Bone resorption processes in patients wearing overdentures. A 6-years retrospective study

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Abstract

Objectives:
1. – To measure the alveolar resorption processes that occur in patients wearing mandibular overdentures on 2 implants and fully-removable maxillary dentures, and to evaluate the same process on patients wearing fully-removable dentures on both arches.
2.- To verify whether Kelly's Combination Syndrome occurs in the group of patients wearing overdentures.
Method and Material:
Forty patients were evaluated, of which a "cases" group was formed by 25 patients wearing mandibular overdentures on 2 lower jaw implants and fully-removable dentures on the opposite arch. The other 15 patients formed a control group that wore fully-removable dentures on both arches.
Each one of the patients underwent orthopantograms from the moment the dentures were inserted until an average of 6 years later, which were assessed based on the Xie et al. method to estimate vertical bone loss. Once the data was collected, it was subjected to statistical analysis.
Results:
In terms of the maxillary midline, we observed a greater loss in patients wearing overdentures, which was statistically significant, as it registered 0.32 mm/year. Mandibular bone loss was 2.5 times less in patients in the cases group. The rest of the clinical criteria for Kelly's Combination Syndrome were not observed.
Conclusions:
Kelly's Combination Syndrome did not occur in the patients in the cases group. In spite of the greater bone loss on a premaxillary level in this group, the placing of the overdenture on the implants significantly reduced mandibular bone resorption.

Key words: *Bone resorption, Kelly's combination syndrome, anterior hyperfunction syndrome, premaxillary resorption.*

Introduction

Bone resorption in edentulous alveolar processes has been studied extensively, and the conclusion has been reached that it is a chronic, progressive and irreversible process that occurs in all patients (1).

Differences have been observed between individuals in the amount and speed at which alveolar bone is lost, which have been attributed to a diversity of factors such as age, sex, facial anatomy, metabolism, oral hygiene, parafunctions, general health, nutritional status, systematic illnesses, osteoporosis, medications and the amount of time the patient has been edentulous (2,3).

One of the factors that has been studied the most has been the mechanisms and more specifically the influence of fully-removable dentures. Campbell (4) observed that patients wearing complete dentures presented smaller edentulous ridges than edentulous patients with no denture treatment.

In patients with complete dentures there is a greater degree of mandibular resorption than maxillary resorption. Studies such as that of Atwood or Tallgren show that mandibular loss is four times greater than maxillary loss. These resorption differences are attributed to the fact that the support surface for the complete lower denture is smaller and as such, the pressure exercised on it is much greater (5-7).

In 1972, Ellswoth Kelly (8) studied the changes produced in patients wearing complete upper dentures who had some natural teeth in the anterior mandibular area, together with a partial removable denture. In these patients, during occlusion, a fulcrum axis is established in the complete upper denture at the first premolar, generating positive pressure on the premaxilla and negative pressure on the posterior part. This gives way to a characteristic pattern of bone resorption, which is defined by a greater bone loss in the premaxilla and an overgrowth of the tuberosities. These two characteristics, together with the extrusion of the anteroinferior teeth, papillary hyperplasia in the hard palate and a bone loss in the area of the prosthetic bases of removable partial mandibular dentures were termed the Combination Syndrome by Kelly.

A common clinical situation occurs when a patient who wears a complete denture on both arches experiences problems with retention, usually on the lower arch. In this case, one of the solutions is to insert two lower jaw implants and to attach an overdenture onto them with mechanical joints.

This prosthetic situation is biomechanically similar to that produced in the patients studied by Kelly. We have a fulcrum axis that goes through the implants. The anterior part of the prosthesis is be rigid, due to the fact that the forces exercised are very close to the axis and the rotary component is minimal. The posterior part, however, behaves in the same way as a removable partial denture. These circumstances mean this type of denture is implant-mucosupported and part of the forces are distributed over the edentulous ridge. The implants are therefore subjected to less tension.

This biomechanical pattern, which is beneficial and necessary when a denture is supported by two implants, also generates a series of pressures on the fully-removable denture on the opposite arch. During occlusion, as mentioned earlier, a fulcrum axis is established on the upper complete denture, which generates greater pressure at the anterior level (9). We pose the following question as a result of this situation: Are we iatrogenetically causing Kelly's Combination Syndrome?

Objectives

The main objective of our work is to determine the bone resorption patterns that occur in patients wearing complete upper dentures and lower overdentures on two implants. We take the bone loss that is produced in patients wearing complete dentures on both arches as a reference, in order to verify if Kelly's Combination Syndrome occurs.

Other objectives involve studying the influence of different variables, such as the following: type of overdenture attachment, age, sex and whether or not the patient wore complete dentures on both arches before initiating the study.

Materials and Method

Forty patients, 22 women and 18 men, were studied at the Prostodontics and Occlusion Training Unit of the Faculty of Medicine and Odontology at the University of Valencia. All of the patients had complete edentulism and the average age at the start of the study was 71.1±6.6 years. None of the patients presented any pathologies or were taking any medication that would alter their bone metabolism.

Two groups were established: a "control" group formed by 15 patients wearing complete dentures on both arches and a "cases" group formed by 25 patients wearing complete upper dentures and a lower overdenture on two lower jaw implants in which two different types of attachments were applied. Additionally, 12 of the patients in the study had worn removable complete dentures on both arches before wearing the dentures that were to be evaluated.

The method that was used to assess bone loss was by measuring bone height using orthopantograms, as other authors have in the past (2, 10-13).

In the control group, we used ortopantograms that were taken three weeks before inserting the dentures as an initial record. The radiographs taken subsequently, for clinical reasons relating to planning and diagnosis that were not related to the study, were used to assess the evolution of the alveolar resorption. The average time period from the initial record to the final record is 6 years. The radiographs were carried out using the same orthopantogram (Panelipse II, General Electrics, 3135 Easton Turnpike, Fairfield, Connecticut, U.S.A.) in every single case.

In the cases group, the initial record was based on orthopantograms that were taken to evaluate the status of the implants before inserting the dentures. The rest of the radiographs that we used to evaluate the bone loss were taken in successive clinical check-ups and were used in our study as the final record. As in the previous case, the time interval between the initial and the final record was 6 years. In this group, the radiographs were taken with 2 types of orthopantograms: Panelipze II and Orthophos Plus DS (Sirona, Central Fabrikstrasse 31 64625, Bensheim, Germany).

We measured the alveolar height based on the radiograph records. To do this, we traced a series of reference lines and we defined the measurement areas. This is a linear measurement method based on the technique described by Xie et al. (12) which we will describe in detail.

In the premaxillary area, the maxillary midline and distal line for both canines were selected as the measurement zones. In the posterior area of the maxilla we took four measurement zones as a reference, two that were each distal to the second premolars and another two that were distal to both first molars.

In the lower arch, we also assessed midline bone loss, which together with the distal canine measurement, gave us the mandibular anterior resorption data. We also used four posterior measurement areas for the mandibular, as with the maxilla, two distal to both second premolars and two points distal to the first molars.

The next step after determining the measurement areas was to locate ascertain the distance between the measurement zone and the midline of both arches. In order to do this, we studied 50 orthopantograms for patients with a complete set of natural teeth, in which we traced a series of reference lines that gave is a stable position from which to perform all the measurements. The reference lines are as follows (Figure 1): in the maxilla, a tangent at the lower edge of the maxillary zygomatic processes (Lz). There are four tangent lines on the mandibular, two on the lower edge of both sides of the mandibular structure (Lc) and two more that go through the most external part of the condyle and the ramus of the mandible, also on both sides (Lr) The last reference line is the one that goes through the midline of both arches (Lm). We then located each one of the abovementioned areas. In the maxilla, we have marked the midline, which is perpendicular to Lz. The rest of the areas go from the most coronal point of the interproximal ridge to the distal side of the canines, the distal side of the second premolar and the distal side of the first molar to line Lz. Each one of these marked lines should be perpendicular to Lz. In the mandibular, we performed the same procedure, taking into account that now the traced lines would be perpendicular to line Lc.

Once all the lines were traced, we marked the maxilla and mandibular width. At upper arch level, we marked two points that coincide with the most posterior part of both maxillary tuberosities. The distance from the midline to each one of these points is the hemimaxillary width.

In the mandibular, we used the point where lines Lm and Lc cross and the point where lines Lr and Lc cross as points of reference to calculate the width. The distance between both points is the hemimandibular width. Once we had obtained this data, we measured the distance from the midline to each one of our measurement points. Once the maxillary width was calculated, we could easily determine at which average percentage each point is located from the midline (Figure 2).

With this data we could locate the measurement areas in edentulous patients. We simply needed to trace the reference lines (Lz, Lr, Lc and Lm) and calculate the hemimaxillary and hemimandibular width. With this data, we applied a rule of three to find out how far away each of the points is from the midline.

When tracing them at a maxillary level, it was important to keep in mind that they had to be perpendicular to Lz, and they went from this line to the bone ridge. The same was done in the mandibular, with lines that were perpendicular to Lc.

The measurements were taken with a vernier caliper as this instrument reads to decimal fractions of mm. The vertical distances to be measured go from the edge of the alveolar ridge for each one of the points of measurement to the Lz reference line in the maxilla and the Lc in the mandibula.

Another figure to be kept in mind was the degree of magnification on the radiographs. In the control group, both radiographs were performed with the same orthopantogram apparatus and, as such, the degree of magnification is similar in all the radiographs as long as the position of the patient is correct. Considering that our objective is to find out the difference, the influence of the degree of magnification must therefore be minimal (11).

With regard to the patients in the cases group, the final radiography was performed with another model of orthopantogram. . Its magnification is calculated with the help of the radiographic image of the implants, in which the physical measurements are taken as a reference (Figure 3).

The results obtained were statistically processed in a descriptive manner and Kolmogorov-Smirnov, Mann-Whitney, Kruskal-Wallis tests were performed, depending on the variable to be studied, as explained in the next section.

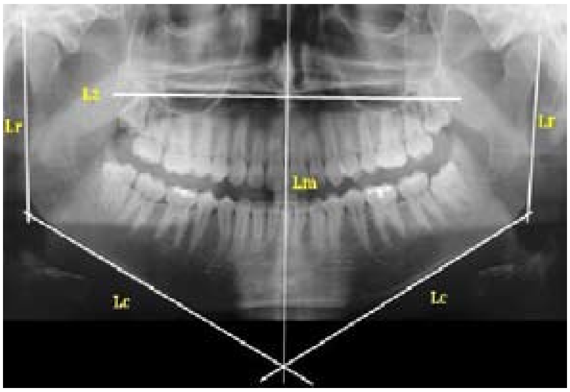

Fig. 1. Reference lines.

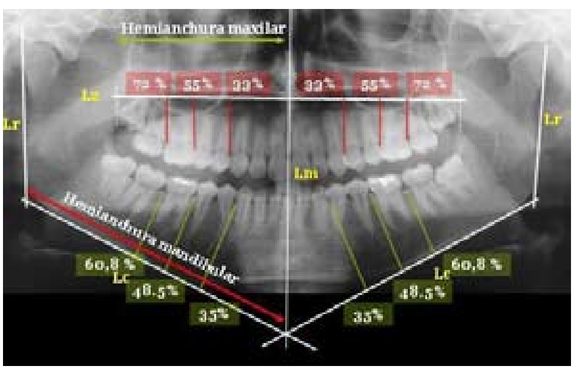

Fig. 2. Reference points in the lower jaw.

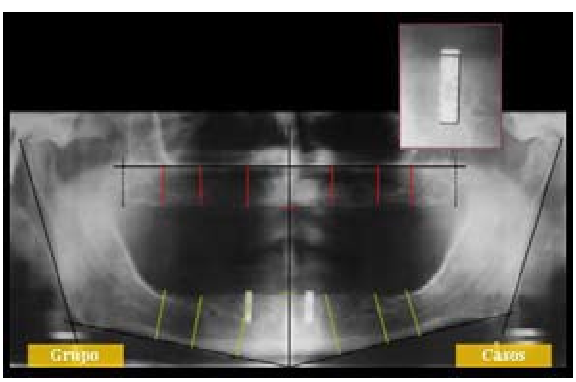

Fig. 3. Final radiography in cases group.

Results

Bone loss assessment:

Annual bone loss was the variable used for these contrasts as this was a way of bringing together the measurement in order to compare the differences. The first approach was to check the correlation that exists between them. In order to do this, we first confirm their normality using a Kolmogorov- Smirnov test.

The hypothesis is that the contrast distribution is normal, and therefore, significances of less than 0.05 reject this hypothesis. Given that all the p-values are greater than 0.05, we concluded that all the variable for annual bone loss are normal.

Next we verified the correlations between them using Pearson correlations. Relationships with coefficients that are higher than 0.45 are considered to be significant. The most relevant differences are found between arches in which we observed no correlation between the upper and lower arch.

Accordingly, the conclusion is that annual bone loss in the maxilla is independent of the loss in the mandibular; within the same arch, however, bone loss for all the positions is related to a greater or lesser extent.

According to the group:

We applied a non-parametric Mann-Whitney test to verify whether or not there were significant differences in bone loss between the control group patients and the cases group patients. This type of test sets forth that the statistical hypothesis is that the distributions are equal. Therefore, significances of less than 0.05 reject this hypothesis.

The differences in bone loss for the maxilla between the control group and the cases group are significant (sig. < 0.05) only for the average maxillary line. More specifically, bone loss is greater in patients from the cases groups (Table 1).

At a mandibular level, bone loss has a different distribution in all the mandibular position (sig.< 0.05) between the control group and the cases group. More specifically, bone loss is an average of 0.32 mm/year greater in patients from the control groups (Table 2).

According to Sex:

In this section we analyse whether there are significant differences in bone loss between men and women. Since that we did obtain differences in bone loss between the two groups (control/cases) however, it is therefore appropriate to consider a model that considers the possible interaction between sex and group. For example, we know that mandibular bone loss depends on the group; but, do the difference in bone loss between the groups reach the same extent between men and women?

To do this, we analysed the distribution difference fo the bone loss variables depending on the sex for each one of the two groups by applying a non-parametric Mann-Whitney test.

We observed that for the cases group, the only differences between sexes (sig. < 0.05) were shown in the variables relating to the maxilla. More specifically, the women from the cases group lose more bone each year than the men from the same group.

According to age

We analysed the distribution differences between age levels within each group (under 70, between 70-74 and over 74) using a non-parametric Kruskal-Wallis test. Once the results were analysed and no significance were found, we concluded that age is not an influential factor in bone loss for either of the two groups.

According to type of attachment

It proved worthwhile to analyse whether the type of an-

Table 1. Contrast Statistics[b]. Upper jaw.

	ANTERIOR MAXILLARY MIDLINE BONE LOSS	ANTERIOR MAXILLARY CANINE BONE LOSS	POSTERIOR MAXILLARY 2nd MOLAR BONE LOSS	POSTERIOR MAXILLARY 1st MOLAR BONE LOSS
Mann Whitney U	115.500	180.500	174.000	175.000
Wilcoxon W	235.500	300.500	499.000	500.000
Z	-2.012	-.196	-.378	-.379
Asymptotic sig. (bilateral)	.044	.845	.706	.727
Exact Sig. [2nd (Unilateral Sig.)]	0.43[a]	.847[a]	.720[a]	.740[a]

a. Not corrected for ties
b. Grouping variable: Group
sig. Significant

Table 2. Contrast Statistics[b]. Mandible.

	ANTERIOR MANDIBULAR MIDLINE BONE LOSS	ANTERIOR MANDIBULAR CANINE BONE LOSS	POSTERIOR MANDIBULAR 2nd MOLAR BONE LOSS	POSTERIOR MANDIBULAR 1st MOLAR BONE LOSS
Mann Whitney U	27.000	29.000	72.000	105.500
Wilcoxon W	352.000	354.000	397.000	430.500
Z	-4.546	-4.489	-3.232	-2.291
Asymptotic sig. (bilateral)	.000	.000	.001	.022
Exact Sig. [2nd (Unilateral Sig.)]	.000[a]	.000[a]	.001[a]	.021[a]

a. Not corrected for ties
b. Grouping variable: Group
sig. Significant

chor influences annual bone loss for the cases group. O-ring and Barra attachments were only used in 2 patients and 1 patient, respectively. We eliminated them for the analysis for this reason, and only contrasted the differences in annual bone loss between the Locator (Zest Anchors 2061 Wineridge Place Escondido, CA 92029, U.S.A.) and Dal-Ro (Biomet 3i Dental Iberica Sl. Alameda Park Edf.1 planta 1, Cornella de Llobregat, Spain) attachments. To do this we performed a non-parametric Mann-Whitnet test. In view of the resulting p-values greater than 0.05, we can conclude that bone loss in the cases group patients does not depend on the type of attachment.

According to whether the patient had been a complete denture wearer

Thirty percent of the entire sample group that was analysed had worn a complete denture on both arches before wearing the denture under consideration in the study. It is, therefore, worthwhile to study whether having worn this denture before had a significant influence on annual bone loss.

Due to the fact that no p-value was less than 0.05, we concluded that the prior complete dentures did not significantly affect the annual bone loss.

Discussion

Orthopantograms were the method chosen to assess the bone loss. This type of radiograph is subject to variations in magnification and distortion, although these problems were minimised once we were made aware of the level of magnification of our orthopantogram. This radiographic method is considered to be a suitable method for assessing alveolar resorption processes (2, 10-13).

Tallgren (7) carried out some studies that shed light on the resorption process that occurred in patients wearing complete dentures on both arches. He arrived at the conclusion that it was an irreversible phenomenon that occurs in all patients to a greater or lesser degree. In this study, bone loss occurs in all the patients, although we do find differences in magnitude from one person to another. This result coincides with that cited by the vast majority of authors, as well as explaining the multifactorial character of the resorption process (6, 7, 14, 15). In spite of these differences from one individual to another, it was observed that a correlation exists in the loss suffered, as we saw in the first section of the results.

In the patients in the control group, mandibular bone loss is 2.5 times greater than maxillar bone loss. This

greater degree of mandibular resorption is observed by other authors such as Atwood (6), Tallgren (7) and Tuncay (16) among others, in which the loss was 3 or 4 times greater than in the maxilla.
Studies on the effect of removable complete dentures on bone resorption have reached quite unanimous conclusions. To the contrary, the bibliography that exists in relation to the effect of mandibular overdentures together with fully-removable maxillary dentures is not as abundant and the conclusions reached in all of the studies tend to differ.
In our study, we observed greater bone loss in the premaxilla, in the cases group to a significant degree. the most relevant data that we obtained however, was in the midline in which the loss is 0.32 mm/year in comparison with the control group, whose loss at the point indicated was 0.22 mm/year, this being is a statistically significant difference. The bone loss that Kelly observed in his study with regard to the midline was 0.43 mm/year. It is noted that the speed of loss that we observed in our study in the premaxilla is slower. In this aspect, coincidences exist with Barber (9) who, as other have, observed greater resorption in the midline and this occurs at a speed of 0.36 mm/year.
As such, we deduce that greater resorption occurs at the midline of the premaxilla in patients wearing complete maxilla dentures with an overdenture on two implants on the antagonist arch. This loss occurs in a slower manner than with Combination Syndrome, however.
The hypothesis that the bone resorption pattern that is produced in patients wearing a complete maxillary denture with a mandibular overdenture on two implants is in fact similar to that produced with Kelly's Combination Syndrome is supported by numerous authors. Maxson et al. (17) found very similar signs to those described by Kelly. Kreisler et al. (2) observed greater resorption in the anterior part of the maxilla than in the posterior part, with a premaxilla loss percentage of between 5% and 12%. The percentage of anterior loss in our study was 9.7% on average.
On the other hand, authors such as Närhi (18) and Jacobs (11) did not find statistically significant differences in premaxillary bone loss.
One of the results is the decrease in bone loss that occurs in patients wearing mandibular overdentures. In the mandibular midpoint over the 6 years, patients in the control group lost 3.01 mm. In this same location, for patients in the cases group the loss was 0.71 mm. Crum and Rooney (19) assessed bone loss that occurred in patients wearing mandibular overdentures on two teeth compared with patients wearing complete dentures. The duration of the study was 5 years and the results for the anterior mandibular were a resorption of 5.2 mm in patients wearing complete dentures and 0.6 mm in patients wearing overdentures.
As such, wearing a mandibular overdenture would appear to slow down the resorption process in the view of the results and the bibliographic review (5, 20).
One of the factors that classically has been related with bone resorption has been the hormonal effect depending on the sex of the patient, where the loss is greater in women (21). Our study reflects a tendency towards greater resorption in women, but this is only statistically significant in the case of patients in the cases group, in which we see greater maxilla bone loss in women.
Statistically significant differences were not found between bone resorption and variables of age, attachment used and patients who had worn a complete denture prior to the study.

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