cast couldn' t be reflected perfectly since the distance between abutments on the same plane by fixing the arm which moves Z axis to prevent the distortion of imaginary abutment column according to the displacement of vertical plane was compared. This suggested that more accurate data can be obtained in future if a study method which can measure the three dimensional displacement while objectifying into digital values can be designed.

CONCLUSION

In this study the accuracy of impression techniques was assessed after measuring abutment central point coordinate of conventional impression technique with open tray and new impression technique with thermoforming PMMA tray using 3-D coordinate measuring equipment. As a result of measuring the distance between abutment centers the following conclusions were established.

1. The working casts made by the conventional impression technique and new improved

impression technique all showed similar values for measured distances between abutment center points in simulator and between lab analog center points in the study cast.

2. For both the conventional impression technique and new improved impression technique, the total dimensional change between analog distance of study cast was maximum of 0.05mm and there was no specific trend according to the impression technique difference.
3. There were no dimensional changes observed between the study cast made by fixing the lab analog with each other and the study cast made without fixing the analog for the new improved impression technique. Additional attempts may be unnecessary for accurate working cast making.

According to above results, the new improved impression technique using thermoforming PMMA tray can decrease the discomfort of patients during taking the impression and is able to make a highly accurate working cast.

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Reprint request to:

SOK-MIN KO, D.D.S., M.S.D., PH.D.
DEPARTMENT OF DENTISTRY, MEDICAL SCHOOL,
AJOU UNIVERSITY
SAN 5 WONCHON-DONG YOUNGTONG-GU
SUWON-SI GYEOUNGGIDO, 443-721, KOREA
Shugoi@ajou.ac.kr