PAULO HEMERSON DE MORAES

REHABILITATION OF FULLY EDENTOULOUS MAXILLA: RETROSPECTIVE SURVIVAL ANALYSIS OF DENTAL IMPLANTS IN NATIVE X AUTOGENOUS BONE AND PROPOSED TECHINIQUE FOR BONE RECONSTRUCTION WIT rhBMP-2

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Universidade Estadual de Campinas
Faculdade de Odontologia de Piracicaba

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Thesis presented to the Piracicaba Dental School of the University of Campinas in partial fulfillment of the requirements for the degree of doctor, in the area of Oral and Maxillofacial Surgery

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ORIENTADOR: PROF. DR. JOSÉ RICARDO DE ALBERGARIA BARBOSA

Este exemplar corresponde a versão final da tese defendida pelo aluno Paulo Hemerson de Moraes e orientada pelo Prof. Dr. José Ricardo de Albergaria Barbosa

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ABSTRACT

In maxillary severely absorbed as rehabilitation treatment, can be used conventional dental implants. However, these situations are present obstacles to the installation of the implants as insufficient and inadequate quality of bone found in the jaw , as well as the expansion of the maxillary sinus pneumatization . In these situations, it is necessary reconstructive surgery to restore the dimensions of thickness and height on rim thus allowing proper installation of these implants. Generally, these reconstructions using autogenous bone taken from a donor site from the patient , such as calota craneal , rib and the iliac crest . Alternatively, with advances in tissue engineering, rhBMP-2 (recombinant human bone morphogenethic protein-2) appeared eliminating the need to remove any donor site as well as any other biomaterial in the maxila bone reconstruction procedure with leaving the lower morbidity and higher patient acceptability. Given the above, this research presents two studies described in the following chapters. **CHAPTER 1:** The objective of this study was to evaluate the survival of implants placed in native bone in the maxilla as well as in maxilla reconstructed with autogenous bone. We obtained a follow-up of 8-10 years with both groups of patients rehabilitated with fixed prostheses on dental implants. The survival of implants in maxilla was reconstructed with autogenous bone implants inserted into the lower maxilla with native bone. **CHAPTER II**: The objective of this study was to present a new technique for reconstruction of maxilla bone using rhBMP-2 seeking precision in increased bone volume needed. The suggested technique offered precision in bone volume to be obtained in the maxilla bone reconstruction with rhBMP-2.

Key-words: osseointegrated dental implants, bone graft

RESUMO

Em maxilas severamente absorvidas, como tratamento de reabilitação, podem ser utilizados os implantes dentais osseointegráveis convencionais. Todavia, nestas situações, estão presentes obstáculos para a instalação dos implantes como: quantidade insuficiente e qualidade inadequada do osso encontrado na maxila. Nestas situações, são necessárias cirurgias reconstrutivas para restabelecer as dimensões do rebordo avelolar em espessura e altura possibilitando assim a instalação adequada destes implantes. Geralmente, essas reconstruções utilizam osso autógeno retirado de algum sitio doador do paciente, como a calota craniana, costela e crista do ilíaco. Alternativamente, com os avanços da engenharia tecidual, a rhBMP-2 (recombinant human bone morphogenethic protein-2) surgiu eliminando a necessidade de qualquer remoção de sítio doador como também qualquer outro biomaterial nas reconstruções ósseas dos maxilares deixando o procedimento com menor morbidade e maior aceitabilidade dos pacientes. Desta forma, a presente pesquisa apresenta 2 estudos descritos nos capítulos a seguir. **CAPÍTULO 1:** O objetivo deste estudo foi avaliar a sobrevida de implantes instalados em osso nativo de maxilas como também nas reconstruídas com osso autógeno. Foi obtido um acompanhamento de 8-10 anos com pacientes de ambos os grupos reabilitados com próteses fixas sobre implantes dentais. O sucesso dos implantes em maxilas reconstruídas com ósso autogeno não apresentaram diferenças estatisticas à implantes inseridos em maxilas com osso nativo. **CAPÍTULO 2:** O objetivo deste estudo foi apresentar uma nova técnica de reconstrução óssea de maxila utilizando rhBMP-2 objetivando previsibilidade e melhores resultados no aumento do volume ósseo necessário. A técnica sugerida ofereceu bons resultados no volume ósseo a ser obtido nas reconstruções ósseas de maxila com rhBMP-2.

Palavras Chave: implantes dentários osseointegrados, enxerto ósseo

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EPÍGRAFE

“A verdadeira medida de um homem não é como ele se comporta em momentos de conforto e conveniência, mas como ele se mantém em tempo de controvérsia e desafio”.

Martin Luther King Jr.

INTRODUÇÃO

Em maxilas severamente reabsorvidas, como tratamento de reabilitação, podem ser utilizados os implantes dentais osseointegráveis convencionais. Todavia, nestas situações, estão presentes obstáculos para a instalação dos implantes como: quantidade insuficiente e qualidade inadequada do osso encontrado na maxila, como também a ampliação por pneumatização do seio maxilar. Nestas situações, são necessárias cirurgias reconstrutivas para restabelecer as dimensões do rebordo em espessura e altura possibilitando assim a instalação adequada destes implantes. Geralmente, essas reconstruções utilizam osso autógeno retirado de algum sitio doador do paciente, como a calota craniana, costela e crista do ilíaco (Windmark *et al.* 2001).

Há mais de 40 anos o osso ilíaco tornou-se a área doadora favorita para os enxertos e reconstruções ósseas em função da quantidade de osso cortical e de osso medular. Neste caso, a intervenção cirúrgica deve ser realizada em ambiente hospitalar, com anestesia geral com a presença de uma equipe multidisciplinar.

O enxerto pode ser delimitado na área doadora com moldeiras pré-fabricadas em forma de U, que correspondem à forma da maxila atrófica, ou em blocos bicorticais (raros), ou cortical e medular, ou somente medular. O enxerto é remodelado e esculpido para melhor adaptação e fixação sobre a área receptora. O ilíaco oferece uma grande quantidade de osso, com predominância de medular, e, às vezes, tem textura comparável à do osso do túber.

Vários fatores afetam a condição da maxila e podem resultar em diminuição na sobrevida do implante e/ou aumento nas complicações protéticas. O rebordo maxilar anterior geralmente tem osso disponível inadequado para o implante osseointegrado. A lâmina cortical vestibular pode ser reabsorvida devido a uma doença periondontal ou podem em geral se fraturar durante uma exodontia. A maxila apresenta um osso poroso e fino no lado vestibular, compactos porosos muito finos e densos na região nasal como também osso

cortical espesso na vertente palatina.

Além disso, em diversos estudos publicados sobre instalações de implantes em maxilas severamente absorvidas, a média de sucesso é maior para implantes instalados em osso residual maduro junto às áreas que receberam enxerto ósseo, encontrando faixas de 13% a 25% de falha após dois anos de acompanhamento (Widmark et al., 2001; Lekholm et al., 1999).

Embasada em achados científicos, a experiência clínica há muito elegeu o osso autógeno como material de eleição para a reconstrução de defeitos ósseos dos maxilares. Suas propriedades osteogênicas, osteoindutoras, osteocondutoras e não antigênicas o asseguram como o material ideal para a resolução clínica de problemas de disponibilidade de tecido ósseo (Ehrenfeld & Hagenmaier, 2002). Talvez a única, mas não menos importante desvantagem da utilização do osso autógeno, é a necessidade de um segundo sítio cirúrgico para a coleta do material, o que aumenta significativamente o custo e a morbidade associada ao procedimento. É comum observar certa rejeição por parte dos pacientes à menção da necessidade de colheita e enxertia óssea, e muitos acabam optando por opções restauradoras alternativas ou aquém do ideal pura e simplesmente em função da necessidade desta etapa adicional. A fim de minimizar este problema, substitutos ósseos estão disponíveis para a tarefa de auxiliar na reconstrução dos maxilares.

No entanto, um grande avanço nas possibilidades de enxertia óssea ocorreu com a descoberta das proteínas ósseas morfogenéticas (conhecidas como BMP, do inglês bone morphogenetic proteins), cujo estudo foi iniciado por Marshall Uris tem 1965. Embora tecnicamente seja considerado um enxerto, este material tem como efeito principal a indução da formação óssea (Wilk, 2004). Classificadas como um subgrupo da super-família dos fatores de crescimento transformadores beta (TGF-β, do inglês *transforming growth factor-β),* as BMP são polipeptídeos multifuncionais que desempenham importante papel em uma gama de funções e processos celulares como a embriogênese, o

crescimento e a diferenciação celular, e a cicatrização óssea e reparo de fraturas (Ai-Agl et al., 2008; Canalis et al., 2003; Song et al., 2009).

Adicionalmente, oferecendo a eliminação da necessidade de sítio doador como qualquer outro biomaterial tornando simplificado o procedimento com menor morbidade e maior aceitação dos pacientes.

O uso clínico da rhBMP-2 vem sendo divulgado positivamente na literatura pertinente às especialidades da implantodontia e cirurgia bucomaxilofacial (Herford et al., 2008; Triplett et al., 2009). Nestes estudos, em canídeos, foi avaliado o efeito da rhBMP- 2 na formação óssea em defeitos de continuidade na mandíbula. Em estudos realizados, observaram que, entre os 3 e 6 meses pós-operatórios, a resistência mecânica dos defeitos reconstruídos aumentou consideravelmente, de forma compatível com o grau de mineralização e espessura óssea (Toriumi et al.,1991).

Posteriormente, foi avaliada a funcionalidade em longo prazo do osso regenerado por rhBMP-2 em grandes defeitos segmentares da mandíbula[29], com a comparação entre os resultados obtidos pela instalação de implantes cônicos em osso regenerado por rhBMP-2 e em osso reconstruído por auto-enxerto. Enquanto todos os implantes instalados no osso regenerado por rhBMP-2 se osteointegraram, metade daqueles instalados em osso enxertado falharam. Os resultados histológicos obtidos no grupo em que a rhBMP-2 foi utilizada, apontaram excelente regeneração óssea em termos da porcentagem da superfície osso-implante preenchida por matriz óssea calcificada. Segundo estes autores, o aumento e a manutenção da densidade óssea, além do bom padrão de remodelação na interface entre o osso-implante cônico indicam a estabilidade em longo prazo do osso regenerado por rhBMP-2 (Boyne & Nakamura, 1998).

Tecnicamente, a reconstrução de maxila de rhBMP-2 torna-se um procedimento mais simples que as reconstruções com osso autógeno, no entanto, necessita de cuidados no que tange na quantificação de aumento ósseo a ser obtido no procedimento, visto que a rhBMP-2 é carreada em uma esponja

de colageno que não apresenta resistência mecânica para manutenção do arcabouço e geralmente são utilizadas malhas de titânio ou absorvíveis para a manutenção deste arcabouço para o ganho de espessura óssea desejado.

Desta forma, esta tese apresenta 2 estudos em reabilitações de maxilas totalmente edentulas com implantes dentais subdivididas em 2 capitulos objetivando avaliar a sobrevida de implantes entre maxilas com osso nativo como e maxilas reconstruídas com ósso autogeno (crista anterior do ilíaco). Além disto, outro capítulo, focando nos avanços da engenharia tecidual, descrevendo uma nova técnica em reconstruções ósseas de maxila com rhBMP-2 otimizando os resultados.

CAPÍTULO 1

A 8-10 year follow-up survival analysis of dental implants in maxilla with autogenous grafts and native bone

Authors: Paulo Hemerson de Moraes, DDS, MS[a] ; Andrezza Lauria, DDS, MS[a]; Roger William Fernandes Moreira, MD, DDS, MS, PhD[b]; Márcio de Moraes, DDS, MS, PhD[b] ; José Ricardo de Albergaria-Barbosa, DDS, MS, PhD[b]

Keywords: dental implants; atrophic maxilla; autogenous graft; native bone, osseointegration

Purpose: This study evaluates survival rate of osseointegrated dental implants placed into autogenous graft and native bone maxilla.

Patients and Methods: 42 patients, without systemic dysfunction as well habits, (17 men, 25 women) were included in the study and required treatment with osseointegrated dental implants in maxilla. 22 patients selected were scheduled for autogenous bone graft of the iliac crest (AGG) for further rehabilitation with implants. In native bone (NBG), 10 patients, selected for rehabilitation for rehabilitation. Were observed survival rate of implants in both groups by periodic radiographies as well as clinical evaluations. Cumulative survival rate (CSR), survival rate and marginal bone changes were measured.
Results: 306 dental implants placed, 30 implants (9.8%) failed in maintenance of osseointegration and were subsequently removed. Nineteen (11.7%) implants lost in AGG eleven (7.6%) in NBG. The functional implant survival rate was 96% for the AGG and 97.7% for the NBG after a mean follow-up of 8 to 10 years. . For AGG, the marginal bone level was on average 3.1 mm (SD: 2.21) from the reference point after a mean follow-up of 79.6 months. For the NBG, the marginal bone level was on average 2.6 mm (SD: 1.84) from the reference point after a mean follow-up of 87.3 months.

Conclusions:

The overall implant survival rate was similar between AGG and NBG groups after a mean of 8 to 10 years of follow-up.

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INTRODUCTION

Dental rehabilitation of totally edentulous patients with osseointegrated dental implants (ODI) has become a routine treatment modality in the last decades with sufficient bone volume.[1-5] Patients with adequate maxillary bone are ideal candidates for implants, but are the exception. Patients with moderate to severe atrophy challenge the surgeon to discover alternative ways to use existing bone or resort to augmenting the patient with autogenous or alloplastic bone materials.

One requirement for successful treatment with ODI is a sufficient bone volume to achieve primary stability[6]. In patients with advanced resorption of the maxilla this bone is not available, therefore augmenting procedures to reconstruct the alveolar crest to increase the vertical and horizontal dimensions are necessary.

Among the different methods for the reconstruction of deficient alveolar ridges, which include osteoinduction with growth factors such as bone morphogenetic proteins (BMPs),[7,8] guided bone regeneration,[9-12] distraction osteogenesis,[13-16] reconstruction with allografts,[17,18] reconstruction with autogenous bone grafts and reconstruction with revascularized free flaps, the use of autogenous bone blocks represents the most frequently used treatment modality for both limited and extended bone defects. [19-21]

The aim of reconstruction with bone grafts and implants is to restore facial morphology. The condition of the alveolar crest determines the choice of surgical technique to optimize function and appearance for the patient. The anterior iliac crest is a common donor site, especially when both cortical and cancellous bone are required.

The aims of this study were to evaluate the ODI survival rate and marginal bone level after long-term follow-up in grafted and nongrafted edentolous maxilla.

PATIENTS AND METHODS

A retrospective chart review of patients receiving ODI was conducted. The patients were referred to the Department Oral Diagnosis, Oral and Maxillofacial Surgery Division, Piracicaba Dental School, State University of Campinas-UNICAMP, for treatment of the rehabilitation with ODI. The study included 42 patients with edentulous maxillary between 1999 and 2012, treated with ODI. The mean age of the patients was 59.8 years (range 40-71 years). The choice of treatment was based on the amount of bone available for implant placement as determined by clinical and radiographic pre-surgical examinations. Routine implant treatment was commenced if the remaining bone volume was evaluated as adequate. Twenty patients (8 men, 12 women, mean age of 60.2) total edentulous possessed enough native bone sufficient for rehabilitation treatment with ODI belonging to the native bone graft (NBG) (Table 1). Patients with severe atrophy, autogenous graft group (AGG), this group included 22 patients, 9 men and 13 women, with a mean age of 59.3 years, underwent a bone augmentation procedure using autogenous bone grafts prior to implant placement (Table 1) with the goal of the treatment was to provide the patients with a fixed prosthesis. Most these patients didn't have sufficient bone height or/and thickness in the maxilla, Class V and VI according to Cawood and Howell[22] that prior to installation of the implants underwent reconstruction of maxilla with iliac crest graft. All patients participating in the study did not present systemic dysfunctions as well as habits like smoking and alcoholism to avoid methodological bias.

Protocol Reconstructive Surgery

Surgery was performed under general anaesthesia with local administration of 2% lidocaine (20 mg/mL + 12.5 µg/mL) to reduce bleeding. The iliac crest was chosen as the donor site. The iliac crest graft was obtained following the technique described by Grillon et al[23] using a cutaneous approach via elective lines of incision. The recipient site was approached as described by Triplett and Schow.[24] Intraorally, a mucoperiosteal flap, labially directed through a

midcrestal incision, was raised to expose the lateral wall of the sinus, nasal aperture and the anterior maxillary alveolar crest. The surgical bone-grafting procedure, preparation of the sinuses, and elevation of the sinus mucosa have been described previously[25] and the bone grafts were placed in the sinuses bilaterally.

Each cortiococancellous bone blocks were adjusted and placed on the alveolar process and rigidly fixed with 2-3 titanium screws utilizing “lag screw” technique[26] (2 mm diameter) and autogeneous bone chips were used to fill any gaps between the grafts and the recipient area. In order to avoid tension on the mucoperiosteal flap, a periosteal horizontal incision was made to increase the length of the flap. The mucoperiosteal flap was then closed with single sutures. All patients underwent appropriate antibiotic, analgesic, and anti-inflammatory therapy. The patients were not allowed to wear removable dentures during the first 4–6 postoperative weeks.

Protocol Implant Surgery

For the native bone group (NBG), the ODI were installed immediately. However, for autogenous graft group (AGG), six months after bone graft surgery, the ODI was performed, under local anesthesia and conscious sedation. The bone graft fixation screws were removed at implant surgery. A surgical guide was used to optimize the position of the implants. Twenty-five patients received 8 implants, two patients 7 implants and fifteen patients 6 implants. A total of 306 implants were inserted. The implants were supplied with cover screws and left for healing for 6 months before abutment connection in most cases.

After the ODI placement or grafting procedure the patients did not use their conventional dentures for 4–6 weeks. In patients who lost implants, a decision was made whether to install supplementary implants. Depending on which implant had been lost, the position of the remaining implants, the dentition in the opposing jaw and individual factors such as loading, functional habits and cantilever length played an important roll in determining if supplementary

implants should be inserted.

Protocol Prosthetic Treatment

During the healing period, the patients were recalled for individual check ups and, if needed, the dentures were relined with a soft-tissue relining material. After implant surgery, the dentures were again relined. All prostheses made in NBG and AGG were fixed. After delivery of the final prosthesis the patients were instructed in oral hygiene and an individual recall programme was set up.

Radiographic Examination

The patients were then invited to come for a clinical assessment to evaluate the status of the implants. However, the retrospective radiographic examinations had not been performed consistently at the time of the abutment connection surgery and at the annual check-ups. Radiographs used in this study were taken at the prospective follow-up. Panoramic and periapical radiographs were obtained to assess the osseous–implant interface.

The orthopantomograms were obtained with the patients in standardized positioning. An intraoral radiographic paralleling technique[29] was utilized at the time of the prospective patient follow-up. The distance from a reference point on the implant to the most apical marginal bone level at the mesial and distal surfaces of each implant. Linear measurements were performed to the nearest millimeter. The reference point used was the junction between the implant and the abutment. All baseline and subsequent radiographs of implant placement were assessed for peri-implant radiolucency.

Additionally, peri-implant bone resorption was measured by comparison of radiographs with respect to the proportion of implant length that remained osseointegrated. Both the mesial and distal crestal bone levels were assessed, and a mean value of implant-bone height was obtained for each dental implant.

All clinical and radiographic measurements were performed by one author to eliminate interexaminer variation.

Requirements for defining success in ODI

All patients were clinically examined in a postoperative maintenance program, and the dental implants were checked individually. A surviving implant was defined as being immobile; free from peri-implant radiolucency, infection, or neurologic disturbances[1-30], and without associated pain, either spontaneous or upon application of a torque of 10 to 20 Ncm.[27] In addition, the implant had to allow for placement of a functional fixed prosthesis.[28]

Statistics

Life table analyses were performed to calculate the cumulative survival rate (CSR) for the implants. The Wilcoxon rank sum test was used to test differences in implant survival rates between the nongraft group and the graft group. The level of statistical significance was set at 5%.

Nonparametric methods were used to evaluate the significance of the changes in radiographic bone height. Because the data were discrete and asymmetric in distribution, the Wilcoxon signed-rank test (statistical significance level $\alpha = 0.05$) was used to evaluate the significance of the differences in bone remodeling.

RESULTS

The mean follow-up time for all implants was 87.3 months in AGG and 79.6 in NBG (Table 1).

Table 1. Distribution of Patients in Treatment Groups with Regard to Gender

Treatment Group	Nº Patients	Male/Female	Mean Age(y)(SD)	Age range(y)	Follow-up period(mo)	Follow-up period range (mo)
Autogenous Graft Group	22	9/13	59.3 (7.84)	40-71	87,3	65-126
Native Bone Group	20	8/12	60.2 (6.53)	48-69	79,6	51-97

Of the 306 dental implants placed, 30 implants (9.8%) failed in maintenance of osseointegration and were subsequently removed (Table 2). Nineteen (11.7%) implants lost in AGG eleven (7.6%) in NBG (Table 2).

Table 2. Distribution of Implants Between Autogenous Graft and Native Bone Groups

Group	Total
Graft group	19/162 (11.7)
Nongraft group	11/144 (7.6)
Lost implants in both groups (%)	30/306 (9.8)

The data on the remodeling of peri-implant apical bone measured. The mean distances between the implant hex base and the alveolar crest. For the autogenous graft group, the marginal bone level was on average 3.1 mm (SD: 2.21) from the reference point after a mean follow-up of 79.6 months. For the native bone group, the marginal bone level was on average 2.6 mm (SD: 1.84) from the reference point after a mean follow-up of 87.3 months.

In the AGG, ten (6.17%) of 162 implants placed were lost during the healing period and abutment connection surgery. Three (1.85%) failed before abutment connection surgery. Between abutment connection surgery and definitive prosthetic loading, another 3 implants (1.85%) were lost. At the time of prosthetic loading the total number of lost implants was 13 (8%). Six implants were lost after loading, including two implants lost in the first year after loading, for a CSR of 88.2% after a mean follow-up period of 87.3 months. Calculated from the date of abutment connection surgery, the percentage of functioning

implants was 93.7%, and calculated from the date of definitive prosthetic loading, the percentage of functioning implants was 96% (Table 3).

Table 3. Distribution of Failed Implants in the Autogenous Graft Group (AGG)

	Before abutment surgery	At abutment surgery	Before loading prosthesis	Period after loading of prosthesis (y)		
				1	4	10
Implants surveyed	162	159	152	149	147	143
Implants failed in interval	3	7	3	2	4	0
Interval failure rate (%)	1.9	4.4	2.0	1.3	2.7	0
Cumulative failure rate (%)	1.9	6.2	8.1	9.3	11.8	11.8

In the other group, NBG, five (3.5%) of 144 implants were lost through the end of the before or at abutment connection surgery period. At the time of prosthetic loading the total number of lost implants for this group was 8 (5.6%). After 1 year of loading with fixed prostheses, another 2 implants had been lost. After a mean follow-up period of 79.6 months the CSR was 92.3%. Calculated from the date of abutment connection surgery, the percentage of functioning implants was 95.1%, and calculated from the date of definitive prosthetic loading, the percentage of functioning implants was 97.7% (Table 4).

Table 4. Distribution of Failed Implants in the Native Bone Group (NBG)

	Before abutment surgery	At abutment surgery	Before loading prosthesis	Period after loading of prosthesis (y)		
				1	4	8
Implants surveyed	144	143	137	133	132	130
Implants failed in interval	1	4	3	1	2	0
Interval failure rate (%)	0.7	2.8	2.2	0.8	1.51	0
Cumulative failure rate (%)	0.7	3.5	5.6	6.3	7.7	7.7

DISCUSSION

Multiple reasons for implant failure or success, including smoking, systemic illness and medications, extremes of implant length, immediate implant placement, implant location, and skills of the clinician have been reported in the international literature[31,32,33]. Out of these, smoking is probably the most frequently and generally accepted factor associated with poor outcome in dental implant[33,34]. The adverse effect of smoking has recently been proven in experimental work[35]. In this study, the effect of smoking was apparent only in periodontal health in one patient. Unstable diabetes and the use of corticosteroids have also been claimed to affect osseointegration[36,37]. However, no features regarding the patients' general health (chronic illness or regular medication) seemed to be important in this study.

Placement of dental implants in patients with addictions to drugs and alcohol would seem to be unwise due to a patient's lack of commitment to long-term health and the questionable ability to maintain implants. However, biologically, there is little evidence that chemical addictions can alter the successful integration of implants. Weyant[38], in a 5-year study of Veterans Administration implant patients, found that abuse of alcohol was a risk factor for poor implant healing and eventual failure. However, Ekfeldt et al,[39] in a study of patients with multiple implant failures, found no histories of addiction to alcohol or drugs.

Due to the divergence found in the literature, only healthy patients without systemic dysfunctions described previously and without habits such as smoking and alcohol consumption were included in the study.

Thus, the success of an implant depends on various factors, beginning with the diagnosis and case selection up to prosthetic rehabilitation and maintenance. After being placed in the selected site, implant must achieve primary stability in the surrounding bone which is important in the bone healing,

by resisting micromovement and the resultant damage to the bone healing process.

Micromovement or motion between freshly placed implant and bone can jeopardise osseointegration. Therefore primary stability immediately post implant placement and in the early healing phase is necessary until the time secondary stability is gained by bone remodelling and osseointegration.[40]

Successful outcome of implant placement can be attributed to primary stability.[41] It is determined by surgical technique used to place the implant, implant design and the density of the bone site. This latter, contributing to justify a higher number of failures AGG.

Primary stability depends on mechanical engagement of an implant with bone but it decreases with time as bone remodelling occurs around it.[42]

Parafunctional habits (clenching and bruxism) have been identified as concerns in implant treatment planning due to the increased pressure on the implants, resulting in possible metal fatigue and fracture and possible surrounding bone loss.[43] Overload caused by either improper prosthesis design or parafunctional habits is considered one of the primary causes of late-stage implant failures. However, Engel et al,[45] in a study of 379 patients who had worn implant-retained restorations for many years, found that increased occlusal wear, usually an indicator of the severity of a bruxism parafunction, had no effect on implant integration and did not result in an increased loss of bone around implants.

Rather than regarding excessive occlusal forces in patients with parafunctional habits as absolute contraindications, many authors have recommended attempting to mitigate these forces.[46] Methods suggested include educating patients about habits, placing an increased number of implants, placing larger implants, planning the placement of implants to reduce bending overload,[57] avoiding the use of cantilevers, using bruxism appliance therapy, increasing time intervals during the prosthetic restoration stages to provide more opportunity for progressive loading techniques, paying diligent attention to occlusal contact design, and using acrylic resin teeth in the prosthesis.[47]

However, 7 patients in the study sample showed parafunctional habits (clenching and bruxism). Only one of these patients (AGG) have lost two implants during the study. An important fact to be considered is that those patients who had complications or lost the ODI may have been subjected to several factors that led to failure. Patients who abused their provisional prosthesis during mastication placed more force on the implants and / or poor adaptations of prostheses after surgery.

Only vertical and distal crestal bone levels can be evaluated on the conventional radiographs taken during the follow-up visit. Buccal or palatinal bone loss cannot be observed on conventional radiographs. In this study the mean periodontal pocket depth was similar for both groups; 3.1 mm (SD: 2.21) in AGG and 2.6 mm SD: 1.84) in NBG. Deeper periodontal pockets were commonly observed on the buccal and palatinal sides of the implant in AGG and on the mesial and palatinal sides NBG. Clinicians should be aware of buccal and palatinal bone loss during the clinical examination and evaluate the periodontal pocket depth at all sides of the implant at control appointments.

A higher implant failure rate was seen in the graft group in spite of this, which most likely could be related to the bone grafts' ability to integrate the implants. This may be explained by the grafts' biomechanical properties as well as the healing capacity of the bone. Another negative factor could be that the healing period for the bone graft was not long enough (mean: 5.4 months), resulting in immature bone graft quality and impaired osseointegration as well as poor incorporations caused by considerable gaps between the receptor site and bone graft.

Finally, loading times of implants placed in grafted areas is also still controversial: although no conclusive recommendations can be made, due to the wide range of waiting times proposed and to the different characteristics of macro-, micro-, and nanogeometry of different implant systems (which may influence osseointegration times), most investigators suggest waiting times similar to those proposed for implants placed in non reconstructed bone (3-6 months), with no detrimental effects on osseointegration.[48] However, it is worth

noting that, although limited, there is also evidence that early or immediate loading of implants placed in reconstructed areas may lead to successful integration.[49]

CONCLUSION

The overall implant survival rate was similar between AGG and NBG groups after a mean of 8 to 10 years of follow-up.

FUNDING

None.

COMPETING INTERESTS

None declared.

ETHICAL APPROVAL

This study was submitted to and approved by the Piracicaba Dental School (State University of Campinas-UNICAMP) Ethics Committee Nº 133/2006.

PATIENT PERMISSION

All patients signed an informed consent form allowing the publication of the collected data ensuring their privacy and confidentiality.

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CAPÍTULO 2

Maxillary reconstruction with rhBMP-2 using stereolithographic models

Authors: Paulo Hemerson de Moraes, DDS, MS[a] ; José Ricardo de Albergaria-Barbosa, DDS, MS, PhD[b]

Abstract: Authors present a novel technique for jaw bone reconstruction using rhBMP-2. It was noted to optimize the surgical outcomes, reduce operating time and result in desired postoperative bone volume considering both height and thickness.

INTRODUCTION

Maxillary Atrophy in fully edentulous patients is a major clinical problem for dentists who need to treat patients using prostheses and osseointegrated dental implants. Simplified surgical techniques minimize postoperative complications. Tissue engineering holds great promise for many bone grafting procedures.

The development of bone morphogenetic proteins (rhBMP-2) has offered an alternative to traditional bone grafting, which has been considered the gold standard for oral and maxillofacial reconstruction. Collagen sponges alone cannot be used as a scaffold for rhBMP-2. Surgeries involving onlay grafts require use of absorbable or titanium mesh to hold the rhBMP-2-containing framework in place. However, determining the increase in bone volume needed for the rehabilitation using rhBMP-2 is a challenge for dental surgeons since it is difficult to reproduce, during the surgery, what has been planned.

The authors present a method to optimize surgical outcomes, reduce operating time and result in desired postoperative bone volume.

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TECNIQUE

A stereolithographic model was obtained from a three-dimensional computed tomography image of the maxilla (Fig. 1). Atrophy of the alveolar bone (Fig. 2) was then checked out and bone measurements were made using a ruler and compass to fabricate wax increments that would meet the volume needed for the reconstruction.

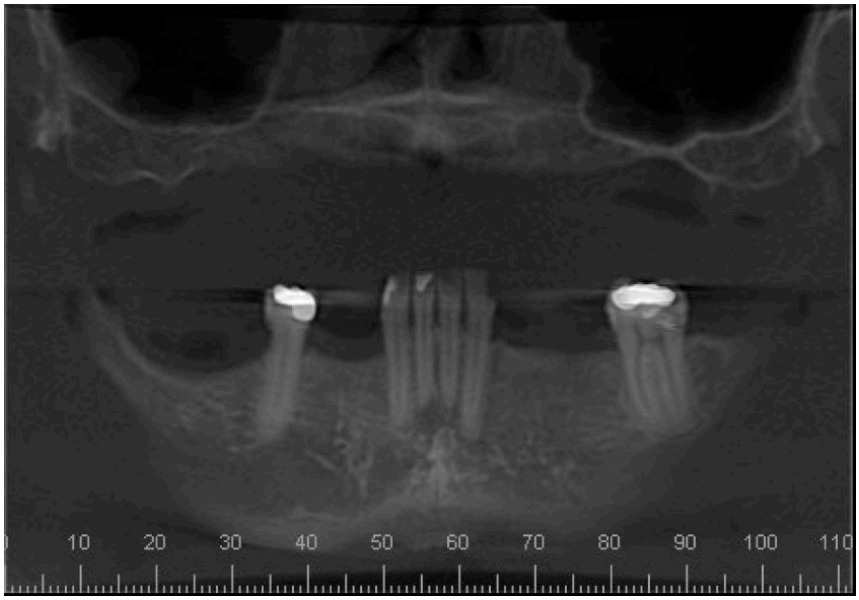

Figure 1: Computed tomography showing atrophic maxilla

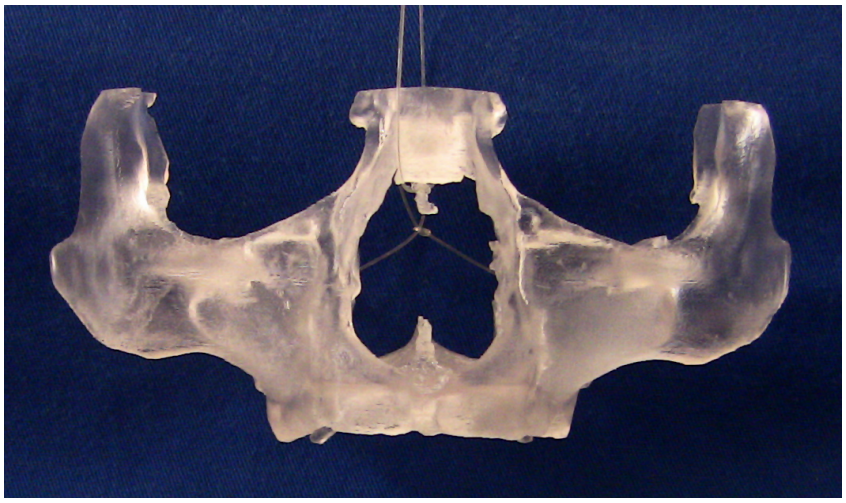

Figure 2: Front view of the stereolithographic model showed the bone atrophy in the vertical and horizontal planes

These increments were then placed on the maxilla and shaped (Figs. 3 and 4) to reproduce the desired bone volume initially planned. Next, a titanium mesh was trimmed and shaped to meet the dimensions of the wax increment (Fig. 5), as well as the area for mesh fixation (screws).

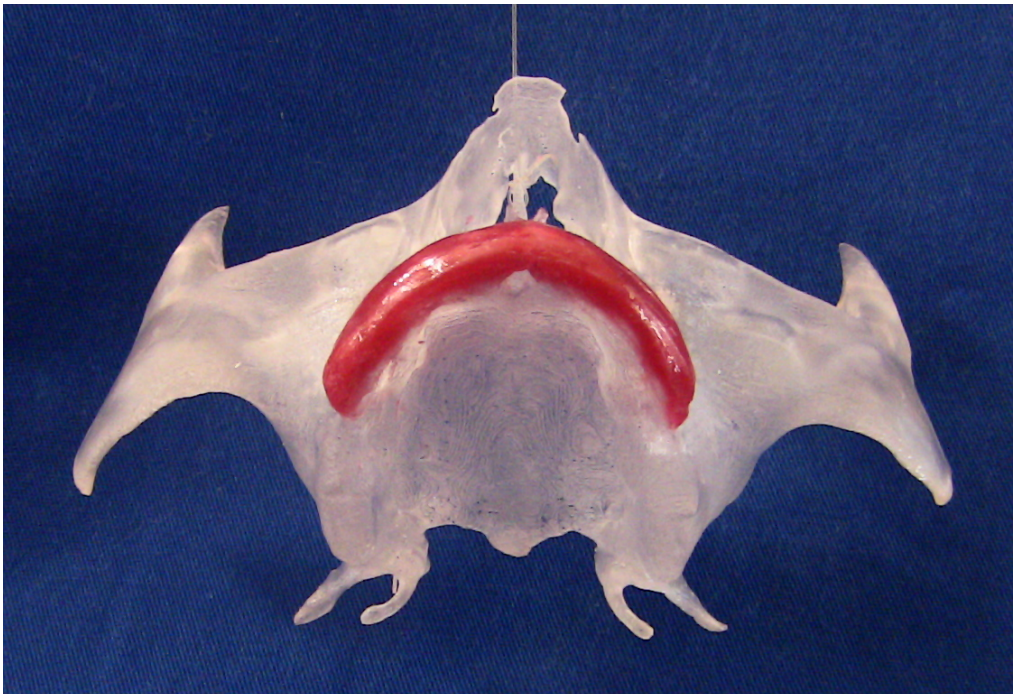

Figure 3: Down-up view with increased bone volume planned in wax

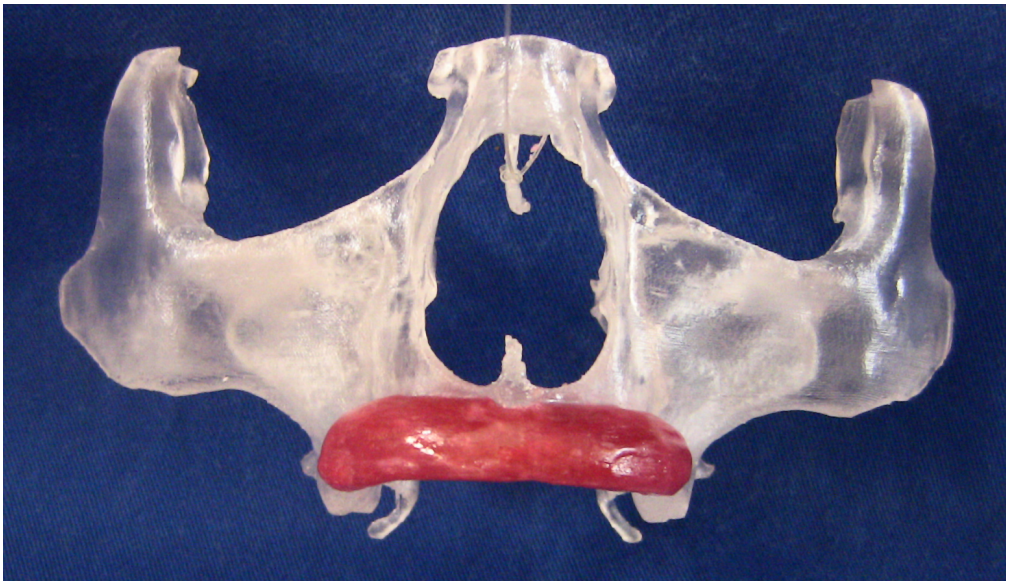

Figure 4: Front view with increased bone volume planned in wax

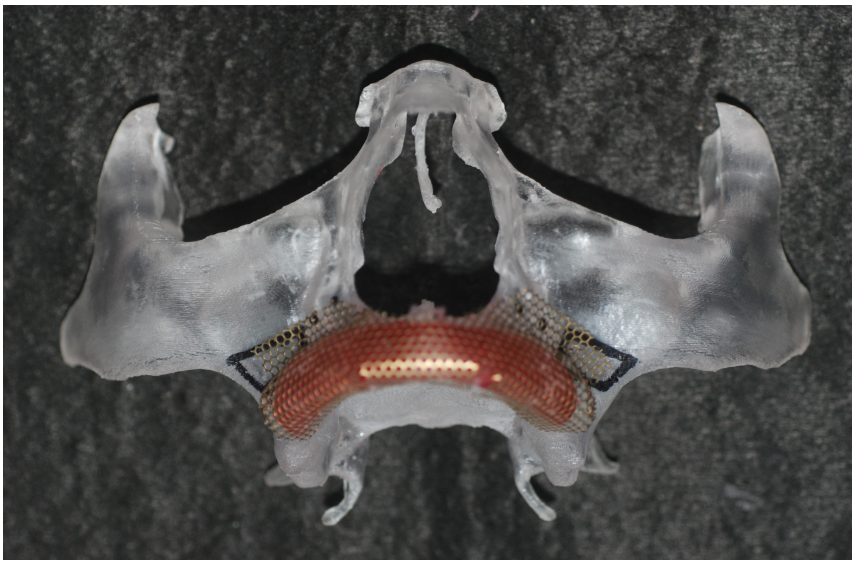

Figure 5: Pre shaped mesh with increased bone volume planned

With regard to the surgery, Local anesthesia along with a vasoconstrictor was used during the surgical procedure, and was applied to the area once the oral mucosa, submucosa, and facial muscles are lushly vascularized. A vestibular approach was used to expose the maxilla. The incision is usually placed approximately 3 to 5 mm superior to the mucogingival junction. Leaving unattached mucosa on the alveolus facilitates closure. The surgeon should not make the incision more superior in the anterior region because entrance into the piriform aperture, with damage nasal mucosa[1].

After the maxillary vestibular approach, access to the maxillary sinus was carried out using an ultrasonic diamond bur (piezosurgery). The sinus membrane was lifted and a rhBMP-2 containing collagen sponge inserted to increase bone height in the posterior maxilla. The pre-shaped mesh was then installed by initially fixing its superior part with screws. It was then filled with the sponge according to what was previously planned and its inferior part fixed. Finally, a juxtaposition of the mucosa was attained with continuous sutures.

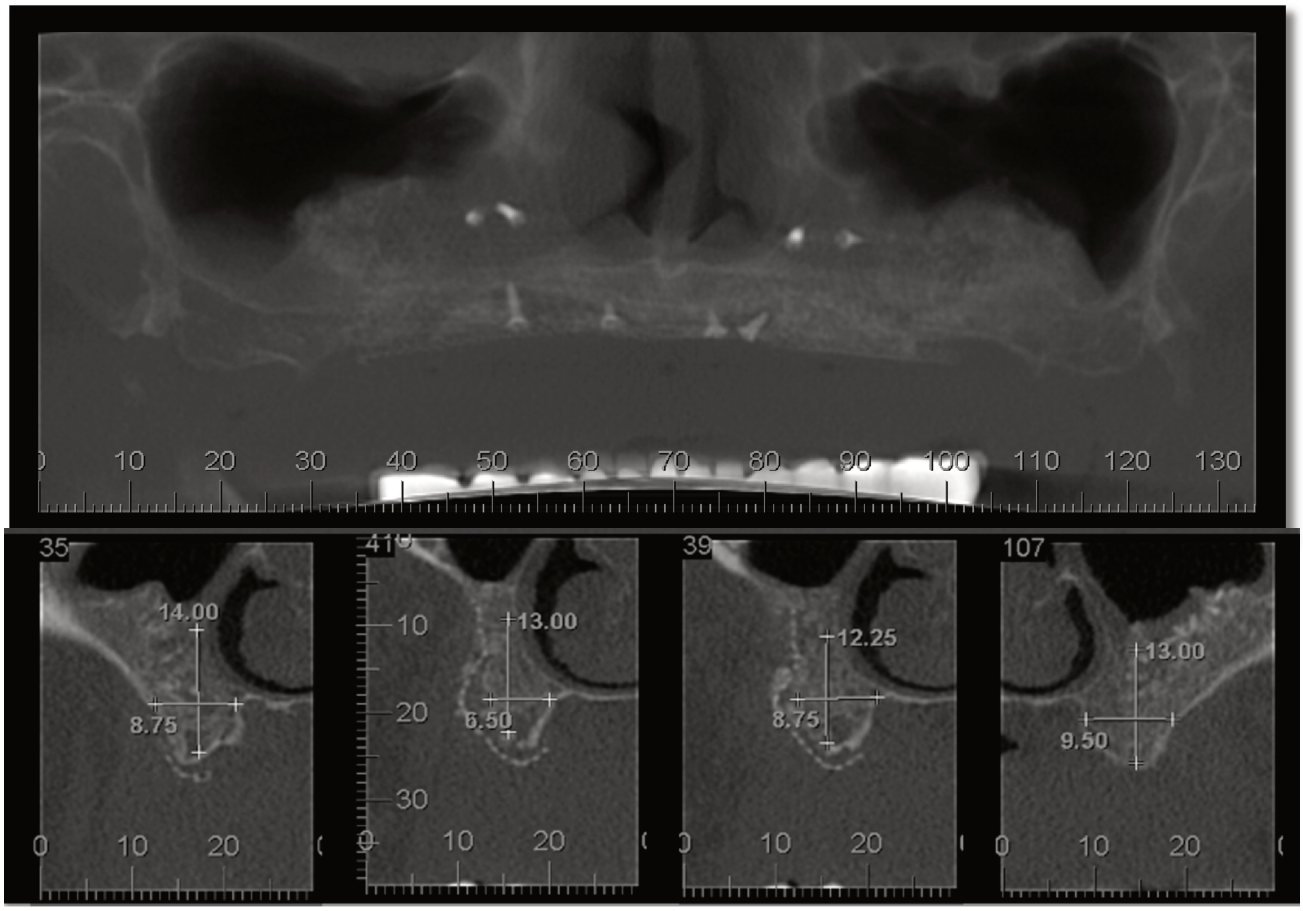

Figure 6: Computed tomography postoperative 7 months showing sufficient bone for adequate rehabilitation with dental implants.

DISCUSSION

Conventionally, maxillary bone reconstruction with rhBMP-2 is empirically carried out. The mesh is shaped during the surgery, thus making it difficult to quantify the bone volume needed for a reconstruction with dental implants. Different from the access approach using the alveolar bone ridge, our technique uses the maxillary vestibular access, an approach that is more likely to prevent tissue suture dehiscence due to the non-keratinized mucosa in this area.

This novel technique offers a surgical instrumentation that allows the surgeon to attain a bone volume according to that pre-surgically planned (Fig. 6). Moreover, it optimizes the surgical outcomes and reduces operating time. No postoperative complications regarding this technique has been reported.

COMPETING INTERESTS

None declared.

FUNDING

None.

ETHICAL APPROVAL

Not required.

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CONCLUSÃO

1 – A taxa de sucesso dos implantes em maxilas reconstruídas com ósso autogeno apresentaram semelhantes aos implantes inseridos em maxilas com osso nativo.

2 – A técnica sugerida otimizou o trans-operatório na mensuração dos volumes ósseos necessários para reconstrução óssea utilizando rhBMP-2.

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APÊNDICE 1

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Grupo "pacientes"

Você está sendo convidado a participar da pesquisa intitulada: "Sobrevida de Implantes Dentais Osseointegrados em Diferentes Técnicas de Reabilitação**"**, tendo como responsáveis o aluno de mestrado Paulo Hemerson de Moraes e o Prof. Dr. Roger Wiliam Fernandes Moreira. Esse estudo é importante para a verificação do comportamento de implantes em regiões enxertadas como também em osso nativo, assim como a previsibilidade de sucesso destas técnicas. Dessa forma, pode-se colher informações que, somadas a outros estudos, poderão facilitar o planejamento, indicações e conseqüentemente taxas de sucesso destes tipos de cirurgias. O objetivo dessa pesquisa é avaliar o nível de satisfação dos pacientes e índice de sobrevivência dos implantes nas diferentes técnicas de reabilitações adotadas. Não há método alternativo de obtenção dessas informações, sendo por isso importante a sua participação.

Esclarecimentos (informação)*:*

Essa pesquisa será realizada em voluntários adultos, edentulos em maxila (faixa etária: 30 a 80 anos), que realizaram tratamentos de reabilitação oral por meio de instalação de implantes dentais na Área de Cirurgia e Traumatologia Buco-Maxilo-Faciais (FOP/UNICAMP). Vocês serão convidados a realizar aos seguintes exames:

1-) Radiografias periapicais e panorâmica da face para auxiliar no diagnóstico de perda óssea adjacente aos implantes;

2-) Exame físico intra-bucal por meio de sondas periodontais que serão inseridas ao redor dos implantes para verificar a profundidade dos sulcos e/ou presença de bolsa peri-implantar ao redor dos implantes.

3-) Realização de teste de sensibilidade em pacientes portadores de parestesia (amortecimento/dormência) após a realização de enxertos ósseos e/ou implantes dentais.

4-) Aplicação de questionário para avaliação do nível de satisfação do tratamento cirúrgico e protético realizados.

Quanto aos riscos previsíveis, a radiação emitida para a obtenção das radiografias pode levar a danos já conhecidos pela comunidade científica. Porém, essas radiografias serão feitas independente da nossa pesquisa, e serão utilizadas pequenas doses de radiação e protetores de chumbo para minimizar esses danos. Sua participação é importante para a comunidade científica, que após essa pesquisa poderá lançar mão de melhorias no planejamento e indicações das técnicas de reabilitação por meio de prótese sobre implantes dentais osseointegrados.

A sua identidade não será divulgada e não há benefícios diretos pela participação da pesquisa. Também não há grupo placebo envolvido nesse trabalho.

O voluntário tem a liberdade de deixar de participar da pesquisa a qualquer momento, e retirar o seu consentimento quanto à utilização dos materiais de pesquisa, sem penalização alguma ou prejuízo ao seu tratamento. Todo o material colhido e os seus dados confidenciais permanecerão em sigilo. Não há previsão de indenização nem de ressarcimento, já que não há risco previsível e o voluntário não terá despesas causadas pela pesquisa. Os procedimentos serão realizados em uma única consulta. Uma cópia deste documento ficará com o voluntário. Ao final desta página estarão os endereços e telefones de contato do pesquisador e da instituição para que você possa entrar em contato caso surjam dúvidas ao longo dessa pesquisa.

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FACULDADE DE ODONTOLOGIA DE PIRACICABA

CONSENTIMENTO LIVRE ESCLARECIDO

Eu, _____, RG nº_____, telefone nº_____ declaro que, após suficientemente esclarecido acerca dos objetivos e normas da pesquisa estou plenamente de acordo com a colaboração no fornecimento dos dados para o preenchimento do formulário clínico a mim apresentado. Concordo plenamente que todos os registros, radiografias e modelos sejam utilizados pela Área de Cirurgia Buco-Maxilo-Facial da FOP, Unicamp, ao qual dou pleno direito de uso para fins de ensino e pesquisa, além da sua divulgação em revistas científicas, ciente de que não será divulgada a minha identidade. Assim autorizo a minha participação no programa estando de acordo com o fornecimento dos dados, atestando a minha participação efetiva e consciente por meio da minha assinatura.

Por ser verdade, firmo o presente.

Data: ___/___/___

_____

(Assinatura do mesmo ou responsável)

Dúvidas em relação à pesquisa devem ser esclarecidas com os pesquisadores.

Pesquisador responsável:
Paulo Hemerson de Moraes
Av. Limeira, 901- PG Cirurgia e Traumatologia Buco-Maxilo-Faciais- Tel: (19) 8188-9982 / 21065390
email:phmoraes@fop.unicamp.br

Em caso de dúvida quanto aos seus direitos como voluntário da pesquisa, entrar em contato com:

Comitê de Ética em Pesquisa:
FACULDADE DE ODONTOLOGIA DE PIRACICABA
CEP — COMITÊ DE ÉTICA EM PESQUISA
Caixa Postal 52, 13414-903 - Piracicaba, SP FONE/FAX (0xx19) 2106-5349
cep@fop.unicamp.br – website www.fop.unicamp.br/cep

APÊNDICE 2

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

Piracicaba, 10 de março de 2010.

Prof. Dr. Jacks Jorge Junior
Coordenador CEP/FOP

Venho através deste solicitar a inclusão de Paulo Hemerson de Moraes, RA 088409, aluno de Mestrado em Clínica Odontológica, Área de Cirurgia Buco-maxilo-faciais, junto à pesquisa **"Sobrevida de Implantes Dentais Osseointegrados em Diferentes Técnicas de Reabilitação"**, de minha responsabilidade.

Informo que a pesquisa foi aprovada pelo CEP/FOP, tendo como número de protocolo 133/2006.

Em anexo CV do aluno.

Atenciosamente,

Prof. Dr. Roger William Fernandes Moreira
Cirurgia e Traumatologia Buco-Maxilo-Faciais
FOP Unicamp
CROSP 55929

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COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**Análise epidemiológica dos pacientes submetidos à reconstrução dos maxilares com área doadora de crista ilíaca atendidos no serviço de Cirurgia Buco-Maxilo-Facial da Faculdade de Odontologia de Piracicaba - Unicamp**", protocolo nº **133/2006**, dos pesquisadores **RENATO SAWAZAKI e ROGER WILLIAM FERNANDES MOREIRA**, satisfaz as exigências do Conselho Nacional de Saúde – Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 27/09/2006.

The Research Ethics Committee of the School of Dentistry of Piracicaba - State University of Campinas, certify that project "**The epidemiology of maxillary reconstruction using the iliac crest donor site in patients treated in the Maxillo-Facial Surgery service, Faculdade de Odontologia de Piracicaba - UNICAMP**", register number **133/2006**, of **RENATO SAWAZAKI and ROGER WILLIAM FERNANDES MOREIRA**, comply with the recommendations of the National Health Council – Ministry of Health of Brazil for researching in human subjects and was approved by this committee at 27/09/2006.

Profa. Cecilia Gatti Guirado
Secretária
CEP/FOP/UNICAMP

Prof. Jacks Jorge Júnior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
Notice: The title of the project appears as provided by the authors, without editing.