Mechanical Analysis of a Palateless Denture

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The purpose of this study was to compare the strain of complete dentures with and without full palatal coverage and to determine the effect of reinforcement. Three types of maxillary complete dentures (with palate, without palate, and without palate but with reinforcement) were fabricated, and reinforcements were made from a cobalt-chromium alloy. Strain gauges were attached to the polished surface, and a vertical load was applied in the region of the first premolar and first molar. The strains were statistically compared. The greatest strain occurred on the anterior palatal surface and was tensile in the denture with palatal coverage and compressive in the denture without palatal coverage. Significantly less strain occurred in dentures with reinforcement than without reinforcement. *Int J Prosthodont 2013;26:419–422. doi: 10.11607/ijp.3489*

Maxillary complete dentures are frontline prosthetic treatments for maxillary edentulous patients. However, patients with a strong vomiting reflex and/or large palatine tori find full palatal coverage to be intolerable, and even patients without these traits can find them uncomfortable. Although some researchers believe that palateless dentures are superior to conventional complete dentures in terms of oral function,[1] gag reflex,[2] patient satisfaction,[3] and temperature and sensorimotor function,[4] they are thought to be weak and deformable. However, there is little published data describing mechanical analysis of outcomes such as deformation and fracture. As a result of this lack of data, palateless dentures are generally used for their beneficial properties.

An early report about the deformation of maxillary complete dentures[5] showed that when functional forces are applied to artificial teeth, the top of the alveolar ridge on both sides becomes a loading point and the median of the palatal plate acts as a fulcrum. As a result, the posterior palatal contour is flattened, tensile strain is generated at the midline of a conventional complete denture, and dentures are often fractured at the midline.

Moreover, palateless dentures have often been supported or retained by implants. In the case of implant overdentures, it was reported that fracture occurrs at the implant sites in addition to the midline.[6]

Therefore, this study was conducted to compare the strain on the base of complete dentures with and without palatal coverage and to determine the effect of reinforcing the base.

Materials and Methods

A plaster cast of an edentulous residual ridge was covered with silicone (Fit Checker, GC) to simulate a 2-mm-thick mucosa, and maxillary complete dentures with and without palatal plate were fabricated.

Three types of acrylic resin denture bases (Palapress Vario, Heraeus Kulzer) processed using a standard pouring method were tested: a maxillary complete denture with palate, a maxillary complete denture without palate, and a maxillary complete denture without palate but with reinforcement (Fig 1). They were simulated in an occlusal rim, and their heights were 12 mm at the anterior and 10 mm at the posterior. The thickness of the denture base was 1.5 mm. Reinforcement (4 mm wide × 0.5 mm thick) ran along the top of the residual ridge and was made from cast cobalt-chromium (Co-Cr) alloy (Cobaltan, Shofu).

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Fig 1 **(a)** Maxillary complete denture with palatal plate; **(b)** maxillary complete denture without palatal plate; **(c)** maxillary complete denture without palatal plate but with cast cobalt-chromium reinforcement.

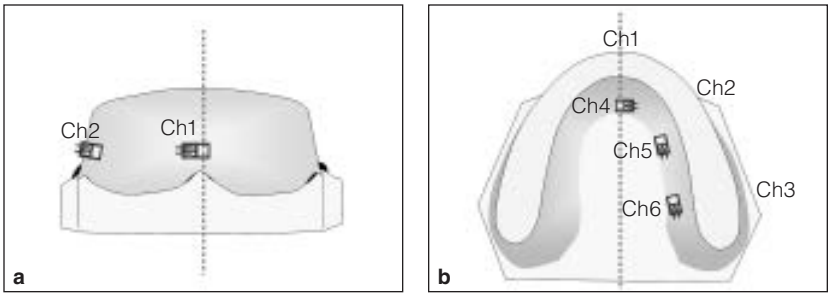

Fig 2 Strain gauge positioning. **(a)** Occlusal view; **(b)** labial view. Dotted lines denote the midline of the denture. A strain gauge was attached to the polished surface both lingually and palatally at the anterior midline, canine, and first molar positions (Ch1 = lingual midline, Ch2 = lingual canine, Ch3 = lingual first molar, Ch4 = palatal midline, Ch5 = palatal canine, Ch6 = palatal first molar).

Strain gauges (KFG-1-120-C1-11L50C2R, Kyowa Electronic Instruments) were attached to the lingual and palatal polished surfaces of the denture at the anterior midline, canine, and first molar positions (Fig 2) and connected to sensor interfaces (PCD-300A, Kyowa Electronic Instruments) controlled by a personal computer (Dynabook SS N10, Toshiba).

A vertical occlusal load of 49 N was applied bilaterally to the first premolar and first molar. The strains were recorded, and all measurements were repeated five times.

Comparisons of strains were made by an analysis of variance (ANOVA) with a post hoc comparison using the Bonferroni method. Differences between with and without reinforcement were made using a Student *t* test ($P < .05$). All statistical analyses were performed using SPSS version 11 software (IBM).

Results

For both loadings, the largest strain occurred in the anterior midline of the palate. This strain was tensile in dentures with palate but compressive in those without it (Fig 3). When comparing the effect of base reinforcement, reinforcement significantly ($P < .05$) reduced the strain of the denture in the anterior midline of the palate (Fig 4).

Discussion

Palateless dentures experienced more strain in the anterior midline than those with palate and of a different type. These results suggest palateless dentures deform easier than conventional dentures and curve inward buccopalatally (centered on the anterior midline), whereas others flex outward along the midline.

Although the strain of the palateless denture was greater than that with a palatal plate, the former was compressive and the latter was tensile. Because the compressive strength of acrylic resin is generally three to four times higher than tensile strength, palateless dentures appear not to be inherently weaker or more fragile than conventional complete dentures. However, it is clear that maxillary dentures deform easier without the palatal plate.

The strain at the anterior midline was lower in the conventional complete denture than in the palateless denture. Because palateless dentures adopt a U shape, stress tends to be concentrated at the narrow, curved anterior area such as in mandibular dentures.[5] However, embedding Co-Cr reinforcement reduced this strain. The authors' previous study about the maxillary complete denture[7] also showed the same results and potentially negated the risk of fracture and deformation. As the denture base becomes thicker

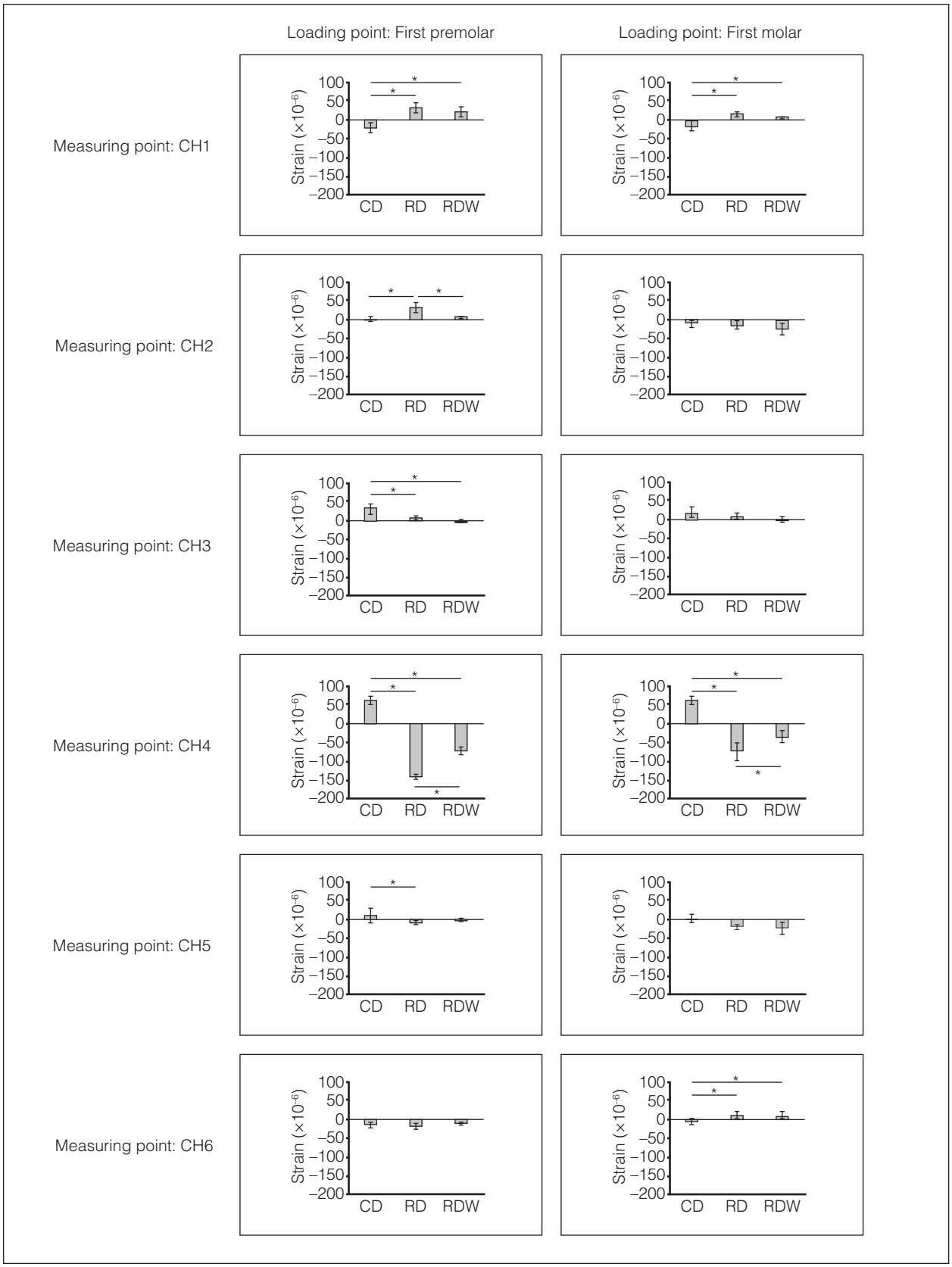

Fig 3 Strain experienced in denture bases under 49-N load (CD = complete denture with palate, RD = complete denture without palate, RDW = complete denture without palate but with Co-Cr reinforcement, Ch1 = lingual midline, Ch2 = lingual canine, Ch3 = lingual first molar, Ch4 = palatal midline, Ch5 = palatal canine, Ch6 = palatal first molar). *Statistically significant difference ($P < .05$).

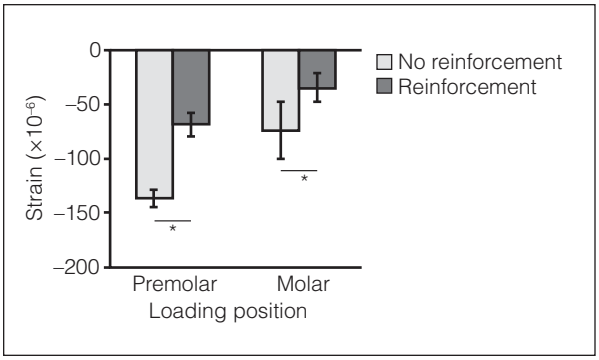

Fig 4 Strain experienced in maxillary complete denture without palatal plate. *Statistically significant difference ($P < .05$).

and thicker, the strain is smaller and less deformation and fracture will occur. On the other hand, this change will also make denture wearers more uncomfortable. Therefore, Co-Cr reinforcement in palateless dentures appears to be effective in reinforcing rigidity without changing the dimension of the denture base.

In recent years, palateless dentures have often been supported by or retained with implants. Maeda et al reported that deformation of the denture base leads not only to denture base fracture, but also to ridge resorption from compressive stresses transmitted to the bone.[8] High deformation by functional loading in implant-supported palateless overdentures risks transmitting stress to the load-bearing implants, which may cause them to fail. To prevent such problems, reinforcement is essential for palateless dentures.

Although anterior teeth are used to cut foods, both sides of the premolars and molars are used for mastication with dentures. Therefore, loads were applied only in the posterior regions in this study.

The palate is the primary stress-bearing area in complete dentures. By removing the palate, the stress that is normally transferred to the palate will need to be transferred to other parts of the denture and mucosa. Reinforcement will help the denture become more rigid and will lessen the stress to the tissues. However, it is unclear what effects reinforcement will have on soft tissues and underlying structures in the long term.

Conclusion

Within the limitations of this study, the strain of palateless dentures was of a different type (compressive) and larger compared with complete dentures with a palate. The strain was maximal in the anterior palatal area. Reinforcement of the palateless denture base reduces the risk of fracture and deformation.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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