Influence of Palatal Morphology on Strain in Maxillary Complete Dentures: A Preliminary Report

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The purpose of this preliminary investigation was to assess the influence of palatal morphology on deformation of maxillary complete dentures in vivo. The palatal morphology of the maxillae of eight edentulous subjects was measured. Experimental dentures were fabricated, and a strain gauge was attached at the first molar position at the midline of the polished surface of each denture. Subjects were instructed to bite a metal bar placed bilaterally at the denture's first molar region with a force of 49 N. The resultant strains were recorded, and the correlation between strain and palatal morphology was evaluated using the Pearson correlation coefficient. A strong correlation between strain and both palatal depth and radius of curvature was noted, suggesting that edentulous patients with wide, shallow palates have a higher risk of denture deformation, which may lead to material fracture. *Int J Prosthodont 2012;25:619–621.*

Deformation of complete denture bases is a common and recurrent problem for denture wearers. Deformation may lead to denture base fracture and will presumably generate adverse compressive stresses to the supporting tissues.[1] Numerous factors influence denture material deformation, including the morphology of the supporting tissues and especially of the palate. The purpose of this preliminary investigation was to assess the influence of palatal morphology on the deformation of maxillary complete dentures in vivo.

Materials and Methods

A convenience sample of eight subjects who were successfully wearing maxillary complete dentures (four men and four women; mean age: 72.5 ± 7.4 years; range: 55 to 83 years) was selected from patients treated at the Department of Prosthodontics and Oral Rehabilitation, Osaka University Dental Hospital, Osaka, Japan. All subjects had worn their dentures successfully for at least 6 months and showed good general health without any orofunctional disorders. The distribution of opposing dentitions was as follows: one subject with an intact dentition, six subjects with distal extension removable partial dentures, and one subject with a complete denture. The pilot study's protocol was approved by the Ethical Committee of Osaka University Graduate School of Dentistry, and informed consent was obtained from all subjects.

Duplicate experimental dentures were made from acrylic resin (Palapress Vario, Heraeus Kulzer), and a strain gauge (KFG-1-120-D17-11L1M3S, Kyowa Electronic Instruments) was attached at the midline of the polished surface (Fig 1) and connected to sensor interfaces (PCD-300A, Kyowa Electronic Instruments) controlled by a personal computer (Dynabook SS N10, Toshiba).

The experiment was carried out in a manner that could be regarded as a preliminary step in designing a more comprehensive clinical research study of functional deformation of maxillary denture bases. Subjects sat upright, and their heads and necks were stabilized with the chair's headrest to keep the Frankfort plane parallel to the floor. They were instructed to bite a metal bar placed bilaterally at the denture's first molar region with a force of 49 N, as reported in a previous study.[2] A three-dimensional (3D) digital model was established by scanning the maxillary cast with a noncontact 3D digitizer (VIVID 910, Konica Minolta Sensing). Three measurements (palatal width, palatal depth, and radius of curvature) were taken at the first molar position using 3D morphologic analysis software (3D-Rugle, Medic Engineering) (Fig 2).

The correlation between denture strain and each morphologic measurement was evaluated with the Pearson correlation coefficient.

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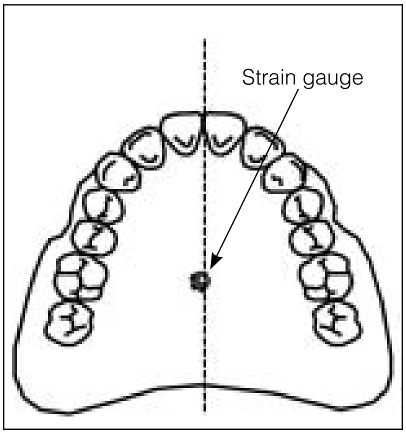


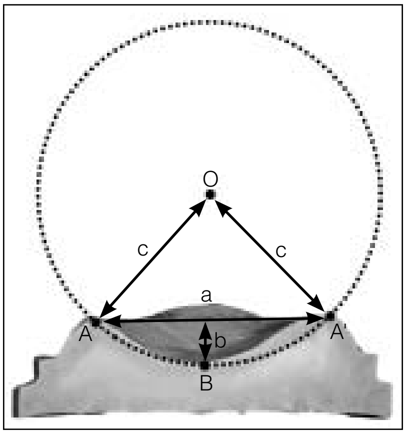


Fig 1 *(left)* Schematic illustration of the position of the strain gauge (occlusal view). The dotted line shows the midline of the denture. The strain gauge was attached at the first molar position at the midline of the polished surface of each experimental denture.

Fig 2 *(right)* Schematic illustration of the cutting surface of the maxillary edentulous cast at the first molar position. The dotted circle shows the curvature of the palate. A, A' = top of the alveolar ridge; B = median of the palate; O = center of the curvature of the palate; a = palatal width: distance of A to A'; b = palatal depth: distance of A-A' to B; c = radius of curvature: distance of O to A, O to A', and O to B.

Table 1 Measurements of Strain, Palatal Width, Palatal Depth, and Radius of Curvature

Subject	Strain ($\times 10^{-6}$)	Palatal width (mm)	Palatal depth (mm)	Radius of curvature (mm)
1	320.6	44.1	5.4	48.2
2	116.3	36.4	8.3	38.7
3	86.0	39.5	8.2	41.0
4	297.9	42.5	5.9	48.7
5	195.2	47.9	6.6	42.5
6	81.9	40.7	7.4	36.4
7	73.5	40.7	8.3	34.1
8	141.6	44.0	5.0	33.2

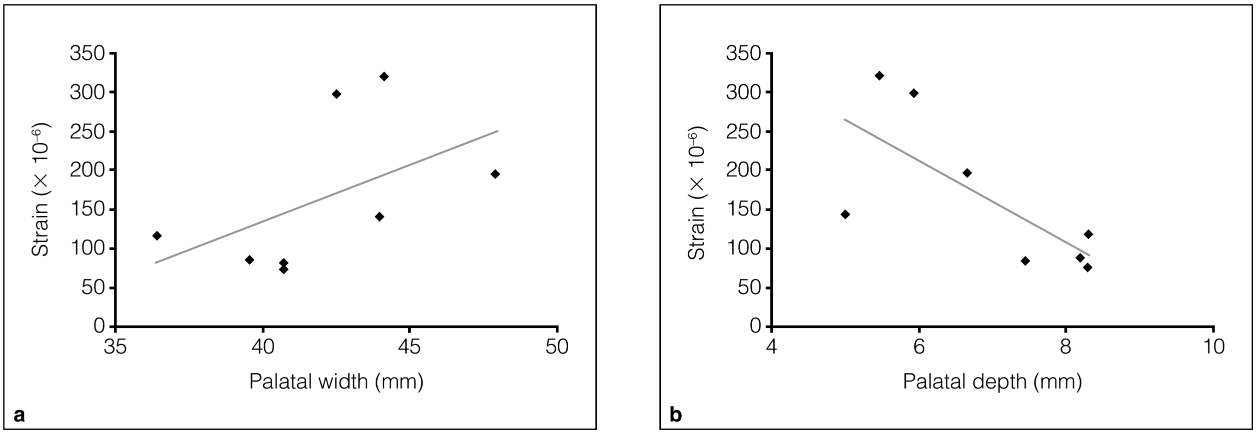
Results

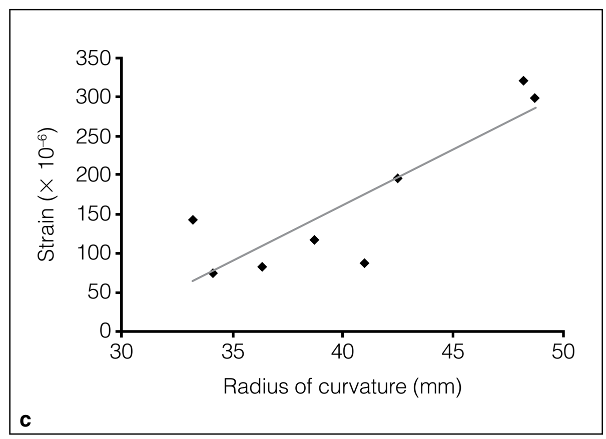
Table 1 shows the results of the morphologic and strain measurements. There was a poor positive correlation between strain and width ($r = 0.514$), a significant negative correlation between strain and depth ($r = -0.714$; $P < .05$), and a significant positive correlation between strain and radius ($r = 0.864$, $P < .01$) (Fig 3).

Discussion

It has been suggested that minimizing denture base deformation is important to preclude material fracture and stabilize the denture by controlling displacement forces.[1] A previous report stated that palatal depth has a greater influence on denture deformation than palatal width[3]; however, in that study, both depth and width were individually investigated. The present study addressed morphologic differences among subjects and thus included the radius of curvature along with palatal depth and width.

Denture deformation was observed primarily at the midline, which is where most denture repairs occur.[4] When certain functional forces are applied to artificial teeth, both sides of the alveolar ridge may be simultaneously loaded, leading to a fulcrum at the palatal midline and a resultant generation of tensile strain. This suggests that a strong correlation exists between midline deformation and palatal morphology. Moreover, the presence and size of the torus palatinus may create discomfort for the denture wearer[5] and heighten the risk of deformation and fracture. Only one of this study's eight subjects presented with a large palatal torus; therefore, this consideration could not be addressed in the current report. This limitation serves as a strong reminder that compelling clinical studies on the topic require a large number of patients





Figs 3a to 3c Correlation between strain and **(a)** palatal width, **(b)** palatal depth, and **(c)** radius of curvature.

with well-defined descriptive criteria that account for a broad spectrum of palatal morphologies accompanied by a range of functional forces (as opposed to the static force employed in this investigation).

The radius of curvature showed the strongest correlation with strain; however, this information is difficult to apply in a clinical setting because measuring the radius of curvature is time consuming and requires special equipment. The authors suggest that surrogate indices are needed to more easily determine the radius of curvature; further, they suggest that these indices could very well be palatal width and depth.

Conclusions

This preliminary study's observations suggest that the maxillary dentures of patients with wide, shallow palates may be more susceptible to deformation. Such dentures should therefore be reinforced and given optimal occlusal arrangements to avoid development of adverse midpalatal forces.

References

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