Various factors may be used as a basis for the quantitative evaluation of oral function following restoration of a missing tooth, such as the occlusal force, occlusal contact area, masticatory efficiency, electromyographic pattern of the masticatory muscle, and mandibular movement. Goshima et al reported an increase in the occlusal force, occlusal contact area, and masticatory efficiency 1 month after single implant restoration. Nam et al reported an increase in the occlusal force and occlusal contact area 1 month after single implant restoration in the second molar region.

Occlusal force is affected by dental status. The occlusal force increases as the number of teeth increases, and the position of teeth is also associated with the occlusal force. Gibbs et al found that the occlusal force was lower in individuals with one or more missing teeth than in those with full dentition. The greatest occlusal force is found in the molar area, and the first molar has the greatest occlusal force.

The occlusal force and occlusal contact area are closely related. Bakke et al reported that the occlusal contact area has a greater effect on the occlusal force than the number of teeth, and therefore, the loss of molars can be the most significant factor for the decrease in the occlusal force. Moreover, lower occlusal force in patients with malocclusion is due to a small occlusal contact area, and the occlusal contact area and occlusal force are associated with each other.

The occlusal force can be affected by the method of evaluation, including the device and measuring technique. Various devices for measuring the occlusal force have been developed, including a strain gauge that uses electrical resistance, deformation-sensitive piezoelectric film, and pressure-sensitive film. Devices with a strain gauge can quantify the occlusal force by converting deformation of the device from occlusion into changes in voltage and electrical resistance. However, such devices have limitations in that the metal sensors used pose a risk of tooth or restoration fractures. Additionally, measurements cannot be made with the

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### Initial Change in the Occlusal Force and Occlusal Contact Area Following Single Molar Implant Restoration

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**Purpose:** The occlusal force and occlusal contact area may be used to evaluate oral function following restoration of a missing tooth. This study aimed to monitor the initial changes in these factors after single molar implant restoration.

**Materials and Methods:** Patients who underwent single implant restoration between December 2018 and September 2019 were recruited for this study. Occlusal force was measured before, immediately after, and 1 month after prosthesis placement. The occlusal contact area was evaluated immediately and 1 month after the placement. Data were grouped by sex, restored tooth, and restored side for analysis. **Results:** In most groups, occlusal force was significantly increased 1 month after the placement compared with that before placement ($P < .05$), and the change was more significant in the first molar group than in the second molar group. There was a significant difference in the occlusal contact area of the implant prosthesis immediately and 1 month after placement when a thickness of 9 µm was used. The occlusal contact area of the natural tooth in the mesial side was significantly increased 1 month after placement ($P < .05$). **Conclusion:** Occlusal force was significantly increased 1 month after implant restoration, and restoration of the first molar had the most significant effect on the occlusal force. Occlusal contact areas may differ according to the occlusal indicator used in the clinical setting because the changes were significant with only 0 to 9 µm.

**Keywords:** implant restoration, masticatory efficiency, occlusal contact area, occlusal force, oral function

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mouth fully closed due to the thickness of the sensor. T-scans use a piezoelectric film (Tekscan) and calculation of the occlusal force by measuring the electrical resistance of the force applied between conductive inks. Although it can detect the magnitude, distribution, and timing of occlusal contact and occlusal force, the film can be moved or bent due to its flexibility, and there is a controversy regarding its accuracy.\(^{12,13}\) The Dental Prescale system consists of pressure-sensitive films and a scanner (GC Dental Products). In the color-forming layer of the approximately 150-µm-thick film, microcapsules of various sizes are uniformly distributed. When pressure is applied, the microcapsules break and react with the developer, forming a red color. The formed color is used to calculate the occlusal contact area, occlusal pressure, and occlusal force.

Occlusal contact area measurements can be affected by the measuring method and device. Measurements can be made using articulating paper, diagnostic cast analysis, T-scans, silicone interocclusal recording material, and pressure-sensitive film.\(^{14}\) Analysis of the occlusal contact area using articulating paper has low reliability and can be influenced by the physical property and thickness of the material used.\(^{15}\) With respect to pressure-sensitive films, pressures of < 5 MPa cannot be measured, which somewhat limits their use in measuring the occlusal contact area. Imamura et al\(^{16}\) reported that the occlusal contact area measured using a pressure-sensitive film was smaller than that measured using a silicone interocclusal recording material. Because the silicone interocclusal recording material has high fluidity and low thickness at the occlusal contact point, it is effective for measuring the occlusal contact area.\(^{17}\) BiteEye (GC Dental Products), an occlusal contact area analysis device, uses photo occlusion analysis to measure the occlusal contact area.\(^{18}\) Polyvinyl siloxane silicone (Fit Checker Advanced Blue, GC Dental Products) or wax (BiteEye Wax, GC Dental Products) may be used, and a more detailed analysis is possible with silicone.

Changes in dental status with the implant restoration can affect oral function. The functional changes should be observed during the initial phase of restoration.\(^{1,2,19}\) This study aimed to monitor the initial changes in oral function by evaluating the occlusal force and occlusal contact area.

**MATERIALS AND METHODS**

**Subjects**

Patients who underwent single implant restoration between December 2018 and September 2019 were recruited for this study (Fig 1, GWNUDH IRB 2018-15). All patients had undergone a healing period of ≥ 6 months after extraction of the first or second molar and did not require bone grafts. Patients were excluded if they required multiple implant restorations, lacked opposite teeth, or had parafunctions such as bruxism or clenching. All procedures were performed after obtaining informed consent from patients.

An external butt joint–connection implant was placed in the patients. Following a 6-month and 3-month osseointegration period for the maxilla and mandible, respectively, a definitive prosthesis was fabricated. All prostheses had metal occlusion (gold or Co-Cr). An occlusal contact similar to the adjacent tooth was formed, and shimstock was used to confirm the occlusion. Occlusal adjustments were made to minimize the lateral force applied to the implant.

**Occlusal Force Measurement**

The maximum occlusal force was measured with a pressure-sensitive film and scanner. Measurements were recorded three times (before implant prosthesis placement, immediately after implant prosthesis placement, and 1 month after placement) to assess the occlusal force after functional adaptation.

For the reproducibility, patients were instructed to clench the extra film several times before the measurement. Films were selected according to the arch size of the patient (small [S], medium [M], large [L]). After placing the film, patients were instructed to clench the film for 3 seconds with maximum clenching force at upright position. The saliva on the film was then gently removed with a cloth, and the film was dried.

Prior to scanning the films, a calibration sheet was placed on the scanner for software calibration. The film was positioned such that the logo of the film would face down on the positioning template before the film was positioned such that the logo of the film would face down on the positioning template before the film was placed on the scanner for software calibration. The film was positioned such that the logo of the film would face down on the positioning template before the film.
was scanned. The position was adjusted according to the film outline on the software, and the occlusal force (N) was analyzed by removing unnecessary parts and extracting the red-colored areas (Fig 2). Data were grouped by sex (male or female), restored tooth (first molar or second molar), and restored side (left or right) for occlusal force analysis.

Occlusal Contact Area Measurement

After applying silicone to the occlusal surface of the mandibular teeth, patients were instructed to clench at a maximal intercuspal position (MIP) and hold for 60 seconds at an upright position. Although the initial setting time of polyvinyl siloxane silicone is approximately 15 to 20 seconds in the mouth, 60 seconds of holding was done for stable recording. After the silicone was set, it was removed from the mouth. Unnecessary pieces were removed, and adjustments were made such that the occlusal plane was parallel to the floor. The interocclusal record was placed in the occlusal contact area analysis device and aligned with the upper and lower limits and the midline to acquire an image for analysis.

The occlusal contact area was converted to the occlusal contact area ratio for analysis because the anatomy and teeth size of the patients are different. The occlusal contact area ratio was calculated to compare occlusal contact areas before and after functional adaptation. The occlusal contact area ratio was expressed as a percentage of the occlusal contact of one area of the total occlusal contact area (Fig 3):

\[
\text{Occlusal contact area of one area (mm}^2\text{)} \times 100 \\
\text{Total occlusal contact area (mm}^2\text{)}
\]

When measuring the total occlusal contact area, the third molar was excluded. Before prosthesis placement, the occlusal contact area of the prosthesis is 0, so measurements were recorded twice (immediately after prosthesis placement and 1 month after placement).

In the occlusal contact area analysis device, analysis of the occlusal contact area can be analyzed for a total of 14 interocclusal thickness levels from 0 to 4 to 0 to 200 μm. The occlusal contact area ratio of the implant was analyzed using the default thickness level, 0 to 149 μm, as well as the thickness levels for articulating paper (0 to 89 μm), articulating film (0 to 19 μm), and shimstock (0 to 9 μm). As with the occlusal force, data were grouped by sex, restored tooth, and restored side for analysis.

In addition, the occlusal contact area ratios of the tooth adjacent to the implant and the opposite natural tooth were measured. For first molar implants, the occlusal contact area ratios of adjacent teeth, second premolar and second molar, and opposite first molar were measured, whereas for second molar implants, the occlusal contact area ratios of the adjacent tooth, first molar, and opposite second molar were measured. Patients who lacked an adjacent tooth or opposite natural tooth were excluded from this analysis.

Statistical Analysis

Statistical analyses were performed using SPSS (IBM SPSS 25.0, IBM). The differences in occlusal force before prosthesis placement, after prosthesis placement, and 1 month after prosthesis placement were compared using a repeated-measures analysis of variance (ANOVA), followed by the Wilcoxon signed-rank test to determine the differences at each time point.


Table 1  Mean (SD) Value of Maximum Occlusal Force (N)

<table>
<thead>
<tr>
<th></th>
<th>Before placement</th>
<th>After placement</th>
<th>After 1 mo</th>
<th>Before placement vs after placement</th>
<th>After placement vs after 1 mo</th>
<th>Before placement vs 1 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (n = 31)</td>
<td>653.7 (68.8)</td>
<td>723.3 (72.1)</td>
<td>.078</td>
<td>723.3 (72.1)</td>
<td>787.5 (55.5)</td>
<td>.196</td>
</tr>
<tr>
<td>Female (n = 19)</td>
<td>573.1 (71.4)</td>
<td>634.2 (82.9)</td>
<td>.159</td>
<td>634.2 (82.9)</td>
<td>638.3 (83.9)</td>
<td>.546</td>
</tr>
<tr>
<td>First molar (n = 29)</td>
<td>594.6 (62.3)</td>
<td>683.1 (79.6)</td>
<td>.044*</td>
<td>683.1 (79.6)</td>
<td>713.7 (65.7)</td>
<td>.701</td>
</tr>
<tr>
<td>Second molar (n = 23)</td>
<td>656.4 (82.7)</td>
<td>696.9 (74.7)</td>
<td>.260</td>
<td>696.9 (74.7)</td>
<td>751.0 (70.1)</td>
<td>.094</td>
</tr>
<tr>
<td>Left (n = 29)</td>
<td>566.6 (59.5)</td>
<td>610.9 (63.0)</td>
<td>.265</td>
<td>610.9 (63.0)</td>
<td>660.4 (58.9)</td>
<td>.304</td>
</tr>
<tr>
<td>Right (n = 21)</td>
<td>701.0 (86.3)</td>
<td>798.0 (93.0)</td>
<td>.042*</td>
<td>798.0 (93.0)</td>
<td>828.1 (75.3)</td>
<td>.274</td>
</tr>
</tbody>
</table>

*Indicates significant difference by Wilcoxon signed-rank test (P < .05).

Table 2  Mean (SD) Ratio of Occlusal Contact Area (%) at Different Interocclusal Thickness Level

<table>
<thead>
<tr>
<th></th>
<th>Placement 0 to 149 µm</th>
<th>Placement 0 to 89 µm</th>
<th>Placement 0 to 19 µm</th>
<th>Placement 0~9 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (n = 31)</td>
<td>.500</td>
<td>.537</td>
<td>.63 (1.81)</td>
<td>.949 (1.22)</td>
</tr>
<tr>
<td>Female (n = 19)</td>
<td>.983</td>
<td>.206</td>
<td>.95 (2.56)</td>
<td>.084 (1.95)</td>
</tr>
<tr>
<td>First molar (n = 27)</td>
<td>.446</td>
<td>.666</td>
<td>.68 (1.81)</td>
<td>.685 (1.43)</td>
</tr>
<tr>
<td>Second molar (n = 23)</td>
<td>.808</td>
<td>.163</td>
<td>.84 (2.47)</td>
<td>.145 (2.57)</td>
</tr>
<tr>
<td>Left (n = 29)</td>
<td>.500</td>
<td>.581</td>
<td>.83 (1.88)</td>
<td>.162 (1.83)</td>
</tr>
<tr>
<td>Right (n = 21)</td>
<td>.509</td>
<td>.689</td>
<td>.65 (2.44)</td>
<td>.906 (2.49)</td>
</tr>
</tbody>
</table>

*Indicates significant difference by Wilcoxon signed-rank test (P < .05).

To compare the differences in the occlusal contact area ratio immediately after prosthesis placement and 1 month after placement, the Wilcoxon signed-rank test was used. To compare the degree of change between groups, the Mann-Whitney test was used. The significance level was set at 95%.

RESULTS

The subjects comprised 50 patients (31 male/19 female, ages 38 to 78 years). The changes in occlusal force before prosthesis placement, after prosthesis placement, and 1 month after prosthesis placement are summarized in Table 1. The occlusal force before prosthesis placement was significantly different from that after 1 month of placement in men (P = .005). In women, there were no significant differences before, immediately after, and 1 month after prosthesis placement. The occlusal force before and after prosthesis placement (P = .044) and before and 1 month after placement (P = .032) significantly differed in the first molar group, whereas only the occlusal force before and 1 month after placement (P = .023) significantly differed in the second molar group. Regarding the side of restoration, the occlusal force before and after placement (P = .042) and before and 1 month after placement (P = .009) significantly differed in the right-side group, whereas in the left-side group, there were no significant differences in the force before, immediately after, and 1 month after prosthesis placement.

Analysis of the implant occlusal contact area ratio using a thickness of 149 µm indicated no significant difference immediately after prosthesis placement and 1 month after placement for all groups (male, female, first molar, second molar, left side, and right side groups; P > .05, Table 2). Analysis using different interocclusal
thickness levels revealed a significant decrease in the occlusal contact area 1 month after placement in the female and second molar groups when a thickness of 9 µm was used (P = .036 and .024, respectively).

For analysis of the adjacent natural tooth, patients without a natural tooth at the distal side (n = 7) in the first molar restoration group were excluded. The occlusal contact area ratio of the natural tooth at the mesial side was significantly increased in both groups (P = .029 and .023 in the first and second molar restoration groups, respectively), while no significant difference in the occlusal contact area ratio of the natural tooth at the distal side was found (P > .05, Table 3). For analysis of the opposite natural tooth, patients without opposite natural teeth (first molar or second molar) were excluded (n = 1, n = 2, respectively). No significant difference in the occlusal contact area ratio of the opposite natural tooth was found in the first molar (n = 26) or second molar (n = 21) restoration groups (P > .05, Table 4).

**DISCUSSION**

A significant difference in the occlusal force was found after single implant restoration. At 1 month after placement, the changes in the occlusal contact area of the implant prostheses differed according to interocclusal thickness, and the changes were significant with only 0 to 9 µm.

In most groups, a significant increase in occlusal force was found 1 month after prosthesis placement compared with that immediately after prosthesis placement. No significant changes in occlusal force were found in women, whereas the occlusal force was greater after 1 month of placement than before it in men.

Considering the results of previous studies indicating that men have greater occlusal force because they have a larger occlusal surface and greater clenching force\(^2\) and that satisfaction scores regarding implant treatment and acceptance rates were higher in men,\(^2\) it seems that men exhibit a higher adaptability to the implant. In a study by Ferrario et al\(^7\) on single-tooth occlusal forces in healthy adults, the greatest occlusal force was found on the first molar. The finding of the present study of a significant difference between the first and second molar restoration groups regarding occlusal force may be interpreted similarly. In addition, more significant changes were found at the right side than at the left side, and differences in occlusal condition (eg, preferred chewing side) between individuals may have had a greater effect.

The pressure-sensitive film calculates the occlusal force via a pressure sensor, and hence, there is a high probability of false positives. Although there is a function for modifying these points, it is difficult to determine to which points the pressure is actually applied. Kwon et al\(^2\) reported that false-positive occlusal contact may occur during clenching with teeth in maximum intercuspation. The measured force may be higher than the actual occlusal force due to the technical limitation of recognizing the whole unit of analysis even when dots are present in only parts of the unit.

Although the occlusal force increases as the number of teeth increases, it varies widely between individuals. According to Gibbs et al\(^5\), some individuals with moderate loss of tooth support had greater occlusal force than healthy subjects with complete dentition. Therefore, the present study aimed to monitor the changes in occlusal force over 1 month in each individual. In addition, changes in occlusal force depending on the

| Table 3 Mean (SD) Ratio of Occlusal Contact Area of Implant and Adjacent Teeth |
|----------------|-----------------|-----------------|-----------------|
|                | Placement       | After 1 mo      | P value         |
| Mesial         | 6.22 (1.17)     | 7.35 (0.98)     | .029*           |
| Implant        | 10.9 (1.42)     | 11.5 (1.14)     | .968            |
| Distal         | 18.9 (2.25)     | 19.3 (2.30)     | .490            |
| P value        | Placing        | After 1 mo      | Placement       |
| Mesial         | 17.7 (0.98)     | 19.1 (0.90)     | .023*           |
| Implant        | 9.8 (1.50)      | 9.4 (1.11)      | .808            |

*Indicates significant difference by Wilcoxon signed-rank test (P < .05).

| Table 4 Mean (SD) Ratio of Occlusal Contact Area of Implant and Opposite Natural Tooth |
|----------------|-----------------|-----------------|-----------------|
|                | Placement       | After 1 mo      | P value         |
| Implant        | 11.8 (1.61)     | 13.4 (1.46)     | .389            |
| Opposite natural tooth | 18.1 (1.87) | 16.8 (1.51) | .128            |
| Ratio          | 1.35 (0.56)     | 1.25 (0.44)     | .757            |
| P value        | Placing        | After 1 mo      | Placement       |
| Implant        | 7.6 (0.94)      | 7.9 (0.79)      | .823            |
| Opposite natural tooth | 15.8 (1.85) | 13.9 (1.34) | .082            |
| Ratio          | 0.64 (0.12)     | 0.82 (0.21)     | .455            |

*Indicates significant difference by Wilcoxon signed-rank test (P < .05).
clenching strength should be considered. Kumagai et al\textsuperscript{20} reported that both the occlusal force and occlusal contact area increase with increasing clenching strength. During clenching, the arches of the maxilla and mandible are brought closer, thereby increasing the occlusal contact area, which leads to greater occlusal force. In the present study, patients were instructed to clench with maximum clenching force. However, because the measurements were made at different time points, the possibility that the occlusal force may have changed due to differences in clenching strength could not be ruled out. In addition, the total occlusal contact area may change depending on the clenching strength, and therefore, the actual occlusal contact area was converted to the occlusal contact area ratio for analysis.

There was no significant difference in the implant occlusal contact area ratio immediately after placement and 1 month after placement when a thickness of 149 µm was used. Occlusal contact occurs when the interocclusal distance between the occlusal surfaces is very small, but the materials for measuring occlusal contact area have their own thickness of various ranges. Taking this into account, an analysis was performed using the thickness of the articulating paper (0 to 89 µm), articulating film (0 to 19 µm), and shimstock (0 to 9 µm). The analysis using 9-µm thickness indicated a significant decrease in the occlusal contact area ratio immediately after and 1 month after placement in the female and second molar restoration groups. In their study on axial displacement in external and internal implant-abutment connections, Lee et al\textsuperscript{24} reported an axial displacement of approximately 2.6 µm in external implant-abutment connections after cyclic loading of 1,000,000 cycles. Although this is a very small displacement, it can affect the occlusal contact area ratio at the smallest interocclusal thickness. The wear of the prosthesis can also cause a decrease in the occlusal contact area ratio. Ekdeldt et al\textsuperscript{25} reported that the degree of prosthesis wear and occlusal contact area increased, and a shallow depression and grooves were observed 1 month after prosthesis placement. These observations indicate that a very close and narrow occlusal contact area became a more distant and wide occlusal area due to wear. In the present study, all prostheses had metal occlusion (gold or Co-Cr), and because the degree of wear may change depending on the prosthodontics material and opposite tooth,\textsuperscript{26} additional research is needed. Although occlusal contact was formed similar to the adjacent tooth, severe wear may be observed in implant prostheses without periodontal ligament. Significant differences were found in the female and second molar restoration groups due to a small total occlusal contact area.

When the distance between occlusal surfaces changed, the occlusal contact area ratio also changed. This demonstrated that the thickness of the measurement material affects the occlusal contact area, and therefore, use of various occlusal indicators is recommended for occlusal adjustment.

The analysis of the occlusal contact area of adjacent teeth and the opposite natural tooth indicated that the occlusal contact area ratio of the natural tooth in the mesial side significantly increased in both the first and second molar restoration groups; however, no significant difference in the occlusal contact area was found for the natural tooth in the distal side and opposite natural tooth. Based on this finding, it can be inferred that the occlusal contact emerged in the implant prosthesis and adjacent tooth due to the adaptive changes after restoration. In addition, after implant prosthesis placement, physiologic tooth migration due to restoration of the proximal contact may have played a role.

Some studies have reported an increased occlusal contact area following single implant restorations,\textsuperscript{1,2} and these studies compared the occlusal contact area of the full arch rather than the occlusal contact area of the implant prosthesis. This makes it difficult to determine whether the increase was actually due to adaptation after restoration or simply due to the increased contact area from the implant. Moreover, these studies used the pressure-sensitive film, and it can be said that the analysis was conducted on the area to which pressure was applied rather than the actual occlusal contact area.

Yun et al\textsuperscript{27} compared changes in the occlusal contact area after implant restoration using silicone interocclusal recording material and T-scans and found that the thickness of the interocclusal recording material was significantly decreased and the occlusal contact area, as measured by T-scan, was significantly increased after 10 months. This may be because the initial implant occlusion was set as hypo-occlusion; thus, closer occlusion was possible due to physiologic tooth migration.

Many studies have examined the reproducibility of BiteEye. Uchida et al\textsuperscript{28} reported that the occlusal contact area measured with BiteEye was correlated at 0.7 in the anterior teeth and 0.8 in the posterior teeth, and Kubo et al\textsuperscript{29} reported that BiteEye has a high reproducibility in measuring the occlusal contact area, with a correlation coefficient of 0.9 or higher. However, when measuring the occlusal contact area, there were cases in which an accurate impression of the MIP could not be obtained due to the foreign sensation of silicone. In these cases, interocclusal records were obtained several times until it was determined that an accurate impression was obtained. The different occlusion conditions of each patient may have influenced the results as well. Some patients had a unilateral hypo-occlusion prosthesis, and because the occlusion of the implant prosthesis was adjusted to a similar degree to that of the adjacent
teeth, the very high occlusal contact area ratio of the implant may have affected the statistics. The authors of the present study believe that a comprehensive occlusal adjustment was needed prior to implant placement.

Occlusion changes gradually over a long time. Although 1 month may seem to be a short period for examining adaptive changes, most changes occur largely during the initial weeks after implant restoration; therefore, changes were measured 1 month after placement. To assess all changes in the occlusal force immediately after implant prosthesis placement and after adaptation, the occlusion force was measured for a total of three times (before placement, immediately after placement, and 1 month after placement). The occlusal contact area ratio before placement was not measured because the occlusal contact area of the prosthesis is 0. Hence, it was only measured twice, immediately after placement and at 1 month after placement.

As mentioned earlier, both the occlusal force and occlusal contact area can be affected by the clenching strength. Several studies have controlled for clenching strength by measuring the level of activation of the masseter muscle and other masticatory muscles. However, this is also an indirect method, and accurate control of clenching strength is difficult. The present study was not able to measure the activation level of the masticatory muscles. However, to minimize the differences in clenching strength in each measurement, patients were instructed to clench with maximum force. The present authors believe that compared with other methods of adjusting the clenching intensity, clenching with maximum clenching force can be a reference point and may be reproducible.

In the present study, the occlusal force and occlusal contact area before and after single molar implant restoration were compared to determine the effects of implant restoration on occlusal function. However, this study has some limitations. The measurement devices themselves have limitations, including false positives and lack of reproducibility. Occlusal force and occlusal contact area can be affected by clenching strength, but accurate control of clenching strength is difficult. Despite these limitations, this study is significant in that it demonstrated via quantitative analysis that implant restoration has a significant effect on occlusal function.

CONCLUSIONS

Occlusal forces and occlusal contact areas were compared in patients who underwent single implant restoration, and the following conclusions were drawn.

The occlusal force was increased 1 month after implant prosthesis placement compared with that before prosthetic placement (P < .05). Restoration of the first molar was found to have the most significant effect on the occlusal force.

At 1 month after placement, the changes in the occlusal contact area of the implant prostheses differed according to interocclusal thickness, and the changes were significant with only 0 to 9 µm. Occlusal contact areas may differ according to the occlusal indicator used in the clinical setting.

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REFERENCES

20. Shinogaya T, Bakke M, Thomsen CE, Vilmann A, Sodeyama A, Matsu-
moto M. Effects of ethnicity, gender and age on clenching force and
ress and trends in patients’ mindset on dental implants. II: Implant
acceptance, patient-perceived costs and patient satisfaction. Clin
22. Kwon HK, Yoo JH, Kwon YS, Kim BI. Comparison of bite force with
Dental Prescale and unilateral bite force recorder in healthy subjects.
Occlusal force distribution on the dental arch during various levels of
2014;25:e83–e89.
25. Ekfeldt A, Fransson B, Söderlund B, Oilo G. Wear resistance of
some prosthodontic materials in vivo. Acta Odontol Scand
26. Kim JH, Yang SW, Oh NS. Clinical study on the comparison of gold
and zirconia wear in an implant-supported fixed prosthesis. J Dent
27. Yun CH, Kim DG, Yi YJ, Cho LR, Park CJ. Clinical evaluation of occlusal
contact changes in implant prosthesis. J Dent Rehabil Appl Sci
Reliability of occlusal contact examinations by using Blue Silicone. J
contact area measurements using a BiteEye tooth contact analyzing