
Evaluation of Masticatory Function of Senegalese Patients for Removable Partial Dentures Wearers with Distal Extension Edentulism

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Abstract

Background/Aim. The aim of this study was to evaluate the masticatory function of subjects wearing a metal partial denture restoring Kennedy's class I and II edentulism and to compare them with a control group.

Methods. The evaluation included 68 patients (33 wearers of removable partial metal denture restoring terminal edentulism and 35 dentate control subjects without appliances). Peanut and raw carrot were used as test foods. Video recordings were used to collect values for the number of chewing cycles and chewing times. After passing through the calibrated sieves, a "Mastica" input mask was used to record the average particle size of the chews (D50).

Results. In the 33 subjects with removable partial denture (RPD), 82% of whom had Kennedy class I edentulism and 18% had class II edentulism. Among them, 54.5% were women and 45.5% were men. The age group 46-71 years was predominantly represented in this study with 75.7%. The subjects who had worn their prostheses for 6 months were in the majority with 57.57% of the population. Concerning the length of edentulism (LE), 42.4% had a small LE, 39.4% a medium LE and 18.2% a large LE. For both test foods, the number of chewing cycles was twice as high with RDP wearers compared to the control subjects. For the duration of the sequence, subjects with RDP performed twice as long for the carrot and three times as long for the peanut to make the food suitable for swallowing. The average D50 of RDP subjects was similar to that of the control subjects, i.e. 1.90 mm \pm 0.19 (D50 peanut control: 1.93 \pm 0.5) and 1.74 mm \pm 0.36 (D50 carrot control: 1.79 mm \pm 0.44) for peanut and carrot respectively.

Conclusion. This study revealed that subjects with RPD restoring distal extension edentulism had efficient compensatory chewing with a greater number and time of chewing sequences than randomly selected normodont subjects. The comparative analysis between the chewing kinetic parameters of the RPD wearers and control subjects was statistically significant.

Keywords: Distal extension edentulism, Removable partial denture, Mastication, Masticatory muscle, Granulometry

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Introduction

The removable partial denture (RPD) is highly anticipated for the restoration of good masticatory function in addition to its objectives of replacing missing teeth and preserving the health of existing structures.^{1,2} However, the level of functionality of the RPD is conditioned by the multitude of possible edentulous situations and the different states of the existing paraprosthodontic structures.³ Faced with these disparities, various movements destabilizing removable metal prostheses have been reported by the authors.^{4,5,6}

For RPD restoring terminal edentulism, Tabet describes six fundamental movements including three translational movements and three rotational movements.^{5,6} These different movements impose a specific characteristic on the metal prosthesis restoring a terminal tooth loss and can thus induce a particular physiology of the chewing of the wearers of this type of prosthesis.

Bessadet *et al* have shown that the constraints to which the prosthesis is subjected will differ according to the number of teeth to be replaced and the type of edentulism (recessed or terminal).⁷ In the event of terminal edentulism, these constraints are subject to defects in the stability of the prosthesis which lead to masticatory difficulties and changes in eating habits. In fact, a partially edentulous arch has two support structures of different compressibility, namely the teeth and the fibromucosa. It is accepted that mastication gradually deteriorates from fully dentate maxillae to atrophic edentulous alveolar ridges.⁷

Adaptation to the increasing hardness of food results in an increased number of chewing cycles in normodont subjects.^{7,8,9} So in the partially edentulous, it is predictable to observe variability in mastication depending on the food consumed. The evaluation of masticatory parameters of these partially edentulous subjects, such as the masticatory frequency and the granulometry of the masticated boluses could make it possible to describe the functionality of their mastication. Throughout the literature, lower masticatory performance has been reported in wearers of partial removable prosthesis compared to normodont subjects.^{7,10,11,12}

As part of the prosthetic follow-up, the evaluation of the functionality of the prostheses delivered remains an obligation and more particularly that of the chewing function.

The objective of this study was to evaluate the masticatory function of subjects wearing partial metal dentures restoring terminal edentulism by comparing them with dentate control subjects who did not have appliances.

Methods

Ethical approbation

This study was approved by the ethics committee of the Faculty of Medicine, Pharmacy and Dentistry (Cheikh Anta Diop University, Dakar, Senegal) and followed the guidelines of Helsinki Declaration. The problematics, purpose, objectives and protocol of the study were explained to the subjects. Written informed consent was obtained from all study participating. The barrier precautions for Covid-19 were respected.

Study description

This is a cross-sectional and descriptive study carried out with patients rehabilitated in the prosthesis clinic of Odontology-Stomatology Institute of Cheikh Anta Diop University (Dakar, Senegal). After analyzing the files of patients rehabilitated since 2015, telephone calls made it possible to recruit subjects to participate in this study on a voluntary basis.

Study population

Selection

Patients wearers of removable partial metal denture restoring Kennedy class I or II tooth loss were included in this study. They had to have worn their prosthesis(es) for at least three months since the last post-treatment check-up. These patients had responded positively to the telephone invitation and had given their verbal and written consent to participate in the study.

Patients who wore their prostheses using a prosthetic adhesive, deprived of autonomy or on a special diet were not included in this study. Patients who had control sessions in another structure were excluded from this study.

Sampling

The sample size was determined using the Schwartz formula for descriptive studies with:

$n = (\epsilon \alpha)^2 pq / I^2$ where ϵ = reduced deviation = 1.96; α = risk of error = 0.05; p = theoretical prevalence = 50%. Let $q = 1 - p = 0.50$; I = accuracy = 4%.

A total of 68 patients were included including 33 wearers of removable partial metal prostheses restoring terminal edentulism and 35 dentate control subjects without appliances. Sampling was random, the subjects chosen all had the same chance of being recruited.

Chewing procedures

All subjects included in the study participated in chewing sessions. They were asked to chew two test foods, raw carrots and peanuts. The latter have a different hardness and consistency, therefore of different rheology and are commonly consumed by the study population. In addition, these foods allow easy particle size analysis of masticates from sampled bowls^{7,10}. Each subject was first trained to chew a bite of peanut and carrot as naturally as possible. After thorough rinsing of the mouth with water, they were subjected to chewing three peanut samples and then four calibrated carrot samples.

The peanuts were sampled at 3mm in thickness and 5g in weight. The carrots were calibrated using a punch with a diameter of 3 mm at a weight of 4 g and in size 2 cm in length. The chewing had to continue until he perceived that the bowl was fit to swallow. There, the bite had 2 spells, either it was swallowed, or it was spat out into a cup. The 2 possibilities were performed alternately for each test food. All the sequences were filmed from the mouthing of the sampled bowl until the moment of collection of the masticate in a goblet. After each chewing sequence, the subjects had to rinse their mouth as many times as necessary until the oral cavity was completely empty of all food.

The number of cycles of each chewing frequency were recorded after viewing the videos of the chewing sequences. The masticates after decantation were dried and then passed through a sieve column of decreasing mesh subjected to a laboratory vibrator (figures 1,2).



Figure 1: Laboratory sieve on vibrator



Figure 2: Top view of sieves after vibrating.

After sieving, the content of each sieve is weighed with a precision balance 0.01g Brifit® Digital Pro Scale (An Hui Uni Electronics and Co®). The analysis of the particle size (D50) of the masticates was carried out on a "Mastica" input mask developed from the Rosin Rammler equation (figure 3).¹³

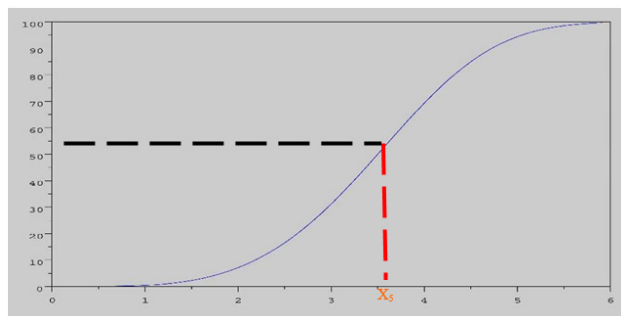


Figure 3: Respective values of the median particle size distribution (X_{50}) and the range of particle size distribution and uniformity (b) of 3.4 mm and 4 obtained and fit to the Rosin- Rammler equation.¹³

Variables

The data relating masticatory cycles, the chewing frequency and the chewing granulometry of the test foods were recorded on a spreadsheet. Excel®.

Statistical analysis

The analysis was carried out on the R® software. The quantitative variables were described with the extremes, the average and the standard deviation and the qualitative variables were described with their relative frequencies. Confidence intervals were

estimated at 95%. Shapiro’s test was used to check the normality of the distribution. Non-parametric tests (Wilcoxon MW, Spearman, Kruskal Wallis) were used in situations where one of the distributions did not follow a normal law. Apart from these situations, parametric tests (Student, ANOVA) were used. The effects associated with our p-value were considered statistically significant at a threshold below 0.05.

Results

The sample consisted of 68 individuals. After reviewing 57 records, 33 edentulous patients’ wearers of removable partial metal denture restoring terminal edentulism responded favorably to participating in this study. For the control group, 35 volunteer subjects dentate without appliances followed the peanut and carrot chewing sequences.

For 33 wearers of removable partial metal denture, women represented 54.5% of the sample with a sex ratio of 0.83, and in control subjects, men represented 54.3% of the sample with a sex ratio of 1, 18. The individuals with RPD in the study were between 27 and 71 years old. The average age was 55.7±4.5 years. Control subjects in the study were between 33 and 80 years old. The mean age of the control subjects was 54.22±6.21 years (table 1).

Table 1: Characteristics of wearers of removable partial dentures (RPD) and normodent subjects according to sex and age.

		Wearers RPD	Normodent subjects	p-value (t-test)
Age (years)	Male	58.9±12.52	55.1±6.27	0.2
	Female	53.9±11.58	53.2±6.18	
Sample Overall		55.7±4.5	54.22 ± 6.21	0.2

The average duration of prosthesis wearing was 14.4±11.97 months. According to the Kennedy classification, 82% of the individuals in our sample were in class 1. Of our sample, 42.4% had an edentulous extent deemed small and 18.2% had an edentulous extent deemed large (figure 4).

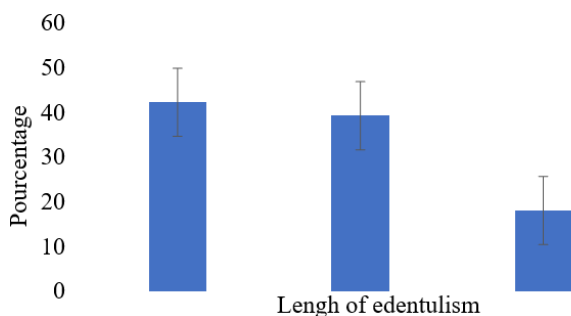


Figure 4: Distribution of individuals according to the extent of edentulousness

Chewing peanuts

The number of cycles found during peanut chewing in subjects with RPD ranged from 51.7 to

296.3 cycles. The average was 129.6±20.97 cycles with a confidence interval between [108.64- 150.58]. For the controls, the number of cycles was 52.9±14.08 cycles. The average number of chewing cycles was significantly lower in the controls than in the wearers of RPD with a p<0.0001 (table 2).

Subjects with RPD had a masticatory frequency for peanuts varied between 0.71 and 2.78 cycles/s. The average was 1.45±0.38 cycles/s, in a confidence interval between [1.31-1.59]. The mean chewing frequency of the controls was 1.70±0.23 cycles/s, with a statistically significant difference (p<0.0006) (table 2).

After chewing the peanut, the particle size (D50) was measured. The D50 was between 1.4 and 2.3 mm. The mean D50 of the subjects with RPD was 1.9 ± 0.19 mm, with a confidence interval between [1.83-1.97].

The average D50 of the control subjects was 1.93 ± 0.5 mm but without any statistically significant difference between the two groups ($p=0.544$) (table 2).

Table 2: Masticatory parameters of peanut for wearers of removable partial dentures (RPD) and normodont subjects.

Masticatory parameters of the peanut	Study subjects (mean \pm standard deviation) [confidence interval]		p-value
	Wearers RPD	Normodont subjects	
Masticatory cycles (number)	129.6 ± 20.97 [108.64 - 150.58]	52.9 ± 14.08 [48.08 - 57.75]	<0.0001
Chewing frequency (cycle/s)	1.45 ± 0.38 [1.32 - 1.59]	1.70 ± 0.23 [1.62 - 1.77]	0.0006
Chewing granulometry- D50 (mm)	1.90 ± 0.19 [1.83 - 1.97]	1.93 ± 0.5 [1.76 - 2.11]	0.544

Chewing raw carrots

In subjects with RPD, the number of raw carrot chewing cycles varied between 40.25 and 286.25 cycles. The average number of cycles was 137.2 ± 19.35 cycles. For the controls, the number of cycles was 68.5 ± 25.44 cycles. The average number of chewing cycles was significantly lower in the controls than wearers of RPD, $p < 0.0001$ (table 3).

Mean carrot chewing frequency was higher in controls (1.72 ± 0.31), and there was a significant difference between the two groups with $p = 0.0058$

(table 3).

The mean D50 after chewing of the carrot by wearers of RPD was 1.74 ± 0.36 mm, in a confidence interval between [1.61-1.86]. There was no significant difference between the two groups ($p=0.624$) (table 3).

In wearers of RPD, both after peanut and raw carrot chewing, there was no statistically significant difference between chewing parameters (masticatory cycles, chewing frequency, and D50) and prosthetic parameters (duration of prosthesis wearing, extent of edentulism) ($p=0.05$)

Table 3: Masticatory parameters of the carrot for wearers of removable partial dentures (RPD) and normodont subjects.

Masticatory parameters of the carrot	Study subjects (mean \pm standard deviation) [confidence interval]		p-value
	Wearers RPD	Normodont subjects	
Masticatory cycles (number)	137.2 ± 19.35 [117.8 - 156.5]	68.5 ± 25.44 [59.2 - 77.9]	<0.0001
Chewing frequency (cycle/s)	1.46 ± 0.47 [1.29 - 1.63]	1.72 ± 0.31 [1.62 - 1.84]	0.0058
Chewing granulometry- D50 (mm)	1.74 ± 0.36 [1.61-1.87]	1.79 ± 0.44 [1.62 - 1.95]	0.624

Discussion

The constraints to which the prosthesis is subjected in the case of a terminal edentulousness are subject to defects in the stability of the prosthesis which lead to masticatory difficulties and changes in eating habits.

This study evaluates the masticatory function of subjects wearing a metal partial denture restoring Kennedy's class I and II edentulism and to compare them with a control group.

For the peanut, the masticatory performance parameters, the number of cycles and the chewing

time observed with the edentulous subjects with RPD are significantly higher than those observed with control subjects. These results show that subjects wearers of removable partial metal denture restoring terminal edentulism need twice as many chewing cycles and three times as long as normodont subjects to obtain a food bolus (peanut) ready to be swallowed. In fact, studies have shown that rehabilitation with RPD only partially restores chewing function.^{11,14,15} However, the masticatory frequency observed with the subjects' wearers of RPD is significantly lower than that of the control subjects. This fact can be explained by the greater disparities in chewing time observed in the subjects fitted with hearing aids and these had a statistical impact on the confidence interval of these subjects [1.32-1.59], which was larger than that of control subjects [1.62-1.77]. Moreover, the correlative analysis shows that the type of prosthesis had a significant influence on the masticatory frequency. This result is in contradiction with facts reported by authors who had shown that with multiple and frequent mandibular movements, a mandibular removable prosthesis was subjected to more destabilizations resulting in insufficient mastication.^{4,5,6} According to the type of prosthesis, the frequency of chewing in patients with removable complete denture/metal removable partial denture was higher and statistically significant than in patients with metal removable partial denture/natural teeth ($p=0.033$). This same difference is observed with the wearers of metal RPD/natural teeth (1.22 cycles/s) and the wearers of metal RPD/resin RPD (2.5 cycles/s). In these two cases, wearers of metal RPD/natural teeth have a lower frequency compared to other types of prostheses. So, subjects with a normodont arch have better masticatory performance. In fact, the fragmentation of a bowl of peanuts in the wearer of a removable prosthesis is a destabilizing factor for the prosthesis, given the rheological nature of this food.

The mean particle size (D50) found is almost similar for the fitted patients and control subjects being 1.9 mm, which is not in line with the results of some studies.^{10,16,17}

With regard to carrot, the same trend as with peanuts is observed for the number of cycles and chewing time. In fact, the fitted subjects do twice

as many cycles and times as the control subjects. Higher values for the number of cycles and chewing time were found in patients with removable complete denture/metal removable partial denture as for the peanuts. These results are similar to those of Moraru et al.¹⁸ and can easily be explained by the instability of the removable complete denture linked to the phenomena of bone resorption.¹⁹ Comparative analysis with control subjects showed a significant difference in the number of cycles, time and frequency of chewing, as with peanuts. The higher activity of the masticatory muscles in wearers of removable prostheses compared to normodont subjects makes it possible to understand this significant difference.²⁰ In addition, a pilot study conducted in patients with removable partial metal denture restoring terminal edentulism revealed fairly long chewing times.¹²

There was no statistical relationship between D50 and prosthetic parameters. However, this similar D50 between the subjects with metal RPD and the control subjects is not in line with the results of Bessadet et al. who had found a D50 in controls higher than the level of metal RPD wearers¹⁰. The chewing performance parameters were significantly higher than those of the control subjects and for the chewing efficiency materialized by the D50 no significant difference was noted. Previous studies showed that metal RPD wearers had moderately or even weakly restored masticatory function.^{21,22}

Conclusion

This study reveals that patients with terminal edentulism rehabilitated by metallic removable prosthesis have an effective mastication by compensation. The masticatory parameters significantly higher than those of normodont subjects in the control group.

Conflict of interest: Authors of this study have no conflict of interest.

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