



Lower gravitational dentures: alternative treatment for atrophic ridges

Dentaduras gravitacionales inferiores: una alternativa en rebordes atróficos

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ABSTRACT

Stability of conventional lower prostheses (CP) is affected by excessive mandibular resorption, the greater weight of a gravitational prosthesis (GP) caused by its combination of metal (internal) and acrylic (external) can increase said stability. **Objective:** In patients with mandibular atrophic ridge, to compare stability, masticatory performance, weight and perception of CP in comparison with GP. **Material and methods:** Informed consent of six adult edentulous patients was requested. Residual lower ridge height was measured in mm. Identical CP and GP were manufactured for each patient: firstly, one was used, and then the other, each one for same periods of time. At the end of prostheses use, a Likert type survey was conducted, as well as analogous visual scale (AVS) measuring clinical stability (Woelfel scale), MP (particle mean size with artificial test foodstuff) as well as prostheses weight in grams. Wilcoxon ranking test was used as well as Spearman's correlations ($p = 0.05$). **Results:** Significant differences were found in the clinical stability test ($p = 0.046$) favoring GP. Correlation among variables analysis indicates that to lesser movement, greater ease for speech and food processing was found. No statistically significant difference was found in MP ($p = 0.893$). **Conclusions:** In spite of limitations imposed by sample size, results indicated that GP were more stable and could represent a suitable treatment alternative for patients who are not candidates for surgery or suffer financial limitations.

RESUMEN

La estabilidad de una prótesis convencional (PC) inferior se ve afectada por una excesiva resorción mandibular; el incremento de peso de una prótesis gravitacional (PG) por su combinación metal (interno) y acrílico (externo) puede aumentarla. **Objetivo:** Comparar la estabilidad, desempeño masticatorio (DM), peso y percepción del paciente con reborde atrófico mandibular de PC contra PG. **Material y métodos:** Se solicitó el consentimiento informado en seis adultos mayores desdentados. La altura del reborde residual inferior fue medida en mm. A cada paciente se le elaboró una PC y una PG (idénticas). Se utilizó primero una y luego la otra; cada una en periodos de tiempos iguales. Al término del uso de cada prótesis se les realizó una encuesta tipo Likert y una escala visual análoga (EVA), midiendo la estabilidad clínica (escala de Woelfel), DM (tamaño medio de partícula con el alimento prueba artificial) y el peso de las prótesis (g). Se utilizó la prueba de rangos de Wilcoxon y la evaluación de correlaciones de Spearman ($p = 0.05$). **Resultados:** La prueba clínica de estabilidad resultó con diferencia significativa ($p = 0.046$) a favor de la PG. El análisis de las correlaciones entre variables indica que a menor movimiento mayor facilidad en el habla y la reducción del alimento. En el DM no se obtuvo diferencia estadísticamente significativa ($p = 0.893$). **Conclusiones:** A pesar de la limitación del tamaño de la muestra, los resultados indican que las PG son más estables y pueden ser buena alternativa de tratamiento para pacientes con limitaciones económicas o no candidatos a cirugía.

Key words: Gravitational prosthesis, lower residual ridge atrophy, Woelfel scale, multiple screening method, prosthetic stability.

Palabras clave: Prótesis gravitacional, atrofia del reborde residual inferior, escala de Woelfel, método de tamizaje múltiple, estabilidad protésica.

INTRODUCTION

All dentists must be aware of the feeling senior citizens experience with respect to the influence of their dental circumstances with their daily life, and request information on whether this affects their quality of life. These patients require competent and empathic professional care, even in cases when process might be difficult or lengthy, since state of mind bears enormous influence on patient's interest in a prosthetic treatment.¹⁻³ Mistakes and dissatisfactions arising in these treatments can have varied and complex causes, ranging from lack of communication between patient and dentists, to the

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Received: November 2016. Accepted: November 2017.

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dental technician's performance of the full treatment. Success of a full prosthesis mainly depends on the base stability degree, which is a result of suitable retention elicited by preserved bone remnant, which must be prosthetically usable. In cases when bone ridges suffered marked resorption, the prosthetic triad of the denture will result compromised.⁴

When teeth are partially or totally lost, mastication, deglutition and food intake might be impaired, representing a risk factor for problems such as dyspepsia.⁵ When placing an artificial denture, masticatory ability is partially restored, and patients can preserve suitable nutrition. Nevertheless, proprioception offered by the periodontal ligament disappears, thus force is uncontrolled and moreover perception of food taste is distorted.⁶⁻⁸ Maximum masticatory load of full denture bearers is five to six times lesser in total denture users when compared to subject with natural teeth.² Groups of patients not wearing dentures, either with teeth or partially edentulous, have been assessed in order to observe MP (degree of trituration a test foodstuff can be subjected to in a given number of masticatory strokes or cycles), or masticatory efficiency (number of additional masticatory strokes or cycles required to achieve suitable trituration by subjects who have lost system integrity).

Another factor subject to study was whether age interfered with the aforementioned parameters. It has been found that natural ageing of the human being is fully related to a decrease in masticatory muscular activity, which per force increases to double the number of masticatory cycles required for the formation of a suitable food bolus.^{2,6,9-11}

MP can be measured in two different manners:

- Subjectively: this method consists in inquiring about subject's perception by means of questionnaires related to his masticatory ability.
- Objectively: with the help of multiple techniques such as measurement of sugar loss in a chewing gum, the colorimetric and photometric methods, optical scanning method of volumetric screening method.^{6,12}

Foodstuffs used for objective evaluation can be natural (carrots, peanuts, soft bread among others) or artificial (heavy polymethylsiloxane). Artificial foodstuff is mostly used in order to circumvent great variation in results, since natural foodstuffs can exhibit variable physical properties (hardness, fracture resistance, size and shape).^{6,11}

The method of multiple volumetric screening (Yurkstas and Manly 1950) measures the volume of artificial foodstuff particles, since they are made to traverse a tower of screens with different mesh openings.¹⁰

Hardness of artificial foodstuff (Optocal) is decreased for full denture wearers, contemplating as a base changes of mastication forces with what was previously described. Nevertheless, some authors report in their studies that this tablet is still inadequate for some full denture bearers.¹³⁻¹⁶

Structural weight plays an important role in prosthesis stability. In the upper jaw, a light denture will exert lesser displacement gravitational force: this is not the case for the lower jaw where slight overweight (30-40 g total) will favor settling within prosthetic limits.^{1,17} Patients wearing dentures frequently limit the load of supporting tissues by selecting foodstuffs not requiring masticatory effort to achieve tissue tolerance, moreover, due to tongue activity,¹⁸ lower dentures exhibit the flaw of not being retained during mastication. Patients will then have to resort to pharmaceutical lining which will compromise oral health.^{2,8}

Since olden times «heavy weight» metallic bases have been used in full dentures, due to the following advantages: greater strength, lesser porosity, thermal conductivity, considerable tissue tolerance, and greater weight, causing thus better stability and lesser deformation. Nevertheless, their use has been discontinued due to the following reasons: they are costlier, more rigid, cause irritation, re-adaptation or rebase is complicated, and for lower bases, can only be of two types 1) using peripheral coverage with resin in the residual ridge crest, and 2) with total coverage of mandibular space and denture.^{19,20}

Some authors have implemented upper denture weight decrease and lower denture weight increase, calling them «gravitational prostheses».^{21,22}

Lower GP is a combination of acrylic resin CP, lodging within it a metallic structure. This structure can be made of different alloys (gold, chrome-cobalt or chrome nickel).²⁰⁻²² Nevertheless, implementation of these dentures has been empirically performed, this forcibly requires structured research of these prostheses. Thus, the aim of the present study was to compare stability, retention and MD in patients with two types of full prostheses: CP versus GP; studies were conducted at the Total Prosthodontics Clinic of the National School of Dentistry, National University of Mexico, UNAM.

MATERIAL AND METHODS

A crossed clinical examination was conducted (using the subject as his own control). A convenience

sample was performed selecting patients attending the Total Prosthodontic Clinic, National School of Dentistry, National University of Mexico (UNAM). Patients were fully edentulous with classification of residual ridge V or VI according to Cawood and Howell (1988), with height not exceeding 2 mm, ages ranging 55-85 years, lacking mental disorders and systemically controlled (*Figures 1 and 2*). Patients were initially assessed according to House Boucher² mental attitude classification. All selected patients were invited to participate in the research project; subjects who accepted did so under validly informed consent. Clinical procedure was conducted dividing subjects into two groups. Group 1 used CP initially, group 2 used GP from the beginning. A six month usage period was established for both groups; required adjustments were performed and written instructions were administered. After this period, lower dentures were replicated with closed mouth impressions, to then change groups (crossed design) (*Figure 3*).

Stability was measured according to method described by Woelfel: with the patient in physiological rest position, index and thumb were placed on the lower denture, exerting horizontal and rotary forces, thus determining the degree of movement (*Table I and Figure 4*).²³

MD was achieved through determination of mean particle size of chewing tablets made with modified Optocal and subjected to volumetric screening.^{6,13-16,24} To achieve this, the patient was placed in a resting physiological position, sitting down on a bench placed opposite to the operator. The patient was instructed to chew on the artificial foodstuff in quantities indicated in the test,^{6,9} chewing normally for 40 masticatory cycles, and taking his time. Immediately

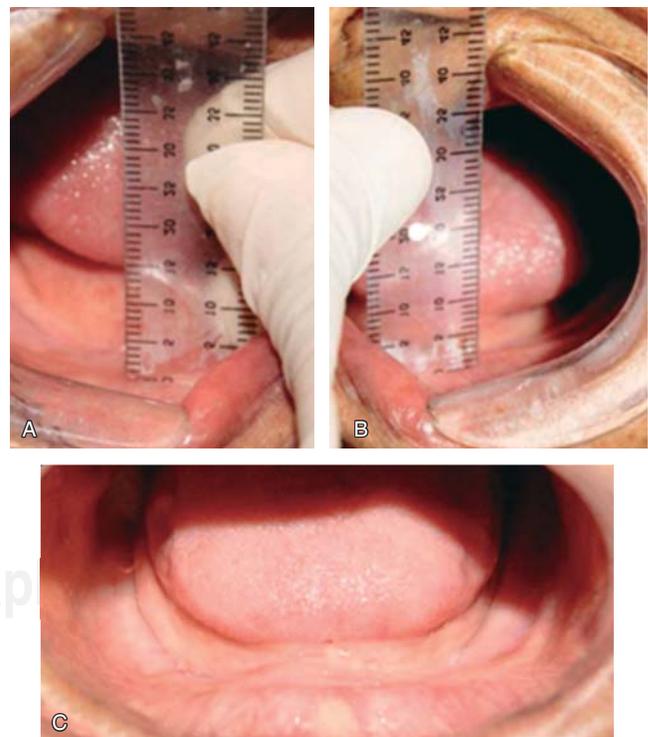
afterwards, they spat all fragments within their mouth, into a filter paper, rinsing their mouth with water in order to recover remnants and rinsing their dentures. Moreover, the oral cavity was examined in order to ascertain that no remaining particles were left. This procedure was repeated for a total of six times. The first sample was discarded, since it was only used as a familiarization test. All samples were rinsed and dried in a chamber by means of silica pearls during 24 hours. After this they were placed in a tower of seven sieves (mesh opening of 5.6, 4.0, 2.8, 2.0, 0.85, 0.425 and 0.25 mm) on a dental vibrator for two minutes. Material in each sieve was weighed in the 0.01 g OHAUS[®] precision scale (*Figure 5*). MPS was calculated by means of the Rosin Rammler equation ($Q_w = 100 [1 - 2^{-(x/x_{50})^b}]$).²⁵

Patient's perception was determined by means of a subjective instrument of 15 items, through Likert-type scales, and an analogous visual scale, assessing stability, retention, mastication and conformity with treatment (*Figure 6*). Moreover, all types of prostheses were weighed.



Direct source.

Figure 1. Orthopantomography showing severe mandibular resorption.

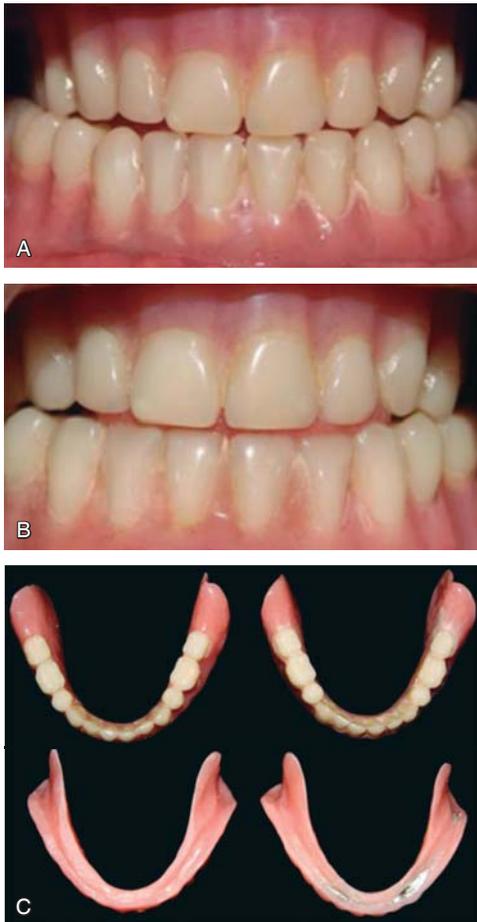


Direct source.

Figure 2. Class V of residual ridge. **A** and **B**) 2 mm height of residual ridge, respectively right and left premolar are. **C**) Required clinical characteristics to be included in the study.

Statistical analysis

Descriptive analysis procedures were undertaken. Considering the number of cases to be evaluated, comparisons were analyzed with Wilcoxon sign rank



Direct source.

Figure 3. Identical conventional full lower denture, and gravitational denture. **A)** Conventional. **B)** Gravitational. **C)** Comparison of both types of prostheses.

test and Spearman correlation test. Established significance level was $p \leq 0.1$. Analysis was conducted with support of statistical package SPSS, version 16.

RESULTS

Initially, 30 subjects participated in the test, nevertheless, this number decreased to six, mainly due to health causes (falls, physically limiting diseases, demises, among others). Weight of prostheses increased up to 40% ($z -2.201$ $p = 0.028$) Stability test revealed that GP were more stable ($p = 0.046$); with respect to masticatory performance, no differences between prostheses were found in MP (z value -0.125 , $p = 0.893$).

With respect to the survey with Likert-type questions and analog visual scale (AVS) (Figure 6) total sum indicates contrast between both types of prostheses: gravitational prostheses were more functional (AVS $p = 0.043$). Statistical comparison tests mainly identified a difference ($p = 0.039$) in the question «lateral mobility of the denture when speaking» as well as «pain when using it», which would indicate more pain and difficulty to speak with conventional dentures (Figure 7 and 8).

As an example of generalized feeling we reproduce comments of a patient who, due to health reasons did not continue in the study, but he was very grateful: «Immediately after placement of gravitational denture (without knowing the clear purpose of the project) I felt greater weight. Increase of weight is to give it more stability, right? I feel improvement when eating, speaking, and my denture no longer moves. I feel happy!»

DISCUSSION

Use of full acrylic resin prostheses is conventional, taking into account the advantages they offer when compared to metallic base prostheses.⁷ Nevertheless, use of acrylic/metal combines some benefits of both materials used in the present study. Results showed

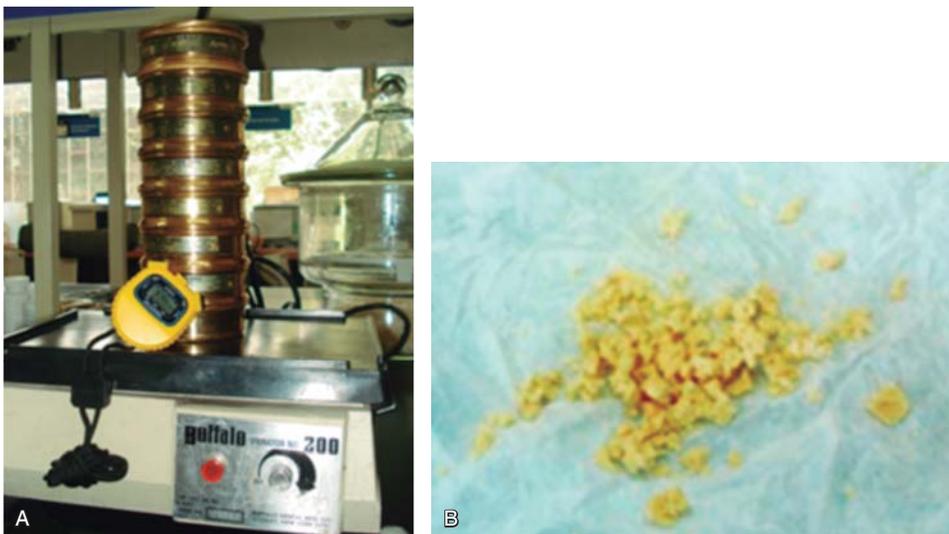
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Table I. Stability scale.²³

Woelfel scale	
Excellent (4)	Prosthesis does not have movement, or there is slight movement when strong direct or rotating force is applied
Good (3)	Prosthesis does not have movement, or there is slight movement when applying strong rotating force, but it moves or is dislodged when a strong direct force is applied on one side or the front of the denture
Acceptable (2)	Prosthesis has considerable movement when rotating force is applied and is dislodged when moderate direct force is applied
Poor (1)	A soft direct or rotating force causes movement in the prosthesis and can dislodge it. Denture must be re-based or replaced



Direct source.

Figure 4. A) Application of circular loads on the denture. B) Application of direct force on the right lateral section of the prosthesis. C) Application of direct force on the left lateral section of the prosthesis.



Direct source.

Figure 5.

A) Equipment to calculate distribution of artificial foodstuff I different-sized meshes. B) Tablets chewed during 40 masticatory cycles.

improvement in denture function, such as mentioned by Reis (2009), although not as accentuated as improvement observed with implant-supported dentures.^{13,21,26-29}

Stability was clearly greater in gravitational prostheses. It is clear that the main treatment to «recover» ideal size of residual ridge for suitable retention and stability will always be surgical procedure, nevertheless, not all patients are candidates for such procedures, or do not possess the required financial means, thus, gravitational prostheses, even though with increased price due to metallic structure, can be a viable alternative to treatment.

Normally, dentists instruct patients wearing full prostheses in the sense that foodstuffs must be well hydrated to facilitate their breakdown. Artificial food Optocal, being plastic, hinders saliva entrance thus decreasing humectation, therefore, it could be modified to resemble more natural foodstuffs consumed by

these patients, especially because detriment of this MP has been shown in total prostheses wearers, even more so in atrophic borders,¹⁴ thus compromising satisfaction of the prosthetic treatment. Nevertheless, material standardization facilitates procurement of more objective results. Certainly, several factors intervene in determination of adequate mastication, such as age, salivation, size of the residual ridge, decreased or increased vertical dimension, denture retention, placement of artificial teeth including width of occlusal surface of the teeth, up to quality and hardness of foodstuffs. In the present study difficulties were encountered with DM test, even though the test foodstuff possesses hardness of 40% lesser than the foodstuff used in patients with teeth. When comparing TMP masticatory performance patients in this research (3.34 mm) with that of average of young males and females with full dentition and lacking Optosil-measured malocclusion (1.8 mm), it could be observed

Importance survey

Name:		Type of prosthesis:			
Age:	Years	Gender:	Date:		
In all the following questions cross out the number better suited to your opinion on the importance of the matter in question. Scale appearing on top of the numbers reflects the different opinions.					
Question	Scale of importance				
	5	4	3	2	1
1. Is your denture comfortable?	☺	☺	☺	☺	☹
2. Can you speak well with your dentures?	☺	☺	☺	☺	☹
3. Is it easy to eat with your dentures?	☺	☺	☺	☺	☹
4. Do you enjoy eating with your new dentures?	☺	☺	☺	☺	☹
5. Do you like the look of your new dentures?	☺	☺	☺	☺	☹
6. Do you dare laughing with your new dentures?	☺	☺	☺	☺	☹
7. Are you satisfied in general with received treatment and its results?	☺	☺	☺	☺	☹

In the following question mark with an **X** the place which is nearest to your answer.

- Does the lower denture move upwards when you speak?
 A lot |-----|-----|-----|-----|-----| Nothing
- Does your lower denture move laterally when you speak?
 A lot |-----|-----|-----|-----|-----| Nothing
- Does your lower denture move laterally when you eat?
 A lot |-----|-----|-----|-----|-----| Nothing
- Does your lower denture move upwards when you eat?
 A lot |-----|-----|-----|-----|-----| Nothing
- Do you feel pain when wearing your dentures?
 A lot |-----|-----|-----|-----|-----| Nothing
- Is your lower denture heavy?
 A lot |-----|-----|-----|-----|-----| Nothing

Date: _____

Direct source.

Figure 6. Likert type survey and analog visual scale.

that they exhibited MP lesser in 46%.³⁰ The fact of not having found differences in TMP even though patients reported they could eat better with gravitation prostheses, is due to a smaller effect, therefore the size of the sample should be much greater. Other studies⁶ surprisingly report that TMP only decreased in 9% when comparing original and new prostheses, thus implying that benefits derived from foodstuff

fracture capacity experience small increase. These data confirm the fact that masticatory function of toothless patients requiring full dentures is greatly impaired, causing great difficulties when chewing hard foodstuffs.³¹⁻³⁴ It is well known that patients afflicted with mastication problems caused by partial or total edentulism exhibit nutritional deficiencies³⁵⁻³⁷ and systemic disorders such as dyspepsia,⁵ these patients'

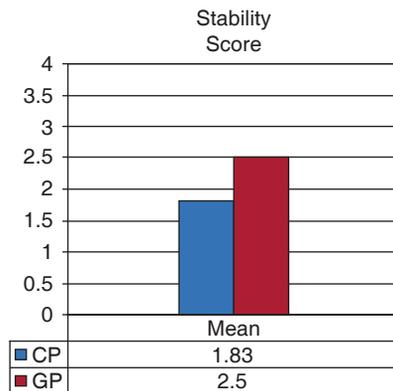


Figure 7. Stability results.

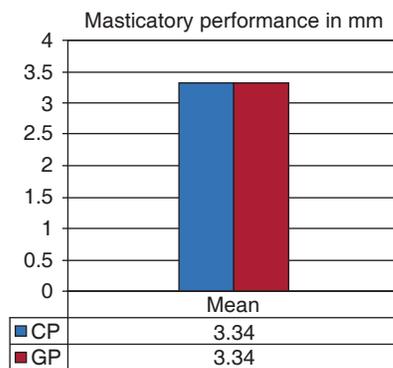


Figure 8. Masticatory performance results.

increase intake of soft foods and carbohydrates, decreasing intake of fiber-rich foods,^{37,38} and proteins found in animal meat.^{34,35} These problems decrease quality of life and increase mortality. (Heath, 1972, Miura 2000, De Souza-e-Silva et al 2010, Greksa 1995 and Sherder 2008), thus it is of the utmost importance to improve masticatory function.

It is important to stress that lack of previous studies in order to be able to compare obtained results was a limiting factor for this clinical assay, other limitations were the following: health problems such as depression, trauma and demise, which reflected upon patient cooperation and attendance. There are no records of standardization in metallic structure manufacturing, only records of metallic bases are available, and some dental technicians provide reports on metallic bar shapes.^{20,21}

CONCLUSIONS

According to results of statistical tests and correlations on patients' perceptions, it is hereby concluded that there was greater function and satisfaction with gravitational prostheses. Patients

were able to speak better and they smiled more often, felt stability when prostheses were heavy and, at the same time, they experienced better food processing abilities, this can lead us to believe that gravitational prostheses are a suitable treatment alternative for patients with extreme mandibular atrophy.

One of the advantages found in the present study was subjective measurement to complement tests conducted in the mouth,⁶ since, gauged standardized tests are quite different from freely undertaken daily mastication, and therefore it is important to evaluate patients' satisfaction with respect to speech, eating etc.

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