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RCT Comparing Posterior Occlusal Forms for Complete Dentures

ABSTRACT

Complete dentures can be produced with different types of occlusal forms. There is some evidence to suggest that it may be advantageous to provide complete dentures with cusped posterior teeth. The aim of this research was to compare the levels of subject satisfaction with 3 types of posterior occlusal forms for complete dentures, in a randomized cross-over trial design. Forty-five participants were randomly assigned 3 sets of complete dentures with different posterior occlusal forms (zero-degree, anatomic, and lingualized occlusions). Subjective data were collected according to visual analogue scales after 8 weeks of denture-wearing. Statistical analysis consisted of repeated-measures analysis of variance, followed by paired *t* tests. Lingualized and anatomic occlusal forms were perceived to be significantly superior in terms of chewing ability, when compared with zero-degree posterior occlusal surfaces.

KEY WORDS: randomized controlled trial, complete dentures, occlusal forms, patient satisfaction.

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INTRODUCTION

The stability and retention of complete dentures can be compromised by displacing forces, which are created during mastication, swallowing, and parafunctional habits. Throughout these functions, the maxillary and mandibular teeth come into contact, and unfavorable displacing forces can overwhelm the retention and stability of the dentures, creating discomfort from trauma to the underlying mucosa.

If the fitting and polished surfaces are ideal, it is assumed that the form of the occlusal surfaces and the nature of their contacts become critical for successful denture function. The search for the most appropriate occlusal form and tooth arrangement for complete denture occlusion has been ongoing for almost two centuries (Lang, 2004).

Before this research was conducted, a Cochrane review was performed to determine if there had been previous randomized controlled trials comparing the efficacy of different occlusal schemes for complete dentures (Sutton *et al.*, 2005). The objective of the systematic review was to identify a superior occlusal scheme for complete dentures in terms of the patient satisfaction. Of the 1076 papers reviewed, one paper satisfied the inclusion criteria for the review (Clough *et al.*, 1983). The trial suggested that participants preferred prosthetic teeth with cusps as opposed to cuspless ones (zero degree), because of their improved chewing performance. However, this study was judged to be at high risk of bias, owing to the provision of insufficient information regarding the method of randomization and allocation concealment. In addition, the method for assessing participant satisfaction was unclear. This paper was published in 1983, when validated indices were in their infancy. With the advent of implant-stabilized prostheses and an emphasis on demonstrating value for money in medical and dental health care, there are now numerous indices available (Feine *et al.*, 2002).

The purpose of this research was to conduct a randomized cross-over trial to test the null hypothesis that there is no variation in the level of people's satisfaction for 3 different types of posterior occlusal forms for complete dentures.

MATERIALS & METHODS

A medical statistician (HVW) was consulted regarding protocol design prior to the study. A randomized cross-over design was chosen, since this method of assessment has been used successfully in evaluating individual preferences for different types of prostheses in previous high-quality trials (de Grandmont *et al.*, 1994; Feine *et al.*, 1994; Tang *et al.*, 1997; Awad and Feine, 1998; de Albuquerque Junior *et al.*, 2000; Awad *et al.*, 2003).

This study used 50 edentulous individuals taken from the waiting list of the University Dental Hospital of Manchester, UK, and requiring the provision of replacement complete dentures. The protocol of the study was approved by the City of Manchester local research ethics committee (study number 01/454).

Persons were to be excluded from the study if one or more of the following was/were present:

- chronic debilitating diseases, neuromuscular disorders, or stroke;
- a confirmed diagnosis of psychiatric disorder and medication; or
- the presence of oral pathology, including mucosal lesions and xerostomia.

Subsequent to providing informed consent, the participants were randomly assigned 3 sets of complete dentures with 3 different types of posterior occlusal forms, according to a cross-over design. The posterior occlusal surfaces of the 3 dentures consisted of anatomic teeth, lingualized teeth, and zero-degree teeth. The prosthetic teeth used in this trial were the Basic 6/8 range of prosthetic teeth (Heraeus Kulzer, Newbury, UK). The anatomical posterior teeth used were 33° prosthetic teeth, arranged and adjusted to balanced articulation. Balanced articulation is the bilateral, simultaneous, anterior, and posterior occlusal contact of teeth in centric and eccentric positions (Glossary of Prosthodontic Terms, 2005). The lingualized posterior teeth were modified 33° prosthetic teeth, arranged and adjusted to balanced articulation. Lingualized occlusion is the form of denture occlusion where the maxillary lingual cusps articulate with the mandibular occlusal surfaces in centric working and non-working positions (Glossary of Prosthodontic Terms, 2005). The modification consisted of tilting the maxillary posterior teeth, to avoid contact of the buccal cusps, and selective grinding of the mandibular posterior teeth, creating a concavity in the occlusal surfaces (Lang, 2004). The zero-degree posterior teeth were 0° prosthetic teeth, arranged to balanced articulation. Subsequent to all post-insertion adjustments, the participants wore each set of complete dentures for 8 wks, following which a visual analogue scale (VAS) was completed.

The objective of this randomized controlled trial was to test the null hypothesis that there is no variation in the level of individual satisfaction for 3 different types of posterior occlusal forms for complete dentures.

The primary outcome measure was a VAS focusing on 5 aspects of denture satisfaction (Feine *et al.*, 1994). Data were gathered from the participants at baseline, regarding their original dentures, and 8 wks post-final review, following the interventions with anatomic, lingualized, and zero-degree occlusal forms, according to the VAS. The participants were asked to draw a vertical line at the point that best represented their perceptions regarding "the appearance of your dentures", "the ease of cleaning your dentures", "the stability of your dentures", "your ability to speak with your dentures", and "your ability to chew with your dentures". The anchor words of "unacceptable" on the left and "perfect" on the right provided broad limits at each end of the 100-mm horizontal line. A previous study of implant-supported complete dentures calculated a sample size based on this outcome, with a standard deviation of the mean difference between the ratings of 2 prostheses of 7.46 mm (de Grandmont *et al.*, 1994). It was found that total sample sizes required for differences of 20, 10, and 5 mm were eight, 14, and 40 participants, respectively, with $\alpha = 0.05$ and $\beta = 0.20$. The study was therefore designed to detect differences in the order of 5 mm with 80% power, with a sample size of 40 participants. To compensate for potential drop-outs, we increased the number of participants to 50.

The participants were randomized into six groups among which the different possible sequences for the wearing of the sets of dentures were allocated. A medical statistician (HVW) operated a computer program that generated a random sequence of numbers between 1 and 6. The randomized numbers were placed in unmarked non-transparent envelopes. As an individual entered the trial, the next envelope was opened, revealing the randomized occlusal form sequence. The treating prosthodontist (AFS) was unaware of the sequence of intervention allocation until treatment was commenced.

The complete dentures were provided in the prosthodontic department of the University Dental Hospital of Manchester by one prosthodontist and one dental technician. The dentures were fabricated according to standard prosthodontic practice consistent with the British Society for the Study of Prosthetic Dentistry Guidelines in Prosthetic and Implant Dentistry (Ogden, 1996). Duplication of the dentures was performed once the first set of dentures required no further adjustment, according to the following technique: The working casts were duplicated and mounted on an articulator (Denar Mark II, Water Pik Technologies Inc, Anaheim, CA, USA) in the same relationship as the working casts. A stone index attached to the mandibular member of the articulator recorded the positions of the maxillary anterior teeth of the first denture. The original set of dentures was duplicated in laboratory-addition-cured silicone (Sherasil, Werksfoff-Technologie GmbH & Co. KG, Lemförde, Germany), which produced acrylic bases and wax teeth. The maxillary acrylic base with wax teeth was mounted in the articulator with the stone index. The maxillary anterior teeth were set up with the stone index. The stone index was then replaced with the mandibular working cast, on which the mandibular acrylic base with wax was positioned. The remaining mandibular anterior wax teeth were replaced with identical mandibular anterior prosthetic teeth. The wax posterior teeth were replaced by prosthetic posterior teeth with the allocated occlusal form. The dentures were processed according to standard prosthodontic practices.

The participants were not informed of the type of occlusal form provided or the sequence in which they were allocated. We prevented direct comparisons with the 2 duplicate sets of dentures by withholding them during the trial period. It was not possible for the prosthodontist to be blinded to the type of occlusal scheme given.

The General Linear Model (GLM) repeated-measures procedure provided analysis of variance (ANOVA), because the same measurement was made 3 times on each participant (Nelder and Wedderburn, 1972). The null hypothesis was tested by the general linear model procedure for both between-participant factors and within-participant factors. The repeated-measures p-values with Greenhouse-Geisser adjustment for lack of sphericity were completed with different statistical models, and the range of these was considered (Greenhouse and Geisser, 1959). If the values were not significant ($p > 0.05$), no further analysis was conducted. Otherwise, we used paired *t* tests to determine where the differences between and among the interventions lay.

RESULTS

The results of this trial were analyzed with SPSS (Statistical Package for the Social Sciences, SPSS, Inc., Chicago, IL, USA), version 12.01.

Fifty edentulous individuals were assessed for eligibility, with five being excluded from enrollment because they refused to participate (Fig.). The remaining 45 individuals were randomly assigned to one of six intervention groups (Table 1). In total, data from 41 individuals were used in the analysis.

There were no protocol deviations from the study as planned. The duration of the clinical trial was from May, 2002, until April, 2004.

Forty-one out of 45 participants were included in the study analysis (Fig.). Two of the participants, one male and one female, were lost to follow-up because they refused to continue with the research. One male and one female were too ill to participate further, and were therefore removed from the trial. These persons' pre-intervention scores were not included in the analysis.

The data recorded from the VAS were measurements in millimeters, made from the start of the horizontal lines on the lefthand side to the vertical lines drawn by the participants (Table 2).

The test complete dentures required a period of adjustment prior to the eight-week trial period. The dentures provided with anatomic posterior teeth required a mode of 3 adjustments (range, 0-12), the dentures provided with lingualized posterior teeth required a mode of 3 adjustments (standard deviation, 0-14), and the dentures provided with zero-degree posterior teeth required a mode of 3 adjustments (range, 0-15).

The GLM repeated-measures procedure provided ANOVA comparing the 3 interventions (Table 3). There were significant differences among the groups for appearance, cleaning, and chewing. We conducted paired *t* tests to see where these differences lay. There were significant differences for appearance and chewing with anatomic and lingualized compared with zero-degree. There was a significant difference with lingualized compared with zero-degree for cleaning.

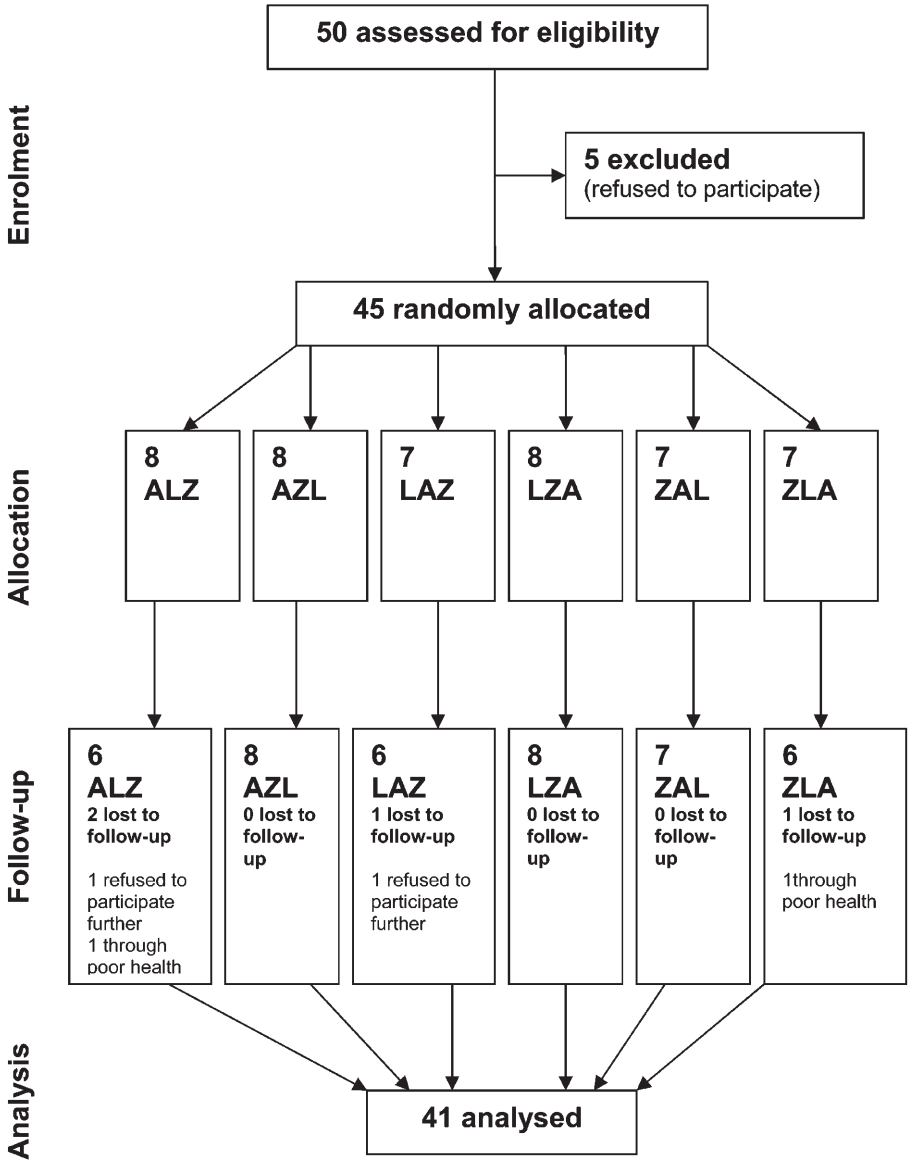

Figure. Flow diagram of the progress through the phases of the randomized trial. Key: A = Anatomic posterior teeth; L = Lingualized posterior teeth; Z = Zero-degree posterior teeth.

DISCUSSION

The null hypothesis—that there is no variation in the level of participant satisfaction for 3 different types of posterior occlusal forms for complete dentures—was rejected.

The chewing function of the complete dentures provided with lingualized and anatomic posterior occlusal forms was preferred significantly over that of zero-degree posterior occlusal forms ($p = 0.004$ and $p = 0.001$, respectively). These findings were similar to the results of an earlier randomized controlled trial, where statistically significant improved masticatory ability was reported with lingualized posterior occlusal forms in comparison with zero-degree posterior occlusal forms (Clough *et al.*, 1983). Less force has been observed to be required to masticate through the bolus with

Table 1. Frequency Distribution of Participant Demographics for Each Group at Baseline

Order Dentures Allocated	Frequency	Percent	Mean Age (SD)	Gender, M:F
A L Z	8	17.8	57.6 (20.2)	3:5
A Z L	8	17.8	66.1 (9.1)	2:6
L A Z	7	15.6	69.8 (8.2)	2:5
L Z A	8	17.8	66.9 (7.6)	2:6
Z A L	7	15.6	72.7 (3.8)	3:4
Z L A	7	15.6	64.2 (8.9)	2:5
Total	45	100.0	66.2 (12.6)	14:31

Key:
A = Anatomic posterior teeth.
L = Lingualized posterior teeth.
Z = Zero-degree posterior teeth.

Table 2. Means (standard deviations) of the Visual Analogue Scale Data at Baseline and Following Intervention (41 participants) in Millimeters

Functional Characteristic	Baseline	Intervention		
		Anatomic	Lingualized	Zero-degree
Appearance	36.6 (33.5)	73.2 (26.0)	77.1 (21.2)	58.9 (37.6)
Cleaning	56.9 (36.4)	82.4 (19.0)	86.2 (18.4)	68.4 (35.9)
Stability	10.6 (16.1)	74.9 (25.5)	77.0 (22.9)	71.2 (30.6)
Speech	32.3 (33.2)	71.1 (24.5)	78.1 (21.8)	78.8 (21.8)
Chewing	11.4 (17.3)	71.7 (29.3)	68.3 (27.2)	49.6 (38.1)

Table 3. P-values from the Repeated-measures Analysis and from Paired *t* Tests Comparing the Follow-up Scores for the Intervention Groups for Each Functional Characteristic Measured, by Visual Analogue Scale Scoring

Functional Characteristic	Repeated-measures p-values*	Paired *t* Tests		
		Anatomic *vs.* Lingualized	Anatomic *vs.* Zero-degree	Lingualized *vs.* Zero-degree
Appearance	0.027†	0.38	0.047†	0.023†
Cleaning	0.029†	0.28	0.061	0.021†
Stability	0.40	0.56	0.47	0.20
Speech	0.15	0.19	0.07	0.79
Chewing	0.002†	0.57	0.001†	0.008†

* With the Greenhouse-Geisser adjustment.
† p-value ≤ 0.05.

teeth having cusps than with zero-degree teeth. The teeth with cusps had a reduced surface area of contact compared with zero-degree teeth, and it was concluded that they required a reduced chewing force to penetrate food (Hickey *et al.*, 1963).

The appearance of the complete dentures provided with lingualized and anatomic posterior occlusal forms was preferred significantly over that of the complete dentures with zero-degree posterior teeth ($p = 0.047$ and $p = 0.023$, respectively). Both the maxillary lingualized and anatomic posterior denture teeth have shapes that are more like natural teeth.

Those complete dentures with lingualized occlusal surfaces were judged to be significantly easier to clean compared with the dentures having zero-degree teeth ($p = 0.021$). It may be that food remnants were removed more easily from the modified occlusal surfaces of the lingualized mandibular posterior teeth, because of the reduced fissure patterns of the occlusal surfaces, with food clogging the zero-degree teeth fissure patterns more readily.

There were no statistically significant differences detected between the anatomic and lingualized posterior occlusal forms in this trial. The lingualized posterior occlusal forms may have been sufficiently similar to the anatomic occlusal forms to account for this.

Guidelines in Prosthetic and Implant Dentistry, produced by the British Society for the Study of Prosthetic Dentistry, were used as the technical standard for the complete dentures constructed in this study (Ogden, 1996). The work of van Waas (1990) and Beck *et al.* (1993) has shown the important contributions of technical factors in producing successful treatment outcomes with complete dentures. Since all of the clinical stages were carried out by one prosthodontist (AFS), and all of the technical stages of the denture production were carried out by a single laboratory technician, clinical and technical consistency was ensured. The randomization of the dentures ensured that any minor differences owing to the duplication procedure were minimized.

VAS have a long-established record for measuring people's general satisfaction with oral clinical interventions. These scales have been shown to be valid and reliable instruments in previous studies (de Grandmont *et al.*, 1994; Feine *et al.*, 1994; Tang *et al.*, 1997; Awad and Feine, 1998; de Albuquerque Junior *et al.*, 2000; Awad *et al.*, 2003).

The duration of the trial period for each of the sets of dentures was 8 wks. Ideally, this period would be longer, possibly up to 1 yr for each set of complete dentures. A six-month trial period for 2 sets of dentures has been reported by Shetty (1984). However, this would have seriously limited the practicality of this trial with 3 sets of dentures, in the following ways:

- Recall of the participants may have become problematic.
- Changes may have occurred with the participants' denture-bearing areas.
- Reproducibility of the trial by other centers would be less practical.

It was impossible to blind the participants to the trial allocation. However, we minimized the effect of this by withholding the other 2 sets of dentures while the allocated set was being tested, thus preventing the participants from direct visual comparison.

It was impossible to blind the prosthodontist to the type of intervention given to each participant. The bias this may have caused was minimized by the design of the trial, whereby each participant received different occlusal forms in a cross-over randomized order.

Within the limitations of this research, individuals wearing complete dentures provided with either lingualized or anatomic posterior occlusal forms had a significantly higher level of self-perceived satisfaction compared with those given zero-degree posterior teeth. The choice of posterior occlusal forms for complete dentures rests with the clinician in discussion with his/her technician; however, it seems sensible that the least complicated approach should be the guiding principle in occlusal reconstruction for complete dentures.

The results of this research are probably valid externally, when complete dentures are constructed to high technical standards.

The findings of this study suggest that the participants significantly preferred posterior occlusal schemes with anatomic and lingualized teeth, compared with cuspless teeth. This RCT has provided essential evidence-based treatment information that clinicians need to provide the highest level of care for their patients.

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