Evaluation of Clinical Accuracy of Implant Abutment Level Impression Technique

Using Digital Superimposition of Customized Abutment

Jin-Wan Kim, DDS, MSD¹/Won-Tak Cho, BSPH²/ Eun-Bin Bae, MSD, PhD³/Jung-Bo Huh, DDS, PhD⁴

¹Doctoral student, Department of Prosthodontics, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

²Graduate student. Department of Prosthodontics, Dental Research Institute, Dental and Life Sciences Institute, BK21 PLUS Project, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

³Doctoral researcher. Department of Prosthodontics, Dental Research Institute, Dental and Life Sciences Institute, BK21 PLUS Project, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

⁴Associate Professor. Department of Prosthodontics, Dental Research Institute, Dental and Life Sciences Institute, BK21 PLUS Project, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

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Correspondence to: Prof Jung-Bo Huh, Department of Prosthodontics, School of Dentistry, Pusan National University, 20, Geumo-ro, Mugeum-eup, Yangsan 50612, Republic of Korea. Fax: +82-55-360-5134.
Email: huhjb@pusan.ac.kr

Abstract

Taking a conventional implant abutment-level impression with the gingival retraction technique can cause side effects such as gingival recession and bleeding. In order to overcome these problems, an impression technique using digital superimposition of the customized abutment is newly introduced. In this technique, digital impression data and pre-scanned abutment data are
superimposed to reproduce the abutment’s location and shape on computer-aided design software. The present investigation was conducted to evaluate the clinical accuracy of the newly adapted digital superimposition impression technique by assessing the fit of fabricated prostheses. The results showed clinical efficacy of this technique, satisfying both convenience and clinically acceptable marginal and internal fit. Int J Prosthodont 2021. doi: 10.11607/ijp.6959

Introduction

When making abutment level impressions, the gingival retraction technique has been performed to achieve an accurate impression of the abutments with subgingival margins. However, the gingival retraction technique may cause not only pain, longer chair time, and gingival recession, but also an inaccurate impression due to gingival crevicular fluid and blood. In order to overcome these problems, before placing the abutment to the implant, the abutment is scanned to produce pre-scanned data in CAD software. Then, after connecting the abutment to the implant, a digital impression is made without gingival retraction. The two data are superimposed on the computer-aided design (CAD) software, then the supra-structure is fabricated. The purpose of the present investigation was to evaluate the clinical accuracy of the digital superimposition technique by comparing it to digital impression with the gingival retraction technique through the assessment of the definitive prostheses.

Material and Methods

The present investigation was approved by the Institutional Review Board of the Pusan National University Dental Hospital (IRB No. PNUDH-2019-036). A total of 42 healthy patients in need of an implant-supported fixed dental prosthesis were recruited (n=21 for each group). After digital impression using digital impression coping and intraoral scanner (Trios, 3shape, Copenhagen, Denmark), a CAD software (Exocad GmbH, Darmstadt, Germany) was used to design the customized abutment. A flat surface was formed on the abutment to enable an accurate overlap (Fig 1a). This flat
surface was placed on the occlusal third of the buccal or lingual surface of the abutment, for the ease of scanning. The customized abutment was milled using the 4-axis milling machine (ARUM 4X-100, DOOWON ID, Daejeon, Korea), and then scanned to produce pre-scanned data (Fig 1b,c). When making implant abutment level impressions, Group R (n=21) used the conventional method, in which the digital impression was made after gingival retraction. In Group S (n=21), the digital impression was made without retracting the gingiva, followed by the superimposition of the flat surface on the saved pre-scanned data to digitize the shape and location of the abutment. After this, monolithic zirconia supra-structure was fabricated using the 5-axis milling machine (Trione M, Dio implant, Busan, Korea) (Fig 2).

The fit of the prosthesis was evaluated using the replica technique via Fit Checker Advanced Blue (GC Cor., Tokyo, Japan). A framework was fabricated for fixation and dissection of the replicated specimen to minimize its deformation (Fig 3a). The center of the replicated specimen was dissected buccolingually and mesiodistally (Fig 3b). Twenty reference points were set, five on each buccal, lingual, mesial, and distal sides as they were referenced by the previous study (Fig 3c). The marginal and internal gaps were measured using an image analyzing program (i-solution, IMT isolution, Vancouver, BC, Canada), with the aid of measuring microscope at 100x magnification.

An independent t-test was performed for each aspect and the significance was tested. SPSS software ver. 21.0 (SPSS Inc., Chicago, USA) was used for the statistical analysis and all measured values were evaluated with the 5% of the level of significance.

Results

As shown in table 1, according to the marginal dissection analysis, the value of absolute marginal discrepancy and marginal gap for Group S were significantly lower than in Group R (P = 0.000). According to the internal dissection analysis, the value of marginal internal gap for group S was significantly lower than Group R (P = 0.003). The difference of the axial internal gap and the line angle
internal gap between the two groups were statistically insignificant (P > .05) (Table 1).

Discussion

Digital superimposition technique showed clinically acceptable marginal and internal fit. So, this technique is useful in making accurate impression of the abutments with sub-gingival margins. This enables the gingival retraction technique, which causes pain, bleeding, and gingival recession, to be bypassed.

This technique not only enables acquiring images of the subgingival margins without the gingival retraction technique, but also helps reproducing images that are difficult to scan using intraoral scanners, such as interproximal spaces. However, the limitations of this method are that extra errors may occur during the scanning process for generating the pre-scanned abutment data, and the superimposition process. Another disadvantage is that this requires a supplementary scanning process for generating the pre-scanned data. When fabricating definitive prosthesis with abutment simultaneously, this method is limited.

In the present investigation, a flat surface was formed on the abutment as a standard for superimposition. In the future studies, alteration of the superimposing area and shape must be considered for a more efficient superimposition. Also, further studies regarding the effects of the flat surface on the abutment on the mechanical strength and the retention of the prosthesis are necessary.

Conclusions

Implant prostheses fabricated with digital superimposition technique showed better fit at the prosthesis-abutment interface than those fabricated with digital impression using the gingival retraction technique. Both groups had clinically acceptable marginal and internal fit. By using this technique, impression can be made more accurately, easily, and conveniently on abutment level impression.
References


Tables

Table 1. Means and SDs of gap width at each reference point (μm).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>AMD Mean</th>
<th>AMD SD</th>
<th>MG Mean</th>
<th>MG SD</th>
<th>MIG Mean</th>
<th>MIG SD</th>
<th>AIG Mean</th>
<th>AIG SD</th>
<th>LIG Mean</th>
<th>LIG SD</th>
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<td>39.6</td>
<td>15.8</td>
<td>27.9</td>
<td>15.7</td>
<td>22.9</td>
<td>12.2</td>
<td>11.1</td>
<td>4.8</td>
<td>26.3</td>
<td>11.4</td>
</tr>
<tr>
<td>S</td>
<td>21</td>
<td>29.9</td>
<td>13.5</td>
<td>18.2</td>
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</tr>
</tbody>
</table>

*p < .05, **p < .01, ***p < .001

AMD = absolute marginal discrepancy; MG = marginal gap; MIG = marginal internal gap; AIG = axial internal gap; LIG = line angle internal gap.
Figures

Fig. 1. (A) Customized abutment with subgingival margin showing a flat surface on top of the buccal surface was designed using CAD software. (B) Customized abutment was scanned using die scanning jig of model scanner (E3 scanner, 3shape, Copenhagen, Denmark). (C) Pre-scanned abutment data was generated with the scanned data in CAD software.

Fig. 2. Matching the intraoral scan data to the pre-scanned abutment data in CAD. (A) Intraoral scan data with unclear abutment margin. (B) Superimposition of the pre-scanned data and the intraoral scan data. (C) Reproduced data showing a clear abutment margin. (D) Designing definitive prosthesis on the superimposed data.
Fig. 3. (A) The framework for uniform cutting of silicone replicas was designed through Meshmixer (Autodesk, San Rafael, CA, USA). 0.7mm space was allocated in the middle of the framework to dissect the specimen uniformly. (B) Cross-section of Replica Specimen. (C) Reference points for measuring thicknesses of silicone replicas. AMD = absolute marginal discrepancy; MG = marginal gap; MIG = marginal internal gap; AIG = axial internal gap; LIG = line angle internal gap.