8-10 year follow-up survival of dental implants in maxillae with or without autogenous bone graft reconstruction

Paulo H de Moraes¹, Sergio Olate²,³, Andrezza Lauria¹, Luciana Asprino⁴, Márcio de Moraes⁴, José Ricardo de Albergaria-Barbosa⁵

¹Division of Oral and Maxillofacial Surgery, State University of Campinas, Brazil; ²Department of Oral and Maxillofacial Surgery, Universidad de La Frontera, Chile; ³Center for Biomedical Research, Universidad Autónoma de Chile, Chile; ⁴Division of Oral and Maxillofacial Surgery, State University of Campinas, Brazil; ⁵Division of Oral and Maxillofacial Surgery, State University of Campinas, Brazil

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Abstract: The aim of this research was to ascertain the survival of implants installed in the atrophic maxillae of patients treated with or without autogenous bone graft at 8 to 10 years of follow-up. A retrospective study was conducted using clinical and imaging analysis. 42 adult patients were selected, treated with osseointegrated implants in a fixed maxillary prosthesis model with suprastructure using 6 to 8 implants; of these, 22 underwent reconstruction with a bone graft taken from the anterior iliac crest and 20 were treated without any type of bone graft. The sequence of removal, installation and management of the grafts followed routine patterns, and the implant installation and prosthesis preparation also followed parameters established in previous publications. Variables of implant survival, stage of loss and bone stability of the implants were analyzed with the Wilcoxon signed-rank test, considering a value of P<0.05 to obtain statistical significance. After 8 to 10 years of follow-up the 306 implants installed in the 42 patients were evaluated. 162 implants were in the bone graft group, where 8.0% of implants were lost in the pre-loading stage, 3.7% in the post-loading stage and 88.7% had complete survival. In the group without bone graft, 6.17% were lost in the pre-loading stage, 1.85% in the post-loading stage and 90.97% had complete survival. There was no significant difference in the survival of the implants between the two groups (P=0.082). Cervical bone loss between the groups showed no significant differences either (P=0.241). The implants in grafted maxillae with cases of severe maxillary atrophy are just as efficient as implants installed in maxillae without bone graft.

Keywords: Autogenous bone graft, maxillary reconstruction, implant survival

Introduction

The rehabilitation of totally edentulous patients with dental implants has become a routine treatment in recent decades. Patients with variations in bone quality and quantity show dental implant therapies [1]; however, patients with severe atrophy of the maxillae are a constant challenge for stable and esthetic rehabilitation with dental implants [2].

Adaptive techniques with dental implants have been used with relative success; angled implants used in 4-implant models have shown adequate stability for application in atrophic maxillae with over 90% success [3] and the use of zygomatic implants have an over 80% success rate [4]. In reconstructive techniques, the use of bone grafts has proven successful using different types of bone for the subsequent installation of 6 to 8 implants [5, 6].

Autogenous bone is the gold standard in maxillary or mandibular bone reconstruction [7]. Usually the iliac crest is used, its main disadvantage being rapid remodeling and the mediate functional limitations experienced by the patient (which are recovered in the medium term) [8]; 5-year follow-up studies using 2D analysis (panoramic x-ray) have shown a resorption between 44% and 50% [9]. Studies into bone stability in the initial 5 postoperative
months using 3D analyses showed 50% resorption [10], whereas in 1.5 years a remodeling from 42% to 46% was observed. Other studies indicate that in six years of follow-up, there is 87% resorption in grafts installed in the mandible and almost 100% resorption in the maxillary graft, maintaining 100% survival of the implants, confirming that graft remodeling is not an obstacle to implant function and stability with loading [6].

Other non-autogenous materials have been used in maxillary reconstruction, mainly because they have caused less remodeling than autogenous bone [5]. However, there are no long-term data on extensive mandibular or maxillary reconstructions; in 2012, Accocella et al. [11] used fresh-frozen bone allografts in maxillary reconstruction, concluding that the blocks installed comparable to those of autogenous grafts were a success.

In terms of implant stability, Adel et al. [12] reported an implant survival between 89% and 98% in the mandible and 81% to 82% in the maxilla in 10 years of follow-up. In 2004, Nyström et al. [13] showed controversial results of 72.8% survival (50.9% in grafted patients and 83.1% in non-grafted patients), indicating that implant loss occurred mainly in the first 3 to 5 years; no implant loss was observed after 5 years of follow-up and after 3 years no significant loss of cervical bone was observed in the installed implants.

These low survival rates in grafted patients were later contrasted with the results by Sbordone et al. [6], who described 100% success in 16 patients treated with bone reconstruction with an iliac crest graft.

The aim of this study was to analyze implant survival in a follow-up of 8 to 10 years, comparing treatments in groups of patients with extensive maxillary reconstructions performed with iliac crest grafts and patients who did not undergo any reconstructive techniques.

**Patients and methods**

A retrospective study was designed of patients treated in the Division of Oral and Maxillofacial Surgery at the State University of Campinas. 42 patients with edentulous maxillae treated between 2000 and 2012 were included. This research is a part of an extensive research in dental implants survival; was approved by the “Comite de Ética em Pesquisa” of the State University of Campinas with the protocol 133/06 and was realized without financial support of institutions or companies.

All the patients underwent the same diagnosis and treatment planning protocol. Inclusion criteria were: ASA I and ASA II patients, patients with 1) complete follow-up based on imaging present in the clinical file and 2) initial diagnosis of a bone ridge classified as III, IV, V or VI according to Cawood & Howell [14]. Exclusion criteria were: patients who smoked, alcoholic patients (data present in the clinical file and confirmed at the time of assessment) and patients with a history of reconstructive surgeries or implants prior to that performed for this protocol.

The patients admitted to the study comprised two groups. Group 1 presented maxillary bone reconstruction with iliac crest graft (exclusive autogenous bone graft with no biological membrane use) and subsequent installation of 6 to 8 conventional implants; group 2 presented adequate bone volume that allowed the installation of 6 to 8 implants without the need for any type of bone graft or support of other elements like membranes.

**Protocol for reconstructive surgery**

In all the patients the donor site for the bone graft was the unilateral anterior iliac crest of the right or left side. The surgery was performed under general anesthesia with an initial local administration of 10 ml of 2% lidocaine. The iliac crest was accessed according to the proposal by Grillon et al. [15], while the preparation and removal of the bone were done according to the indications of Triplett and Schow [16].

The intraoral procedure was executed by means of a mucoperiosteal flap through the area of the alveolar crest, exposing the bone surface up to the infraorbital foramen, an area of pyriform aperture and the lateral walls of the maxillary sinus; the bilateral maxillary sinus was approached with a bone window of 1 cm², where the sinus mucosa was separated without damaging or lacerating it [17], using the conventional techniques to elevate the maxillary sinus floor.
The bone graft obtained was cancellous particulate bone and blocks of corticocancellous bone. Particulate bone was used in the intra-sinus filling. Each block of corticocancellous bone was manipulated and adapted for the installation using a stable internal fixation with 12 to 16 mm titanium screws (2.0 system); in all of them the lag screw technique was used [18] to improve stability.

The entire recipient bed was treated with a superficial decortication (using an egg bur at low speed) prior to the installation of the blocks; the remaining spaces between the block and the recipient bed were filled with particulate bone. Incisions were made in the periosteum with a scalpel, increasing the tissue dimensions to reduce the tension on the bone graft and improve the suturing conditions. Single sutures with absorbent material were used in all patients. Analgesics, anti-inflammatories and antibiotherapy were used on an individual basis. No type of prosthesis was used for 3 to 4 postoperative weeks to avoid complications with the bone graft integration.

Protocol for implant surgery

The systematization for implant installation included the study of x-rays and plaster models that made it possible to visualize the condition as well as prosthetic and surgical planning. The oral rehabilitation team built non-strict surgical guides to monitor the position the implants. For the installation, implants 4.3 mm, 4.0 mm and 3.75 mm in diameter were used, with the shortest one being 10 mm and the longest 15 mm.

All the surgeries at this stage were performed under local anesthesia, with the incision being made in the alveolar crest; in the case of previously reconstructed maxillae, the removal of the osteosynthesis material at this same stage was done using the flap made for the implant installation to optimize the procedure. In these patients, the implants were installed between 5 and 6 months after the reconstructive surgery.

Conexao (ConexaoSistema de Prótese, Sao Paulo, Brazil) and NeoDent (Neodent, Curitiba, Brazil) external hex implants were used. In all cases the drilling sequence indicated by the manufacturer was used; installation torque was set with use of the motor and if 35N could not be achieved, it was done manually considering up to 25N acceptable. The implant that did not reach the required stability had one of three options: 1) change to one of larger diameter, 2) modify its position towards another one adjacent or 3) wait 6 weeks to repeat the operation in the same place using the same surgical protocol. The implants were kept submerged with a cover screw and 5 days after the procedure, the patients could use a removable total prosthesis.

Protocol for prosthetic treatment

All the patients received deferred loading, where the connector surgery (second surgery) was done 4 to 6 months after the implant installation surgery. Prosthetic rehabilitation was done by means of a suprastructure, splinting all the implants with the prosthetic system. All the patients received instructions for correct care and hygiene. Subsequent check-ups occurred weekly in the first month and every three months during the first year; there were biannual check-ups from the second year on.

Radiography and clinical follow-up

All the patients underwent x-ray exams in the initial and final stages of the assessment. Clinical check-ups took place every 6 months, following protocols assigned by the institution, in which standardized panoramic x-rays were obtained for each patient biannually in the first year, annually from the second to the fourth years and then at the time of evaluation for the current study (8 to 10 years later). Nevertheless, given the differences in image quality (technology developed during the years of patient follow-up), differences in film quality and differences in the technical personnel involved in taking the images, an arbitrary and reproducible point was determined for ongoing evaluation among the x-rays; the selected point was the implant-abutment junction (IAJ) to establish the distance of the most cervical point of the bone present in the mesial or distal sector up to the IAJ. For all the comparisons of measurements obtained by x-ray, the observer was calibrated and repeated measurements were analyzed to obtain the kappa value among the measurements taken.

The implants were considered functional when their perceptible individual immobility was
established in the clinical analysis, functional loading was maintained with the installed prosthetic system, radiolucency was absent on the periphery of the implant, infections or sensitive alterations and pain were absent in the patient’s daily functioning [19].

**Statistical analysis**

A descriptive study was performed with an analysis of survival of the implants. A Wilcoxon signed-rank test was used to compare the results between the two groups, considering a 5% level of statistical significance.

**Results**

A total of 306 dental implants were installed in the 42 patients in this study; 25 patients were treated with 8 maxillary implants, two with seven maxillary implants and 15 with 6 maxillary implants. In all of them the protocol used was to submerge the implant in the installation stage and after 5 to 6 months the second surgery took place to connect the prosthetic systems. All the patients included for the first surgery were ASA I and II, although during the 8 to 10 years loss of suitable control of diabetes was observed in 5 subjects, who were later managed by the internal medicine unit.

The average age of the patients was 59.8 years (40-71 years of age) and the selection of the treatment type, with or without bone graft, was based on the clinical and x-ray analysis and study models that enabled identification of the desired implant position. All the patients were examined on the basis of the classification established by Cawood and Howell, establishing the bone volume needed to install implants with or without a bone graft. All the grafts used were in block with or without intrasinus filling (particulate autogenous bone), and no case presented a Lefort I osteotomy for mobilization or any other type of bone augmentation procedure.

Of the 306 implants installed, 30 implants (9.8%) were lost or removed due to a fault in the osseointegration, of which 19 (11.7%) were lost in the bone graft group and 11 (7.6%) were lost in the non-bone graft group (Table 1).

In the bone graft group, of the 162 implants installed, 10 (6.17%) were lost during the osseointegration stage or when the abutment connector was installed (the first 6 months), 3 (1.85%) failed immediately after installation of the abutment or in the prosthetic abutment connector stage, which indicates that 13 implants (8.0%) were lost before the installation of any prosthetic system. Subsequent to prosthesis installation, 6 (3.70%) implants were lost, including two in the first year and four during the next the two years. After the third year of prosthetic functioning, no implant losses were observed (Table 2).

Considering the installation times, 88.27% survival was obtained for the implants from the installation stage and 95.97% survival from the prosthetic loading stage (Table 3).

In the group that did not use a bone graft, of the 144 implants installed only 5 (3.5%) were lost in the osseointegration stage and in the surgical stage of installing the connector screw (sec-
ond surgery). After the installation of the prosthesis systems, 8 (5.6%) implants were lost, of which 2 were lost during the first year of follow-up and the remaining 6 before three years of follow-up (Table 2). The survival of the implants calculated from the installation stage was 90.97%, whereas when calculated from the prosthesis insertion stage it was 94.2%. No significant differences were observed between the groups with or without graft, or in the survival of the implants considering the initial stage of the surgery or the initial stage of prosthetic loading (P>0.05) (Table 3).

With respect to the remodeled bone observed in the implants, the average distance observed between the most cervical bone and the IAJ (considering the mesial and distal sector of each implant) in the bone graft group was 3.1 mm (± 2.21 mm). In the group without bone graft, the average bone height from crestal level to the IAJ was 2.6 mm (± 1.84 mm). The average difference of 0.5 mm observed between the two groups did not present significant differences (P>0.05).

**Discussion**

Various factors related to long-term implant stability, such as the use of tobacco, general systemic conditions, implant design and the surgeon's skill, are associated with the success and failure of the implants [20]. Tobacco has regularly been indicated as one of the most important risk factors in implant failure [21]; in this study the effect of tobacco was eliminated by including patients in the study who did not smoke. At the beginning of the treatment only ASA I and ASA II patients were included, although after 8 to 10 years some alterations were observed in some patients (high blood pressure and diabetes), which were kept under control by the internal medicine team.

The most important results of this study show there were no significant differences between the group with autogenous bone graft and the group without bone graft in terms of implant stability in the follow-up period or in cervical bone loss after 8 to 10 years of follow-up.

The stability of the autogenous bone graft installed in edentulous maxillae has been analyzed before. Studies by Nyström et al. [22], with a follow-up of 9 to 14 years, established considerable bone resorption of the grafted bone blocks during the first 12 months, indicating that the results would be stable in the long term. Other orientations show high bone resorption rates where Sbordone et al. [5] reported a resorption rate close to 50% in follow-ups of 6 to 18 months. In another study, Sbordone et al. [6] suggested after 6 years there was almost total bone graft remodeling with no implant loss, which supports the notion that bone remodeling likely does not influence implant stability and maintains function without alterations.

Dasmah et al. [23], in a 2-year follow-up, indicated that the most significant resorption occurs in the first 6 months, without presenting significant differences between sectors grafted with particulate bone and sites grafted with bone block fixed with screws. A situation that may be associated with bone remodeling is vascularization during graft integration, which is greater in the particulate than in the cancellous bone [24]. However, Dasmah et al. [25] concluded that implant installation limits bone resorption so that early installation of the implants could help maintain bone structure. Sbordone et al. [5] reported that the use of non-autogenous materials was related to the greater preservation of bone volume, and Accocella et al. [11] indicated that the success of bone-block allografts would be comparable to the autogenous ones. In the case of long-term follow-ups, there are no conclusive studies into the impact of these materials on implant survival.
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In light of the existing information and considering our results, it is estimated that although there is bone resorption in the grafted sites, the concept that best represents the phenomenon is bone remodeling; autogenous bone, due to bone integration capacities, will naturally have a blood supply and access to the normal bone metabolism pathways \[26, 27\]. Wolff’s old law states that bone responds and adapts to its function \[28\] so that grafted bone which is not needed to resist implant loading and function must enter a remodeling stage, which means both bone resorption and bone regeneration. In the case of biomaterials, these enter the remodeling with difficulty in the beginning, since remodeling demands a protein exchange, cell mediators and nutrients that the biomaterial does not initially possess. In this light, in the first stage this material will enter the remodeling stage with difficulty because the cell markers are not always going to detect it as an element of the host, and thus the remodeling stage may not begin \[29\]. Without a doubt this phenomenon has been the object of multiple studies, but the fact that there is a decrease in bone volume in the autogenous graft may have more to do with bone integration at the receptor site and the normal bone metabolism.

A greater failure has been reported of implants installed in atrophic maxillae than implants installed in any other type of bone \[30, 31\], and when the results of implants at sites with and without bone grafts were compared, Vidmark et al. \[32\] reported an 87% success rate of maxillary implants without bone graft and a 74% success rate of implants with bone graft prior to installation, with losses mainly in the first 2 years. Jemt et al. \[33\] indicated similar results with 90% success in implants installed in non-grafted edentulous maxillae in 15-year follow-ups, comparable to our results which in non-grafted cases were 90.97%.

The long-term stability of implants in grafted sites has been controversial. Nyström et al. \[22\] determined 90% success in the follow-up of their patients for a period of 9 to 14 years. Nevertheless, comparative studies that analyze the survival of implants in edentulous maxillae with or without a graft indicate success in 84-87% of non-grafted maxillae and 75% in grafted maxillae \[34\], which is very far from our results.

Our results show a success rate in grafted sites of 88.27% of the implants from their installation stage and 95.97% from the prosthetic loading, comparable to the results of the non-grafted sites with 90.97% from their installation stage and 94.2% from their loading stage. Differences between our results and other studies may be justified by the implant models used in the patients (design characteristic and implant surface, implant load distribution, presence of prosthesis antagonists) and in the capacity of the bone grafts to stabilize prior to implant installation and functioning (characteristics in the fixation of the grafts, times from graft installation to implant installation, characteristics of patients’ health and habits).

A recent study reviewed the publications that have reported implant survival over 10 years \[35\]; they chose 23 articles showing survival on average of 94.6% (73.4%-100%). The most frequent losses occurred prior to prosthetic loading (70%), as was also observed in our results. In addition, they indicated that mean bone loss was 1.3 mm (0.1-2.67 mm). The average bone loss in our results was close to 3.1 mm in the bone graft group and 2.6 mm in the non-bone graft group, with no significant differences between the groups. The bone loss in our patients was greater than that observed in other studies; a condition likely caused by deficient hygiene of the prosthetic system and the patients’ difficulty with daily care \[36\]; on the other hand, the biomechanics of function and implant position may influence this \[37\]. A limitation of the analysis in our study is that bone loss could only be valued in the mesial and distal sectors due to the 2D imaging used. It is possible that differences between the groups based on the angulation of the implants and their position require a 3D analysis for enhanced definition.

On the basis of our results, we can conclude that there are no significant differences in the survival of implants installed in edentulous maxillae previously grafted with autogenous bone or not.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Sergio Olate, Facultad de Odontología, Universidad de La Frontera,
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References


