



Can Time of Implant Placement influence Bone Remodeling?

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ABSTRACT

Since the alveolar process is tissue “dental dependent,” after the extraction of the dental element, this process suffers some degree of atrophy during the healing process, which can be reduced with the installation of immediate implants, aiming to maintain the original bone architecture. The aim of this study was to investigate the influence of the time of implant placement on bone formation around them. Seven dogs were selected and randomly divided into two groups: Group 1, where implants were placed immediately after extraction of two lower premolars without flap elevation, and group 2, where implants were delayed by 4 months after extractions. Each group received 14 implants, and 4 months after the second surgery, the samples were processed and analyzed histomorphometrically. A mean average analysis and the Kruskal–Wallis test ($p < 0.05$) were performed. The buccal bone–implant contact (BIC) mean average was found larger in immediate implants (42.61%) compared with delayed implants (37.69%). Group 1 had statistically higher outcomes in bone formation and BIC on the buccal bone wall. It was concluded that performing immediate implants with the palatal approach technique and leaving a buccal GAP enables a higher or at least equal rate to BIC and bone area around them, when compared with delayed implants.

Actually, the patients and dentists want to do a shorter treatment with satisfactory results, but it is necessary to understand whether different times of implant placement can influence the results and longevity of the treatment.

Keywords: Bone remodeling, Delayed implantation, Histomorphometric analysis, Immediate implant, Osseointegration.

How to cite this article: Rafael CF, Passoni B, Araújo C, de Araújo MA, Benfatti C, Volpato C. Can Time of Implant

Placement influence Bone Remodeling? J Contemp Dent Pract 2016;17(4):270-274.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The waiting period between tooth extraction and implant placement according to Branemark’s protocol is 6 to 8 months,¹ but it has already been described in the literature that, in this period, bone resorption (vertically and horizontally), gingival collapse, and migratory movement of the teeth adjacent to the extraction space occur.² This alveolar bone loss may compromise the selection of implant dimensions³⁻⁵ and may require bone grafts before placement of the delayed implants.

The terms to describe implant placement time are very controversial,² but according to ITI classification, type 1 is the placement of an implant at the same time as the tooth is extracted (immediate); while type 2 is the placement of an implant after soft tissue healing (2–4 weeks after tooth extraction); type 3, when the placement is performed after significant bone healing; and type 4, when the implant is placed in fully healed and mature bone.⁶ All techniques have advantages and disadvantages, but types 1 and 2 are usually preferred due to the short waiting period than the other techniques^{7,8} and because some authors indicate that the immediate implant placement provides a decrease in the atrophy of the alveolar process and in the bone remodeling.^{4,9,10} On the contrary, studies have described bone loss even following immediate implant placement and more pronounced in the buccal plate relative to the lingual plate.¹¹ To prevent this loss, the bone plate should be 2 mm thick,¹² but research shows that in the vestibular surface of the anterior region, 87% of cases have a thickness not exceeding 1 mm, indicating the need for bone graft in that region.¹³ Authors also suggest that the early implant placement protocol may be more successful

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than immediate placement, due to the complete soft tissue healing in early implant placement,² but Soydan et al² concluded in their research that the hypothesis that the early implant placement protocol is more successful than the immediate placement was not valid.

It is important to try to reduce the remodeling of the alveolar process, because alterations in hard tissues following tooth extraction may lead to deficiencies in bone contours and soft tissue, compromising the esthetic.¹⁴ Some studies suggest that immediate implant placement through the palatal approach could reduce this remodeling when compared with delayed or early implants. This approach would result in bone formation, allowing the structural continuity between the bone in close contact with the implant surface and newly formed bone due to the alveolar repair.¹⁵

There are many controversies in the literature about the implant placement time and its influence on peri-implant bone characteristics, so the aim of this research was to investigate the influence of the time of implant placement on bone formation around them.

MATERIALS AND METHODS

Ethical Aspects

This study was approved by the ethics committee research and education on animal, the University of São Paulo, School of Dentistry of Bauru, with protocol number #14/2006.

Methodology

This research study was an analytical, investigative, cross-sectional surveys in dogs.

Seven adult dogs, mongrel breed, were selected, weighing approximately 20 kg and in good general health. The number of animals was based on statistical calculations for group formation, because at the time of extractions two groups were formed according to the time of implant placement: Group 1, where implants were placed immediately after extraction of two lower premolars without flap elevation and using the technique of palatal approach; group 2, where implants were delayed by 4 months after extractions, being positioned on the center of remaining alveolar ridge after full flap elevation. Each group received 14 implants, making a total of 28 implants (14 implants HE Ice Implants – 3i, Implants Innovations[®], Palm Beach, FL, USA, and 14 implants 3.5×11 mm Neodent CM Titamax EX – Neodent[®], Curitiba, Brazil, in each group). The cone morse implants were performed 2 mm below the crest and the external hexagonal implants were positioned at the crest level. The groups received seven implants of each manufacturing.

Surgical Procedures

For surgical procedures, the dogs were subjected to a combination of drugs for sedation, unconsciousness, and short- to medium-term moderate analgesia. Moreover, the animals were fasted 12 hours before the surgery in order to prevent vomiting and aspiration of gastric contents. One hour before the start of the surgical procedures, the animals received an intramuscular dose of antibiotic (Pentabiotic, Fort Dodge – Pfizer[®], Campinas, São Paulo, Brazil), and this was extended to 5 days. Sedation was performed with 0.2% injectable Acepromazine (0.2% Acepran, Univet[®], São Paulo, Brazil) at a dose of 0.1 to 0.2 mg/kg body weight by intramuscular injection to promote widespread muscle relaxation and to optimize the method of anesthesia. The anesthesia was also induced intramuscularly through the use of the combination of Xylazine injectable (Anasedan – Vetbrands Brazil Ltda.[®]) at a dose of 0.1 mL/kg and ketamine injection (Dopalen – Vetbrands Brazil Ltda.[®]) at a dose of 0.06 mL/kg. Besides these drugs, local anesthetics/local block (Lidocaine with epinephrine 1:100,000, DFL[®], Rio de Janeiro, Brazil) were performed for completion of the anesthetic effects. During the healing period, animals received anti-inflammatory and analgesic (Banamine Pet, Schering-Plough[®], São Paulo, Brazil) (1 mg/kg) for the first 3 days, and were then evaluated periodically once a week.

The groups were defined randomly, from the time of the first surgery, whereas only two premolars on one side of the lower arch, referring to groups of delayed implantation (group 2), were extracted in this first surgical step. The procedure started with an intrasulcular incision, and we proceeded with the odontosection buccolingually. Thus, the roots were removed separately by a forceps for as much atraumatic extraction as possible. The sockets were sutured with resorbable wires 3.0 (Techsuture[®] Bauru, São Paulo, Brazil) and then we waited for the healing period for subsequent implant placement.

In the second surgical phase, after 16 weeks, with the extraction sockets healed, late implants (group 2) were installed through an incision over the crest of the ridge and with a total flap. Surgical site was prepared as recommended by the manufacturer and the implant was installed on the center of the crest of the alveolar ridge. Each animal received two implants on this side with 4.5 mm distance between them in a random distribution according to the type of implant.

On the opposite site, which was randomly selected for immediate placement, the (group 1); the surgery proceeded with extraction of dental elements, as described above, without the need for folding the flap (flapless). To anchor the implant, the palatal approach was performed,

leaving a gap (small space of 1–2 mm) between the implant and the buccal wall. Just as in group 2, each animal received two implants on this side of the arch.

Prosthetic Procedures

The abutments were specifically chosen according to the prosthetic connection, and the transmucosal straps were 3.5 and 1 mm for the cone morse and external connection implants respectively. The technique of immediate loading has been applied through the use of abutment with 4.1 mm of the platform and protective cylinder for the external hexagonal connection.

Histological Procedures

Four months after the second surgery, the dogs were sedated by intramuscular injection with Xylazine (Anasedan – Vetbrands Brazil Ltda) at a dose of 0.1 ml/kg and ketamine injection (Dopalen – Vetbrands Brazil Ltda.) at a dose of 0.06 ml/kg, and then euthanized by an injection of potassium chloride 19% 1 ml/5 kg dose. The mandibles were sectioned, fixed, and embedded in historesin for histomorphometric evaluation. All specimens were washed in saline solution, packaged, and stored in a container with 10% formalin. These samples were dehydrated through serial washes in increasing concentrations of ethanol and subsequently embedded in resin (Technovit 7200 VLC, Kulzer®, Wehrheim, Germany). After polymerization, samples were placed on glass slides by using a cyanoacrylate glue and worked through cutting hard tissues system (Exakt, Apparetebau® GmbH, Germany). The specimens were then sectioned (cut 150–300 mm) along its longitudinal axis with a system of stainless steel discs called diamond: Need 1 Automated System (Assing®, Rome, Italy). After this, the plates were again refined in the Exakt system, until approximately 80 mm sections were obtained. The completed samples were stained with toluidine blue and Acid Fuchsin.

A slide analysis was performed using a bright field microscope (Laborlux S, Leitz, Wetzlar, Germany) connected to a video camera with high resolution (3CCD, JVC KY-F55B, JVC®, Yokohama, Japan) and connected to a computer (Intel Pentium III 1200 MMX, Intel®, Santa Clara, CA, USA). This optical system was associated with a digitizing system (Matrix Vision GmbH, Oppenweiler, Germany) capable of image capture (Image-Pro Plus 4.5, Media Cybernetics Inc., Immagini & Computer Snc Milano, Italy). For histomorphometric analysis of the images, a software AxionVision 4.8.3 (Zeiss®, Germany) was used, and a single calibrated examiner measured: Buccal bone–implant contact (BIC), palatal BIC, total BIC, and the buccal and palatal areas of all slides in question. To

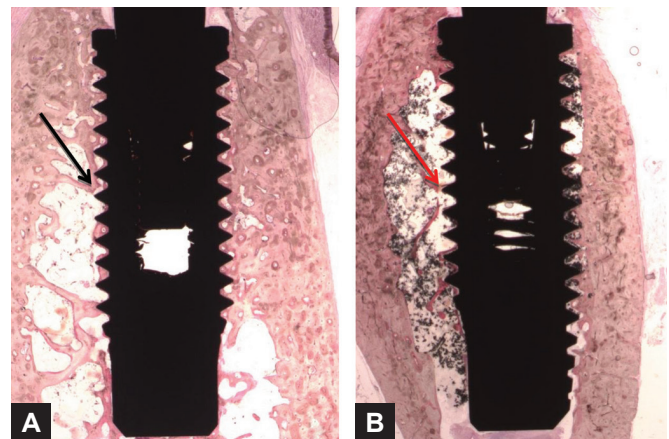
measure the area, the distance was delimited to 150 mm to vestibular and to palatal from the implant platform. And similarly, the measurements of BIC were made.

Statistical Analysis

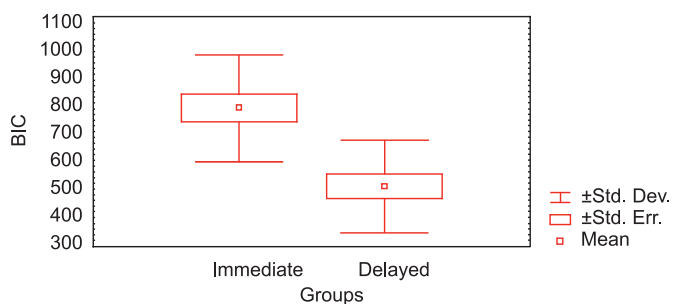
After the analysis, all data were tabulated. For statistical analysis of intergroup data, the nonparametric Kruskal–Wallis test was used. As for intragroup analysis, the choice was the Wilcoxon paired test. Statistically significant differences were accepted at $p < 0.05$. In addition to these tests, a table of BIC percentage was also performed from the BIC data.

RESULTS

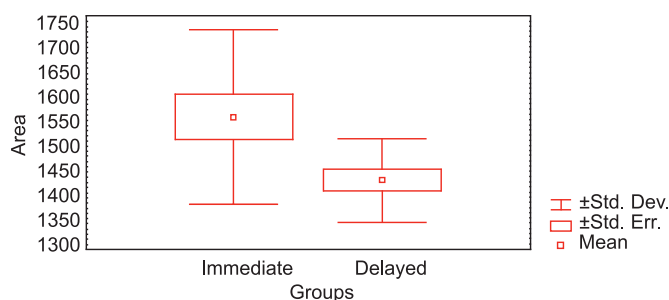
Histomorphometric analysis showed a BIC average percentage of 42.61% for immediate implants and 37.69% for delayed implants (Figs 1A and B). In the BIC (mm) analysis of the buccal surface, there was a statistically significant difference ($p < 0.05$) between the groups of immediate implant and delayed implants, showing a better BIC in group 1, which received immediate implants (Graph 1). Moreover, the lingual surface showed no statistically significant difference.



Figs 1A and B: Histomorphometric images showing the bone-to-implant contact of the (A) immediate implant and (B) delayed implant. It is possible to observe that immediate implant presents more contact between the implant and bone and more new bone, mainly in buccal plate (indicated by the arrow), probably related also to the approach technique used



Graph 1: Results of difference on BIC of immediate vs delayed implants



Graph 2: Results of difference on buccal bone area on immediate vs delayed implants

About the area of bone tissue around implants, again on the buccal aspect, in group 1, it was significantly higher when compared with group 2 (Graph 2) and also statistically superior to bone formation on the buccal surface, when compared with group 2, of delayed implants. The lingual surface did not show any statistical difference between groups.

DISCUSSION

The high success rates with classical protocols for implant placement is already described,^{16,17} but new concepts about the time of placement of the implants have been suggested to reduce the final prosthetic rehabilitation treatment time. These are not only the advantages of immediate implant, but they also suggest that this technique can reduce the bone remodeling around the implants. This remodeling could be influenced by coagulum presence, surgical technique, and host factor, among others and causes significant soft and hard tissue horizontal and vertical changes after the tooth extraction during the first 3 to 6 months. Studies have demonstrated a buccolingual ridge width loss of 3 to 7 mm¹⁸⁻²⁰ within the 1st year and an apicocoronal height loss of 2.0 to 4.5 mm within the first 4 months.²¹ The buccal wall of the extraction site appears particularly prone to resorption,¹⁴ probably due to (1) lack of height and minimal thickness of the buccal alveolar bone, (2) disruption of blood supply via the periosteum and periodontal ligament, and (3) loss of bone (up to 1.0 mm) during wound healing via bone remodeling.²² The results of this study agree with those of the literature about bone loss around immediate or delayed implants,^{19,20} showing that the area of bone tissue formed around the implants is quite similar between the groups. This feature is found mainly on the lingual surface, a fact that was already expected, since regardless of the technique and the time of installation, both implants will be in contact with this wall. It is very important to find ways to reduce the remodeling because this dimensional change in osseous tissue can compromise the ability to eventually place an implant and also contribute to alterations in soft tissue contours that can compromise esthetics.¹⁴

Immediate implants today appear as a popular technique due to the many advantages over the conventional techniques such as the requirement for only one operation and reduced overall treatment time.²³⁻²⁵ However, they also present some disadvantages, including the inability to predict bone modeling that may compromise outcomes especially in the esthetic zone and the inadequate soft tissue volume that causes tension during the closure of the mucoperiosteal flap.² The present research contributes to these findings because it shows the results of BIC after both techniques, which demonstrate higher values of immediate implants than delayed implants, in agreement with the literature,^{15,23} and to overcome these limitations, the present research suggests surgery flapless to reducing these risks.

Furthermore, results of this study show higher values of bone formation on the buccal surface in immediate implants compared with delayed implants. The time of implant placement and your influence in the esthetics are important. Authors suggest that the second surgery in the delayed approach contributes to the overall loss of proximal tissue height and that immediate implant placement may result in a predictable midbuccal soft tissue margin position and that proximal tissue changes may be an important consideration irrespective of the treatment approach.¹⁴

CONCLUSION

With the limitations of this research, it is suggested that immediate implant is highly predictable clinically, when the technique described in this article is performed, including flapless surgery, palatal approach, and a buccal gap.

CLINICAL SIGNIFICANCE

Actually, the patients and dentists wanted to do a shorter treatment with satisfactory results, but it is necessary to understand if different times of implant placement can influence the results and longevity of the treatment.

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