Effects of Occlusal Rest Design on Pressure Distribution Beneath the Denture Base of a Distal Extension Removable Partial Denture—An In Vivo Study

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This study aimed to investigate the pressure distribution beneath the denture bases of removable partial dentures (RPDs) with different occlusal rest designs (ORDs) by in vivo measurement. Four types of detachable occlusal rests (mesial and distal, distal, mesial, and nonrest) were placed on the direct abutment teeth of distal extension RPDs in four patients with free-end edentulous mandibles. Pressure measurements were obtained by using thin and flexible tactile sensors. The results showed significant variances with different ORDs in all four patients ($P < .05$), leading to the conclusion that the pressure distribution on the residual ridge beneath the RPD base was dependent on the ORD. *Int J Prosthodont 2014;27:469–471. doi: 10.11607/ijp.3847*

Occlusal rest designs (ORDs) on the direct abutment tooth of a distal extension removable partial denture (RPD) are thought to influence the pressure distribution beneath the denture base.[1] Excessive pressure acting on the residual ridge may induce pain, inflammation, and, eventually, bone resorption.[2] However, there have been few records to support the ORD theories by in vivo measurement of pressure, and the mechanobiological reactions behind them remain understudied.[3–5] This study aimed to investigate the pressure distribution beneath the denture base of RPDs with different ORDs using a tactile sensor sheet in vivo. Null hypothesis of this study is that the ORD has no influence on the pressure distribution.

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Materials and Methods

Four people with free-end edentulous mandibles participated in this study, and the research protocols were approved by the Research Ethics Committee of Tohoku University Graduate School of Dentistry. A signed consent form was obtained from all of the participants after full explanation of the procedures.

An experimental distal extension RPD was prepared for each participant, consisting of detachable mesial and distal occlusal rests with Beyeler attachments (Cendres & Métaux) on the direct abutment tooth of the distal extension (Fig 1a). Four different ORDs were investigated in this study: mesial and distal rests (MD), distal rest (D), mesial rest (M), and nonrest (N; Fig 1b). Pressure distribution was measured by using tactile sensor sheets with a measurement range from 0 to 2000 kPa (TactArray Sensor, Pressure Profile Systems; 1.0-mm thick; Fig 2a) at maximum voluntary clenching.

The sensor sheet is made of flexible material that allows it to form a sophisticated shape with multiple three-dimensional curvatures. Electrodes 2 mm in width were regularly arranged as orthogonal and overlapping strips, which formed a capacitor at each cross-point and detected the change of capacitance induced by pressure at each sensing point. The sensor sheets were fitted to the residual ridges beneath the denture base in the same way as direct relining using an autopolymerizing resin and were bonded using an adhesive (Fig 2b). Adaptation of the sensor sheets to residual ridges was assessed *(1)* by measuring the pressure distribution, which was displayed

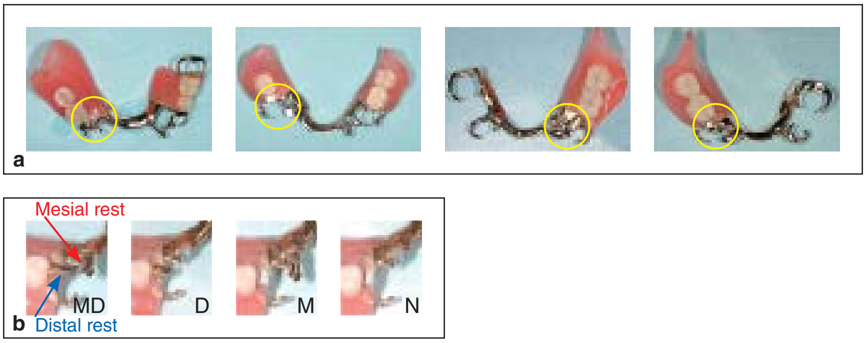


Fig 1 Experimental RPDs for the participants and detachable occlusal rest system. **(a)** Experimental RPDs for patients A to D *(left to right)*. Orange circle indicates detachable occlusal rest system on the direct abutment teeth. **(b)** Four types of occlusal rest designs by the detachable occlusal rest system with Beyeler attachments. MD = mesial and distal rests; D = distal rest; M = mesial rest; N = nonrest.

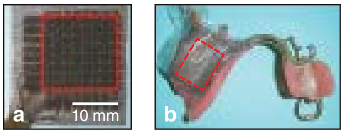


Fig 2 Tactile sensor sheet. **(a)** Appearance of sensor sheet. Sensing area is indicated by red dotted lines. **(b)** Basal surface view of the experimental RPD with the sensor sheet (patient A).

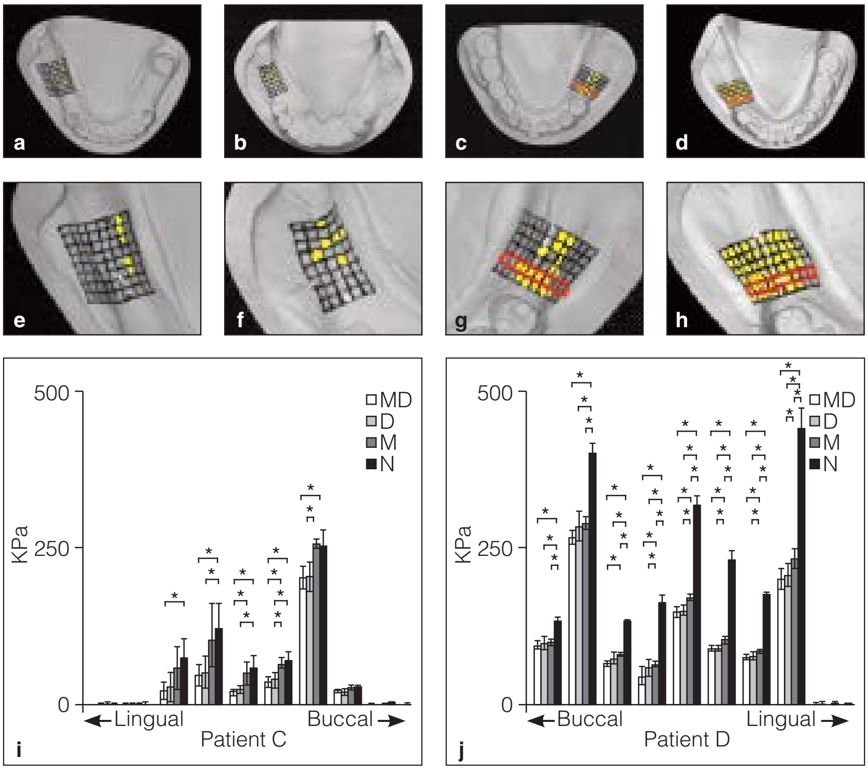


Fig 3 Effect of occlusal rest design on pressure distribution. **(a to d)** The measured area projected on the residual ridges of patients A to D. Yellow dots indicate the sensing points at which pressure values differed among the four occlusal rest designs significantly. **(e to h)** Magnified images of the measured areas **(a to d)**. **(i and j)** Pressure values of the sensing points in the areas indicated by red open squares shown in **(g)** and **(h)** (*$P < .05$; Tukey's HSD test).

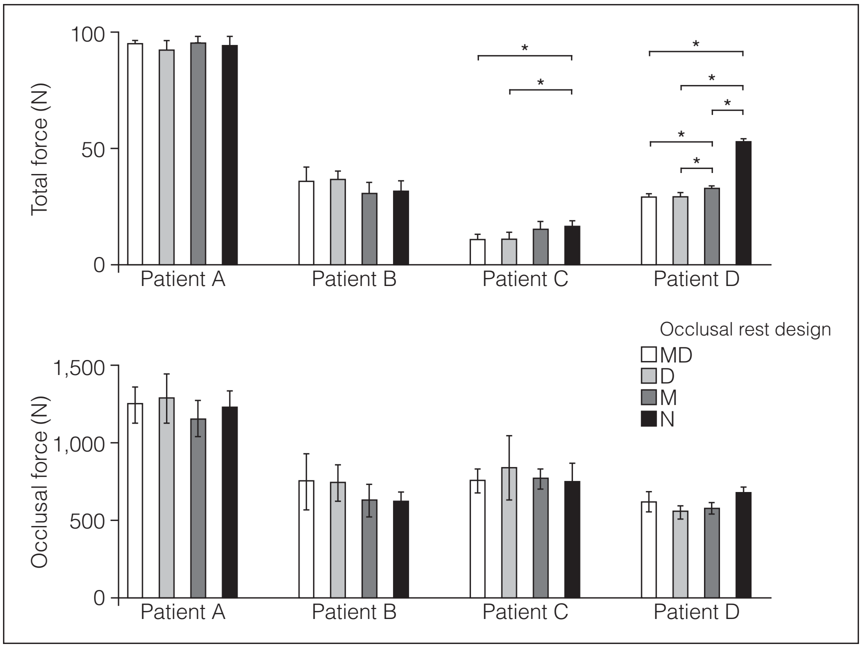
on the computer monitor, before clenching and *(2)* by an adaptability test using white silicone (Fit Checker, GC). The total force on the sensor sheet was defined as the sum of forces at each sensing point.

Occlusal contacts were adjusted before measurements so that the occlusal contact points were distributed symmetrically along the dental arch. Occlusal force on the dental arches also was measured simultaneously using pressure sensitive film (Dental Prescale, Fuji Photo Film). Five trials were conducted for each ORD.

Results

Pressure distribution changed significantly in all four patients when the ORD was exchanged ($P < .05$; multivariate analysis of variance [MANOVA]). The null hypothesis was rejected. However, the post hoc test revealed that there were no statistical differences between MD and D in any patient ($P < .05$, Tukey's honestly significant difference [HSD] test; Fig 3). In participants C and D, the total force for N was significantly higher than those for MD and D ($P < .05$; 1-way

Fig 4 Total force and occlusal force (*$P < .05$; Tukey's HSD test).



ANOVA, Tukey's HSD test) despite there being no significant differences in occlusal forces on the RPDs of all four patients (1-way ANOVA; Fig 4).

Discussion

The results showed that the ORDs affected the pressure distribution pattern beneath the denture base of distal extension RPDs under the same occlusal forces. Furthermore, there was no statistical difference between MD and D in pressure distribution, which means that the distal rest may have a greater influence than the mesial rest on the pressure distribution. Participants C and D, who had the same RPD design, showed a similar trend in the pressure distribution change when the ORDs were exchanged. On the other hand, the ORD of the direct abutment tooth had less effect on pressure distributions in participants A and B, whose RPDs had more proximal plates than RPDs of patients C and D. These indicate that pressure distribution depends on the RPD design, including the ORD of the direct abutment tooth.[1]

Conclusions

The pressure distribution on the residual ridge beneath the RPD base was found to be dependent on the ORD.

Acknowledgments

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