Original article

Influence of mandibular residual ridge resorption on objective masticatory measures of lingualized and fully bilateral balanced denture articulation

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Abstract

Purpose: To assess the influence of mandibular residual ridge resorption (RRR) on objective masticatory measures of two occlusal schemes: lingualized occlusion (LO) and fully bilateral balanced articulation (FBBA).

Methods: The enrolled patients ($n = 22$) were randomly allocated one set of complete dentures with either LO or FBBA. Maximum occlusal force, masticatory performance (by the MPI), and mandibular movements were measured at 3- and 6-month follow-ups. Mandibular RRR was assessed as the sum of the mandibular bone height at the midline, first premolar region, and least vertical height region, and from the mental foramen to the alveolar crest, measured on panoramic radiographs; the treatment groups were subclassified into severe or moderate RRR subgroups by the value of the sum of individual measurements.

Results: Significant differences were observed in the between-subgroup comparisons (Kruskal–Wallis test) of the MPI (3 months, $p = 0.01$; 6 months, $p = 0.04$) and linear deviation from intercuspal position (anterior–posterior: 6 months, $p = 0.01$; inferior–superior: 3 months, $p = 0.008$; 6 months, $p = 0.02$). The patients with severe RRR in the FBBA group showed a significant decrease in the MPI and increase in linear inferior deviation from intercuspal position at 3 months (post hoc comparison) as well as a significant increase in the linear posterior and inferior deviation from intercuspal position at 6 months.

Conclusions: LO is the preferable occlusal scheme for patients with severe RRR. (This trial has been registered at http://clinicaltrials.gov/ct2/show/NCT00959530.)

1. Introduction

The optimal occlusal surface design should be considered for ideal complete denture retention, stability, and support. Masticatory forces influence denture retention and stability; important design factors for controlling occlusal forces may be the type of tooth arrangement and the manner of occlusal adjustments. Bonwill and Balkwill promoted the view that unfavorable masticatory force, induces undesirable denture base movements, and can be reduced by ensuring contact between the maximal number of teeth on both sides of the arch during centric and all excursive mandibular movements [1]. This occlusal scheme, described as fully bilateral balanced articulation (FBBA). FBBA occlusal scheme is designed for the bilateral, simultaneous anterior and posterior occlusal contact of the denture teeth in the centric and eccentric positions [2] with a cross-arch balanced articulation.

Although FBBA has been considered the ideal occlusal scheme, it may be difficult to achieve clinically as well as time consuming to master [3]. Therefore, a less-complicated occlusal scheme fulfilling clinical patient requirements became necessary [4]. Lingualized occlusion (LO), advocated in the 1940s as an alternative to FBBA [5], is defined as denture occlusion that articulates the maxillary lingual cusps with the mandibular occlusal surfaces in centric working and nonworking mandibular positions [2]. This means that the buccal cusps of the upper teeth and the cusps of the lowers take no part in the articulation. Consequently, not only tooth arrangement but also occlusal correction is easier in LO than in FBBA.

LO is selected as an occlusion design type by the planned reduction of lateral inferences and reduced timing of occlusal force contact and directions. As a result there is report of

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clinically successful outcomes for patients with compromised ridges [4]. The LO has shown distribution of masticatory force toward the lingual side, thus stabilizing the mandible denture in simulated studies [6,7]. These results suggest that LO assists in greater denture stability in patients with severe residual ridge resorption (RRR) or arch length discrepancy between the ridges. Therefore, analysis of clinical findings and measurement of outcomes of LO and FBBA would be helpful in clinical recommendations for patients with diagnosed RRR.

Many different posterior tooth arrangement and occlusal design schemes have been discussed in the literature. However, a systematic review in 2005 [8] revealed that only one paper [9] met the inclusion criteria. Since then, a well-conducted pilot study [10] and several randomized controlled trials have been reported comparing anatomic, lingualized, and zero-degree posterior form [11,12], canine guidance and balanced occlusion [13], and canine guidance and lingualized occlusion [14] for conventional complete dentures. Similar comparisons have been made for implant overdentures [15,16]. However, none have provided evidence in support of LO especially in patients with severely compromised alveolar conditions such as severe RRR.

Therefore, the aim of this study was to test the null hypothesis that there is no difference in objective masticatory measures, namely maximum occlusal force, masticatory performance, and mandibular movements, between two occlusal schemes for complete dentures, LO and FBBA, with the main focus being the level of mandibular RRR.

2. Materials and methods

2.1. Clinical trial

The trial was conducted between December 2007 and August 2009 at Nihon University Hospital, Chiba, Japan. Patients having significant problems with at least one of their existing complete dentures and able to understand and respond to a test questionnaire were recruited. The exclusion criteria, after preliminary examination, were symptoms of temporomandibular disorders, xerostomia, orofacial motor disorders, severe oral manifestations of systematic disease, or psychological or psychiatric conditions that could influence the response to treatment. At baseline, data on the clinical characteristics, functional measures, and mandibular bone height were collected, and the patients were stratified according to a diagnostic system [17] indicating treatment difficulty from class I to class IV. A research assistant blinded to the study protocol assigned the patients to the treatment groups with either LO or FBBA by using computer-generated random numbers in a concealed manner to avoid allocation bias. Although blinding of the clinicians to the treatment allocation was not possible, the patients were not aware of their assigned group. Those patients classified into class III (substantially compromised) or class IV (severely compromised) with the prosthodontic diagnostic index for complete edentulism [17] and who completed the 3- and 6-month follow-ups were included in the analyses ($n = 22$).

All enrolled patients were informed of the study and their written consent was obtained. The study protocol was approved by the ethics committee of Nihon University School of Dentistry at Matsudo (07-014) and has been registered with the ClinicalTrials.gov registry (http://clinicaltrials.gov/ct2/show/NCT00959530).

2.2. Denture fabrication procedure

A stock tray (Mesh tray; Hayashi Dental Supply Co., Tokyo, Japan) and alginate (ALGIACE-Z; DENTSPLY-Sankin K.K., Tokyo, Japan) were used for the preliminary impression. The final impression was registered by using a custom tray, fabricated on the cast obtained from the preliminary impression and border-molded with impression compound (Peri Compound; GC Corp., Tokyo, Japan), followed by a wash impression with polyether impression material (Impregum soft; 3 M ESPE, St, Paul, MN, USA). After occlusal registration, the cast was mounted on a semi-adjustable articulator (Hanau H2; Teledyne Water Pik, Fort Collins, CO, USA) using a facebow record. For the LO group, lingualized occlusion was developed by using lingualized posterior teeth (e-Ha Quattro blade; Heraeus Kulzer GmbH, Hanau, Germany) while avoiding all contact of the buccal cusps. For the FBBA group, 33-degree posterior teeth (Ace posterior; Shofu Dental Corp., Kyoto, Japan) was arranged to develop cross-arch balanced occlusion. After the try-in session, occlusal adjustment was carried out in both groups for maximum intercuspation as well as lateral excursive and protrusive movements by selective and spot grinding. For FBBA, milling was additionally carried out to refine the occluding surfaces by using silicon carbide abrasive materials (Lapping paste; GC Corp., Tokyo, Japan). The denture was delivered to the patients, and control appointments were scheduled. At the first control consultation, remounting was performed for both groups. A board-certified prosthodontist from the Japan Prosthodontic Society was responsible for the treatment procedures and a laboratory technician was responsible for all the laboratory procedures.

2.3. Measurement of mandibular bone height

Bone height was measured by using panoramic radiographs with a magnification ratio of 1:1.3 registered via a digital panoramic X-ray unit (Veraviewepocs; J. Morita Mfg. Corp., Kyoto, Japan). The midline was determined by images of the nasal septum, anterior nasal spine, and nasopalatine foramen. A line was drawn tangential to the mandibular angle and lower border of the mandibular body; the horizontal length of the mandible was measured parallel to the tangent 10 mm above the lower border of the mandible. According to a previous study [18], the first premolars are located at a distance of about 35% of the length of the mandibular body from the midline. Four sites were selected to assess RRR: midline (L_1), average value of bilateral first premolar region (L_2), area with the least vertical height (L_3), and average value of bilateral mental foramen