
Occlusal Contacts of Edentulous Patients with Mandibular Hybrid Dentures Opposing Maxillary Complete Dentures

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The purpose of this study was to evaluate differences between the occlusal contacts of edentulous patients with mandibular implant-supported hybrid dentures opposing maxillary complete dentures and those of patients with conventional maxillary and mandibular complete dentures. Six parameters related to occlusion were measured in the 2 groups (n = 40 for each group) using pressure-sensitive film. The mean values generated by each test group for each parameter were compared using a *t* test. Pearson's correlation coefficients between occlusal force, age, and time in function were examined. Occlusal force and area in the implant denture wearers were larger than those in the conventional denture wearers. No significant difference was seen in occlusal force balance between the left and right sides. The center of occlusal load in the implant denture wearers was more anterior. The maxillary denture may become more unstable in implant denture wearers. It is suggested that the stability and retention of a maxillary denture be checked and the occlusion be adjusted more frequently in the hybrid denture wearer than in the conventional denture wearer.
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Key words: center of occlusal loads, hybrid denture, occlusal force, pressure-sensitive film, stability

Mandibular implant-supported hybrid prostheses have been used for edentulous patients who could not adapt to long-term use of conventional complete dentures.¹⁻⁴ A hybrid denture is one that is fabricated over a metal framework and retained by screws threaded into the implant abut-

ments⁵ (Fig 1). The anterior part of a mandibular hybrid denture is fixed on implants, while the posterior part of the denture is extended and cantilevered from implants.⁶ Unfavorable occlusal loading on the extension has been reported to cause loosening and breakage of screws and prosthetic posts, framework fracture, and implant loss.^{3,7,8} Loading is determined primarily by the length of the lever arms and distal extensions.⁹ It has been suggested that the extension from the midpoint of the most distal implant must not exceed 15 mm in the mandible.⁷ Others believe that the distal extension must not go beyond the first molars.^{5,7} Therefore, the hybrid denture often has fewer posterior teeth than a conventional complete denture, and the distribution of occlusal loads in the hybrid denture may be different from those in the conventional denture.

Finger and Guerra¹⁰ proposed that when implants are placed in one arch there is the possibility of rendering an opposing complete denture unstable. Zarb and Schmitt³ suggested that the imbalance in stress resolution may lead to rapid resorption of the alveolar ridge in the maxillary

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Fig 1 A hybrid denture is fabricated over a metal framework and retained by screws threaded into the implant abutments.



Fig 2 (Right) Analyzing computer (Occluzer) and pressure-sensitive film (Dental Prescale).

Group	Men	Women	Total (n)	Mean age (y)
Implant group	16	24	40	66.2
Steri-Oss	9	8	17	64.3
Calcitek	2	8	10	66.4
3i	5	8	13	68.5
Conventional group	8	32	40	67.8

arch. But there is little quantitative analysis on the distribution of occlusal loads and the stability of a maxillary denture opposed by a hybrid denture.¹¹

The purpose of this study was to evaluate differences between the occlusal contacts of edentulous patients with mandibular hybrid dentures and patients with conventional complete dentures. Particular attention was paid to the center of the occlusal loads and the resultant anteroposterior effect on the stability of the maxillary denture.

Materials and Methods

Eighty edentulous volunteers, divided into 2 groups, participated in this study. All were selected at random from patients who were recalled for the purpose of treatment maintenance at the implant clinic of the Ohio State University College of Dentistry, the geriatric clinic of Tokyo Medical and Dental University Faculty of Dentistry, and the prosthodontic clinic of Hiroshima University School of Dentistry. All subjects had a class I jaw relationship and no flabby soft tissue. The implant

group consisted of 40 patients with mandibular hybrid implant-supported fixed dentures opposed by maxillary complete dentures (Table 1). Their mean age was 66.2 years (range 44 to 79). The implant group had a total of 201 implants, which were either Steri-Oss (Steri-Oss, Yorba Linda, CA; n = 17), Calcitek (Sulzer Calcitek, Carlsbad, CA; n = 10), or 3i (3i/Implant Innovations, West Palm Beach, FL; n = 13). The implants had functioned for an average of 2.5 years (range 0.4 to 5.4). The second group, the conventional group, wore conventional maxillary and mandibular complete dentures. Their mean age was 67.8 years (range 47 to 77). Their complete dentures had functioned for an average of 1.9 years (range 0.2 to 8.0). All dentures were designed for bilateral balanced occlusion using hard resin teeth.

Occlusal contacts for the 2 groups were analyzed using the Dental Prescale System¹² (Fuji Photo Film, Tokyo, Japan), which consists of very thin pressure-sensitive film (Dental Prescale, Fuji Photo Film) and an analyzing computer (Occluzer, Fuji Photo Film) (Fig 2). The Dental

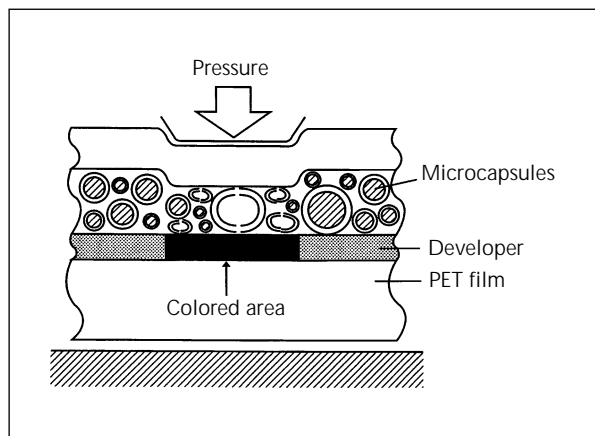


Fig 3 Schematic illustration of Dental Prescale. PET = polyethylene terephthalate.

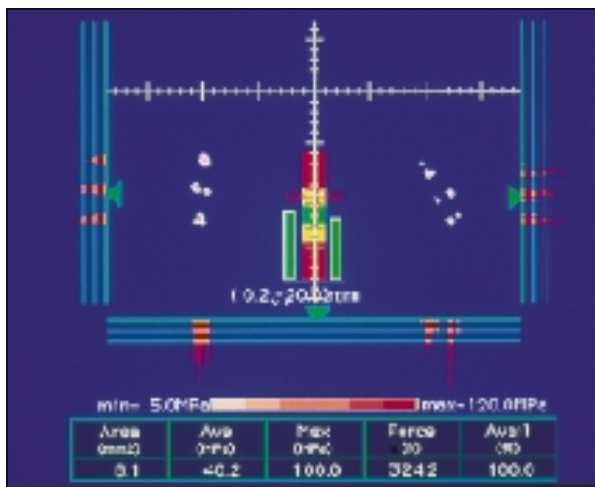


Fig 4 Typical display of a recorded occlusal contact data. Red "+" = center of occlusal loads; area = occlusal area; ave = mean pressure; max = maximum occlusal pressure; force = occlusal force; avail = percentage of areas within a limit of pressure measurement (5 to 120 MPa).

Prescale film contains several sizes of microcapsules and a layer of developer. When pressure is applied to the film, the microcapsules, which contain a small amount of translucent color-former, collapse. The leaked color-former reacts chemically with the developer and then turns red (Fig 3). The density of red formation becomes higher or lower according to the pressure applied to the film. Both the density and area of all the red points were measured and calculated with the Occluzer, which contained a color image scanner. From this analysis, the amount of each occlusal force and area was determined.

Each subject was instructed to occlude with maximum force in the intercuspal position on each of 3 Dental Prescale films (50H R-type). The film that showed the highest occlusal force was analyzed. In addition, to accurately measure the length of the denture, a millimeter scale was placed next to the maxillary complete denture, parallel to the occlusal plane. Pictures were then taken of the scale and the denture. The median line was defined as the line produced from the contact point of both maxillary central incisors to the midpoint between both hamular notches. The distance from the incisal edge of the maxillary central incisor to the midpoint between both hamular notches (the anteroposterior length of the denture) was measured.

The Dental Prescale film measurements gave occlusal force, occlusal area, the number of occlusal contact points, the mean pressure, and the anteroposterior deviation of the center of occlusal loads from the incisal edge of the maxillary central incisor (Fig 4). Then, considering individual variability in length of each denture, the ratio of the deviation of the center of occlusal loads from the maxillary central incisor to the anteroposterior length of the denture (the center deviation ratio) was determined. The Asymmetry Index, which is the occlusal force difference between the right and left sides divided by the total occlusal force multiplied by 100, was then calculated.

The mean values generated by each test group for each parameter were compared using a *t* test. Pearson's correlation coefficients between occlusal force, age, and time in function were examined. Occlusal forces for 2 factors (gender and implant brand) were analyzed using analysis of variance. Values of $P < .05$ were considered statistically significant.

Results

Occlusal force and occlusal area in the implant group were significantly larger than those in the conventional group (Table 2, Fig 5). The mean pressure in the implant group was significantly smaller than that in the conventional group. The center deviation ratio in the implant group was significantly smaller than that in the conventional group (Fig 6). No significant differences were seen in the number of occlusal contact points, the anteroposterior length of the denture, or the Asymmetry Index. A slight correlation between occlusal force and function time was shown in the implant group ($r = .3$, $P < .05$), but this was not the case in the conventional group. No significant difference was seen between occlusal force and the different brands of implants (Table 3).

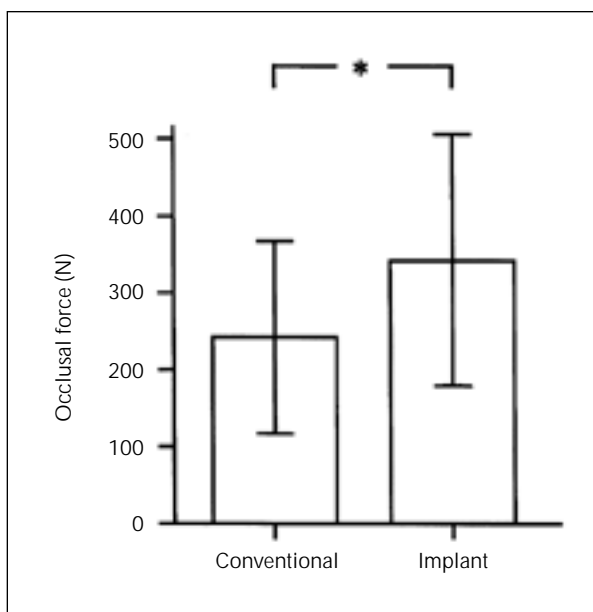


Fig 5 Occlusal force. * $P < .05$.

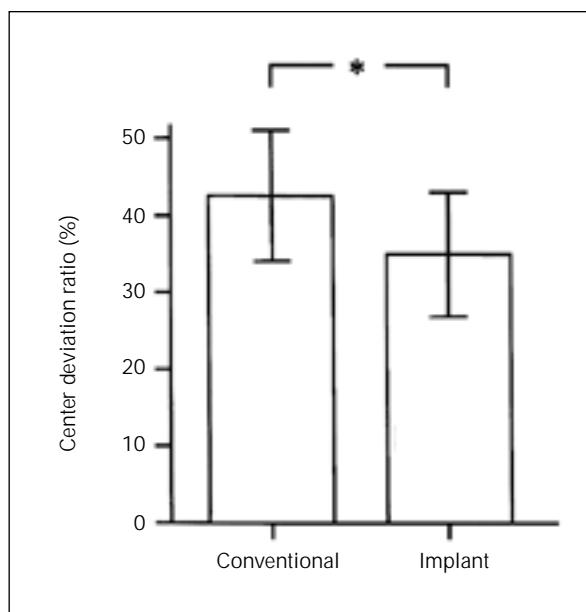


Fig 6 Center deviation ratio. * $P < .05$.

Table 2 Mean and Standard Deviation of Each Occlusal Parameter

	Conventional group	Implant group
Occlusal force (N)	242.0 ± 125.3	342.1 ± 163.6*
Occlusal area (mm ²)	5.9 ± 3.7	10.3 ± 5.2*
Occlusal contact points (n)	14.8 ± 7.6	17.8 ± 9.3
Mean pressure (MPa)	45.3 ± 11.6	33.8 ± 4.1*
Anteroposterior length (mm)	57.3 ± 4.7	60.8 ± 5.9
Center deviation ratio (%)	42.5 ± 8.5	34.9 ± 8.1*
Asymmetry Index (%)	15.7 ± 17.4	17.7 ± 16.8

*Statistically different ($P < .05$).

Table 3 Summary Statistics for the Analysis of Variance of Occlusal Force

	Degrees of freedom	Sum of squares	Mean square	F value	P value
Gender (A)	1	50704.15	50704.15	1.755	0.194
Implant brand (B)	2	30396.67	15198.34	0.526	0.596
A × B	2	17612.34	8806.17	0.305	0.739
Error	34	982441.11	28895.33		

Discussion

The rehabilitation of edentulous patients with hybrid dentures has been observed to achieve greater masticatory function and psychologic satisfaction than with conventional dentures.^{4,13-15} Occlusal forces have been increased considerably following the placement of an implant-supported prosthesis.^{4,14,15} In the present study, the occlusal contacts were more evenly distributed in the implant group than in the conventional group. The occlusal force and occlusal area in the implant group were also larger than those in the conventional group. Therefore, the implant group should have had better occlusal function. Many investigators have studied occlusal force measurements in patients with implant-supported prostheses opposing complete maxillary dentures, but their force measurements vary significantly.^{4,11,14-17}

Occlusal force is influenced by many factors, such as the kind of prosthesis, function time, vertical dimension, gender, age, physiologic and psychologic conditions, and the type of measuring device.^{15,18} Variability may be related to the device and method of measurement.¹⁷ Most previous methods have used strain gauge transducers, which give somewhat limited information about the regions of occlusal force.^{4,11,14-16} These methods required specialized measurement equipment and/or an increase in the vertical dimension. In contrast, the Dental Prescale System makes it possible to measure the force of each occlusal contact point and the location of the center of occlusal loads very close to the maximum intercuspal position. It is not necessary to prepare specialized equipment, and the increase in vertical dimension is negligible.¹² The average occlusal force in this study was similar to the occlusal force that Falk et al¹⁷ measured at a large number of measurement points.

Lindquist and Carlsson¹⁴ reported that average occlusal force increased 39% from 2 months postinsertion to 3 years postinsertion. Moreover, Carlsson and Lindquist⁴ continued to examine the same patients for 7 more years and found that occlusal force continued to increase. Although the subjects in the present study were not followed long-term, a slight statistical correlation between occlusal force and time in function was found in the implant group, but not in the conventional group.

Although the width of the maxillary denture foundation area and the occlusal force balance between the left and right sides were the same in both groups, the center of occlusal load in the

implant group was more anterior than that in the conventional group. It is certainly not advantageous for the stability of a maxillary denture to have the occlusal load primarily in the anterior region. Moreover, the occlusal force in the implant group was larger than that in the conventional group. Large occlusal loads on the anterior region would cause an anterior upward tilting of the maxillary denture, which could lead to rapid maxillary bone loss in the implant group. Jacobs et al¹⁹ found greater annual maxillary bone resorption in patients with mandibular implant-supported fixed prostheses than in patients with mandibular overdentures supported by 2 implants. A maxillary complete denture occluding with a hybrid denture has also been said to increase vulnerability to midline fracture.^{3,20} Based on these findings, it is recommended that the stability and retention of a maxillary denture be checked more often and the occlusion adjusted more frequently to relieve anterior tilting for the hybrid denture wearer.

Conclusion

With pressure-sensitive film, the occlusal contacts of 40 edentulous patients with mandibular hybrid dentures opposing maxillary complete dentures were compared to those of 40 patients with conventional complete dentures. Within the parameters of the study design, the following conclusions can be made:

1. Occlusal force and occlusal area in the implant group were larger than those in the conventional group.
2. No significant differences were seen in the number of occlusal contact points, the anteroposterior length of the maxillary denture, or the occlusal force balance between the left and right sides.
3. The center of occlusal load in the implant group was more anterior than that in the conventional group. Thus, the maxillary denture may be more unstable in the implant group. Based on this, it is possible that large occlusal loads on the anterior region may cause a tilting of the maxillary denture, causing more rapid maxillary bone loss in patients with mandibular hybrid dentures.
4. It is suggested that the stability and retention of a maxillary denture be checked more often and the occlusion adjusted more frequently in the hybrid denture wearer than in the conventional denture wearer.

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