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RETROSPECTIVE COMPARATIVE STUDY OF BONE LOSS IN IMPLANTS WITH AND WITHOUT IMMEDIATE LOADING IN THE EGAS MONIZ UNIVERSITY CLINIC

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Annotation. Aim: To evaluate bone loss after three years in implants placed at the implantology consult at the Egas Moniz University Clinic, relating bone loss to the type of loading (conventional or immediate load). Materials and methods: A comparative and retrospective study, performed on a sample of 65 implants, placed in 24 of 327 patients, who attended the implantology consult at the Egas Moniz University Clinic in 2015, representing 7,3% of the study population through the measurement of distance between implant platform and bone using radiographs. Results: Three years after implant placement with and without immediate loading there is statistically significant bone loss mesially and distally. It was found that when compared bone loss in loaded vs unloaded mesially and distally implants, there were no statistically significant differences. The bone loss of the unloaded implants was compared three years after being placed, with the bone level of the loaded implants also three years later. No significant difference was found. Conclusion: Although no statistically significant differences were found between bone loss in loaded implants vs unloaded mesially and distally, as it is supported by the literature, it was possible to conclude that there was, in fact, a statistically significant bone loss, mesially and distally, three years after implant placement with and without immediate loading. This may be due to poor oral hygiene, a history of periodontitis, smoking and peri-implantitis.
Keywords: implantology; immediate loading; conventional loading; radiographs.

INTRODUCTION

This research was carried out in the ambit of obtaining the master's degree in Dentistry, the aim was to evaluate bone loss after three years in implants placed at the implantology consult at the Egas Moniz University Clinic, relating bone loss to the type of loading - with conventional or immediate load. For a better understanding of the subject now exposed, the concepts of implant, loading and complementary means of diagnosis will be briefly introduced.

Implants: Over the past 50 years, implantology has evolved from experimental treatment to an option increasingly chosen to replace missing teeth. It is a widely used treatment in totally or partially toothless patients as it offers significant functional and biological advantages when compared to conventional fixed or removable prostheses (Buser, Sennerby, & De Bruyn, 2016; Huynh-Ba, Oates, & Williams, 2018).

According to Yalçın, Kaya, Laçin and Arı (2018), dental implant design can be divided into two groups: macro and micro. The macro design divides the implant by neck, body and apex. Micro design includes implant material and surface morphology. The neck of the implant is the most coronal part, usually in contact with soft tissue (gums) and hard tissue (bone). As it may be in contact with the environment of the oral cavity its surface should be easily cleaned to prevent formation or adhesion of plaque. The body is the major part of the implant, located between the neck and the apex, and provides primary stability due to the threads of its structure. The apex, the terminal part of the implant, can be active or passive (Yalçın, Kaya, Laçin, & Arı, 2018).

History of immediate vs. conventional loading: Initially we considered that, to achieve osteointegration, implants needed to be submerged in the mucosa and without any loading for a period of three to six months, to allow the recovery of hard and soft tissues. This unloaded period was used to prevent any micro-movement of the implant that could interfere with its healing process and thus its osseointegration. No load is placed on the implant so that no connective tissue develops between the implant surface and the bone, which in turn causes implant failure due to non-osteointegration due to the inability of the implant to withstand masticatory forces (Sanz-Sánchez, Sanz- Martin Figuero, & Sanz, 2014; Sommer, Zimmermann, Grize, & Stu, 2019). It should also be considered that with the conventional loading protocol, patient satisfaction will be compromised due to the long waiting time for osteointegration. This long waiting time will have negative consequences such as restricted chewing, aesthetics and decreased phonetic function (Sommer et al., 2019). With the evolution of oral implantology resulting in better prognosis and outcomes, the desire for fewer surgical interventions and shorter treatment times, the conventional protocol for implantology has been constantly reevaluated. Recent techniques include reduction in treatment time through immediate placement of implants in the post extraction alveolus and immediate loading of implants. Immediate loading protocols have been widely discussed in literature and considered a suitable treatment approach (Chrcanovic, Albrektsson, & Wennerberg, 2014).

Immediate loading is defined as oral rehabilitation that is placed in occlusal contact within 48 hours of implant placement. This has a short treatment time, which reduces the number of consultations, leading to more effective treatment. Consequently, expenses are lower and patient satisfaction increases. However, caution should be taken to avoid some complications and implant failures, which are often associated with implant mobility due to marginal bone loss. Significant bone loss occurs in the first year after implantation, and according to the literature there is abundant evidence of correlation between this and poor oral hygiene, history of periodontitis, smoking and peri-implantitis. Another factor that can induce bone loss is the use of an improper loading protocol, thus showing that we must be careful not to overload the implant (Sommer et al., 2019).

Complementary means of diagnosis: Radiology is essential at all stages of implant rehabilitation treatment. It is necessary for planning as it allows us to identify which anatomical structures we must follow, the quality and quantity of bone available. During surgery, it allows you to visualize the position of the implant and correct any errors if necessary. Postoperatively it lets us know if the implant was placed correctly and it allows a follow-up of the existing bone level.

We will focus on orthopantomography and periapical radiography as these were the radiologic exams used in our study.

Orthopantomography is a standard tool used worldwide in implant treatment planning. It has several benefits, such as transmitting low radiation dosage, while providing the best radiographic survey (Amarnath et al., 2015). However, distortions in the horizontal plane and enlargement in the vertical plane are inevitable consequences in this type of radiography. In addition, incorrect patient positioning and processing or technical errors have substantial effects on image accuracy. As it is a two-dimensional radiographic examination, it does not exhibit available bone width and exact relationships with neighboring anatomical structures. Structures that appear outside the radiographic focal canal are blurred and appear as shadows and artifacts (Özalp et al., 2018).

Periapical radiography is a standard technique for longitudinal evaluation of dental implants. Some of its most advantageous features are low radiation dosage, low cost and high image resolution. However, as this technique gives us a two-dimensional image it will only be adequate for bone level assessment.

MATERIALS AND METHODS

A comparative and retrospective study was conducted using the clinical file and its radiographs at the Egas Moniz University Clinic, located at the Egas Moniz University Campus – CRL, Quinta da Granja, Monte da Caparica, Portugal. A total of 327 patients attended the implantology consultation at the Egas Moniz University Clinic in 2015. Of these, 24 (7,3%) had radiographic control available in the clinical file at the time of implant placement and three years later, making up a total of 65 implants, which defines the sample as n = 65. The sample was divided into two main groups, implants with a conventional loading protocol and implants with immediate loading. Thus, we have 46 implants distributed by 21 patients with conventional loading and 19 implants distributed by 4 patients with immediate loading protocol.

Inclusion criteria: Informed consent duly signed; Have placed at least one implant in the Egas Moniz University Clinic; Have radiograph on the date of implant placement; Have a radiograph three years after the implant placement date.

Exclusion Criteria: Not having the informed consent duly signed; Not having placed implants in Egas Moniz University Clinic; Absence of radiography on the implant placement date; Absence of radiography three years after the implant placement date.

According to the inclusion and exclusion criteria established and mentioned above, 303 patients were excluded from the study due to the following causes.

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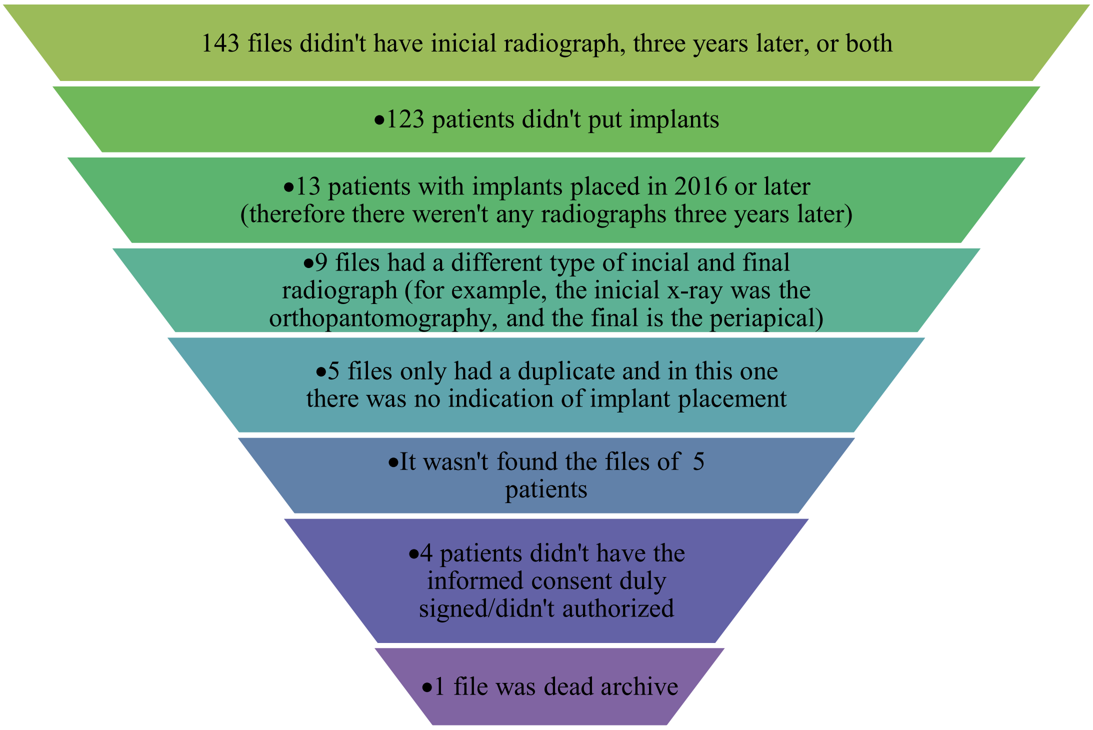

Figure 1. **Eligibility criteria: files excluded during data collection**

Measurement of bone level in radiographs was done by computer when using digital radiographs (see Figure 2a) and by hand for conventional radiographs (see Figure 2b). In the computer, the SIDEXIS XG program was used, which has analysis tools, such as length measurement, which served, in this case, to measure from the implant platform to the bone level. In the case of conventional radiographs, the measurement was made using a millimeter ruler, as shown below in Figure 2.

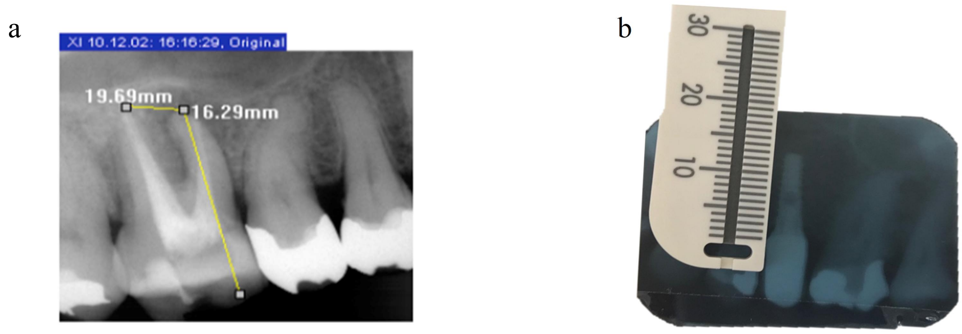

Figure 2. (a) **Example of the measuring tool of the SIDEXIS XG program** (Adapted from Sirona Dental Systems GmbH, 2016); (b) **Conventional periapical radiography measurement**.

Initially, a descriptive analysis of the sample was performed, considering the following variables: gender and age of the patients, location of the implants in terms of quadrants in the oral cavity and type of rehabilitation (single or multiple). Later, inferential analysis was performed considering parametric and non-parametric tests used to compare bone loss after three years in placed implants (with and without immediate loading) considering mesially and distally measures.

The following research null hypothesis (Ho) were formulated:

- H_{01}: Patients without immediate loading don't show mesial bone loss after three years of surgery;
- H_{02}: Patients without immediate loading don't show distal bone loss after three years of surgery;
- H_{03}: Patients with immediate loading don't show mesial bone loss after three years of surgery;
- H_{04}: Patients with immediate loading don't show distal bone loss after three years of surgery;
- H_{05}: The mesial bone loss after three years of surgery in patients with and without immediately loading are the same;

- H_{06}: The distal bone loss after three years of surgery in patients with and without immediately loading are the same;
- H_{07}: Mesial bone level, three years after surgery, is the same in implants with and without immediate loading.
- H_{08}: Distal bone level, three years after surgery, is the same in implants with and without immediate loading.

In the hypothesis tests, to measure the normality of the distributions, the Shapiro Wilks test was used, considering the sample size. In the comparison of independent samples, the t-Student parametric test was used. Alternatively, the nonparametric Mann-Whitney test was performed when the normality of the distributions was violated. In the comparison of paired samples, the normality as well as the symmetry of the distributions were also evaluated. When the normality was verified, the choice was to use the parametric Paired t-test. Otherwise, nonparametric Wilcoxon or Signed rank tests were used, depending on the presence or absence of distribution symmetry. An alpha significance level of 5% was considered.

Statistical analysis was performed using the statistical software R (R Core Team, 2019).

RESULTS

Of the 65 implants considered in this study, 44,6% were placed in male patients (n = 29) and 55,4% were placed in female patients (n = 36). The ages of the patients participating in this study ranged from 40 to 79 years. In order to do the statistical analysis, the age groups were divided into ≤ 50 years, 51 – 69 years and ≥ 70 years. Of these, 36,9% were ≤ 50 years old (n = 24), 46,2% were between 51 and 69 years old (n = 30) and 16,9% were aged ≥ 70 years old (n = 11).

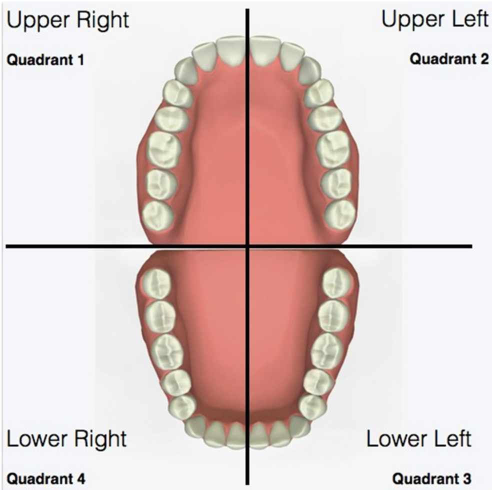

Figure 3. **Dental quadrant nomenclature** (Adapted from Corinna Dental Group)

The sample of 65 implants was distributed by location according to quadrants. Most were located in the 1st and 2nd quadrants, with the same number of implants. In the 4th quadrant there were found 20% of the implants placed and in the 3rd quadrant only 12,3% Table 1 shows the detailed descriptive statistics of implant location relative to quadrants.

Table 1

Descriptive analysis of quadrant location

Location	Frequency (n)	Percentage (%)
1st Quadrant	22	33,85%
2nd Quadrant	22	33,85%
3rd Quadrant	8	12,30%
4th Quadrant	13	20,00%
Total	65	100,00%

Regarding the type of rehabilitation used in this study, we considered two types: single rehabilitation and multiple rehabilitation. Single when it comes to an implant crown, and multiple when it is more than one implant crown, it can be in the case of a partial rehabilitation (bridges or cantilevers, for example) or total rehabilitation (such as hybrid prostheses or overdentures). The type of rehabilitation prevalent in this study was multiple with 63,1% of the sample (n = 41), while single rehabilitation was used in 36,9% of the sample (n = 24).

Regarding the inferential analysis, the first four hypotheses (H01 to H04) refer to paired samples, since the information collected refers to the same patients at two different times (at implantation and after three years). The following results were obtained respectively for each of the hypotheses formulated:

(i) 1st hypothesis (H_{01}) it was verified that the differences of mesial bone loss were not normally distributed (Shapiro Wilk = 0,92; p-value = 0,003) and which are not symmetrical (asymmetry coefficient = 3,08). Signed rank test concludes that there are statistically significant differences (p-value < 0,001; reject H_{01}) in median mesial bone loss in patients without immediate loading;

(ii) 2nd hypothesis (H_{02}) it was verified that the differences of distal bone loss were not normally distributed (Shapiro Wilk = 0,88; p-value < 0,001) and which are not symmetrical (asymmetry coefficient = 3,54). Signed rank test concludes that there are statistically significant differences (p-value<0,001; reject H_{02}) in median distal bone loss in patients without immediate loading;

(iii) 3rd hypothesis (H_{03}) it was verified that the differences of mesial bone loss were normally distributed (Shapiro Wilk = 0,97; p-value = 0,77). The parametric Paired t-test concludes that there are statistically significant differences (Paired t-test = -9,70; df = 18; p-value < 0,001; reject H_{03}) in mean mesial bone loss in patients with immediate loading;

(iv) 4th hypothesis (H_{04}) it was verified that the differences of distal bone loss were normally distributed (Shapiro Wilk = 0,94; p-value = 0,22). The parametric Paired t-test concludes that there are statistically significant differences (Paired t-test = -11,4; df = 18; p-value <0,001; reject H_{04}) in mean distal bone loss in patients with immediate loading.

For the remaining hypotheses (H05 to H08), independent sample tests were used. Since these are independent groups (implants with and without immediate loading) and the normality of the distributions in some of these groups was violated, the nonparametric Mann-Whitney test was chosen.

(v) 5th hypothesis (H_{05}) the nonparametric Mann-Whitney test concludes that there aren't statistically significant differences (Mann-Whitney test = 428; p-value = 0,90; not reject H_{05}) in median mesial bone loss in patients with and without immediately loading;

(vi) 6th hypothesis (H_{06}) the nonparametric Mann-Whitney test concludes that there aren't statistically significant differences (Mann-Whitney test = 494; p-value = 0,42; not reject H_{06}) in median distal bone loss in patients with and without immediately loading;

(vii) 7th hypothesis (H_{07}) the nonparametric Mann-Whitney test concludes that there aren't statistically significant differences (Mann-Whitney test = 530; p-value = 0,14; not reject H_{07}) in median mesial bone level in implants with and without immediate loading;

(viii) 8th hypothesis (H_{08}) the nonparametric Mann-Whitney test concludes that there aren't statistically significant differences (Mann-Whitney test = 561; p-value = 0,11; not reject H_{08}) in median distal bone level in implants with and without immediate loading;

DISCUSSION

This is a comparative and retrospective study, in which 327 cases were consulted from the Egas Moniz University Clinic, concerning patients who went to the Implantology consultation in 2015. Only 24 cases, corresponding to 65 implants (n = 65) were eligible for the study according to the inclusion criteria mentioned above. Making a total of 46 implants with conventional loading and 19 implants with immediate loading. From the analyzed files, 303 were excluded due to the eligibility criteria, as shown in figure 1. It was chosen not to analyze the nine files that presented an initial radiograph different from the final one, as these only covered implants with conventional loading. Therefore, it is impossible to make a comparative analysis with loaded implants. The data analyzed was information collected from the patients' file recorded by the dentist. The analyzed radiographs were attached to the file if they were conventional and the digital ones were consulted through the SIDEXIS XG program.

The sample was characterized taking into account gender and age of participants. Most patients are female (55,4%). From the implants included in this study, 46,2% belong to patients between 51 and 69 years old, 36,9% to people under 50 and 16,9% to patients over 70. The characterization of the implants was made according to their location and type of oral rehabilitation.

In a first analysis in implants without immediate loading, nonparametric tests were performed, and in implants with immediate loading, parametric tests were performed, based on the p-value, the null hypotheses (H01, H02, H03, H04) were rejected both mesially as distally. This means that three years after implant placement there will be significant mesial and distal bone loss, which was found in implants with and without immediate loading. Several studies corroborate this result (Pera et al., 2018; Crespi et al., 2019; Meloni et al., 2018) showing that there is indeed a significant bone loss associated with both unloaded implants and loaded implants.

Subsequently, it was found that when comparing bone loss in loaded vs unloaded implants mesially and distally, the null hypotheses (H05 and H06) were not rejected, so there were no statistically significant differences between bone loss of loaded implants, compared to unloaded implants. In the literature we find the same result, as for example in the systematic review and meta-analysis performed in Egypt in 2017, which shows that there were no significant differences in bone loss in implants with different loading protocols, but warned that we should take into account the numerical limitation of the studies included in the article (Helmy, Alqutaibi, El-Ella, & Shawky, 2017). The same is shown in the systematic review of 2018 in Japan, where it was concluded that bone loss in implants without immediate loading was comparable to bone loss in immediate loaded implants (Sanda, Fueki, Bari, & Baba, 2018). In the following studies the same result was obtained (Chrcanovic et al., 2014; Esposito et al., 2013; Benic, Mir-Mari, & Hämmerle, 2014).

In a final analysis, it was compared the bone level of the implants with conventional loading three years later, with the bone level of the immediate loaded implants also three years later. No significant difference was found between them and the null hypotheses (H07 and H08) cannot be rejected.

One aspect to be improved for future studies is the size of the sample. Most of the cases were excluded due to lack of documentation (radiographic and not only). This demonstrates the high importance not only of the clinical record but also of the radiographic record.

CONCLUSIONS

When comparing bone loss in immediate loaded implants with unloaded implants mesially and distally there were no statistically significant differences. We obtained the same result when comparing the bone level of the implants with conventional loading three years after placement, with the bone level of the immediate loaded implants also three years after placement.We assessed that there was, in fact, a statistically significant bone loss mesially and distally three years after implant placement with and without immediate loading. This may be due to poor oral hygiene, a history of periodontitis, smoking and peri-implantitis.

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