THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL RESEARCH

Effect of denture adhesive on masticatory function and quality of life of distal extension removable partial denture wearers: A randomized crossover clinical trial

Zuila Maria Lobato Wanghon, DDS, MSc,[a] Leocadia Maria Kaminscki, DDS,[b] Henrique César Schimitz Gassen, DDS,[c] Isabela Kendra Rodrigues Oliveira, DDS,[d] Bruno Manoel Medeiros e Silva, DDS,[e] Luiz Otávio de Oliveira Pala, MSc, PhD,[f] and Thais Marques Simek Vega Gonçalves, DDS, MSc, PhD[g]

ABSTRACT

Statement of problem. Distal extension removable partial dentures (RPDs) often exhibit rotational movements that compromise stability, comfort, and mastication. Although denture adhesives (DAs) can improve retention, their effectiveness for RPD remains uncertain.

Purpose. This study evaluated the effects of daily DA use on mastication, rotational movements, quality of life, and satisfaction in mandibular distal extension RPD wearers.

Material and methods. A randomized, crossover clinical trial was conducted with 16 participants (mean age 66 ±9.2 years), all rehabilitated with new prostheses (maxillary complete denture and bilateral distal extension mandibular RPD). After an adaptation period, baseline measurements were obtained for masticatory performance (sieving test – X_{50}), broadness variable (b), rotational movements (VAS and yes/no), quality of life (OHIP-14), and satisfaction (VAS). Participants used either DA and no DA for 30 days, followed by a 7-day washout and crossover. Final measurements were obtained after the second 30-day period. Data were analyzed with Shapiro-Wilk, repeated measures ANOVA, and Bonferroni post hoc tests (α=.05).

Results. Daily DA use significantly reduced rotational movements (P=.025), with improved masticatory performance (P=.02), broadness (P=.04), satisfaction (up to 34.3%) (P<.05), and quality of life, especially in functional limitation and physical pain domains (P<.05).

Conclusions. This clinical trial provides robust evidence supporting the use of DA for mandibular distal extension RPD wearers. Regular DA use significantly improves mastication and quality of life, highlighting its value as a simple and effective adjunct in prosthodontic care. (J Prosthet Dent 2026;135:787.e1-e8)

Partial edentulism remains highly prevalent worldwide, particularly in Latin America and the Caribbean.[1–3] Although preventive oral care has reduced complete edentulism, the number of partially edentulous individuals continues to rise.[4,5] Approximately 19% of adults wear dentures, most of whom use partial rehabilitations (60%),[5,6] with the aging population further increasing the need for prosthodontic treatment to restore mastication and quality of life.[7–9]

Removable partial dentures (RPDs) are widely used, cost-effective solutions to restore function and esthetics.[10]

Supported by the Coordination for the Improvement of Higher Education Personnel (CAPES) and Foundation for the Support of Research and Innovation in the State of Santa Catarina (FAPESC) through postgraduate scholarships. Additionally, the denture adhesives were donated by Haleon.
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
[a]Graduate Student, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[b]Graduate student, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[c]Graduate Student, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[d]Graduate Student, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[e]Graduate student, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[f]Professor, Department of Statistics, Institute of Exact Sciences and Technology, Federal University of Lavras (UFLA), Lavras, MG, Brazil.
[g]Professor, Department of Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.

Clinical Implications

Daily DA use offers an accessible strategy to improve function and quality of life of distal extension RPD wearers. Further long-term studies are needed to assess the effects of DA use on abutment teeth and prosthesis longevity and to guide routine clinical recommendations.

However, distal extension RPDs present biomechanical challenges[11–13] because of differences between mucosal resilience and periodontal support, that can cause prosthesis micromovements.[12,13] These movements may be intrusive, with the denture base compressing the mucosa during the mastication of hard consistency foods (distal rotation), or extrusive, as observed when masticating sticky foods (mesial rotation).[13] Although indirect retainers can mitigate these movements, their effectiveness varies with residual ridge morphology and resin base extension.[12,13] Persistent displacement may lead to food impaction, mucosal trauma, abutment teeth overload, and bone resorption, compromising prosthetic longevity,[11,13,14] and ultimately leading some patients to discontinue use.[15]

Previous studies[10–13,16] have demonstrated that implant-assisted RPDs significantly reduces rotational movements and improve mastication, dietary intake, patient satisfaction, and quality of life. However, anatomic, systemic, surgical, or financial constrains may limit the feasibility of implant placement.[14] In this context, denture adhesives (DAs) represent a simple, noninvasive, and accessible alternative that enhances retention and stability of the removable prosthesis, widely recommended for complete denture wearers.[17–19] Their synthetic polymers swell in saliva and create molecular cross-links, improving retention and stability.[20–22] Despite these promising properties, the clinical effects of daily DA use in distal extension RPD wearers, particularly regarding masticatory function, remain underexplored. The authors are unaware of clinical trials that have specifically assessed this relationship. One in vitro study[23] reported improved retention of distal extension RPDs after DA application, with results influenced by the quantity and location of the DA application. In addition, a recent clinical trial[24] indicated reduced food impaction under the resin base of distal extension RPDs after DA use. Therefore, this randomized, crossover, and controlled clinical trial aimed to evaluate the effects of daily DA use on masticatory function, rotational movements, patient satisfaction, and quality of life in individuals wearing mandibular distal extension RPDs. The null hypothesis was that no significant differences would be found in any of the outcomes following DA use for this population.

MATERIAL AND METHODS

This randomized, crossover, single center, controlled clinical trial was approved by the Research Ethics Committee of the Federal University of Santa Catarina (Florianópolis, Brazil) (CAAE: 49986621.2.0000.0121) and registered at the Brazilian Registry of Clinical Trials (#RBR-6gpv7vs). Written informed consent was obtained from all participants prior to enrollment. The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines. The independent variable was daily use of DA, whereas the primary outcome was masticatory performance. Secondary outcomes included the broadness variable (b), rotational movements, patient satisfaction, and oral health-related quality of life.

The required sample size was estimated based on effect size data obtained from a previous controlled study,[11,13] in which the masticatory performance of the same participant was evaluated before and after the conversion of a conventional RPD into an implant-supported RPD. This prior comparison was used because no published studies evaluating DA in mandibular distal extension RPD wearers were available at the time of planning the present investigation. In that study,[11,13] a mean difference of 0.3 mm in median particle size (X_{50}) (standard deviation: 0.5 mm) was observed between the two conditions. Using these values, a two-tailed paired t-test with 80% power and a 5% significance level indicated that 14 participants would be required. To account for an anticipated 10% attrition rate, a total of 16 participants were recruited (8 per group).

Volunteers of any sex or ethnicity who sought care at the Dental Clinics of the Federal University of Santa Catarina were screened by the researchers. Participants enrollment began in November 2023 and concluded in January 2025. Eligible participants (aged from 50 to 90 years old) were completely edentulous in the maxilla and partially edentulous in the mandible (pure Kennedy Class I without modifications). All had their incisors present, with dentition ranging from one canine to both canines and one premolar, resulting in a total of 5 to 7 remaining teeth. Exclusion criteria included prior DA use in the old RPD, known allergy to DA components, parafunctional habits, temporomandibular disorders (as defined by the RDC/TMD), uncontrolled systemic diseases, cognitive or neurological impairments, stroke, traumatic brain injury, Parkinson's or Alzheimer's disease, and tobacco or alcohol use. All participants provided written informed consent.

All clinical procedures and data collection were conducted at the Clinics of the Federal University of Santa Catarina. During the initial appointment, participants underwent clinical and radiographic examinations, including assessment of alveolar ridges, remaining teeth, oral mucosa, and muscle attachments. Periapical and

panoramic radiographs were obtained to confirm suitability for prosthetic planning before impression and cast fabrication.

All prostheses were fabricated using conventional techniques.[13,25] A similar RPD design (continuous Kennedy bar or lingual plate bar) was applied to all prostheses, based on anatomical considerations. Following specific tooth preparation, definitive impressions were made with alginate (Cavex Cream; Cavex), and casts were poured with type IV dental gypsum (Zero One; Dentona). Cobalt chromium (Co-Cr) frameworks were fabricated and evaluated clinically. Intermaxillary relationships were recorded, casts mounted on a semi-adjustable articulator (4000-S; BioArt) using a facebow (4000-S; BioArt), and artificial teeth (Silver; Defama) arranged for trial evaluation. After approval, the prostheses were processed (Diamond D; Keystone), finished, installed, and adjusted to achieve balanced bilateral occlusion. Follow-up appointments occurred at 7, 15, and 21 days for adjustments. After at least 30 days of continuous prosthesis use and once the patient reported full adaptation with no complaints, baseline measurements were recorded.

Following baseline assessment, participants were randomized for Phase 1 using a computer-generated randomization sequence (Excel; Microsoft Corp) and opaque sealed envelopes to ensure allocation concealment. Randomization was stratified by sex and conducted by an independent researcher (HCSG) not involved in data collection or prosthesis fabrication. Participants in the experimental group received standardized instructions for applying the cream DA (Ultra Corega; Haleon) twice a day – one hour before lunch and dinner – following manufacturer guidelines. Before application, the prosthesis was cleaned and dried, and approximately 1 cm of DA was applied directly to the resin base bilaterally in the posterior region, 2-cm anterior to the retromolar pad (Fig. 1). Following application, the RPD was inserted and pressed into occlusion for 10 seconds. Participants also received detailed oral hygiene instructions regarding the cleaning of both the dentures and remaining natural teeth. In the control group, no DA was used for 30 days during Phase 1, after which all variables were assessed. Following a 7-days wash-out, groups were crossed over: previous nonusers began DA use, while prior users discontinued it for 30 days. Final evaluations were then performed (Fig. 2). All data collection were conducted by a single blinded examiner (ZMLW).

Figure 1. Application of denture adhesive in central part of acrylic resin base of distal extension removable partial denture (RPD).

Masticatory performance – measured as the median particle size (X_{50}) and broadness variable (b) – was evaluated using an artificial test material (Optocal).[11,26,27] The material, based on Optosil silicone (Kulzer GmbH), was prepared by modeling into cubic matrices (5.6-mm edge).[26–31] After polymerization, the cubes were demolded, individually weighed to ensure uniformity, and stored in an oven at 65 °C for 16 hours.[27] The cubes were then divided into standardized portions of 17 cubes (3.7 cm^3) and stored in sealed containers until the testing.[26,27,29] Participants were instructed to masticate each portion naturally for 40 cycles, while the researcher counted the number of cycles.[26,29,31,32] The comminuted material was collected, washed, and dried in an oven at 80 °C for 25 minutes.[33] The dried particles were then sieved through a stack of 10 mesh screens from 0.5 and 5.6 mm (Bertel Industria Metalurgica) for 2 minutes at 2 Hz. [26] The weight of particles retained on each sieve was determined using a precision scale (S203, Bel) with accuracy of 0.001 g.[26,29] The masticatory performance (multiple sieves) was quantified using the Rosin-Rammler equation (nonlinear regression analysis): $Q_w^-(X)=1-(2_{50}^{X/X})^b$), where Q_w^- is the percentage by weight of particles with a diameter smaller than X; X_{50} is the median particle size and corresponds to the opening of a theoretical sieve through which 50% by weight of total masticated material would pass; and b represents the broadness variable (particle size distribution throughout the sieves).[9,26]

The perception of posterior rotational movement of the mandibular distal extension RPD was subjectively assessed using a questionnaire adapted from Kimoto et al.[33] The instrument comprised 4 questions, 3 of which were answered using a visual analog scale (VAS): 2 ranging from "completely dissatisfied" to "completely satisfied," and one ranging from "not at all bothered" to "extremely bothered."[33] The remaining question required a dichotomic "yes" or "no" response. The following questions were asked: *(1)* What is your degree of satisfaction with your lower denture?, *(2)* What is your degree of satisfaction with your ability to chew food?, *(3)* Does the posterior region of your lower dentures rise when you chew?, and *(4)* How much does this movement of your lower dentures bother you?[33,34] The 3 VAS-based questions were considered to calculate mean score, where lower values indicated greater perceived rotational movements.

Oral health-related quality of life (OHRQoL) was assessed using the validated Portuguese version of the Oral Health Impact Profile (OHIP-14).[35–37] This

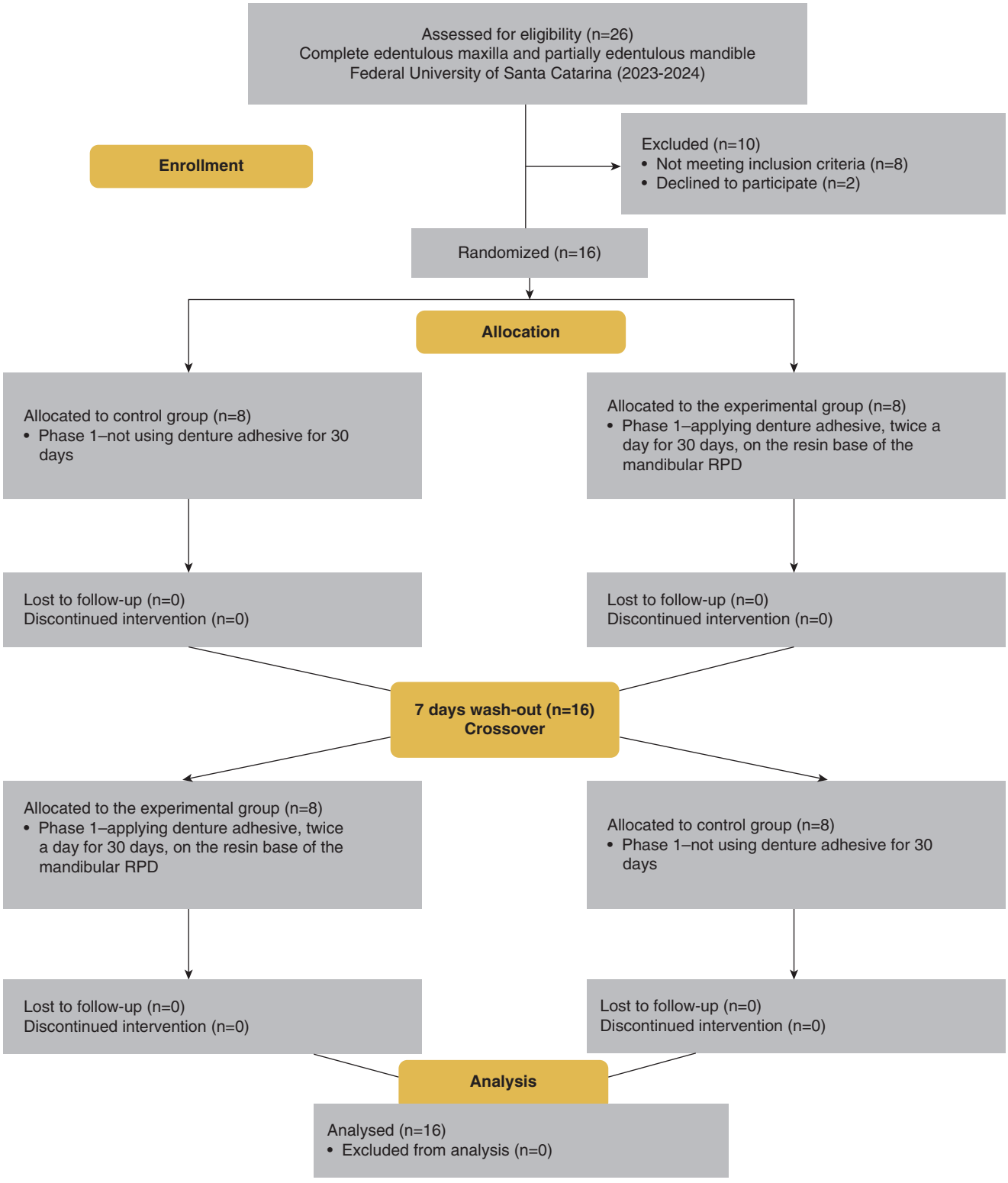

Figure 2. Flow diagram of crossover randomized clinical trial (RPD, removable partial denture; VAS, visual analog scale).

instrument, developed for edentulous patients, consists of 14 items distributed across 7 conceptual domains: functional limitation, physical pain, psychological discomfort, physical limitation, psychological limitation, social limitation, and disability.[35–37] Participants rated the frequency of each item experienced in the previous month using a 3-point Likert scale (0=never; 1=sometimes; 2=almost always). The total score ranges from 0

(very positive OHRQoL) to 38 (very negative OHRQoL).[35–37]

Patient satisfaction with the prosthetic treatment was evaluated using a specific questionnaire composed of 7 items addressing retention and stability, comfort, appearance, mastication capacity, phonation, and cleaning.[38] Each item was rated on a 100-mm VAS anchored by "completely unsatisfied" to "completely satisfied."[38] Participants were instructed to mark their perceived satisfaction by drawing a vertical line across the horizontal scale for each question. The questionnaire was applied individually, with the examiner clarifying any doubts. Lower mean values indicated reduced satisfaction in the respective domains.[38]

The data distribution was assessed using the Shapiro–Wilk test, which confirmed normality for all variables. In this crossover study, preliminary analysis indicated no significant interaction between the 2 experimental periods (P>.05); therefore, data from both periods were pooled. Comparisons among the 3 conditions – baseline, no DA, and DA use – were performed using repeated measures analysis of variance (ANOVA) with the Greenhouse-Geisser correction, if necessary, followed by Bonferroni post hoc test for multiple comparisons. The sphericity assumption was checked with Mauchly's test. In addition, a repeated-measures ANOVA, considering age, number of teeth, and their interactions as covariates was also performed, but no significant effect was observed for age (P=.06) or number of teeth (P=.622). The effect of the intervention was significant (P=.0017), indicating a difference among the means of at least one of the evaluated conditions. For this analysis, the Greenhouse–Geisser correction was applied, given that the null hypothesis of sphericity was rejected by Mauchly's test (P=.037). All statistical analyses were conducted with the EZ package in R (R Core Team) (α=.05). The statistician (LOOP) was blinded to the study phase during analysis to minimize bias.

RESULTS

The study flowchart is presented in Figure 2. A total of 26 individuals were initially screened for eligibility. After detailed anamnesis and clinical examination, 10 individuals were excluded for not meeting the inclusion criteria. The remaining 16 participants (12 women, 4 men; mean age: 66 ±9.2 years, ranging from 55 to 85 years) were randomized into the 2 groups, balanced for age and sex. No dropouts occurred following randomization. The characteristics of the sample are summarized in Table 1.

Masticatory performance significantly improved with DA use. Reductions in median particle size (X_{50} values) (P=.02) and the broadness variable (b value) (P=.04) indicated enhanced comminution ability (Table 2). The subjective analysis of the rotational movements is presented in Table 3 and 4. Before DA use, 9 of the 16 participants reported perceiving rotational movements of the mandibular distal-extension RPD, whereas after DA use, no participants reported such movement (P=.03). The VAS-based questionnaire revealed significant increases in satisfaction with mandibular denture stability (P<.001) and ability to masticate (P<.001); along with a significant reduction in discomfort during mastication (P=.003). No significant differences were observed between baseline and the phase without the DA (P>.05).

To ensure the validity of the repeated measures ANOVA, all underlying statistical assumptions were evaluated. Table 3 presents the results of the normality and sphericity assessments, confirming the appropriateness of the applied analytical model. In addition, the mean values and standard deviation for all subjective and patient-centered outcomes were detailed in Table 4.

Considering the results from OHIP-14, DA use significantly improved overall quality of life, particularly in

Table 1. Characteristics of study participants

Sex	Number (%)
Female	12 (75)
Male	4 (25)
Race	
White	7 (43.7)
Brown or mixed-race	6 (37.5)
Black	3 (18.8)
Education Level	
Complete elementary	6 (37.5)
Complete high school	4 (25)
Incomplete high school	3 (18.75)
Incomplete elementary	2 (12.5)
Complete higher education	1 (6.25)
Oral characteristics	
Number of remaining mandibular anterior teeth	6.12 (±0.73)
5 teeth	4 (25)
6 teeth	8 (50)
7 teeth	4 (25)
Prosthesis characteristics	
Abutment devices	
T-bar clasps	14 (87.5)
Circumferential and T-bar clasps	2 (12.5)
Major connectors	
Lingual plate	11 (68.8)
Double lingual bar	5 (31.2)

Table 2. Mean ±standard deviation value for masticatory performance (X_{50}, mm) and broadness variable (b, mm)*

	X_{50}	Broadness Variable (b)
Baseline	5.41 ±1.02 A	4.73 ±2.29 A
Without Adhesive	5.20 ±0.97 A	4.01 ±1.85 A
With Adhesive	4.44 ±1.04 B	2.90 ±0.76 B

* Uppercase letters indicate differences among each phase of study. For masticatory performance (X_{50}) - Mauchly's Test of Sphericity (P=.448); Shapiro Wilk (P=.219); Repeated measured ANOVA with Greenhouse-Geisser correction (P=.0007), followed by Bonferroni post hoc (P<.05). For broadness variable (b) - Mauchly's Test of Sphericity (P=.521); Shapiro Wilk (P=.194); Repeated measured ANOVA (P=.002), followed by Bonferroni post hoc (P<.05).

Table 3. Repeated measured ANOVA and their respective assumptions of normality and sphericity (Maunchly and Shapiro-Wilk (α=.05))

Subjective Outcome	Specific Domains	*P* Mauchly Test of Sphericity	*P* Shapiro-Wilk	*P* Repeated Measures ANOVA
Rotational Movements	Perceived RPD movement	.460	.07	.011
	Ability to chew	.851	.09	<.001
	Discomfort with the RPD movement	.895	.075	.001
	Satisfaction with the mandibular RPD	.276	.255	<.001
OHIP–14 domains	Functional Limitation	.413	.462	<.001
	Physical pain	.270	.271	<.001
	Psychological discomfort	-	.554	.002
	Physical disability	-	.245	.003
	Psychological limitation	-	.005*	.068
	Social Disability	-	.129	.11
	Handicap	-	.231	.096
Patient Satisfaction	General	.018	.331	<.001
	Retention	.197	.408	<.001
	Comfort	.748	.117	<.001
	Masticatory capacity	.0005	.528	<.001
	Speech	.237	.119	<.001
	Appearance	.064	.186	.027
	Cleaning	.836	.158	.193

Removable partial denture (RPD).

* In case of statistical significance, the repeated measured ANOVA with the Greenhouse-Geisser correction was applied, followed by Bonferroni post hoc ($P<.05$).

Table 4. Mean (±standard deviation) observed for subjective patient-centered outcomes regarding each phase of the study

Subjective Outcome	Specific Domains	Baseline	Without Adhesive	With Adhesive
Rotational Movements	Perceived RPD movement	0.38 ±0.5 A	0.38 ±0.5 A	0.06 ±0.3 B
	Ability to chew	54.5 ±16.0 A	65.3 ±18.4 A	94.6 ±7.5 B
	Discomfort with the RPD movement	66.4 ±30.2 A	76.7 ±28.4 A	98.4 ±5.1 B
	Satisfaction with the mandibular RPD	58.7 ±16.3A	66.4 ±21.6 A	95.4 ±9.7 B
OHIP–14 domains	Functional Limitation	3.81 ±1.6 A	2.75 ±1.6 A	0.94 ±0.9 B
	Physical pain	4.69 ±1.3 A	3.25 ±1.2 B	2.19 ±0.7 C
	Psychological discomfort	1.44 ±1.3 A	0.31 ±0.6 B	0
	Physical disability	1.50 ±1.3 A	0.44 ±0.6 B	0
	Psychological limitation	0.63 ±1.0 A	0.19 ±0.4 A	0
	Social Disability	0.50 ±1.0 A	0.06 ±0.3 A	0
	Handicap	0.38 ±0.6 A	0.06 ±0.3 A	0
Patient Satisfaction	General	70.1 ±17.8 A	71.5 ±9.3 A	94.7 ±5.7 B
	Retention	62.6 ±20.9 A	62.6 ±15.6 A	98.7 ±3.9 B
	Comfort	59.6 ±22.5 A	60.3 ±20.2 A	96.3 ±7.4 B
	Masticatory capacity	58.8 ±23.9 A	58.4 ±11.2 A	96.7 ±5.4 B
	Speech	73.2 ±26.4 A	74.9 ±23.1 A	93.7 ±12.7 B
	Appearance	93.3 ±10.9 A	97.6 ±5.8 AB	99.6 ±1.5 B
	Cleaning	77.9 ±25.7 A	87.4 ±17.0 A	79.9 ±20.4 A

Removable partial denture (RPD). * Uppercase letters indicate differences among each phase of study. Mauchly's Test of Sphericity; Greenhouse-Geisser correction (if necessary), Shapiro Wilk; Repeated measured ANOVA, followed by Bonferroni post hoc ($P<.05$).

the domains of functional limitations and physical pain (Table 4). Compared with baseline, improvements were also noted in physical pain, physical limitation, and psychological discomfort even in the phase without DA use. No significant differences were found in the remaining domains across study phases (Table 3). In terms of patient satisfaction, regular use of DA significantly improved all satisfaction domains, except for appearance and cleaning, which remained unchanged (Tables 3, 4).

DISCUSSION

To the authors' knowledge, no previous clinical study with comparable methodological rigor has confirmed the benefits of DA on masticatory function, quality of life, and satisfaction among distal extension RPD wearers. Thus, the null hypothesis was rejected, since DA use led to a marked reduction in perceived prosthesis rotation, likely contributing to improvements in function and patient-reported outcomes. The randomized crossover design enabled intraindividual comparisons, minimizing confounding variables, while randomization strengthened causal inference. Additionally, the use of validated and reproducible methods for masticatory analysis further enhanced the reliability of the findings.

In terms of masticatory outcomes, daily DA use significantly improved masticatory function, as demonstrated by reductions in median particle size (X_{50}) and increased uniformity of the particle distribution (b), reflecting consistency and control during mastication.[29,31]

Although no prior studies have evaluated DA use in RPD wearers, these results align with previous studies[12,16] reporting functional gains following the incorporation of implants into distal extension RPDs. These improvements were mainly attributed to increased retention and reduced rotational movements, reinforcing the relationship between prosthesis stability and mastication.[12,16] This similarity suggests that DA may offer functional advantages approaching those of implant-supported RPDs, while remaining noninvasive and more accessible option.

In prosthodontics, patient-reported outcomes are crucial, as they reflect how well treatment meets individual expectations for function, esthetics, and comfort.[6,15] Their evaluation ensures that rehabilitation extends beyond tooth replacement to delivery personalized and functionally meaningful care.[36] In this study, daily DA use improved oral health-related quality of life, particularly regarding "physical pain" and "functional limitation" domains (Tables 3 and 4). Participants also reported greater satisfaction in retention, comfort, masticatory capacity, speech, and overall experience, whereas appearance and ease of cleaning were minimally affected (Table 4). Although no prior studies have specifically investigated DA use in RPD wearers, a previous systematic review[3] reported that new RPDs alone often yield limited improvements in satisfaction and quality of life – except when esthetic or occlusal factors are markedly enhanced.[3] In the present study, the observed improvements in such OHIP-14 domains, along with increased satisfaction in comfort, retention, and mastication ability, suggested that DA enhances the perceived masticatory experience.[18] The cushioning effect of DA likely contributed to these improvements by distributing occlusal force more evenly and reducing mucosal pressure.[17,18] These findings underscore the clinical relevance of DA use as a simple, accessible, and noninvasive adjunct to improve patient comfort and satisfaction with distal extension RPDs.[4,20]

Despite the fact that DA use could impair prosthesis hygiene,[17] no negative effects on satisfaction with appearance or cleanliness was observed, suggesting that functional benefits outweighed any added cleaning effort and reflecting strong patient acceptance.[3] Furthermore, the wide age range of participants (55 to 85 years) and differences in the number of remaining teeth could be considered as confounding factors and influenced masticatory performance. However, this was mitigated by the paired study design, in which each participant served as their own control. Moreover, the additional analysis considering age and number of teeth as covariates confirmed no significant interactions with masticatory outcomes, indicating that the benefits of DA were consistent across different patient profiles.

Standardized RPD designs (continuous Kennedy bar or a lingual plate bar) and the inclusion of pure Kennedy Class I arches, minimized anatomical and prosthetic variability, reinforcing internal validity. However, limitations include the specific patient population (edentulous maxilla and partially edentulous mandible) and the short-term evaluation period (30 days), limiting conclusions regarding long-term effects of DA use. Prosthesis quality and basal area coverage influenced adhesive distribution, and some participants reported mild difficulty removing and cleaning the prosthesis and remaining teeth. Additionally, the absence of digital biomechanical measurements (e.g. intraoral scanners or occlusal force mapping devices) restricted more detailed analyses. Future clinical trials incorporating digital assessment methods and longer follow-up periods are encouraged to better understand the long-term effects of DA use on RPD biomechanics, abutment teeth health, and prosthesis longevity.

CONCLUSIONS

Based on the findings of this randomized crossover clinical trial, the following conclusions were drawn:

1. Daily DA use by distal extension RPD wearers significantly reduced rotational movements and improved masticatory function, with enhanced patient-reported outcomes, increasing patient satisfaction and oral health-related quality of life.
2. These findings support the use of DA as a noninvasive, cost-effective adjunct therapy to improve function and comfort of distal extension RPD wearers.

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Corresponding author:
Dr Thais Marques Simek Vega Gonçalves
Department of Dentistry
Federal University of Santa Catarina R. Eng. Agronômico Andrei Cristian Ferreira, s/n -Trindade, Florianópolis, SC 88040–900
BRAZIL
Email: thais.goncalves@ufsc.br

CRediT authorship contribution statement

ZML Wanghon: Conceptualization, Methodology, Data acquisition, Investigation, Manuscript writing – original draft. **L Kaminscki:** Methodology, Data acquisition, Formal analysis, Writing - review and editing. **HCS Gassen:** Data acquisition, Writing - review and editing. **IKR Oliveira:** Data acquisition, Writing - review and editing. **BMM Silva:** Data acquisition, Writing - review and editing. **LOO Pala:** Data statistical analysis, Writing - review and editing. **TMSV Gonçalves**- General coordinator, Conceptualization, Methodology, Data acquisition, Investigation, Manuscript writing – review and editing, Visualization, supervision, Project administration.

https://doi.org/10.1016/j.prosdent.2025.10.056