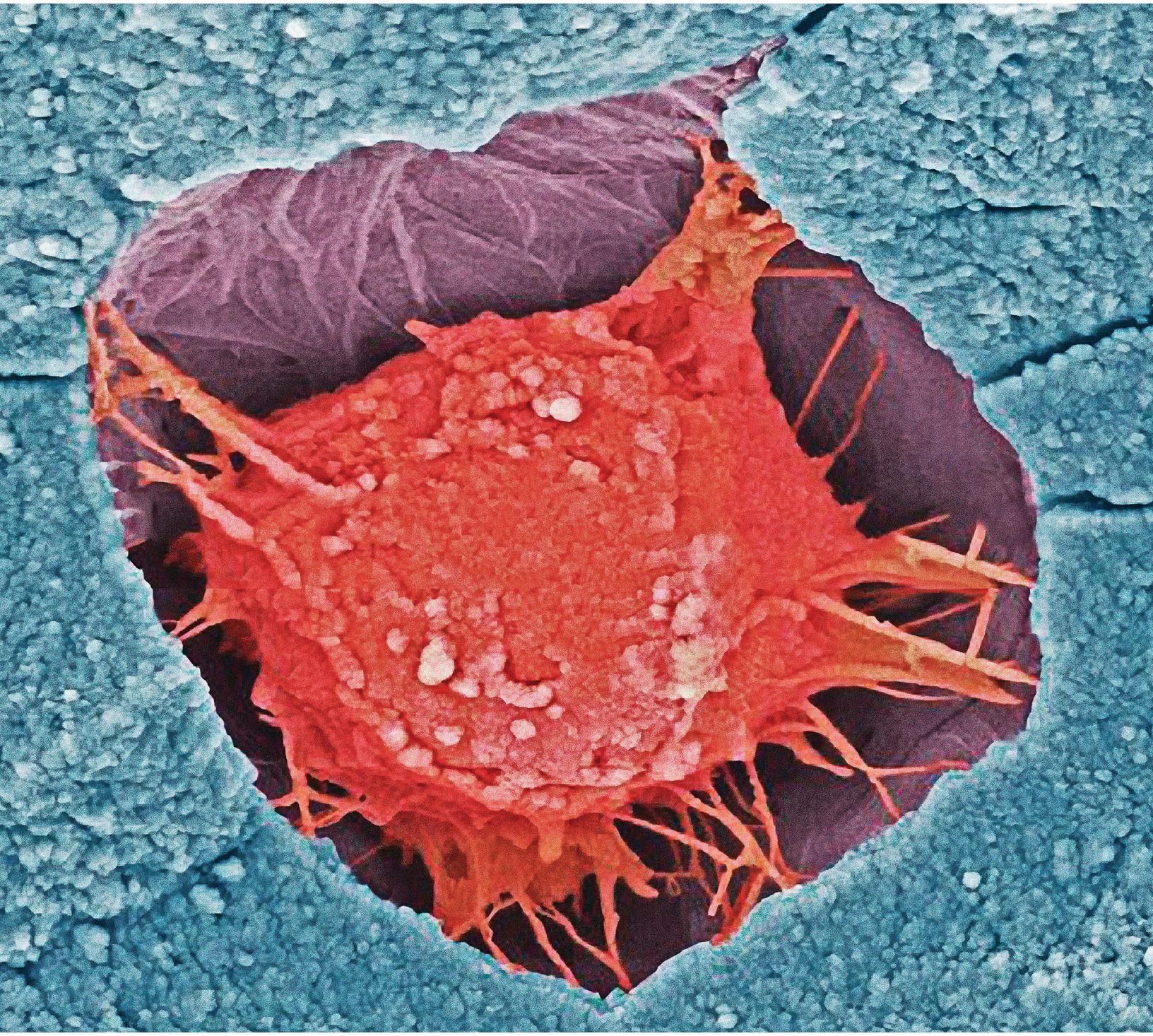
ISSN 2237-650X

Dental Press Implantology

V. 7, N. 4 | October / November / December 2013



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Dental Press
Implantology

Brazilian Journal of Periodontology, Prosthodontics, Oral Rehabilitation and Implantology

Dental Press Implantol. 2013 Oct-Dec;7(4):1-112 | ISSN 2237-650X

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Dental Press Implantology - Qualis / CAPES:

B4 - Odontologia

Indexing:

since 2007

since 2012

since 2007

since 2013

since 2013

CIP: International Cataloging-in-Publication data

Dental Press Implantology. --
v. 5, n. 4 (Oct./Nov./Dec.) (2011) – . -- Maringá : Dental Press International, 2011-

Quartely
Continues the: Revista Dental Press de Periodontia e Implantologia (v. 1, n. 1 – 2007-2011 – ISSN 1980-2269)

ISSN 2237-650X

1. Periodontics. Implantology (Odontology) – Periodicals I. Dental Press International. II. Title.

CDD. 617.643005

Credit: STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY

Caption: Osteoblast bone cell. Coloured scanning electron micrograph (SEM) of an osteoblast (centre) in bone tissue. Osteoblasts are primarily found in regions of new bone growth. They produce and secrete osteoid, a matrix of new bone tissue composed of collagen fibrils and other structural proteins. As soon as osteoid is formed, calcium salts crystallise inside it to form hard, mineralised bone. Magnification: x8000 when printed 10 centimetres wide.

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Subscriptions: dental@dentalpress.com.br or by phone/fax: +55 (44) 3031-9818.

A feeling of accomplishment...

Prof. Dr. Carlos Eduardo Francischone | EDITOR IN-CHIEF

The opportunity and privilege of being the editor of this journal for seven years, following those who expected its publication with great interest and worked hard to develop a journal of which high quality, not only in terms of display, but also content, has been proved within a short period of time, certainly give me the freedom to assert that this has been one of the most rewarding experiences of my career.

Interacting with friendly and active experts, professors and researchers, assimilating their knowledge and experience, and connecting with advanced technology companies that bring news of the global dental market, created an opportunity to link with modernity of which Implantology, always combined with other specialties, is enfolded.

Dental Press Implantology, published in Brazilian Portuguese and English, is currently indexed in *BBO, LILACS, EBSCO, Ulrichsweb* and *Latindex*. It offers more than 3,000 pages of excellence in reading, study and research published in the form of 190 articles, 25 interviews and other reference sections.

Congratulations to the always active and engaged team that has worked on the development of this journal. They are also responsible for achieving the objectives set in the first issue available since early 2007, in which it is emphasized that biological bases and scientific researches is what lays the foundation for good periodontists and implantologists.

With a feeling of accomplishment and a sense of pride at acknowledging that this journal has gradually occupied a unique position in national and international specialized literature as a result of an unceasing search for the best way to meet the demand for serious studies that deal with up-to-date themes, I exchange my position as an editor for that of a reader who can enjoy and celebrate the expressive approaches, results and contributions offered by this journal.

Different matters and projects have been implemented over the years, enriching the journal with new views on biomaterial and oral rehabilitation techniques. Moreover, the journal has offered up-to-date and motivating articles to professors, specialists, students and researchers, demonstrating that modern Dentistry requires its subareas to interconnect in order to establish a sensible and consistent practice that meets ethical and moral standards and embraces broad and up-to-date knowledge.

From this issue on, I end my contribution as the editor of this journal — but only as one of the editors. I believe that others may and must succeed those who took the first steps to accomplish this mission. My contribution remains as I continue to be one of the effective supporters of **Dental Press Implantology**, a journal that, in seven years of existence, has become a reference of content, proving that science and technology are strongly interconnected with progress, given that technology applies the knowledge produced by science.

I am certain that new accomplishments and challenges will come, and I believe that the key to success is searching and working to serve and accomplish.

My most sincere gratitude to all!

Stem cells: hope and reality

Alberto Consolaro
Full professor, Department of Pathology, School of Dentistry — University of São Paulo/Bauru.
Postgraduate Department, School of Dentistry — University of São Paulo/Ribeirão Preto.

"Chinese researchers generate teeth from stem cells!" "Spanish laboratory grows bone from stem cells!" "Hamburger meat is produced from bovine stem cells swallowed by volunteers in London!" In no time, we will come across the news: "Central Bank grows money from stem cells!" Or would they be "stem cents"?

Mental trips are free in Science, with gate-free pathways. In science fiction, there is no difference between expectation and imagination; they mingle and the distance between them is short. Fiction faces a creativity crisis. Interviews with renowned researchers describing brilliant ideas always end with the following: "Further studies and a few years of laboratory tests and clinical assays carried out in animals are necessary before applying the concept to human beings. Anyhow, the research will be published!"

Expectation is the waiting-room for frustration. Those who are anxious tend to eat more and grind their teeth. And there goes fitness and teeth!!! When the news of a scientific publication is spread, the mental trip has already been analyzed by the editors, the reports are approaching applicability and reality is within a few steps.

Many researchers speak up before publication, and a few years later, we find out that the outcomes of their research were not even sent to scientific journals, although they functioned as means to impress society and persuade their bosses, institutions and funding agencies. Without even mentioning family and friends. And that is what happens with stem cells: too much is published, but too little is practiced. There is only hope, but in science, hope is not enough!

Each embryo cell comprising 8 to 16 cells at a few days old is able to independently generate a new life. Due to being totipotent, it has full potential in generating one of the 206 types of cells. Embryo stem cells are capable of developing or differentiating into any type of cell, even after being inactive as frozen embryos for a long time.

Some cells do not multiply when they are mature. However, when cultured in laboratory, embryo stem cells reproduce thousands of them. When injected into damaged organs, such as the heart, kidneys and brain, stem cells may induce the formation of new cells, recovering the function of the organs. Nevertheless, additional studies are necessary to further investigate how to control proliferation and renovation of these cells in order to avoid malign neoplasm.

Mature tissues and organs present a low percentage of nearly embryonic reserve cells or "tissue stem cells". In tissues, those cells function to repair lesions caused by trauma, illnesses or aging, although in a very limited manner. For this reason,

as well as for ethical and moral issues, scientists collect adult tissue stem cells, which return to their embryonic stage by "dedifferentiation". Cultured in laboratory, they can be injected, even into their own donor, to reproduce tissues and organs.

"Adult stem cells" are limited because they are not capable of differentiating into all types of tissue. However, they can be genetically reprogrammed under laboratory conditions, in which case they are subjected to total regression and become totipotent cells known as induced pluripotent stem cells (iPSCs).

Many people strongly believe that injection of stem cells ensures tissues and organs recovery. That is not true. The origin and manipulation of cells, storage and treatment conditions as well as the situation of use are key to therapeutic success. Injecting tissue stem cells in humans is a serious procedure that offers several risks, including cancer. Undergoing authorized experimental protocols may be hazardous, but are certainly worth it. Nevertheless, some people have been subjected to illegal procedures performed by "professionals" who are not even doctors!

Practically speaking, no treatment or therapeutic protocol is authorized to employ stem cells in carriers of a certain disease. Only a few of existing protocols are experiences carried out for especial cases under supervision and authorization of ethic committees, Health Surveillance Agency, Ministry of Health and the Federal Council of Medicine. Stem cells offer hope and prospect, but are not yet a reality that can be applied to the general population: They are exceptionally authorized laboratory researches and occasional assays.

Let us be calm and patient!

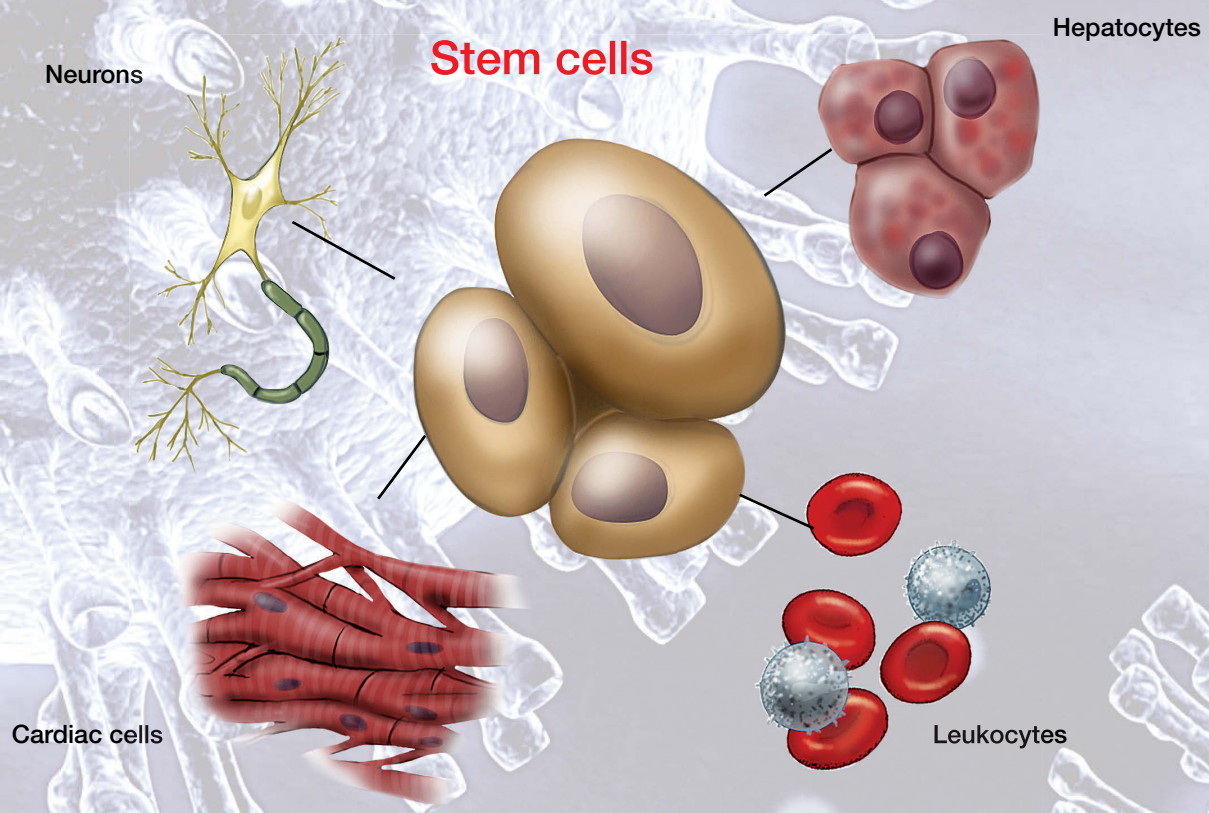

Figure 1: Embryo stem cells and iPSCs may generate any type of human beings cells.

Dentes “fabricados” por células-tronco

Pesquisadores do Instituto de Biomedicina e Saúde de Guangzhou, na China[1], isolaram células epiteliais da urina humana e, em laboratório, tornaram-nas *“células-tronco pluripotentes induzidas (iPSCs)”.* Ao colocar essas células no mesênquima dentário de ratos e inserir o conjunto nas cápsulas renais, Jinglei Cai e sua equipe conseguiram obter estruturas semelhantes a dentes humanos em três semanas. Os dentes apresentaram esmalte, dentina, cemento e polpa, com plena organização dos ameloblastos e odontoblastos, em fotografias muito bem apresentadas.

Na revista “**Cell Regeneration**”, de acesso livre (www.cellregenerationjournal.com/content/2/1/6), os resultados são impressionantes[1]. Os dentes têm vários tipos de tecidos e linhagens celulares que precisam, no tempo e espaço, interagir de forma muito precisa e intrincada. Alguns aspectos metodológicos não foram minuciosamente descritos e os resultados devem ser checados e reproduzidos em outros laboratórios, pela relevância apresentada.

Obs: Essa crônica foi publicada originalmente no Caderno de Ciências do Jornal da Cidade, editado em Bauru, na coluna Ciência no Dia a Dia, publicada semanalmente ha 4 anos.

Referências:

1. Cai et al. Generation of tooth-like structures from integration-free human urine induced pluripotent stem cells. Cell Regeneration 2013, 2:6. doi:10.1186/2045-9769-2-6.

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Luis Guillermo Peredo Paz

Dr. Luis Guillermo Peredo Paz is Bolivian. He lives in Santa Cruz de La Sierra, Bolivia, and speaks perfect, accentless Brazilian Portuguese.

He is widely known in Latin America for belonging to the group of professionals that comprise the New Generation Latin American Dental Seminars (SOLA NG) and the International Academy of Integral Dentistry. Nevertheless, Dr. Luis Guillermo Peredo Paz is especially known for leaving the mark of his high-quality work and extensive Integrated Dentistry knowledge wherever he gives courses and conferences, a result of the four specialization courses as well as Master's and Doctorate's courses taken in Brazil, and his eagerness to be updated in all fields of study.

His Master's thesis in Implantodontics was evaluated by a renowned board of examiners consisted of Professors Dr. P-I Brånemark and Dr. Waldir Janson. On that occasion, his adviser Prof. Dr. Carlos Eduardo Francischone emphasized: "Guillermo has a very interesting global education. His multi and interdisciplinary integration makes him stand out from the crowd."

Dr. Luis Guillermo Peredo Paz has received many awards as recognition of his work inside and outside his country. One of them was the *Galardão Mexicano de Odontologia* given by the Ibero-Latin American Federation of Dentistry as a recognition of his fatigueless effort at broadening scientific knowledge and his renowned professional expertise.

He is currently an honorary member of the Chilean Society of Prosthetics and Oral Rehabilitation and a founder member of the European Academy of Implant Dentistry.

A charismatic and excellent person, he considers Brazil as his second home.

Dr. Luis Guillermo Peredo Paz feels blessed and deeply thankful to Brazil for his successful achievements. He had the opportunity to study at excellent universities in Curitiba and Bauru where he met many renowned professors. He was also privileged to share experiences and have a close relationship with Dr. Per Ingvar Brånemark, the "discoverer" of osseointegration and titanium dental implants, during his Master's course in Implantodontics.

His fluency in English allowed him to present his scientific researches at the University of Tufts (USA) and Gothenburg (Sweden), eternizing his lessons in journals and books overseas. He is deeply thankful for the lifelong and loyal friends he has made, and reveres his masters, particularly highlighting the professional example and advice given by his adviser Dr. Ado Francischone who was responsible for introducing him to Implantodontics.

It could be said that the professional career of Professor Dr. Luis Guillermo Peredo Paz has been extremely successful. It is clear that he does what he loves and is fully supported by his wife Maria Paula, a Brazilian dentist graduated from the University of São Paulo (USP) / Bauru. Such support is proportionally given by their three kids.

An interview with Dr. Luis Guillermo gives the reader an outstanding example of professionalism and personal life.

Luis Rogério Duarte

How to cite this section: Paz LGP. Interview with Luis Guillermo Peredo Paz. Dental Press Implantol. 2013 Oct-Dec;7(4):10-23

This section of Dental Press Implantology, in which we interview an exponent of contemporary Dentistry, usually covers the reason why the expert has become interested in the profession. Thus, could you tell us what influenced and motivated you to work in the field of Dentistry?

I am the youngest child of seven children. I was born in Montero, a little town 45 km far from Santa Cruz de La Sierra, in Bolivia. At the age of six, our family moved to Santa Cruz where I went for high school, at La Salle school.

My family always had a tendency towards Biology. My sister Norma studied Pharmacy and Biochemistry at college, whereas my other sister Aida graduated in Medicine. All of us were deeply influenced by an uncle of ours who was a highly respected doctor in town. At a young age, my father wanted to study Dentistry. However, my grandfather, who was a lawyer and a senator, did not allow him to do so, wishing his son would also become a lawyer — the career my father pursued.

Attending SOLA NG (New Generation Latin American Dental Seminars) conference in Cochabamba-Bolivia with Mariano Flores, Rafael Roca, Rafael Mondelli and other friends.

In my case, I graduated high school wishing to study Medicine. After seating for an entrance exam, I started university at the School of Medicine in San Francisco Xavier — at that time, the best university in the country — in the city of Sucre, the constitutional capital of Bolivia.

In the early 80s, the country faced many political issues, followed by many putsches that resulted in closing the universities, which hindered college graduation. To avoid wasting time, I decided to seek a better alternative for my university education. And that was when I pled, in the Brazilian Embassy of La Paz, the opportunity to study in Brazil, based on an agreement established between both countries (which is still in force nowadays).

On that occasion, I was informed that there was only one vacancy available to study Medicine in Brazil. That had already been fulfilled, and for this reason, they suggested that I chose another career in the Health field, so that I could try to apply for Medicine afterwards. I chose Dentistry. A few months after I had handed in all necessary documents, the Brazilian Embassy disclosed the list of Bolivian students who were selected to study in Brazil. And I was one of them!

I remember that the course of Dental Materials I, which I took during the first semester, was a decisive factor for me to continue studying Dentistry. I liked it so much that I gave up thinking about Medicine.

We know that you received a degree in Dentistry from the University of Paraná. Could you tell us about that experience?

I did receive a degree in Dentistry from the Federal University of Paraná, in the city of Curitiba, from where I have great memories of very good friends and professors. During college, I went for a period of probation in Endodontics. And that was when I became interested in researching. I remember that I conducted a very interesting research on the reliability of root apex locators — which, at that time, were in their fourth generation — in teeth subjected to extraction for orthodontic purposes.

I also fondly remember the university soccer team, for which I played during several years as the goalie. Our coach, Prof. Munir Caluf, was a great person who also had the opportunity to coach Coritiba professional soccer team.

Nevertheless, I also went through times of difficulty, among which I must highlight the initial learning of Brazilian Portuguese, in both speaking and comprehending skills; and my father's death, during my last semester at university, caused by a heart attack. A situation I struggled to overcome.

Master's group (2005) at Sacred Heart University, Bauru/SP.

Brazil is a country with a large number of reference centers for education, improvement and research in Dentistry. Brazilian Dentistry, especially clinical Dentistry, has been considered one of the best in the world for many years. Did such high standard of excellence influence you to complement your formal education in the state of São Paulo, where you went for specialization, Master's and Doctorate's courses?

The University of São Paulo (USP) in Bauru was, at that time, the most prestigious reference center.

The group studying Cosmetic Dentistry, led by Prof. Dr. José Mondelli, had recently published the book *Tratamentos clínicos integrados* (Integrated clinical treatment) — the first book published within that field of study, with photographs of outstanding quality and scientific content of paramount importance.

Fortunately, on that occasion, I had the opportunity to meet a group of dentists from Curitiba who rented a bus to travel to Bauru every Thursday night to attend the classes of the specialization course. They used to leave to Curitiba on Saturday afternoons, arriving in the city on Sunday. That went on every weekend, during a whole year.

This group friendly welcomed me to join them on those trips. That was how I had the opportunity to take my first specialization course in Restorative Cosmetic Dentistry. Afterwards, I wisely decided to live in Bauru, not only due to the wide scope of the course, but also to its interdisciplinary approach with other specialties. The eagerness to deepen my studies in Bauru rendered my stay in Curitiba unfeasible.

I took my second specialization course in Prosthesis with Prof. Dr. Waldir Janson on weekends, which allowed me to develop other activities during the week, for instance, a clinical residency in Cosmetic Dentistry. Profs. Dr. Mondelli and Dr. Francischone gave me the opportunity to contribute to some researches in that same department where I was also allowed to treat the employees of the university by trying new material and preparing the documents of the cases. That was certainly a period of great discoveries and learning, a result of the time I used to spend at the university and at the library during the week, and the specialization course on weekends.

The specialization in Periodontology came afterwards. One thing led to another. The specialization in Prosthesis required in-depth knowledge of tissues. For this reason, before completing the course on Prosthesis, I had already had classes on Periodontology with great professors — Dr. Euloir Passanezi, Deoclécio Nahas and Waldir Janson, a member of the Interdisciplinary Program of Higher Education (PROFIS).

At the same time, one week per month during two years, I had the opportunity to take a spectacular course on Periodontal Prosthesis with professors Waldir Janson and Euloir Passanezi. This course included fantastic and unforgettable lessons on oral rehabilitation, occlusion and Periodontology.

Finally, to complete this cycle, I decided to study apical endodontic surgery with professors Clóvis Bramante and Alceu Berbet before going back to Bolivia. That was when I took the specialization in Endodontics, a subject I enjoyed since my undergraduate course. During that course I met Paula, a classmate to whom I married as soon as I went back to Bolivia.

The time I spent in Bauru was essential not only for the future of my personal life, but also for my professional career. It allowed me to, later on, practice what I had earned during all those years, applying the knowledge I acquired in the city I chose to live: Santa Cruz de La Sierra, Bolivia.

I usually say that everything I own, I owe to my parents, who encouraged me to pursue the best education I could possibly have; and, to the same degree of intensity, to Brazil, the country that opened me the doors to higher education, allowing to meet incredible people and experts who welcomed me and permanently supported me. It also gave me the opportunity to start a family with my Brazilian wife, Paula, and our three children: Juan Guillermo, Ana Paula and Luis Esteban who are Brazilian-Bolivian. In Brazil, I feel at home, as in my own country.

Giving thanks to and welcoming Prof. Brånemark at Santa Cruz de La Sierra/Bolivia (Legislative Council, 2005).

You used to teach at the Bolivian Catholic University. Nowadays, you are a professor at the Postgraduate Center of the College of Dentists and owner of *Peredo Tecnologia y Arte en Odontologia*, a reference center in implants and oral rehabilitation, both in Santa Cruz de La Sierra, Bolivia. Do you believe that your devotion to teaching results from vocation, from an ongoing and necessary quest for updated knowledge or from the positive and direct influence of your former professors?

I believe it is a result of all the factors you mentioned. Teaching is a very serious, serene and committed vocation. We must be free from any sort of selfishness to be able to welcome feelings of joy and plenitude, especially when we follow our students' progress closely, watching them as they become successful in their career as well as in their lives. A good and real professor must be generous in his lessons to be able to set an example and influence students' behavior, gather followers, and become an important leader and adviser.

Preparing a lesson is a very time-consuming, but rewarding activity that allows professors to improve their knowledge: the most motivating and inspiring source of life of any professor.

I have been deeply blessed throughout my whole life, since I left home at the age of 16 to go on an exchange sponsored by the Rotary Club in the United States of America. At the age of 18, I moved to Curitiba for college, and at 23, I arrived in Bauru. That was where I met Prof. Carlos Eduardo Francischone who, since our first meeting, proved to be a good friend that has always welcomed and supported me. His highly respected professionalism has influenced and encouraged me to become an ongoing learner.

As for Prof. José Mondelli, he was responsible for my love for teaching. In fact, I did not intend to pursue a career in teaching because the city I chose to live and work did not have a School of Dentistry. For this reason, my initial goal was to practice integrated Dentistry as satisfactory as possible. It seems probable that Prof. Mondelli's experience, sensibility and intuition led that highly qualified professor to perceive a tendency that was unknown to me at that time, and which would have to be developed later on. Thus, he began to motivate me to go in that direction. I deeply acknowledge and sincerely express my gratitude to him every time I perform such noble duty.

It is worth mentioning that, when I was an undergraduate student, the School of Dentistry at the University of São Paulo in Bauru used to be naturally "addicting", in terms of consistent learning, and often induced students to find out their vocation in teaching.

I believe this was a result of the unquestionable quality of the job performed by professors such as Drs. Waldir Janson, José Mondelli, Euloir Passanezi, Carlos Eduardo Francischone, Clovis Bramante and Alceu Berbet, all of which had a high level of professionalism and exceptional didactics.

Professionally speaking, you are known for your ability to work in different areas within the Dentistry field. In other words, you are a dental surgeon in the true sense of the word, someone who skillfully joins theory and practice. Not long ago, successful professionals had to be specialists. Nowadays, working in high-quality Dentistry requires multi-specialized professionals. What is your opinion about that?

A clinician must receive high-quality basic education. He must know a good deal about the subjects that interact with his specialty in order to be able to diagnose, plan and perform his job as accurately and correctly as possible. Teamwork is also essential. Working in partnership with well-prepared, up-to-date specialists of moral and ethical principles, who share the same desires for growth and development, is imperative. The better the professional's education is, the shorter treatment time will be.

With Drs. Anibal Alonso (Argentina) and David Ovando (Guatemala).

Dental procedures as well as Dentistry in itself have changed a lot around the world, making rapid progress that hampers professionals to ideally follow such development. Practicing Dentistry with perfection requires a vast knowledge that is only acquired by attending courses and conferences, as well as by studying hard.

Technology has advanced at a rapid pace and demands that we be constantly up-to-date in our profession, particularly because with all the information available on the internet, some patients arrive for their appointment questioning their dentist, putting him in a difficult situation in case he does not have enough knowledge on the subject.

The advent of osseointegration, incorporated to Dentistry by Prof. P.I. Brånemark, completely changed the methods of treating oral invalids around the world. At the same time, several multicentric studies on recombinant human bone morphogenetic protein and stem-cells are being conducted and have advanced by leaps and bounds in the search for new therapeutic solutions.

Which lines of research do you believe will have a major impact on Implantology and Dentistry in the next decades?

I believe that changes in Medicine and in the Health Sciences will happen at an increasingly rapid pace. Undoubtedly, studies on stem-cells and morphogenetic protein will change the way we treat patients. We have been currently working with leukocyte- and platelet-rich fibrin (L-PRF) which, differently from platelet-rich plasma (PRP), has yielded satisfactory results.

L-PRF has proved to be effective, positively contributing to some methods of treatment, especially for being an inexpensive and simple procedure that consists of collecting material from the patient (venous blood), centrifuging it in a device that is easily available and applying it onto the site to be prepared. We hope that the long-term results of our experiments be as satisfactory as those yielded by studies conducted on hard and soft tissues. Should that be the case, L-PRF will be widely used not only in Dentistry, but also in Medicine.

Doctorate's group (2010) at Sacred Heart University, Bauru/SP.

You have attended several international scientific events as a speaker and researcher, disseminating new procedures and techniques. What is the main subject that motivates you and, at the same time, raises your interest in passing your knowledge on to others?

I believe that the final esthetic result is what really matters to patients. Thus, during my courses, I like to discuss the importance of comprehensive treatment and planning aiming at esthetics, health, function and longevity, all of which are achieved by means of simple and low-morbidity procedures that do not impair patients' well-being.

In addition to the conventional use of autograft as the "gold standard" of grafting procedures, the techniques of bone reconstruction of atrophic maxilla in totally edentulous patients currently offer a wide range of biomaterial available on the market and aim at optimizing prosthetic rehabilitation of patients with limiting variables. In spite of natural difficulties such as systemic disorders and old age, these techniques yield satisfactory results that have been proved by several researches. Which would be your treatment of choice when treating patients with the aforementioned characteristics: bone graft or zygomatic implants?

Implantology has considerably changed in its 50 years of existence. During my Master's course at Sacred Heart University, I was honored to meet Professor Dr. Brånemark in person when he decided to move from Gothenburg, Sweden, to Brazil (Bauru/SP). I also had the immense pleasure of having the opportunity to work with Dr. Luis Rogério Duarte and professor Hugo Nary Filho on our dissertation on the rehabilitation of atrophic maxilla using four zygoma fixtures in immediate loading system, as proposed by P.I. Brånemark. That was a very important experience in my professional career, with which I learned a lot about atrophic maxilla and its rehabilitation methods. The excellent results of that two-year research provided us with a wide choice to treat oral invalids.

The enthusiasm was infectious, and a lot of people were willing to learn the new technique, including professionals who came from overseas to meet and observe our team.

However, time has proved that this technique must be used as a last resort, only; after all other treatment options have already been considered. Moreover, it must be employed by a skillful team of experts, in very specific cases, carefully selected, studied and planned for rehabilitation of atrophic maxilla using the four zygoma fixtures in immediate loading system.

On the other hand, the great progress made by bone substitutes associated with the technological development of surfaces and implant design has substantially reduced the need for autograft.

Receiving the *Galardão Mexicano* award in Cancun with renowned colleagues from other countries.

Global science and research have been increasingly interested in investigating the biological particularities of the binomial bone-implant. Recurrent studies on macro design, implant surface treatment and prosthetic components seem to constantly prove such concern. The large amount of new material being launched for surgical and esthetic rehabilitation, and the speed with which new products are introduced into the market, often hurry the natural flow of research, interfering in the results, altering pre-established protocols, and undermining the credibility of such material. What is your opinion about it, and what would you recommend for professionals within the Dentistry field?

Professor Brånemark and his team were very careful when proposing a protocol for osseointegration. It is a pity that, nowadays, several companies hurry to launch new products and, with a few exceptions, save little time to test their effectiveness and performance. For this reason, it is important to demand from manufactures the scientific results of researches conducted with their products, so as to prevent patients from being used as human experimental models.

We need to be aware of the advances in technology, but without necessarily being the first ones to catch or hop into the train.

We seed important friends along our professional career. Our professors are certainly included in that list, directly influencing the way we think and act, not only in our professional career, but also in our personal life. Would you like to highlight someone in particular who has decisively contributed to your formal education?

Undoubtedly, since I arrived in Bauru, I had the opportunity to have a close relationship with Prof. Francischone not only as a true and loyal friend, but also as a professor and a guru who wisely advised me. He directly influenced me to work and study in the field of Implantodontics. At the end of 1991, I went back to Bauru to implement an agenda, which included the university library, make a few Xerox copies, keep me up-to-date and visit some of my friends, including Dr. Ado, at their private clinics.

At that time, I knew nothing about osseointegrated implants. On that occasion, Dr. Ado questioned me about the theme, and invited me to attend a course in Rosario, Argentina: an invitation to which I promptly accepted. He immediately telephoned the lead of the group that would be travelling to Rosario in May, 1992, whose proposal was to spend a week in the city to learn more about the subject.

After that, I went on taking other courses on implant studies which, with the experience I had in Periodontology and Prosthesis, became easier and easier. Henceforth, I never left the field of Implantodontics. In 2003, I went back to Bauru for my Master's at Sacred Heart University where, in 2008, I began the doctorate course, both in Implantology, advised by Ado.

Thinking specifically about your profession, what are the main differences between Dentistry practiced in Brazil and Bolivia?

Bolivia is considerably influenced by Dentistry practiced in Brazil, Argentina and Chile.

When I was an undergraduate, many Bolivian students went to Brazil for college. Nowadays, most Bolivians remain in our country to study due to the large number of colleges all around Bolivia. For us to have an idea, only in Santa Cruz there are five colleges, and soon, there will be six. Additionally, the costs of studying in Bolivia are much lower. It is a pity that the level of education remains too low, with underpaid professors who, as a consequence, go to other countries for specialization and Masters' courses which, on the other hand, has improved the level of Bolivian Dentistry.

Wine and cheese night during an event organized by the Northeast Association of Osseointegration (AON) besides Dr. Guillermo Peredo, and from left to right: Profs. Drs. Maurício Barreto, Fred Nigro, Tomas Albrektsson and Franklin Leahy (Salvador/BA, Brazil).

Between 2003 and 2005, you were advised by Prof. Dr. Carlos Eduardo Francischone and Prof. Per-Ingvar Brånemark during your Master's course in Brazil. In your opinion, what are the main lessons you learned during this period, personally and professionally speaking?

We were a privileged group at the Master's course at Sacred Heart University in Bauru (2003-2005). Our academic staff, prestigiously led by Dr. Carlos Eduardo Francischone, included Prof. Dr. Ivette Sartori and Dr. Gilmar Batista, in the Department of Prosthesis; and, Hugo Nary Filho and team, in the Department of Surgery, directly followed and assisted by Prof. P.I. Brånemark who shared his own experiences during seminars, speeches and visits he made to the university clinics. It indeed was a fantastic experience for a small, but privileged group of six Masters students (Reinaldo Janson, Hélcio Lira, Daniela Mattos, José Bernardes das Neves and I) who had the opportunity to study and work with the father of osseointegration. It has probably been one of the most important periods of our formal education.

Having a close relationship with such renowned professor opened us many doors, giving us the opportunity to present, at the University of Tufts, Massachusetts (USA) and in Gothenburg (Sweden) our research on the rehabilitation of atrophic maxilla using the four zygoma fixtures in immediate loading system.

I also had the overwhelming joy of having Prof. Brånemark as a member of my Master's board of examiners, which also included Prof. Dr. Waldir Janson and my adviser, Prof. Francischone. There were times of tension, but also of immense prestige for both my professional career and personal life.

In 2005, Prof. Brånemark visited Bolivia for the first and only time. How was that experience? What did such an important fact represent to your country?

When we were in Gothenburg, our group was invited to have dinner at Prof. Brånemak's house. On that occasion, I invited him to visit Santa Cruz de La Sierra, in Bolivia, and attend a conference we would organize in his honor, an invitation to which he accepted. Having him in our country was a daunting, but highly successful challenge, a milestone for Bolivian Dentistry. The conference we held had participants coming from all over the globe, including our neighbors Argentina, Peru, Chile, Paraguay and Brazil, and had Profs. Laerte Vasconcellos, Israel Chilvaquer, Carlos Eduardo Francischone, Cesar Arita, Rogerio Duarte, among other important experts of Brazilian and international Implantology, as speakers. I believe that was the most important scientific dental conference ever held in Bolivia. He and his wife, Mrs. Barbro Brånemark, were welcomed by the Legislative Council of the city and deemed official guests. It certainly was an unforgettable event.

With Prof. Dr. Carlos Eduardo Francischone during his Doctorate graduation ceremony.

What is your opinion about the advances in Implantodontics in the last 10 years? What are the major advances for patients and professionals?

To my view, Implantodontics has considerably advanced. Immediate loading, for instance, has made huge advances after standardized protocols were established and scientific support was made available, allowing us to perform procedures that not only go from rehabilitation of a single tooth to full rehabilitation, but also yield more predictable and safer results. Improvements in implant surface, in addition to macro-geometry associated with instrumentation techniques, have contributed to reduce the waiting time for implant activation, ensuring that patients will not be without fixed teeth for several months and preventing them from being subject to a new surgical procedure carried out to expose implants for prosthesis. This makes the procedure much more appealing for both patient and dentist.

The advent of platform switching between an abutment and an implant has significantly contributed to reduce cervical peri-implant bone loss, in addition to being an important factor when choosing the type of implant as well as the type of connection, especially in esthetics.

Likewise, I believe that the advances in treatment planning and study carried out with increasingly sophisticated, far-reaching and facilitative software that not only aim at reducing surgical time, but also at yielding satisfactory esthetic and natural results, are of paramount importance.

You are a specialist in Cosmetic Dentistry, Endodontics, Periodontology and Prosthesis, but you also have a Master's and Doctorate's degree in Implantology. After so many years of devotion to Dentistry, are there any facts that make you

regret the path you have taken? Do you consider it difficult to remain in such path? Has your family influenced you along the way?

In my opinion, having several specializations was of paramount importance, since it allowed me not only to have a broader view of all treatment procedures, but it also allowed me to provide patients with the best solution from a comprehensive standpoint.

I have never given priority to Endodontics in my clinical practice, given that my wife Paula is a specialist in that field of study (University of São Paulo — Bauru). But to my view, it is impossible to think about Prosthesis without referring to Periodontology or Implantodontics, and vice-versa. They totally depend on each other. The details state the difference between two or more types of treatment. And, with all the information available as well as with patients' esthetic demand, I believe it is essential to study the aforementioned disciplines in depth.

With his great friends Prof. Dr. Carlos Eduardo Francischone and Ana, Franklin Leahy and Gracinha during the 1st Meeting of Prof. Dr. Carlos Eduardo Francischone's students and former students.

Dentistry is a career that requires a lot from professionals due to being a wide field of study that demands dedication, research, focus on details, concentration, manual dexterity, human relations, etc. Thanks to Dentistry, I can provide my family with everything they need. It gave me the opportunity to start a family, make good friends and meet great professors. I have had a lifelong devotion to my career, which I have built with great joy in spite of it being tiring as a result of the long time I spend at my clinic. Nevertheless, the courses I give allow me to find a balance between things by changing my work environment and focus, even though the theme remains the same.

When my wife Paula and I first began our activities in Santa Cruz, the fact of both of us being specialists arose a great deal of deference which, thank God, resulted in a large amount of work that, in turn, was a consequence of the countless hours of study we spent in Bauru.

Paula has been utterly important, always encouraging me to make progress in my career. She plays a major role in my family and my professional career. We have three children: Juan Guillermo who has a degree in Marketing and Finances (USA); Ana Paula who is in second year of Biomedical Engineering at the University of Rochester (New York), and Luis Esteban, the youngest, who has already told us that he will not pursue a career in Dentistry. It is a pity that none of our children has taken an interest in our field of study, which would certainly make things easier for them, given the well-advanced, safe and strategic start we carefully made towards an extremely beautiful and dignifying work.

But I fully respect their decision.

You are a very beloved figure in the Dental field. And you probably have many Brazilian friends. What is your opinion about Brazil in comparison to the rest of the world in terms of Dentistry?

The time I lived and visited Brazil to attend courses, lectures and conferences, allowed me to meet a lot of people, and make good friends in and out my

field of study. It is highly possible that I have made friends with people from every Brazilian state, not only because Bauru, a reference center in Dentistry, welcomes people from all over the place, but also because the Brazilian people are dearly beloved by foreigners. They are great and very competent people. In Brazil, people tend to say that everything ends in samba, don't they? I am certain that this is what happens during carnival and soccer celebrations. However, with regard to the subjects I am familiar with, Brazil has some key, valuable figures whose serious and competent work is highly respected within our field.

Brazilian Dentistry, and the vast majority of professionals it comprises, certainly is one of the best in the world.

You have a close friendship with Profs. César Arita, Hugo Nary Filho and Waldir Janson. Could you tell us what each one of these experts represents to your professional and personal growth?

César Arita was more than a friend, he was a brother to me. I met him 20 years ago, when he went to Santa Cruz with a large group of Bolivians who were on their way to an event organized by the New Generation Latin American Dental Seminars (SOLA NG) in Cuzco, Peru. SOLA NG consisted of recently graduated dentists from all over Latin America who were somehow prepared to give formal speeches. We kept in touch and attended many scientific events together. César came to Santa Cruz several times to give courses. Our colleagues were all very fond of him and, at the same time, admired the innate didactic skills of such creative and up-to-date professor. He invited me to teach a few lessons in Ribeirão Preto, and to write some papers that would be published by CESDAD, an organization of which he was one of the editors. I was honored to be his best man when he got married to Camila, and our families interacted a lot. César was very intelligent, competent and serious in everything he did; however, his polished and frequent good sense of humor always provided us with a good laugh. It is a pity he had to leave us at such a young age, in the best moment of his career, when he had bright professional prospects ahead of him. He left a huge vacuum in the lives of people who liked him, in Brazilian and international Dentistry.

Closing dinner in honor to Dr. Brånemark's visit to Bolivia at Dr. Guillermo's home, on the occasion of the IV Buccal Implantology International Conference (Santa Cruz, April, 2005).

I have been friends with Hugo Nary since he was near the end of his undergraduate course at FOB/USP and I had recently arrived in Bauru for my specialization course. Later on, we met again when I began my Master's course at Sacred Heart University in Bauru. He was a professor, while I was a student. I learned a lot about surgery with him. Afterwards, during my Doctorate's course, he was my adviser and permanent co-worker. He is definitively a brilliant and talented professional, but an even better friend.

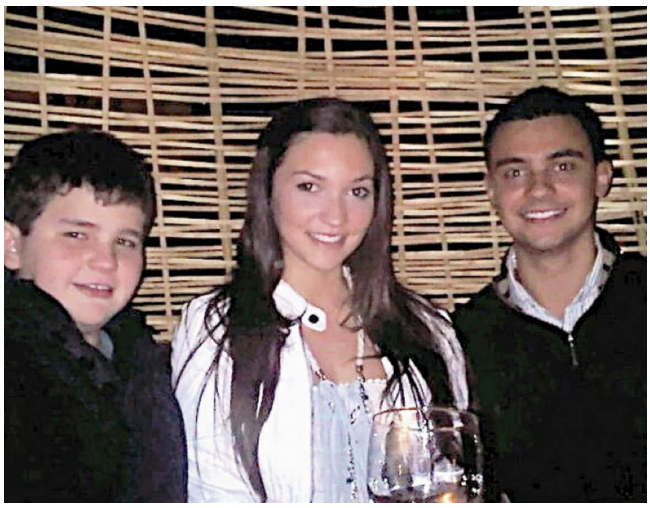
Dr. Waldir Janson was one of Brazil's foremost exponents in the field of Dentistry, a figure I had the pleasure to have a close relationship with. He presented a show when he was teaching. I often attended many of his

Barbecue dinner in Bauru with Drs. Conte, Mondelli and Francischone in 1991.

speeches, all given to packed audiences with a lot of people standing up. The skillful and connective manner with which he dealt with the trinomial Prosthesis / Periodontology / Occlusion encouraged his audience to proceed with their studies. He taught me a lot and changed the way I plan and perform oral rehabilitation.

With regard to oral rehabilitation, what is your opinion on the new CAD/CAM technologies used for dental prosthesis?

CAD/CAM systems are definitively here to stay. Soon, the most important dental clinics around the world will have their own millers used to fabricate temporary teeth, customized abutments, crown substructures, bridges, protocols and surgical guides, in a quick and direct manner. In a few years, these products will be in their best technological moment and whoever does not follow the trend will surely be considered outdated.



Master's closing party with his wife Paula and their three children Luis Esteban, Ana Paula and Juan Guillermo.

Last but not least, we would like you to leave a message for the new generation willing to pursue such beautiful career, which has currently not been first in the ranking of choice at Brazilian universities. Additionally, we would like you to describe such picture in Bolivian universities as well.

In Bolivia, a career in Dentistry is vigorously pursued, especially by female students. With the large amount of colleges available at a low cost, Bolivia faces market saturation with deficient undergraduate courses. This is a sign that young professionals must go on studying, taking high-quality courses that enable them to work with confidence. The results may be achieved in the long-term, but they certainly come if a great deal of effort is made. It is also important and necessary that professionals be associated with other professionals of excellent education, with similar goals and expectations, so as to achieve the desired purpose. There is a famous eastern proverb that says: “Those who walk alone might go faster, but one who is accompanied surely goes further.”

Our profession is definitely in constant motion, a science that encourages us to study continuously and thoroughly. Every day, the dynamic process of introducing new technologies requires that we know them and make them available for the benefit and service of our patients.

Excellence in Dentistry is still a noble art that depends on dedication, interest and a lot of enthusiasm.

Interviewers

Luis Rogério Duarte

» Specialist, MSc and PhD in Implantodontics.
» Dental Press Implantology assistant editor.
» Dental surgeon at the Renaissance Institute — Oral rehabilitation with implants.

Franklin Leahy

» PhD in Implantodontics (São Leopoldo Mandic University)

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Focal osteoporotic bone marrow defect: Concept, diagnosis and osseointegrated implants

Abstract / Focal osteoporotic defects in adult patients must be on the list of differential diagnosis of small and medium uni and multiocular radiolucent lesions, especially in the jaw. Clinical and imaginologic diagnoses are safe; however, a biopsy must be performed in case of doubt, in which case the report will include hematopoietically active medullary tissue. Focal osteoporotic defects in adult patients do not hinder osseointegrated implant placement because, biologically speaking, they do not hamper bone repair. In fact, they may even favor it as a result of the large number of stem and osteoprogenitor cells comprising the bone marrow. Safe diagnosis is essential to differentiate focal osteoporotic defects from more severe similar lesions also found in the mandible. This study highlights the main characteristics of focal osteoporotic defect in adult patients, considering the condition as a variation of normal bone and medullary trabecula.
/ Keywords / Focal osteoporotic defects in adult patients. Mandibular lesions.

Alberto **Consolaro**

Full professor, Department of Pathology, School of Dentistry — University of São Paulo/Bauru and Postgraduate Department, School of Dentistry — University of São Paulo/Ribeirão Preto.

How to cite this article: Consolaro A. Focal osteoporotic bone marrow defect: Concept, diagnosis and osseointegrated implants. Dental Press Implantol. 2013 Oct-Dec;7(4):25-30.

Submitted: November 15, 2013 - **Revised and accepted:** November 20, 2013

Contact address: consolaro@uol.com.br

» The author informs he has no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

» The patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

In the context of oral rehabilitation, bone structure density plays an important role in treatment planning performed with osseointegrated implants. Structural and imaginologic bone density refers to the amount of trabeculae within an area of bone: the more trabeculae, the greater the density.

The jaw may vary in bone density:

a) The maxillary tuberosity tends to be less dense, with thin and short trabeculae.

b) The anterior region of the mandible has thicker trabeculae, with small, but numerous medullary spaces.

An area with increased bone density is known to be undergoing bone sclerosis or focal sclerosis. Should the cause of sclerosis be known, the area in which it is found is called focal sclerosing osteitis. Should it be unknown, the areas are called dense bone islands or idiopathic osteosclerosis.

Nevertheless, bone density may also be characterized by wide medullary spaces dissociated by thin, short trabeculae. The trabecula is so "loose" or dissociated that some clinical cases may be imaginologically diagnosed as inflammatory bone lesions, whether reactional, pseudotumoral and neoplastic. For example, in the posterior and buccolingual region of the mandible, the bone trabecula is so dissociated that may lead to dubious diagnosis when overlapped with images of the mandibular fovea.

A differential diagnosis of bone lesions must consider variations in bone normality (density and uniformity) (Figs 1, 2), including osteoporotic defects in adult patients, which may hinder safe diagnosis of normality during dental treatment planning with osseointegrated implants (Fig 3).

Focal Osteoporotic Defect in adult patients is also known as Focal Osteoporotic Defect or Haematopoietic Focal Osteoporotic Defect.

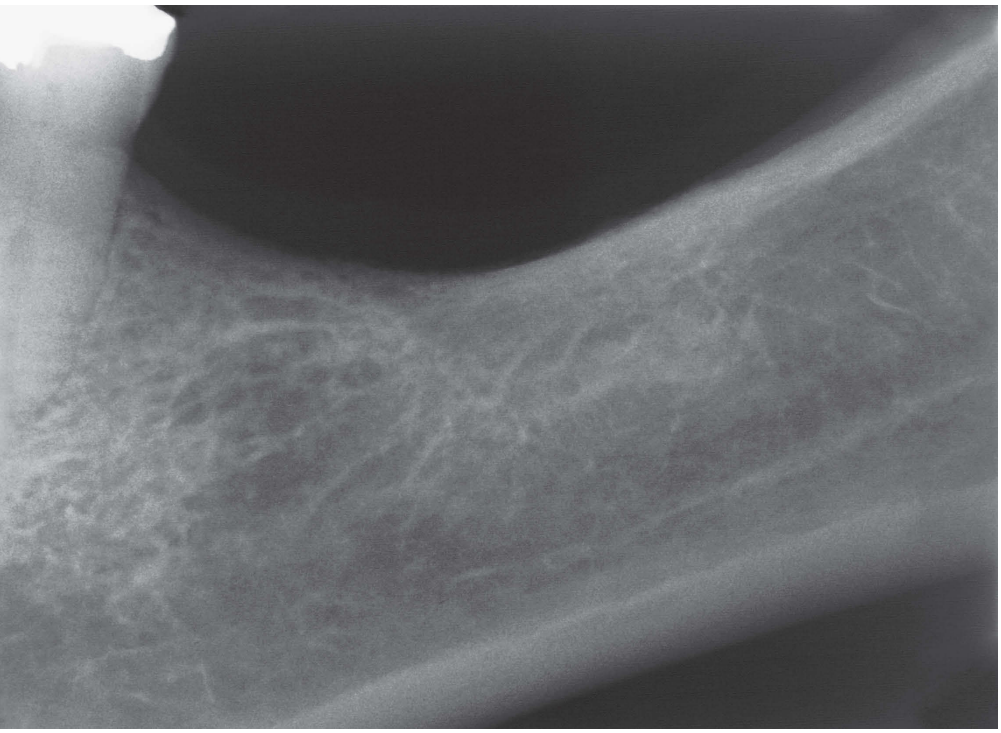

Figure 1: Bone structure density in bone repair after extraction may vary significantly according to previous conditions such as periodontal disease, periapical periodontitis, fracture, etc.

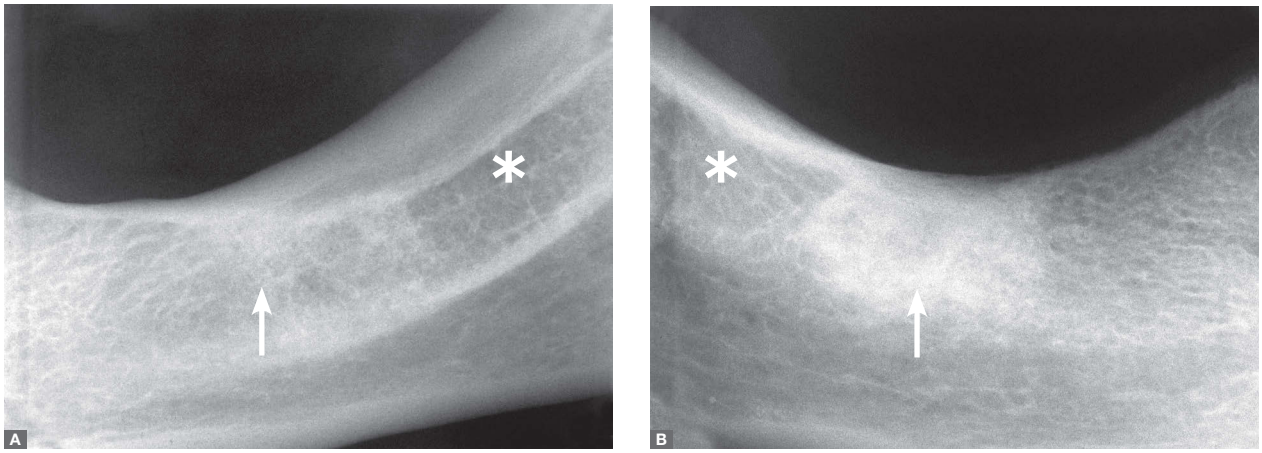

Figure 2: Bone density in bone repair after extraction may vary from extreme (arrow) to loose (*) within one small mandibular area.

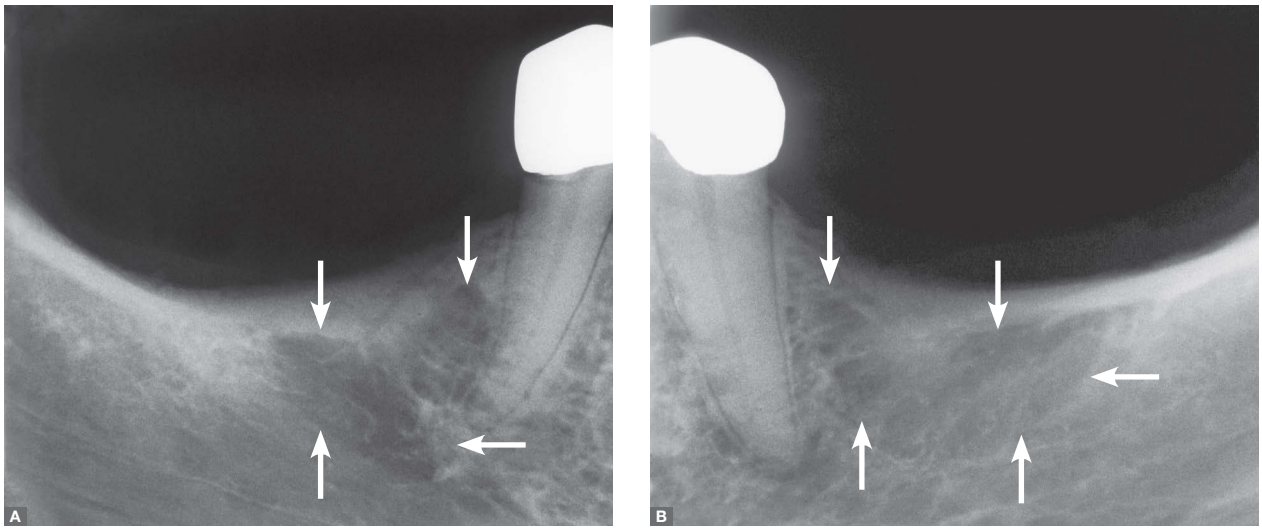

Figure 3: Focal Osteoporotic Defect in edentulous adult patient, probably as a result of changes in bone repair after extraction associated with reactional hyperplasia in hematopoietically active bone marrow. Bilateralism probably due to similarity between both conditions.

FOCAL OSTEOPOROTIC DEFECTS IN ADULT PATIENTS: CONCEPT AND CAUSES

Focal Osteoporotic Defect in adult patients are radiolucent, irregular and asymptomatic lesions that affect the jaw (Fig 3), especially the posterior region of the mandible of middle-aged women (from 40 to 50 years old). Microscopic biopsy[1] revealed that these areas are filled with hematopoietically active (red) bone marrow occasionally permeated by adipocytes typical of yellow bone marrow.

Children and adolescents have their maxillary and mandibular bones filled with trabeculae permeated by active haematopoietic medullary tissue to aid the production of blood cells. Adults, on the other hand,

have atrophic active medullary tissue, with medullary spaces filled with atrophic bone marrow made of adipose and fibrous tissue. For this reason, they have what is known as yellow bone marrow. Red or hematopoietically active bone marrow may be found in three regions of an adult's jaw: maxillary tuberosity, angle of the mandible and mandibular condyle.

Focal osteoporotic defect in adult patients does not promote either expansion of the cortex or asymmetry of the dental arch and/or face. It is usually diagnosed by imaginologic exams taken prior to rehabilitation as well as orthodontic, surgical or other types of dental treatment planning.

Focal Osteoporotic Defect in adult patients is caused[1-7] by the following:

1) Red bone marrow hyperplasia caused by local stimulus such as recent extraction, i.e., a year before (Fig 3).

2) Changes in bone repair with dissociated or loose trabecula as a result of local trauma and/or extraction in areas of functional physical stimulus (Fig 3).

3) Enduring hematopoietically active medullary tissue in these areas since childhood and adolescence, when such tissues are considered normal.

4) Bone marrow hyperplasia induced by an organic demand increased by blood cells as in sickle-cell disease and other hematologic diseases. Focal Osteoporotic Defect in adult patients as a manifestation of hematologic diseases is refuted by many researches.

IMAGINOLOGIC ASPECTS AND DIFFERENTIAL DIAGNOSIS

At their initial and medium stages, Focal Osteoporotic Defect in adult patients may be wrongly diagnosed as ameloblastomas, odontogenic keratocysts, myxomas and other odontogenic tumors. Today, imaginologic exams are often employed by dental and medical practice, thus allowing such lesions to be diagnosed at their initial stages. It is important that the morphological pattern of Focal Osteoporotic Defect in adult patients be well characterized so as to make a differential diagnosis.

The radiolucent areas of Focal Osteoporotic Defect in adult patients are crossed by short, delicate trabeculae randomly and separately distributed, with acute and straight angled drawings among them (Fig 3). Unlike ameloblastomas, keratocysts and other odontogenic tumors (except for myxomas), the radiolucent areas tend to be roundly shaped, without angle-shaped drawings between the trabeculae and reactional bone that surrounds it.

Focal Osteoporotic Defect in adult patients tend to respect the lamina dura of adjacent and topographically-related teeth without inducing root resorption. Ameloblastomas often present root resorption in the roots of teeth adjacent to the lesion. As for myxomas and odontogenic keratocysts, root resorption is rarely found in adjacent teeth. The imaginologic aspects of Focal Osteoporotic Defect in adult patients are rarely mistaken by fibrous bone lesions at their initial stages, for instance, Florid Cemento-Osseous Dysplasia and Fibrous Dysplasia of the Maxilla.

Some Focal Osteoporotic Defects in adult patients must differentiate from Simple Bone Cyst,[6] even though neither of them result in root resorption, and both of them respect and surround the lamina dura without expanding the bone cortex to the corresponding area. Simple bone cyst tends to be unilocular, despite being round-shaped and without delicate, short trabeculae crossing its radiolucent area. Patient's profile is another differential: Simple Bone Cyst prevails among adolescents and young adults, whereas Focal Osteoporotic Defect in adult patients prevails among women aged between 40 and 50 years old.

Out of the 197 cases of Focal Osteoporotic Defect in adult patients analyzed by Barker et al,[1] 50 were found in the mandibular region of first molars, while 28 were in second molars and 59 cases were found in the region of third molars or more distally. Only 18 cases were diagnosed in the maxilla, especially in the maxillary tuberosity. Similar outcomes were described by Lipani et al[4] (16 lesions) and Schneider et al[6] (298 lesions).

Unfortunately, despite being often found, Focal Osteoporotic Defects in adult patients are rarely included in the list of differential diagnosis of mandibular lesions, generally due to being unknown.

MICROSCOPY AND HISTOPATHOLOGY REPORT

Should any diagnostic doubts arise after clinical and imaginologic examinations, incisional biopsy must be carried out so as to avoid postponing the definitive diagnosis. As for Focal Osteoporotic Defect in adult patients, microscopic description reports the presence of hematopoietically active bone marrow and fat cells.[1-7]

Cytology by aspiration may reveal that the content of the risk area consists of hematopoietically active bone marrow, in which case cytological diagnosis is critical for the interaction between clinical and imaginologic data to make an accurate final diagnosis. Should any diagnostic doubts remain after cytology, a biopsy must be carried out.[7]

Microscopic diagnosis is not always accurate with regard to Focal Osteoporotic Defect in adult patients. However, description of hematopoietically active bone marrow tissue crossed with clinical, surgical and imaginologic data allows correct clinical diagnosis. Sending the diagnostic images to a pathologist may favor a more precise and accurate diagnosis.

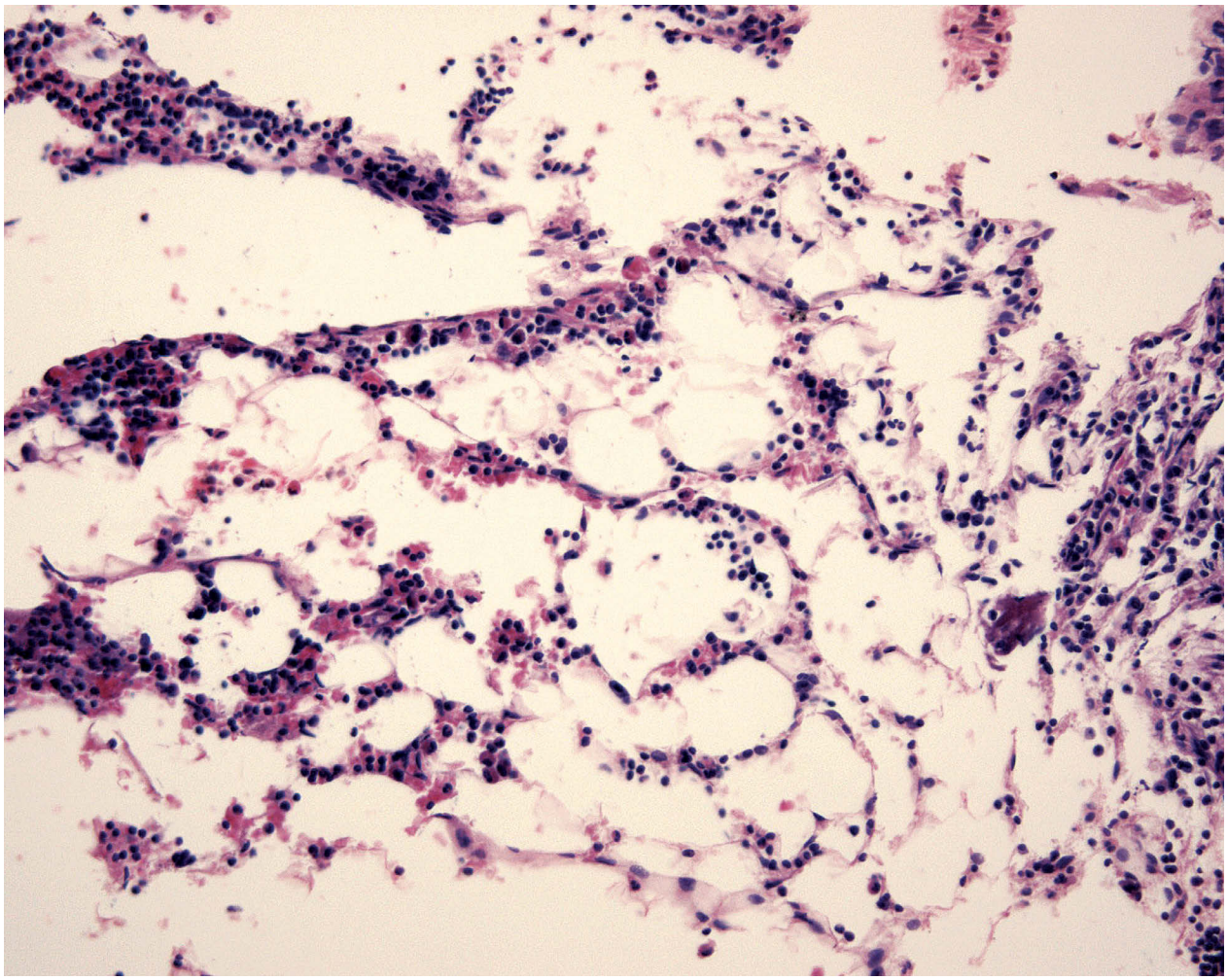

Figure 4: Hematopoietically active bone marrow permeated by adipocytes found in Focal Osteoporotic Defect in adult patients.

FOCAL OSTEOPOROTIC DEFECTS IN ADULT PATIENTS AND OSSEOINTEGRATED DENTAL IMPLANTS

Biology of osseointegration does not hinder implant placement in adult patients with Focal Osteoporotic Defect. However, the fact that their bone pattern offers little immediate mechanical interlocking[7] should be carefully considered.

In spite of offering little mechanical interlocking, the bone pattern of Focal Osteoporotic Defect adult patients gives good biological conditions for osseointegration due to the presence of hematopoietically active bone marrow rich in stem cells as well as osteoprogenitor cells with high potential to osteogenesis, especially in the surface of osseointegrated implants. Focal Osteoporotic Defect in adult patients does not require treatment, although surgical manipulation may alter its trabecular pattern.

FINAL CONSIDERATIONS

Focal osteoporotic defects in adult patients must be on the list of differential diagnosis of uni and multiocular radiolucent lesions, especially in the mandible. Clinical and imaginologic diagnoses are safe, however, a biopsy must be immediately performed in case of doubt, in which case the histopathology report will include hematopoietically active medullary tissue.

Focal Osteoporotic Defect in adult patients does not hinder osseointegrated implant placement because, biologically speaking, it does not hamper bone repair. In fact, it may even favor it, as a result of the large number of stem and osteoprogenitor cells comprising the bone marrow. Safe diagnosis is essential to differentiate focal osteoporotic defects from more severe similar lesions also found in the mandible. Focal Osteoporotic Defect in adult patients represents a morphological variation of bone trabecula of the jaw.

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Dental Press Implantology assistant editor defends a dissertation on the use of bone substitute in animal with systemic disease

On November 13th, 2013, Dental Press Implantology assistant editor Dario Miranda received his Doctor of Implantodontics degree. Professors Dr. Carlos Eduardo Francischone and Alberto Consolaro (editors in-chief) were his advisers. For 20 years, Prof. Dario has worked with bone reconstruction material. Within the same scope, he developed his dissertation on the use of bone substitute in animals with systemic disease. His board of examiners was composed of the aforementioned professors as well as by Profs. Drs. Teresinha Santana and Viviane Sarmento. He has recently participated in a discussion on biomaterial in Philadelphia, and, in Chicago, he took part in a "task force" on scientific researches published around the world.

In addition to being Dental Press Implantology assistant editor, Dr. Dario Miranda is the editor of the Journal of Periodontology, Professor at the State University of Feira de Santana and owner of a dental clinic in the city of Salvador, Bahia.

From left to right: Alberto Consolaro, Bruno Sotto Maior, Carlos Eduardo Francischone, Dario Miranda, Teresinha Santana and Viviane Sarmento.

Giving wings to imagination!

Alberto Consolaro

*Full professor, Department of Pathology, School of Dentistry — University of São Paulo/Bauru and Postgraduate Department, School of Dentistry — University of São Paulo/Ribeirão Preto.

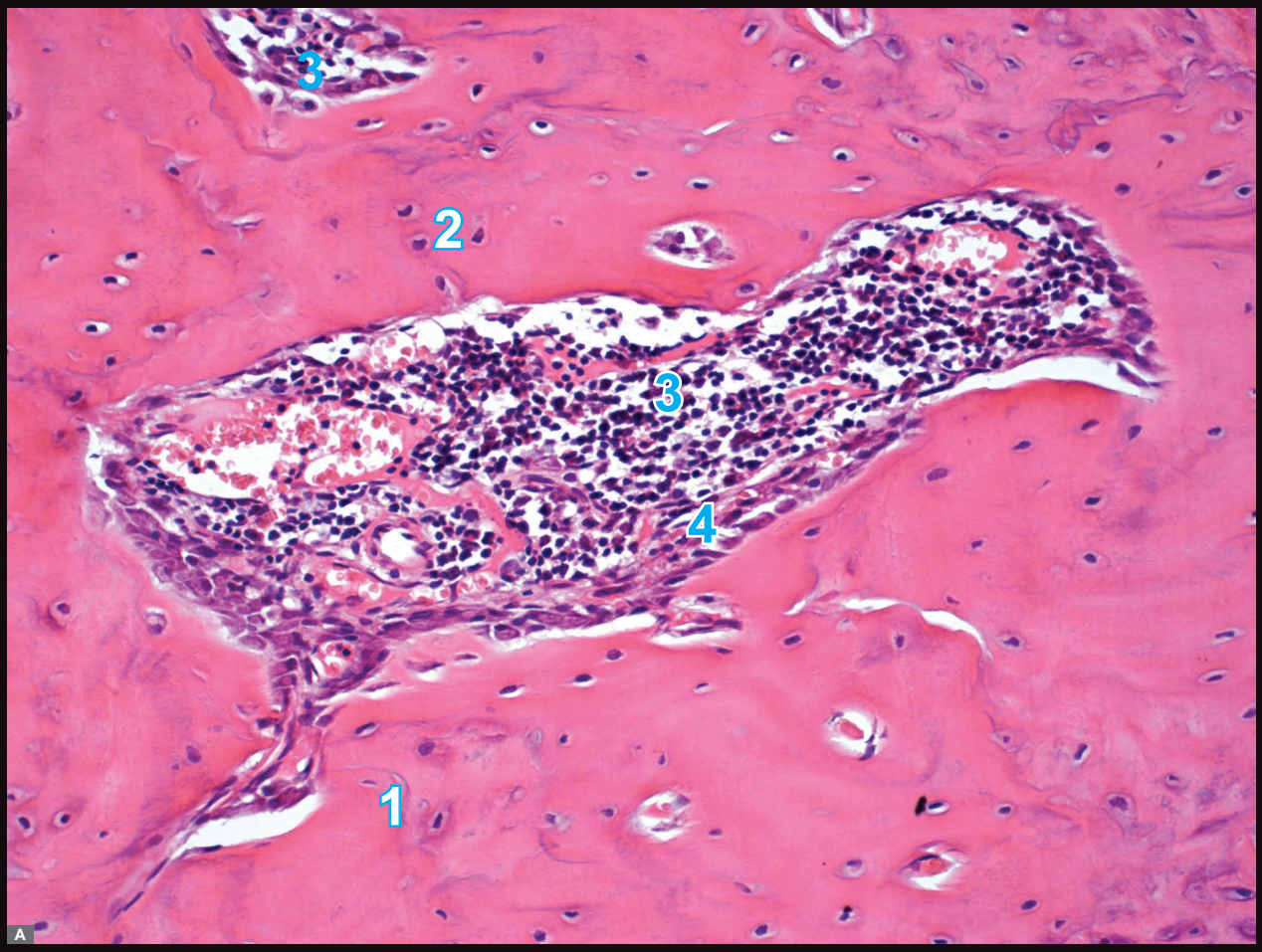
A) In bone repair, after 30 days, granulation tissue was replaced by primary bone tissue with extracellular matrix (1) rich in osteocytes (2) and with several basophilic reversal lines highlighting intense bone remodeling. In medullary spaces (3), haematopoietic tissue is established, with the inner walls full of osteoblasts (4) arranged in palisade and undergoing osteogenesis. In bone repair, photomicrograph registered White-bellied Nothura-shaped medullary space (HE, 40x).

B) The White-bellied Nothura is a species of tinamou found in South America, including Brazil. The bird feeds on insects and fruits. It can fly, but spends most of its time on the ground, hidden in the bushes to escape from predators. It is yellow, brown, white and black. Its scientific name is *Nothura boraquira* (http://brunochavesanimais.blogspot.com.br/2011/12/codorna-do-nordeste.htm; painting by Joseph Smit: http://commons.wikimedia.org/wiki/File:NothuraMarmorataSmit.jpg).

How to cite this section: Consolaro A. Giving wings to imagination! Dental Press Implantol. 2013 Oct-Dec;7(4):32-3.

Submitted: September 15, 2013 - **Revised and accepted:** September 25, 2013

Author's address: consolaro@uol.com.br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Overdentures and masticatory efficiency: literature review

Abstract / Overdenture is defined as a completely or partially removable denture that covers or is supported by one or more remaining natural teeth, roots and / or dental implants. This study aims to examine the masticatory efficiency and patient acceptability of overdentures compared to conventional dentures. A literature review was performed to analyze the importance of dental prosthetic treatment to provide patients with proper function and optimal esthetics.
/ Keywords / Overdenture. Complete denture. Dental prosthesis.

Jovani **Busetti**
Specialist in Dental Prosthesis, Cruzeiro do Sul University.

João Paulo **De Carli**
PhD in Stomatology, Catholic University of Paraná (PUCPR).

Dimas João **Rodrigues Neto**
MSc in Dental Prosthesis, University of Southern Santa Catarina (UNISUL).

Jefferson Ricardo **Pereira**
Professor at the Specialization course in Dental Prosthesis, Cruzeiro do Sul University.

How to cite this article: Busetti J, De Carli JP, Rodrigues Neto DJ, Pereira JR. Overdentures and masticatory efficiency: literature review. Dental Press Implantol. 2013 Oct-Dec;7(4):34-7.

Submitted: September 07, 2013 - **Revised and accepted:** September 11, 2013

Contact address: Jefferson Ricardo Pereira
Rua Recife, 200 – Apto 601 – Tubarão/SC – CEP: 88701-420 – Brazil — E-mail: jeffripe@rocketmail.com

» The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION

Complete denture wearers have a great limitation because of bone loss resulting from the continuous resorption process, which affects the retention and stability of these appliances. The replacement of lost gum tissue by complete dentures is a problem for both the dentist and the patient.

Additional retaining elements, such as remaining roots or implants, can be used to minimize these potential problems and improve the performance of complete dentures. There are several denominations in the literature for this type of treatment, the most common being overdentures.[1]

Overdenture is defined as a partial or complete denture that covers or is attached to one or more natural remaining teeth, roots and / or dental implants,[2] aiming at improving patient's masticatory function and comfort. The esthetic and phonetic aspects will also be greatly improved. These types of implant- or tooth-retained prostheses may be rigid or semi-rigid.[2]

This paper aims to compare, through a literature review, the masticatory efficiency between overdentures and complete dentures.

LITERATURE REVIEW

Adequate planning addressing edentulous patients helps to ensure satisfactory results both esthetically and functionally. Overdentures provide considerable freedom during tooth mounting and allow issues involving placement of implants or tooth-supporting structures to be corrected, thus solving occlusal and esthetic discrepancies.[3]

Some clinical limitations prevent the use of fixed dentures on implants. In these cases, rehabilitation with overdentures is indicated for esthetic, phonetic and chewing purposes, as well as for economic convenience.[4]

Teeth and roots need to be in good periodontal health and favorable position to support tooth-retained overdentures. Because these conditions are not always met, the advent of osseointegrated implants has significantly impacted restorative dental procedures, enabling implant-retained overdentures in a large number of cases.[1]

For a long time, tooth roots were used to promote greater retention and stability to removable dentures. With the development of osseointegrated implants and predictability of this treatment modality,[15,16] the use of roots with retention appliances has become increasingly rare. However, adding retainers to natural roots that would otherwise be extracted is also a therapeutic option for patients, particularly when an implant is contraindicated. Oral rehabilitation using dental roots increases retention and stability of removable dentures, especially because it is a cost-effective treatment.[5]

Tooth-retained overdentures are a rehabilitative treatment option with the advantages of conventional full denture plus that fact that it provides greater retention offered by dental prostheses cemented on pillar teeth. Overdentures using resilient anchoring systems are an alternative for the rehabilitation of partially edentulous patients whose remaining teeth present unfavorable conditions to support fixed or removable partial dentures, providing finer comfort through a more stable reconstruction.[6]

The ideal retention system for overdentures should provide the prosthesis with good retentiveness and stability, so that no great loss of retention capacity occurs over time. It should have easy and inexpensive maintenance, if a replacement is needed. In addition, it should present little height so that it can be used in reduced intermaxillary spaces, which favors esthetics. It must also have biomechanical capacity to help distribute load-bearing forces across the implants and surrounding bone in implant-retained cases.[7]

Implant-retained overdentures in the mandible have been reported throughout the literature with success rates similar to implant-retained dentures (particularly, implant-retained prostheses). However, the most appropriate dental implant system remains controversial.[18]

Implant-retained overdentures function similarly to conventional complete dentures, predominantly mucous-retained, but appliance retention and stabilization are vastly improved by fixing the implants, either as an implant-retained or as mucus-supported overdenture.[8] Implant-retained mandibular overdenture fused to an

infrastructure allows considerable retention and stability, as well as restores patient's masticatory function, safety and well-being.[8,9]

Edentulous patients show great dissatisfaction with complete mandibular dentures, according to case reports found in the literature.[11,12] Masticatory function, speech, quality of life and even nutrition significantly improve when implants are placed into the anterior mandible to support and stabilize an overdenture. Implant-retained overdentures with ball-head attachments provide the patient with greater comfort and masticatory function when compared with conventional full dentures. Patients also feel satisfied because the retention and stability provided by the attachment system enables them to return to social life.[8,10]

Dental implants allow placing the teeth in positions that favor esthetics and phonetic functions. The use of ball-head attachments has demonstrated to be a sensible and economic method due to its relatively low-cost and ease of manufacture and maintenance. This type of treatment provides retention and stability to prosthetic treatment, allowing an increase in masticatory efficiency, safety and improvements in patient's psychological factor and self-esteem. It has biomechanical advantages because of the freedom of movement for the user due to the resilience of the prosthetic socket. It is a rehabilitation option with a prognosis as good as the protocols established by Bränemark for fixed full dentures.[8,11,14,15]

The market offers a variety of retention systems of different brands, each one with its own characteristics, advantages and disadvantages, which can be indicated for distinct clinical cases.[8,12]

Among the denture attachment systems used to support overdentures, there are bar-clip systems, ball-sockets, magnets and telescopic crowns.[8,13]

Choosing the most appropriate denture attachment system will depend on (1) the number of implants or teeth; (2) the location of the implant or teeth; (3) the convenience and / or prosthetic viability; and (4) the cost.[1]

Dental magnets provide the least strength retention and lose their retaining capacity in a shorter period of time when compared to other attachment systems. However, they are easier to handle and have a lower stress transmission to the intermediate pillars.[14]

Bar-clip and ball-socket attachments have a higher degree of retention than the other systems, and are most recommended for advanced atrophy of the alveolar crest and in cases requiring greater retention and stabilization.[13]

It is reasonable to consider that prosthetists should know and evaluate the characteristics of each retention system, so that they can select the most appropriate system for each situation, thus making rehabilitation treatment prognosis more favorable, and increasing the longevity of the prosthetic appliance.[7]

FINAL CONSIDERATIONS

According to the literature reviewed, treatment with tooth-supported or implant-retained overdentures are an alternative to the rehabilitation of partially or fully edentulous patients, providing greater tooth retention and maximum comfort through a more stable reconstruction.

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Imitating nature in prosthetic rehabilitation

Abstract / Treating single-tooth edentulism with implants is a successful method used in Dentistry. However, restoring function with esthetic quality and natural gingival contour is a challenge that depends on the skills and esthetic sense of the professionals involved. This article aimed at discussing the clinical aspects of single-tooth edentulism by reporting a clinical case. / Keywords / Dental prosthesis. Dental esthetics. Dental implant.

Lísia Emi **Nishimori**
MSc in Dental Prosthesis, USP-FUNORP-RP

Ricardo **Annibelli**
MSc Student, Ingá College

Alexandre **Santos**
Specialist in Dental Prosthesis, Studio Dental

Cleverson de **Oliveira e Silva**
Professor of the Masters Course in Prosthesis, Ingá College

Giovani de Oliveira **Corrêa**
Professor of the Masters Course in Prosthesis, Ingá College

How to cite this article: Nishimori LE, Annibelli R, Santos A, Oliveira e Silva C, Corrêa GO. Imitating nature in prosthetic rehabilitation. Dental Press Implantol. 2013 Oct-Dec;7(4):38-45.

Submitted: February 10, 2013 - **Revised and accepted:** November 12, 2013

Contact address: Lísia Emi Nishimori
Av. Itororó, 813 – Sala 2 – CEP: 87013-010 – Maringá/PR – Brazil — Email: lisianishimori@hotmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

The patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

Rehabilitation of patients with anterior dental absences comprises multifactorial problems strongly related to esthetics, function and self-esteem.[1]

The search for solutions to these problems regards not only replacement of the lost tooth, but also its correct positioning, as well as combined dental esthetics and periodontal tissues health, which constitute facial harmony and allow solutions in a social context.[2]

The most viable options for the rehabilitation treatment of a single tooth include the technique of dental implants.[3,4] The biggest challenge is to achieve perfect implant positioning, emergency profile and mimetic coloring in comparison to adjacent teeth.[5] Factors regarding local morphology, damaged structures and patient's acceptability may hinder local reconstruction.[5,6]

The objective of the present study is to briefly analyze single-tooth implant rehabilitation, illustrated by a clinical case report; and verify the possibility of restoring the natural beauty of a lost tooth.

LITERATURE REVIEW

Single-tooth rehabilitation treatment of anterior teeth, particularly upper central incisors, is a challenge when the aim is to establish a balance between esthetic, functional and biological aspects.[7]

Dental implants are indicated to treat such cases, even though a meticulous analysis of previously existing osseous and gingival conditions is necessary in order to minimize potential tissue alterations such as papillae loss, tissue recession, ridge defects and loss of keratinized tissue.[8]

The relationship between implant and natural gingival tissue is established by the interaction of different factors among which an adequate positioning of the implant is highlighted. Proper positioning allows a prosthesis to be fabricated with satisfactory emergency profile, height, width, shape, color, tooth surface texture and periodontal health of red tissues.[9,10]

Single-implant cases are frequently associated with extraction followed by immediate implant placement. For this reason, the quality and amount of bone volume must be closely and strictly inspected, so as to allow the morphology of the mucosal tissue of adjacent teeth to be copied.[11]

Some authors report that smile harmony depends on factors such as: 1) Leveled margins of upper central incisors; 2) Margin of upper central incisors 1 mm higher than the margin of lateral incisors, and at same level of that of canines; 3) Gingival and labial margins contour that mimic teeth cementoenamel junction; and 4) Papilla between teeth that should be equidistant from the incisal edge to the cervical gingival contour in the center of the crown.[10,12]

In this context, several surgical techniques have been suggested to apply esthetic knowledge, among which proper mesiodistal positioning is highlighted, given that it determines the presence or absence of papillae. Salama et al[13] report six classifications that can be employed to establish proximal tissue according to the type of abutment restoration. In case of single spaces adjacent to higid teeth, at least 1.0 mm between the implant and the abutment is necessary to restore 5.0 mm of proximal papillae.

Likewise, wrong implant positioning and inclination negatively affect the esthetics around an implant, leading to mucosal instability and gingival recession.[11]

Good reverse planning is essential to identify the correct three-dimensional positioning of the rehabilitation, for it will serve as orientation for implant placement, thus eliminating potential fixation mistakes in risk zones.[7]

Regardless of the treatment of choice, diagnostic wax-up is the pre-evaluation method that will decrease the chances of future mistakes.

Despite correct implant positioning, the challenge of single-tooth rehabilitation remains. The attempt to meet esthetic expectations and excellence goes beyond scientific knowledge, it requires critical sense in detailing the anatomical and biometric characteristics of a tooth.[4,5,6]

Esthetic smile rehabilitation must be planned on the basis of Restorative Dentistry, observing and imitating the

characteristics of adjacent teeth. References of dental size, width, light reflection area, surface texture and color are crucial to smile harmony.[14,15]

Another important development in prosthetic rehabilitation is the elimination of metallic infrastructures in prosthesis over implant. Among them, the use of high-density zirconia has become very popular due to its resistance to wear, great coloration, bending strength and tenacity against fracture.[16]

Zirconia is an oxide of light color used for several purposes, namely: Nuclear reactors, photography flash light, vacuum tubes, chemical industry where corrosive agents are applied, and glasses.[17] Additionally, it is an excellent material for single-tooth reconstruction of prosthesis over implants, as it meets requisites of tissue biocompatibility, resistance and esthetics.[18]

CLINICAL CASE

Female patient, 28 years old, sought dental treatment with history of trauma in a single anterior tooth (#11). The patient was dissatisfied with her composite resin restoration and its consequent unpleasant odor.

Radiographic analysis revealed oblique root fracture, in which case tooth extraction followed by implant placement were suggested (Fig 1).

A surgical guide was carried out before surgery, according to the position of the clinical crown that would be extracted. Surgery was performed with the bone preservation technique. After this procedure, a meticulous evaluation of bone and gingival quality and volume was carried out for posterior implant placement (10 mm high, 4.8-mm platform) (Straumamm – Switzerland) with a mesiodistal space

Figure 1: Initial clinical aspect.

greater than 1.0 mm. After surgery, a provisional pontic was placed and kept for 3 weeks, followed by the placement of a cemented provisional prosthesis over a zirconia post prepared for fixed prosthesis, which met the needs and criteria to correctly establish peri-implant tissues (Fig 2)

A copying of the same material was made and placed over the zirconia post to mimic and match the color of the dental substrate. This procedure was followed by stratification with fluorapatite-based ceramic, so as to ensure a natural incisal opalescence (Fig 3).

Stratification was carried out with fluorapatite feldspathic ceramic, characterized by great light refraction and esthetics. This procedure allowed clinical proof between sinterization procedures, which also allowed the desired optical results and coloration to be achieved (Fig 4).

After stratification, the element was cemented with dual cured resin cement (U200, 3M ESPE). Given that material in contact with other material did not require surface treatment, their intra-sulcular condition did not interfere in the cementation line (Figs 5 to 8).

Figure 2: Zirconia post clinical proof.

Figure 3: Zirconia copying proof.

Figure 4: Stratification of the feldspathic ceramic.

Figure 5: Final aspect.

Figure 6: Tooth in occlusion.

Figure 7: Final smile (frontal view).

Figure 8: Final smile (lateral view).

CONCLUSION

Single-tooth esthetic rehabilitation requires healthy adjacent teeth and good physiology of edentulous space. Prosthetic restorations rely on adequate ceramic material, satisfactory implant positioning and treatment planning, as well as on the dental surgeon's good performance, skills and accurate esthetic sense.

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Surfaces in Implantology: Characteristics of the main Brazilian implants

doi: http://dx.doi.org/10.1590/2237-650X.7.4.046-051.car

Introduction / The superiority of rough-surface implants over machined ones seems to be consensual today. Different surface treatment methods have been developed to improve potential tissue response. This study critically reviewed the information that some Brazilian companies provide to dentists about the characteristics of surface treatment, methods as well as the recommended loading time, and analyzed whether these important data are based on scientific findings. Methods / Six Brazilian companies, Conexão®, Kopp®, Neodent®, P-I Branemark®, S.I.N® and Titaniumfix® received a questionnaire about their products and respective surface treatment, recommended loading time and scientific evidence. Results / Different treatment methods were reported: acid etching, abrasion followed by acid etching, and plasma immersion ion implantation (PIII). According to the information provided, loading time ranged from 1 to 6 months. Conclusions / Although some companies conduct scientific studies to evaluate their implants, this study found that there was no scientific evidence to support the recommended loading times and that the information provided was not accurate.

Alexandre da Silveira **Gerzson**
Doctorate student in Oral and Maxillofacial Surgery and Traumatology, Catholic University of Rio Grande do Sul (PUC-RS).

Cláudio Ayres **Peres**
Specialist in Implantodontics, Ingá College (UNINGÁ).

Márcio Borges **Rosa**
PhD in Implantodontics, São Leopoldo Mandic College of Dentistry.

Eduardo Poester **Fetter**
Professor, Specialization in Implantodontics, UNINGÁ.

Luiz Antônio **Marchioni**
Msc in Dentistry, Brazilian Lutheran University (ULBRA). Professor, Specialization in Implantodontics, UNINGÁ.

How to cite this article: Gerzon AS, Peres CA, Rosa MB, Fetter EP, Marchioni LA. Surfaces in Implantology: Characteristics of the main Brazilian implants. Dental Press Implantol. 2013 Oct-Dec;7(4):46-51. doi: http://dx.doi.org/10.1590/2237-650X.7.4.046-051.car

Submitted: July 03, 2013 - **Revised and accepted:** September 08, 2013

Contact address: Alexandre da Silveira Gerzson
Rua Dona Laura, 87/506 – CEP: 90430-091 – Porto Alegre/RS — Brazil – Email: alexandregerzson@gmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION

Implantology has undergone constant changes not only to improve tissue response, but also to shorten treatment time. Initial studies about osseointegration used machined implants fabricated from commercially-pure titanium (grades 1 and 2).[1] As studies advanced, researchers realized that modifications on implant surface topography affect the response of adjacent bone,[2] promote greater fibrin integration and interlacing, and create paths for the migration of adjacent cells towards the surface, which favors osteogenesis as a result of increasing direct contact with the implant surface.[3] These changes speed up the process of secondary stability and shorten loading time.

Different implant surface treatments have been developed to accelerate osseointegration and strengthen the integrated interface. The most common methods are: abrasion; laser sintering; anodization; acid etching; and abrasion combined with acid etching.

The constant development of implant surface properties has changed clinical protocols. This study critically analyzed the information provided by some Brazilian companies about the characteristics of treatments used to modify implant surfaces, as well as the recommended loading time. It also analyzed whether these companies have conducted scientific studies using their implants and whether the information provided is based on study findings.

MATERIAL AND METHODS

A questionnaire was used to evaluate the type of surface treatment and the recommended loading time of some of the implants manufactured in Brazil. No other method was used to collect data. Six companies were selected to respond the questionnaire: Conexão®, Kopp®, Neodent®, P-I®, S.I.N® and Titaniumfix®. These companies were contacted by phone and e-mail, and the questionnaires were answered by their scientific consultants.

The questionnaire comprised the following questions: (1) What is the commercial name of the implant surface of your company?; (2) How is the implant surface treated?; (3) What is the recommended loading time, considering time for osseointegration in the maxilla and mandible?; (4) Based on what factors was loading time defined?; and (5) Are there any scientific studies or publications about the surface treatment used by your company? Are these studies available for examination?

RESULTS

Out of the six companies contacted, only S.I.N® did not answer the questionnaire. The answers given by the other companies are summarized in Table 1.

Conexão® names their implant surfaces as Porous and Vulcano Actives. They reported using total acid immersion to modify implant surface topography, with a specific time and temperature set for each type of implant, not disclosed because of business confidentiality. The company recommends the Porous surface for all types of bone density, and a loading time longer than 2 months. Vulcano Actives, in turn, is recommended for bones type 2 and 3, and not recommended for type 1. The recommended loading time is 1 month. According to the company, loading times have been defined in agreement with studies found in the literature. The company made available four studies which had been previously conducted with the aforementioned studies and surface treatments.[4-7]

Kopp® reported that their surfaces receive some type of chemical treatment. Their process is conducted in agreement with the following rules issued by the Brazilian Association of Technical Specifications (ABNT): NBR 12932 — surgical implants, metal supplies, surface preparation and marking; and NBR 14233 — surgical implants, metal supplies, cleaning and pickling of titanium and titanium alloy surfaces. They recommend a loading time of 3 to 5 months and highlight that the exact time depends on each clinical case and patient follow-up. The length of loading time was associated with clinical, surgical and product (implant) factors, such as: contraindications; diagnosis, planning and adequate surgical technique combined with biosafety; correct sequence of burs; administration of pre and postoperative medication; engineering, quality and product origin. Kopp® made reference to two studies,[8-9] which, however, were not conducted with implants manufactured by their company.

Neodent® names their implant surface treatment as Neoporos. The surface is prepared by two processes: abrasion and acid etching. They recommend a

loading time of 2 to 3 months based on bone repair and bone-implant contact (BIC), as estimated by the company. In the item about studies found in the literature, they claimed that a study about loading time using their own implants is to be published soon.

P-I® names its surfaces as Nano® and Micro+Nano®. They reported employing plasma immersion ion implantation (PIII) treatment. Their recommended loading time was of 3 months in ideal clinical situations, based on clinical and laboratory studies conducted by the company. They made reference to six studies already published[10-15] and three others in press, all conducted with implants manufactured by the company, although only two of them investigated the factors discussed herein.

Titaniumfix® reported having hybrid surfaces resulting from abrasion and acid etching. Their machined implants go through aluminum oxide abrasion and are then passivated in nitric acid. The company could not provide further details due to business confidentiality. They recommend a loading time of 6 months for the maxilla and 4 months for the mandible, a loading time supported by findings in current literature. They made reference to nine studies[16-25] that used implants manufactured by their company, although only four investigated the factors discussed herein.

DISCUSSION

Implantology has unquestionably determined the superiority of rough-surface implants over machined ones.[25,26] The surface treatments that best promote cell response have been extensively investigated.

Analysis of surface topography revealed that Titaniumfix® and Neodent® use abrasion followed by acid etching, which, as found in SLA Straumann® implants, results in greater bone-implant contact (BIC) and greater

Table 1: Surface name, implant surface treatment, loading time, determining factors of loading time and scientific studies or publications about the surface treatment used by the companies analyzed in this study.

Company name	Surface name	Implant surface treatment	Loading time	Determining factors of loading time	Scientific studies or publications
Conexão	Porous and Vulcano Actives	Acid etching	1-2 months	Studies found in the literature	Shibli et al[4] Shibli et al[5] Shibli et al[6] Grassi et al[7]
Kopp	Chemical treatment	ABNT 12932	3-5 months	Clinical, surgical and product factors	Carvalho et al[8] Elias et al[9]
Neodent	Neoporos	Abrasion followed by acid etching	2-3 months	BIC – bone repair	-
P-I	Nano and Micro+Nano	PIII (*Plasma Immersion Ion Implantation*)	3 months	Clinical and laboratory studies conducted by the company	Barbosa et al[10] Canullo et al[11] Canullo et al[12] Francischone et al[13] Meirelles[14] Meirelles et al[15]
Titaniumfix	Hybrid surface resulting from abrasion and acid etching	Machined implants go through aluminum oxide abrasion and are then passivated in nitric acid	6 months for the maxilla and 4 months for the mandible	Loading time supported by findings currently found in the literature.	Correa et al[16] D'Avila et al[17] Duarte et al[18] Faeda[19] Neto[20] Ribeiro et al[21] Ribeiro et al[22] Sakakura et al[23] Tavares et al[24]

removal torque than when surfaces are machined.[27] Conexão® and Kopp® use total acid immersion, which results in greater removal torque than that found for machined implants.[28,29] P-I® uses plasma immersion ion implantation (PIII), a new process employed to modify surface implants, which results in greater removal torque than that found for machined surfaces.[15]

Conexão® recommended a loading time of 4 weeks for the Vulcano Actives surface, and more than 2 months for the Porous surface. The company made reference to four studies. In the first, mini-implants treated by abrasion and acid etching were placed in human maxillae and mandibles. After 2 months, the results yielded for implants with abraded and acid-etched surfaces were better than those of machined implants.[7]

Shibli et al[4] conducted a clinical case study in which an anodized and a machined implant were placed in the posterior mandible. The authors found a greater BIC percentage in the anodized implant 3 months after healing. They also developed a study comparing anodized and machine surfaces of mini-implants placed in human posterior maxilla, and found greater BIC and bone density in the thread area (BD) for the anodized group 2 months after healing.[5] A third study was conducted by the same authors with human mini-implants placed in the maxilla and mandible, and found greater BIC in anodized implants 2 months after healing.[6] All studies referred by Conexão® were conducted with the company's implants of which surfaces underwent anodization and abrasion combined with acid etching. However, the company claimed to use only acid etching. The recommended loading time is in agreement with what is suggested in the studies, but the type of surface described is not the same as the one reported in the questionnaire.

The studies referred by Kopp® were not conducted with their own implants, and were limited to evaluating implants with modified surface topography as well as machined implants.

Neodent® did not mention any studies conducted with their own implants.

P-I® recommends a loading time of 3 months. Although 6 studies were mentioned to justify that recommendation, only 2 actually discussed the factor. Canullo et al[11] conducted a study with 417 patients who received immediate loading implants or implants with loading time of 45 and 128 days. They found a survival rate of 96.64% for P-I® implants with subtraction treatment carried out by mechanical ultra cleaning, with no significant differences between survival rates in cases of early and late implant loading. Despite these results, the type of surface treatment used in the study was different from the one reported in the questionnaire. Another P-I® study included implants that underwent PIII, a process in which the implant is first cleaned with argon, followed by surface abrasion with a mix of inert gases, and oxygen implanted to form rutile. The implants were placed in the tibia and femur of rabbits and, one month after healing, removal torque was greater than in machined implants.[15] Both studies were conducted with implants manufactured by the company, but the type of treatment informed in the questionnaire was different from that used in the studies. In spite of that, the data reported in those studies gave support to the use of the recommended loading time. The other studies referred by the company evaluated a new biomaterial (NanoBone®) and did not discuss loading time.[12] They also evaluated the ideal nanotopography to optimize bone response to implants and the role of a collecting implant chamber.[10-13] The other studies referred are in press.

Titaniumfix® recommends a loading time of 6 months for the maxilla and 4 months for the mandible. They referred nine articles to justify the recommended loading time, but five of them did not discuss the factors discussed herein. D'Ávila et al[17] conducted a study with mini-implants placed in the posterior maxilla of smokers, and found greater BIC for implants that underwent abrasion and acid etching in comparison to machined implants. Tavares et al[24] developed a research with rabbit tibias and compared 4 treatment types: laser beam irradiation with and without hydroxyapatite coating (HA), abrasion combined with acid etching and machining. The implants were removed 8 weeks after placement, and the best removal torque was found in the group of implants that received laser beam irradiation and HA coating, followed by laser beam irradiation alone, abrasion combined with acid etching and machining. However, the surface treatment informed by the company was different from the best treatment found

in this study. Another study examined rabbit tibias 4, 8 and 12 weeks after placement and compared implants that received different surface treatments: laser irradiation, HA coating, abrasion combined with acid etching and machining. The best results were found for the implants with HA coating, and similar results were found for those that received laser irradiation and abrasion combined with acid etching, all superior to machined implants.[19] A clinical study evaluated an abraded and acid-etched implant 40 months after loading and found high levels of osseointegration.[23] The other studies referred by the company focused on different factors. Studies with implants subjected to aluminum oxide abrasion (AL_3O_2) found higher BIC values than that observed in machined implants.[21,22] A comparison of aluminum oxide abrasion and machining found that abrasion resulted in higher BIC. These studies evaluated surface treatments that were different from the one used by the company. The other studies evaluated implants treated with plasma nitridation[20] and bacterial adhesion to different implant surfaces and curets.[18] Although some studies found better tissue response of implants treated with abrasion and acid etching, which was the treatment used by the company, loading time was still defined according to the classical Brånemark protocol, developed for machined implants. Moreover, the studies referred by the company reported that other types of treatment had better results than abrasion and acid etching. The results of these studies reveal why the company has not yet recommended any reduction in loading time. All studies were conducted using implants manufactured by Titaniumfix®.

Little scientific evidence was provided by the companies included in this study, and most of the studies they made reference to did not deal with the factors discussed herein. In spite of that, no attempt was made to obtain further information after the questionnaire was returned, given that the central purpose of this study was to clarify whether Brazilian companies explain and provide scientific material to dentists in order to justify their clinical recommendations for surface treatment and osseointegration.

Some scientific studies did not include the companies' own implants, and studies with implants manufactured by other companies were used to justify their recommended loading time. Furthermore, although some companies had a few scientific studies that included their own products, the results were not used to recommend loading time for their implants. Therefore, our findings suggest that the companies included in this study do not follow scientific evidence of ideal loading time for their recommendations. A recent study compared roughness resulting from surface treatment of five of the most important Brazilian implant brands (Biomet 3i do Brasil, Conexão, Neodent, SIN and Titaniumfix) and of world-reference implant surfaces (Straumann – SLA®, Biomet 3i – Osseotite® and Nobel Biocare – TiUnite®), for which there is extensive scientific documentation. The results of Brazilian implants were different, although the manufacturing processes were similar. Most implants had a low roughness index, as well as statistical differences between batches. These results suggest that Brazilian companies should consider re-assessing their surface treatment processes.[30]

CONCLUSION

Although some companies conduct scientific studies with their own implants, this study found that there was no scientific evidence to support the recommended loading times, and that instructions given to dentists are not accurate. Further contact with those companies should be attempted to investigate whether the recommended protocols are supported by findings of other in-house studies.

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Artificial gingiva with papilla restoration in single prostheses over malpositioned implants: an aesthetic and easy to clean alternative

Abstract / This study aimed at describing an alternative approach to the clinical condition of unfavorable implant positioning and unfavorable initial prosthetic planning. This article reports a viable alternative for these situations: the use of single crowns placed over implants with artificial gingiva. This technique reestablishes proper papillae region and proves to be an effective alternative with esthetic benefits and easy cleaning, as well as an important factor that favours the maintenance of peri-implant health.
/ Keywords / Dental implants. Prosthetic complications. Dental esthetics. Artificial gingiva.

Jarbas Eduardo **Martins**
PhD resident in Dentistry, UNICSUL. Professor, EAP-APCD and APCD-UNICSUL.

Eliane Maria Gabriel **Braga**
Specialist in Prosthesis and Implant. Professor, EAP—APCD and APCD—UNICSUL.

Fábio Valverde Rodrigues **Bastos Neto**
PhD in Dentistry and Adjunct Professor, UNICSUL. Professor, EAP—APCD.

Angela Toshie **Araki**
PhD in Dental Sciences, University of São Paulo (USP). Adjunct Professor, UNICSUL.

How to cite this article: Martins JE, Braga EMG, Bastos Neto FVR, Araki AT. Artificial gingiva with papilla restoration in single prostheses over malpositioned implants: an aesthetic and easy to clean alternative. Dental Press Implantol. 2013 Oct-Dec;7(4):52-9.

Submitted: September 15, 2013 - **Revised and accepted:** September 20, 2013

Contact address: Fábio Valverde Rodrigues Bastos Neto
Rua Joaquim Nabuco, 47 – Sala 24 – Brooklin – São Paulo/ SP – Brazil — CEP: 04621-000
bastosneto@terra.com.br

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

The patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

Dental implants have become common in the dental clinic not only for being a simple procedure with high success rates and good longevity, but also for providing users of complete and removable dentures with comfort. In addition to that, modern society has had an increasingly quest for beauty, which is often disclosed by the media. As a result, dental esthetics has been frequently required with a view to restoring a natural smile.[11]

The need for esthetic implant-supported restoration requires that implants be correctly positioned with proper diameter, inclination and apico-coronal dimension. These factors seem to be more important than the implant type or brand.[13]

Several factors may influence the positive results of oral rehabilitation yielded by implant-supported prostheses in the anterior maxilla, especially when, before surgery, there are bone and/or gingival limitations that induce unfavorable implant placement and, as a result, interfere in prosthetic esthetics.[12] Additionally, the structures associated with the peri-implant mucosa, the topography of the edentulous space, the smile, adjacent remaining teeth and the type of restoration are key to prosthetic restoration success.[14]

CASE REPORT

A female patient sought treatment at the EAP clinic. She had four internal hexagon implants (Conexão™) as well as temporary prostheses installed in the anterior maxilla and was deeply dissatisfied with esthetics, mastication and speech (Fig 1).

Thorough clinical and radiographic examination as well as dental casts mounted in an articulator revealed implant osseointegration. However, they also revealed that the issues reported by the patient were caused by the absence of papillae between teeth and insufficient bone and gingiva, thus resulting in long teeth and non-esthetic gingiva.

The patient was informed about the advantages and disadvantages of the following treatment options: gingival graft and epithesis, as well as fixed, single prostheses with artificial gingiva. Since the patient had internal hexagon implants, 11.5 mm in length and 4.0 mm / 3.75 mm in diameter, it was decided on the use of single prosthetic crowns with artificial gingiva between teeth, which would allow oral hygiene with dental floss.

A first diagnostic waxing was carried out over the cast so as to obtain the positioning of the prosthetic crowns.

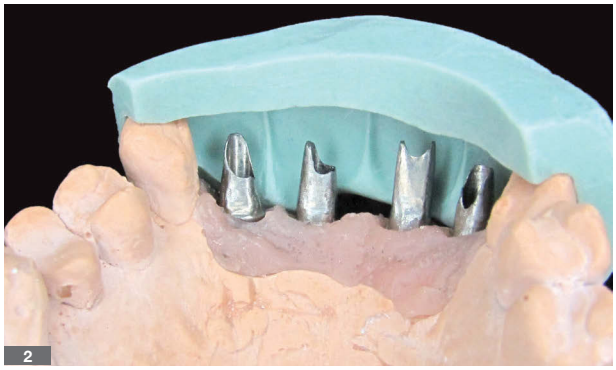
Figure 1: Initial case.

Afterwards, a condensation silicone mold (Zetaplus-Zhermack, Labordental Ltda, São Paulo/Brazil) was produced to guide the positioning of internal hexagon abutments (Conexão Sistema de Prótese, Arujá/SP/Brazil) and subsequent customization (Fig 2).

A guide was made in red acrylic resin using the dental cast as a mold (Duralay, Reliance, USA), so as to allow the customized internal hexagon abutments to be correctly positioned (Figs 3, 4). A periapical radiograph revealed that abutments were precisely fitted to the implants.

In order to precisely shape the artificial gingiva necessary to fill the spaces between teeth, restore esthetics with proper gingival apex, provide proper speech and allow oral hygiene to be easily performed with dental floss, a new diagnostic waxing of the crowns with artificial gingiva contour made in Tomas Gomes resin (STG Wax, Formaden, São José dos Pinhais/PR/Brazil) was requested from the prosthesis laboratory. It allowed prostheses to be tested in the patient's mouth and potential esthetic and/or functional repairs to be carried out (Figs 5-8).

After all necessary corrections were performed, a new silicone mold was created to guide the fabrication of the prosthetic crowns. Subsequently, customized copings were made in Ni/Cr. They were tested and radiographed in the patient's mouth so as to ensure perfect fitting (Fig 9). After the impression was made, color was determined for ceramic application (IPS d'SIGN, Ivoclar Vivadent).



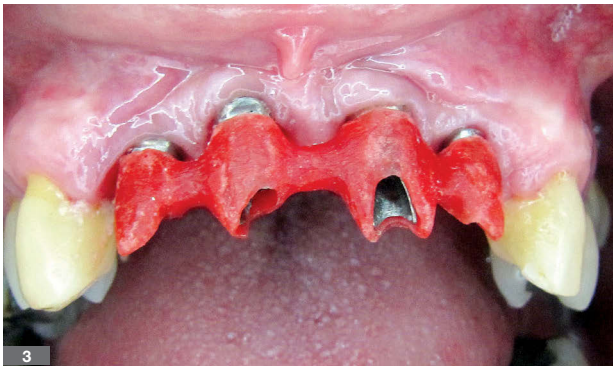


Figure 2: Silicone mold after diagnostic waxing.
Figure 3: Positioning guide for customized posts.
Figure 4: Customized posts positioned over their respective implants.

After ceramic was applied, the prostheses were tested and adapted so as to allow all necessary mandibular occlusal adjustments to be performed. Color and shape were examined and glaze was applied. Teeth were still long-shaped, given that the artificial gingiva had not been applied yet.

The aim was to use single crowns with papillae and artificial gingiva so as to yield satisfactory esthetic results in addition to favoring oral hygiene with dental floss. To this end, artificial gingiva was fixed to the crowns. Ceramage (SHOFU Inc., Japan) (zirconium silicate micro ceramic) was used to determine the shades of the

Figure 5: New diagnostic waxing of crowns and artificial gingiva.
Figure 6: Crown waxing trial with artificial gingiva.
Figure 7: Minor esthetic adjustments carried out to achieve a pleasant smile.
Figure 8: Final analysis of planning and patient's approval.

gingival color scale. This material was chosen due to its excellent ability to bond to ceramic, excellent gingival color reproduction and low curing contraction, all of which favor good fitting of contact points and the use of dental floss between crowns.

With a view to fabricating the artificial gingiva, ceramic was partially removed from the crowns with the artificial gingiva framework precisely determined. Blasting with aluminum oxide was carried out at 0.1 to 0.2 MPa, Solidex Solibond (SHOFU Inc.) bonding agent was applied for 30 seconds, Ceramage Gum (SHOFU Inc.) gingival paste was applied by increments with thickness not greater than 2 mm, thus requiring intermediate curing carried out by 90-second increments. Additionally, Oxy-Barrierb (SHOFU Inc.) was applied, since it prevents air contact before the final curing procedure and avoids an inhibition layer to be established. At last, finishing and polishing procedures were carried out.

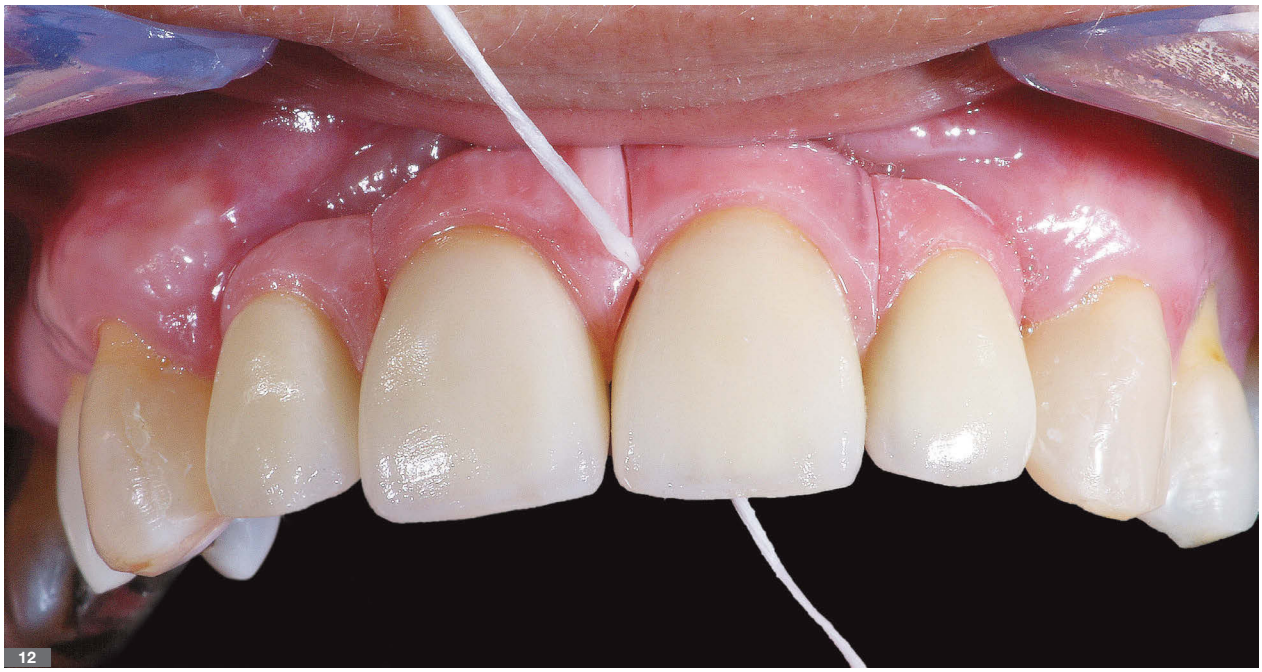
Once again, prostheses were assessed in the patient's mouth. The aforementioned procedures yielded good esthetic gingival results (Figs 10, 11), favored oral hygiene with dental floss (Figs 12, 13) and harmony of prosthetic crowns as a whole (Fig. 14). At last, cementation was carried out.

DISCUSSION

During planning, one must remember that implants function as a prosthesis-supporting structure. Thus, reverse planning of the correct surgical site is of paramount importance[15] to avoid significant differences between surgical and prosthetic procedures,[17] given that after implants have been placed and osseointegrated, they cannot be moved.

This may lead to treatment success or failure and, as a consequence, lack of appropriate prosthesis support, unfavorable biomechanical factors, such as increased tension over supporting structures, and unfavorable esthetic harmony, particularly for treatment performed in the anterior region.[16] Additionally, absence of bone tissue may hinder correct implant positioning previously planned in accordance with reverse planning defined to meet prosthetic needs. Nevertheless, some of these

Figure 9: Metallic copings trial during which marginal fitting and space for ceramic prosthesis was observed.



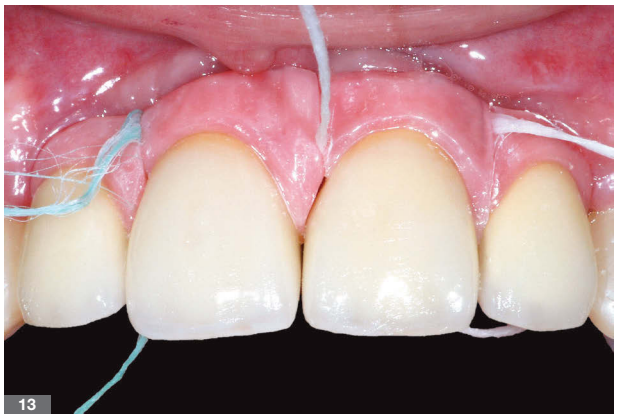


Figure 10: Final metal-ceramic single prostheses with artificial gingival made in Ceramage.
Figure 11: Patient's spontaneous smile with a natural and pleasant appearance similar to natural teeth.
Figure 12 and **13:** Dental floss used to ease oral hygiene.
Figure 14: Detailed profile photograph after case finishing.

situations may be modified by increasing bone and/or gingival tissue before treatment, which provides a proper implant receptor site that meets the esthetic and functional requirements of the planned prosthesis.[18]

In other cases, implants are placed in areas in which the long axis is not compatible with the positioning of the teeth in the arch. In these cases, prosthetic compensation is necessary to correct the problem. To minimize or compensate malpositioned implants, one may opt for a prosthesis that promotes proper oral hygiene and, as a consequence, preserves gingival health, avoids severe damage to the patient and restore, among others, esthetics.[19]

In terms of esthetics, gingival tissue plays an important role, especially in case of patients with a medium or high smile line,[20] given that gingival contour architecture influences the size of tooth crowns. Furthermore, it is worth noting that gingival apex health and contour are of paramount importance for establishing smile esthetics.[21] In this context, patients and dental-surgeons reach a consensus on the fact that a harmonious smile is more pleasant.[22]

In case of malpositioned upper anterior implants, the literature suggests that they be corrected by means of reconstructive gingival surgeries and epithesis, or artificial gingiva. The latter consists of a removable device made of acrylic resin positioned over the cervical surface of teeth with bone loss with the purpose of decreasing interproximal spaces and, as a result, providing a more natural smile.

This treatment approach provides the patient with good hygiene conditions (since epithesis may be removed); speech (since interproximal spaces are completely obliterated) as well as good esthetics (since lip support is completely achieved, as in cases of complete denture).[23,24] Conversely, it is not easily accepted by the patients due to being a removable structure. On the other hand, should a fixed denture with non-removable artificial gingiva[25] be used, it would hinder oral hygiene as additional devices, such as dental floss picks, would be necessary.

Peri-implant bone loss after prosthesis placement over implants is of multifactorial etiology, however, it is directly associated with bacteria accumulation and keratinized mucosa.[1,4,7,8] Additionally, peri-implant disease is time-dependant. According to some authors,[6,9,10] 40% of patients have peri-implant gingival inflammation, while 22% have bone loss as a consequence of poor oral hygiene. Moreover, peri-implant disease is more common among patients with periodontal disease due to poor hygiene.[10]

There is a variety of products available for removal of plaque accumulated around prosthesis placed over implants. However, it is clear that the simpler the hygiene procedure is, the better it will be performed by patients. According to the literature, bone loss around implants of protocol prosthesis or of complete and partial fixed dentures is greater than that found in single prostheses.[2,5,6]

Based on the aforementioned information and from the standpoint of an easy peri-implant maintenance, the use of single crowns provides patients with proper oral hygiene, thus ensuring longevity to bone tissue. To this end, we recommend the use of single crowns with papillae and artificial gingiva so as to yield satisfactory esthetic results in addition to favoring oral hygiene with dental floss.

In the case reported herein, artificial gingiva was fixed to the crowns and Ceramage (SHOFU Inc., Japan) (zirconium silicate micro ceramic) was used to determine the shades of the gingival color scale. This material was chosen due to its excellent ability to bond to ceramic, excellent gingival color reproduction and low curing contraction, all of which favor good fitting of contact points and the use of dental floss between crowns. This technique allowed us not only to provide patients with excellent esthetic results, but also to restore gingival contour, papillae filling and proper speech.

CONCLUSION

Malpositioned upper anterior implants require papillae and gingival esthetics restoration, which can be successfully achieved by means of single fixed prostheses with artificial gingiva. This technique restores papillae framework and has proved efficient in restoring esthetics and masticatory function, as it provides patients with proper oral hygiene — an extremely important factor for maintenance of peri-implant health.

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Acknowledgments

We deeply thank the LOF laboratory technician, Daniel Morita da Silva, for fabricating the prosthetic pieces and providing excellent support.

Anatomic-functional transference of implants

Abstract / In the oral cavity, there are rigid (teeth) and resilient structures (soft tissue) that are reproduced and, unfortunately, present different behaviors when in contact with impression material: Rigid structures do not undergo deformation and can generate accurate copies; whereas resilient structures undergo deformations that need to be conveniently treated so that the prosthesis does not cause injuries to soft tissues. It is essential that implants be precisely transferred to the work models, thus favoring precise positioning of analogues and, as a result, providing the lab technician with the appropriate conditions to fabricate prosthetic pieces that are appropriately adapted to the mouth. We use screwed impression copings that are placed by means of the direct transfer technique. Models are fabricated in two steps: (I) anatomical impression with stock tray and use of impression material of different consistencies, in layers; (II) functional impression carried out with customized tray and polyether or addition-cured silicones with different flows, in layers. After curing the impression material, excesses are removed and the impression copings are fixed to the customized acrylic tray with low shrinkage resin by means of the brush technique. After the impression material is cured, the impression copings are unscrewed and the model is removed from the oral cavity. The anatomical and functional transfer of multiple implants is essential for obtaining faithful models on which prostheses, which properly fit on implants with proper contact with soft tissues, are built, thus preventing potential injuries.
/ Keywords / Dental implants. Anatomic transfer. Passive fit. Implant impression.

Gastão Soares de **Moura Filho**
Professor, Specialization course in Dental Prosthesis, CETAO.

Mauro Martins Ferreira **Tosta**
PhD in Morphology, UNIFESP.

José Antonio Lupi da **Veiga**
Professor, Department of Prosthesis, School of Dentistry — University of São Paulo (USP). Professor, Specialization course in Implants, CETAO.

Luis Fernando Severino **Matos**
Professor, Specialization course in Implants, CETAO.

Daniel Yamane **Hirata**
Professor, Specialization course in Implants, CETAO.

How to cite this article: Moura Filho GS, Tosta MMF, Veiga JAL, Matos LFS, Hirata DY. Anatomic-functional transference of implants. Dental Press Implantol. 2013 Oct-Dec;7(4):60-74.

Submitted: October 30, 2013 - **Revised and accepted:** November 12, 2013

Contact address: Gastão Soares de Moura Filho
Av. dos Jamaris, 393 – São Paulo/SP – Brazil — CEP: 04078-000 – E-mail: gastaosmf@terra.com.br

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

The patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

The impression technique is an important step for rehabilitation treatment and should generate working or functional models that faithfully reproduce the oral conditions. In the oral cavity, there are rigid (teeth) and resilient (soft tissue) structures that have to be reproduced but, unfortunately, have different behaviors when in contact with impression material: rigid structures do not undergo deformation and can generate accurate copies; whereas resilient structures undergo deformations that need to be conveniently treated so that the prosthesis does not cause any trauma to soft tissues. Teeth (worn or not) and soft tissues do not have previously made replicas. For this reason, appropriate plaster models must be casted. Implants already have structures that can be accurately replicated (analogues) and, therefore, they do not need to be molded, but transferred to a working or functional model. For each type of implant system there are impression copings that properly fit to the analogues, in which case the technique employed is the open tray technique. Some impression copings are screwed to the implants / abutments, while others are simply embedded onto them. When impression copings are screwed, the open tray (stock or customized) direct technique is used. As for embedded impression copings, the closed tray indirect technique is used.

It is essential that implants be precisely transferred to the working models, thus favoring precise positioning of analogues and, as a result, providing the lab technician with the appropriate conditions to fabricate prosthetic pieces that appropriately fit into the mouth, whether by the traditional method of waxing and casting or the CAD / CAM technology. This procedure, also known as passive fit, enables appropriate settlement and adjustment of implant-supported prostheses. The clinical methods used to evaluate the fitting of implant superstructures are: digital pressure; visual inspection; radiography; tactile sensation; Sheffield test; marker material; and screw resistance tests.[1] Ideally, one should combine several evaluation methods to check the adjustment of implant-supported prostheses.

LITERATURE REVIEW

The following types of material are the most recommended for impression of teeth / soft tissue and transfer of implants: polyethers and addition silicone, due to their characteristics of dimensional stability and stiffness.[2-6] Polyethers have greater stiffness in comparison to addition silicone. For this reason, they are best recommended for edentulous patients with multiple implants, as they provide good accuracy of impressions and no difficulty in removing impressions in these cases. Addition silicones, on the other hand, are indicated for partially edentulous patients, given that they have favorable modulus of elasticity (stiffness), which allows a smoother removal from the oral cavity, in comparison to polyether.[2]

The literature does not reach a consensus with regard to the best method of implant transfer. The vast majority of studies conducted *in vitro* laboratory analyses on the on the indirect technique as well as on the direct technique, with or without splinting the impression copings. Some authors recommend the splinting technique,[7-12] while others recommend the technique without splinting.[13,14] There are even those who say there is no difference in the accuracy of either approach.[15-18] We can also find researches in which both splinted and non-splinted techniques showed no differences for the master model.[19] Regardless of which technique is used, there are clinical factors, such as the number, depth and angulation of implants, as well as the impression material used, that may influence the accuracy of implant impression.[20] The material most commonly used for splinting is the self-curing acrylic resin applied to the impression copings or bars.[3,5-9,11,12,15-17,21,22] Most authors propose the use of customized acrylic trays for implant transfer,[2-12,15-17,21-25] and the techniques of direct transfer of multiple implants.[2-18,20-24]

TECHNIQUE

We will present a technique for impression / transfer of multiple implants that favors proper reproduction of soft tissues — without compressing them —, and provides accurate implant spatial positioning.[26] Firstly, the number of teeth in the arch where implants were installed must be taken into account. As recommended in the literature, both polyether and addition silicone are indicated for these impressions. Polyether, due to its greater stiffness, is more suitable for edentulous arches; whereas addition silicone is recommended for

cases of partially edentulous patients. The impression copings we advocate are screwed to the implants by means of the direct technique.

PARTIALLY EDENTULOUS ARCHES

In cases of partially edentulous patients, impressions must be carried out with stock trays, alginates, reversible hydrocolloids, polysulfides, polyethers or silicones (addition or condensation), so as to obtain an anatomical model on which a customized acrylic tray will be fabricated. In some cases, a combination of different types of material may prove necessary, even for anatomical impression (Figs 1 to 8). A wax relief should be made in areas with teeth or the presence of undercuts in the model, so as to obtain spaces for functional impression material (Figs 9 to 15).

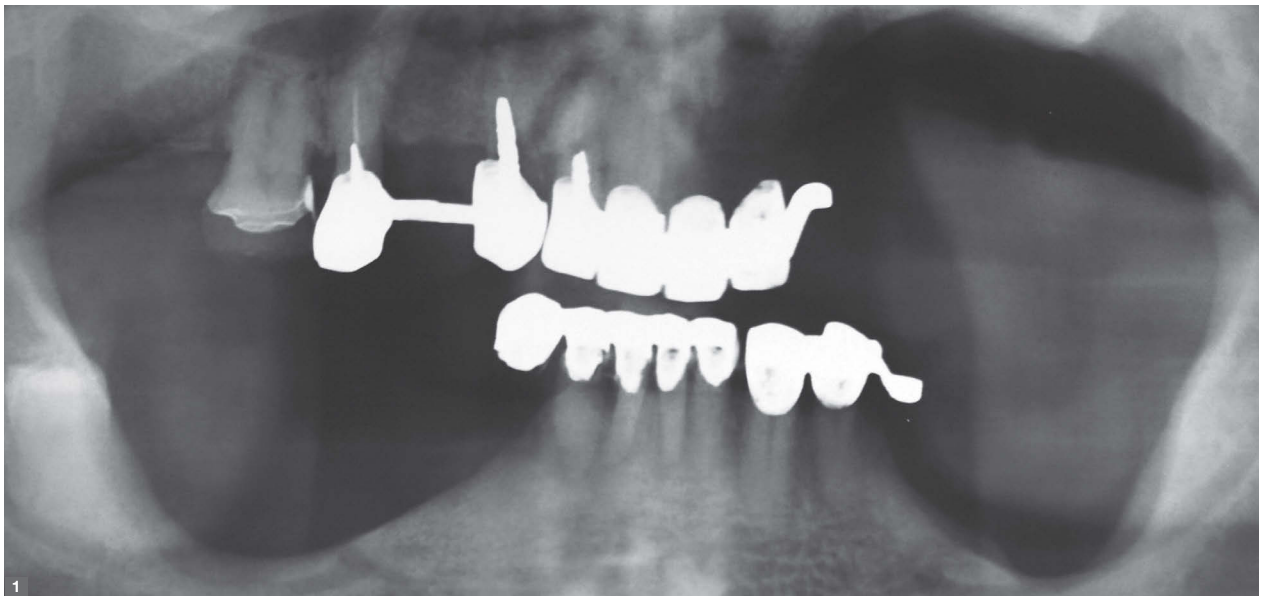
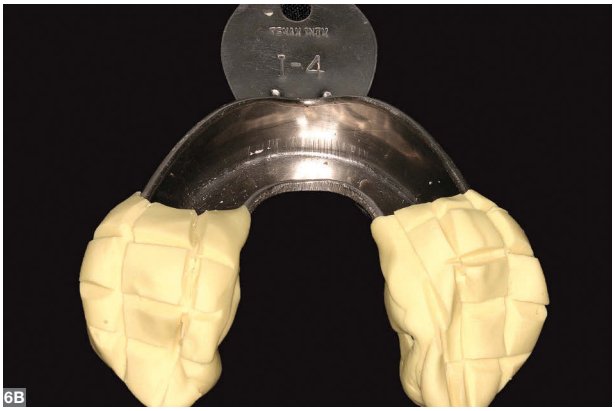


Figure 1: A partially edentulous patient showing bone loss rather strong in upper and lower jaw.
Figure 2: Occlusal view of the upper jaw. **Figure 3** - Occlusal view of the lower jaw.

Figure 4: A) Upper jaw impression with heavy condensation silicone (Optosil Comfort, Heraeus Kulzer), only in the region of bone loss, used to decrease the amount (thickness) of the second impression material. **B**) Grooves made in the condensation silicone for retention of alginate. **Figure 5**: Upper jaw anatomical impression with alginate (Jeltrate Plus, Dentsply). **Figure 6**: **A**) Lower jaw impression with heavy condensation silicone (Optosil Confort, Heraeus Kulzer), in the posterior regions with high bone loss. **B**) Grooves made in the condensation silicone for retention of alginate. **Figure 7**: Lower jaw anatomical impression with alginate (Jeltrate Plus, Dentsply).



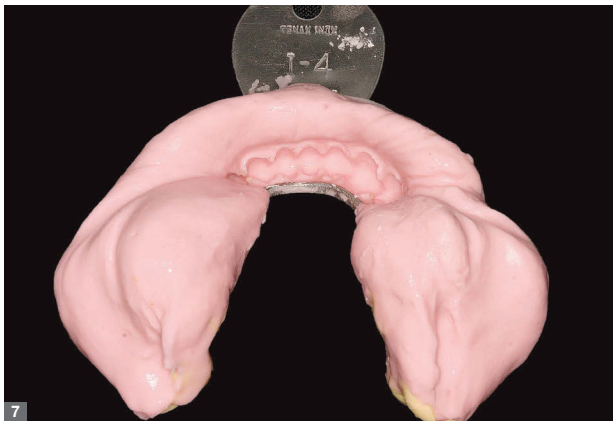
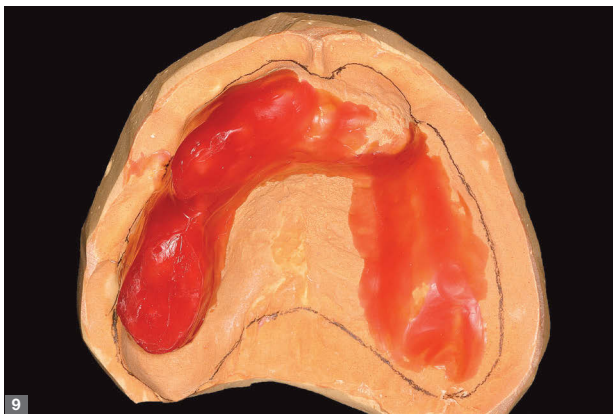
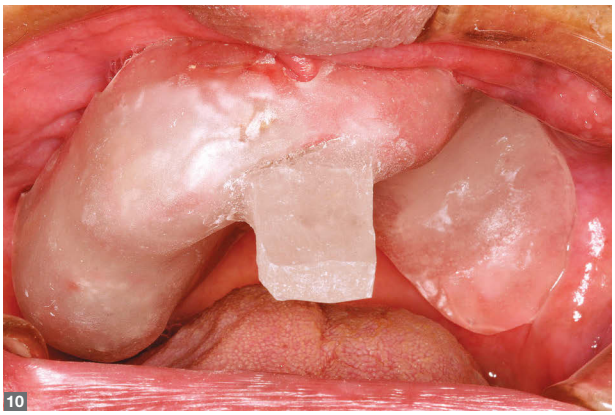


Figure 8: A) Anatomical model of the upper jaw. **B**) Anatomical model of the lower jaw.





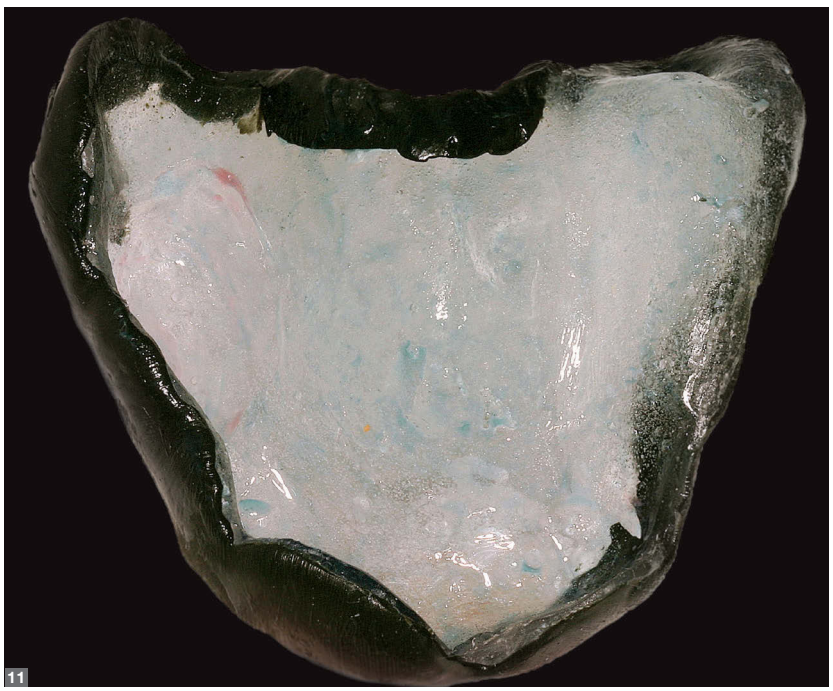
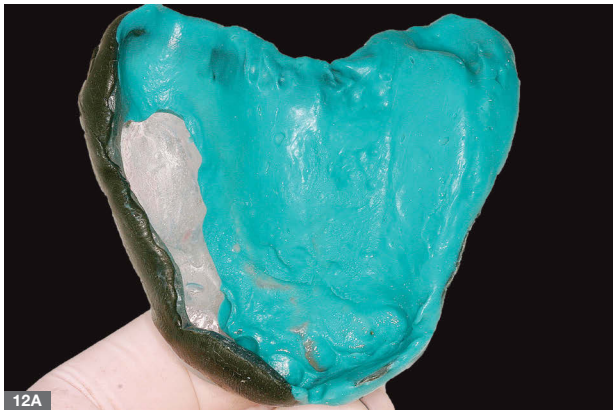
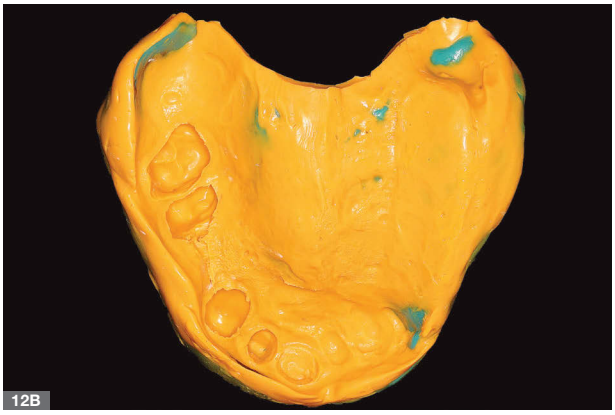


Figure 9: Anatomical model of the upper jaw bounded and relieved for fabrication of the customized tray. **Figure 10:** Upper jaw individual tray cropped and positioned in the mouth. **Figure 11:** Upper jaw customized tray with fixed edges and silicone adhesive applied (Zhermack).





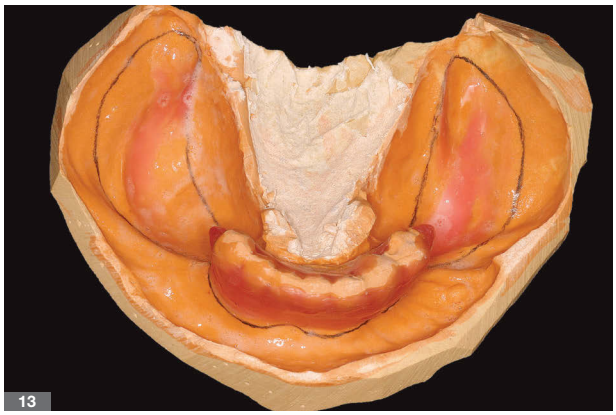
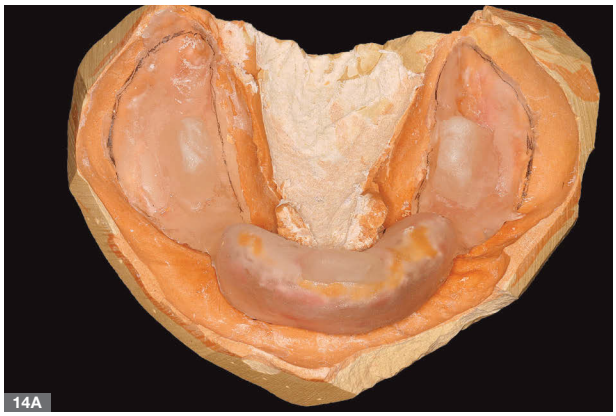


Figure 12: A) First layer of functional impression made with addition medium flow silicone (Aquasil Ultra LV, Dentsply). No material was placed in the region with teeth in order to favor impression removal. **B**) Second layer of functional impression made with addition high flow silicone (Aquasil Ultra XLV, Dentsply). **Figure 13:** Lower jaw anatomical model bounded and relieved for the fabrication of the customized tray. **Figure 14: A**) Lower jaw customized tray over anatomical model **B**) Customized tray with silicone adhesive applied (Zhermack). **Figure 15: A**) First layer of functional impression made with addition medium flow silicone (Aquasil Ultra LV, Dentsply) relieved with cutter in the region with teeth. **B**) Second layer of functional impression made with addition high flow silicone (Aquasil Ultra XLV, Dentsply).



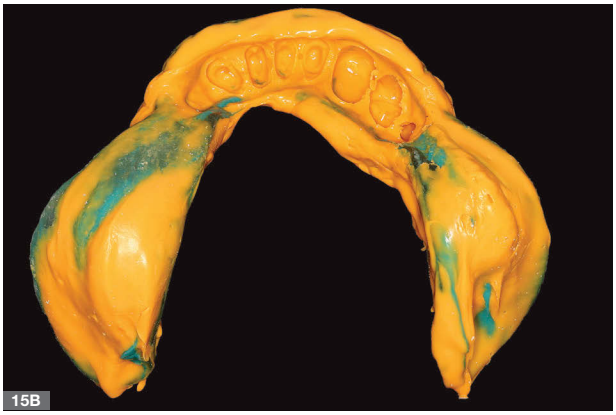


Figure 16: Customized tray made over anatomical model.

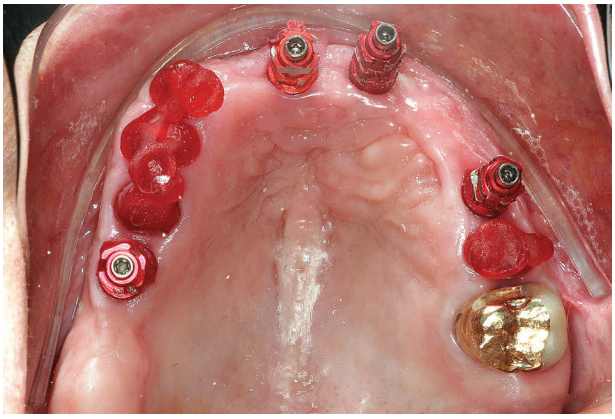


Figure 17: Implant impression copings placed.

Figure 18: Customized tray placed without contact with the impression copings.

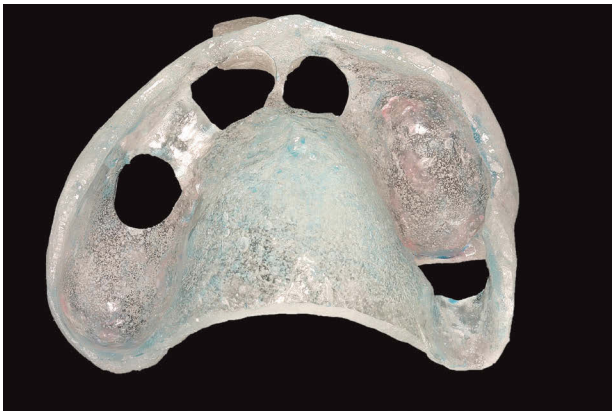
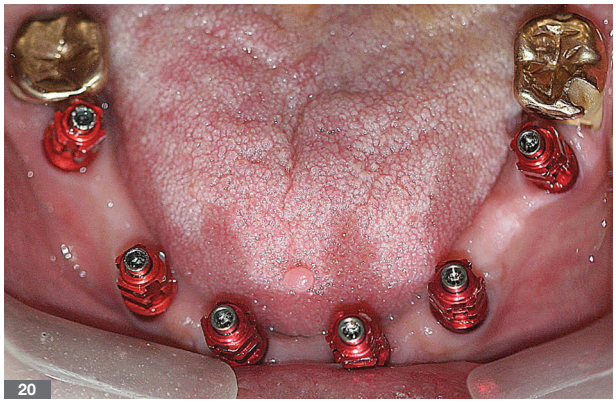


Figure 19: Customized tray with silicone adhesive applied (Zhermack) and ready for fabrication of the impression.

The customized acrylic tray must be perforated to create space(s) for the impression coping(s) where implants occur. There should never be contact(s) between the impression coping(s) and the tray (Figs 16 to 19).

Whenever there is a need to copy the fibromucosa, we examine these regions with a view to assessing their resilience. The flabbier the tissue to be copied, the more fluidity the impression material should have and the lower the pressure applied at the time of impression should be. Usually, even if customized trays are used for impression, we are not able to make precise copies of these areas by using a single-consistency impression material. We usually work with impression material of different consistencies, applied in stages: thick prior to fluid material. Should clinical examinations reveal very flabby areas, we promote the relief of anatomical models in order to decrease the risk of compression in these areas. A good impression of the fibromucosa is one in which no areas of contact with the tray (areas of compression) are observed. Should contact areas between the impression and the tray be observed, a new impression will be fabricated with a different type of material, more fluid than the previous one, with the aim of avoiding areas of compression (Figs 20 to 23 reveal areas with material used in the previous layer, but without contact with the tray).



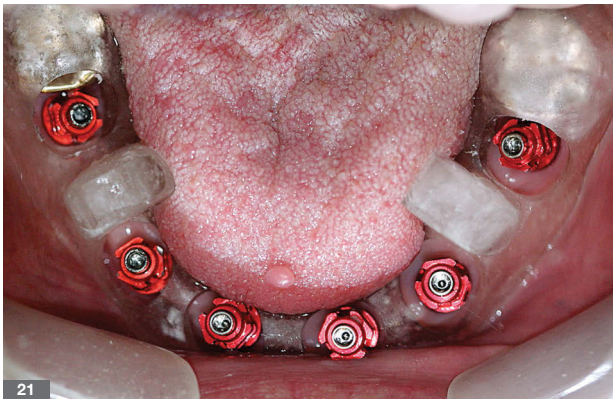
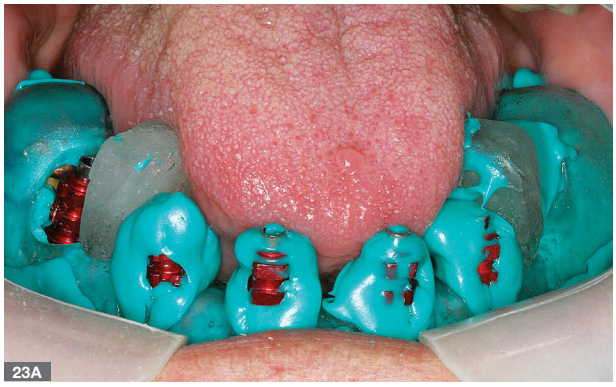
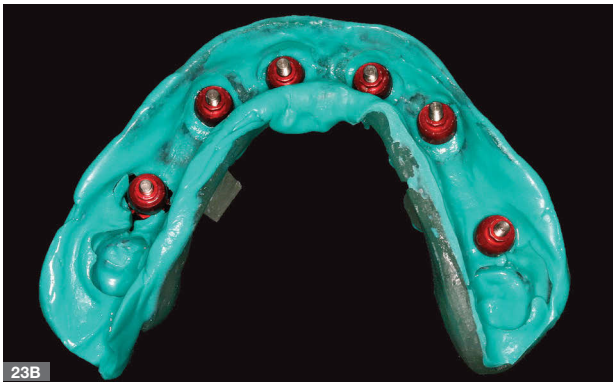


Figure 20: Implant impression copings placed. **Figure 21:** Customized tray placed without contact with the impression copings. **Figure 22:** Impression tray with silicone adhesive applied (Zhermack) and ready for fabrication of the impression. **Figure 23: A**) First layer of functional impression made with medium flow addition silicone (Aquasil Ultra LV, Dentsply). **B**) First layer extraoral view. **C**) Impression copings removed from the cast for impression of the second layer. Note the compression areas in the impression (contact with the tray).



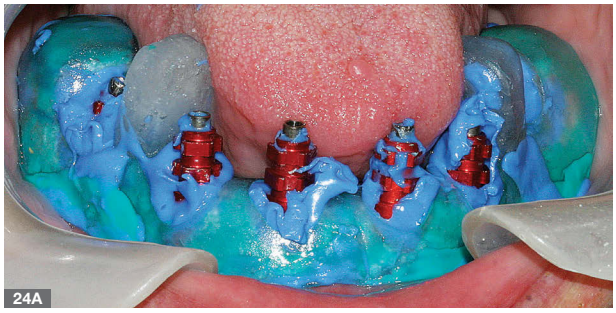


Since we are working with customized acrylic trays, the impression material does not adhere to the tray. For this reason, appropriate adhesives should be used in accordance with the material chosen (polyether or silicone adhesives).

When the implant transfer is carried out by means of this technique, impressions can be made until soft tissues have been properly copied. Should there be several impressions, the impression copings must be removed from the previous cast and repositioned onto the implants. Contact between the impression coping(s) and the repositioned tray should never occur.

After curing the impression material, the excesses around the impression copings must be removed with a sharp instrument, thus fully exposing them as well as the acrylic tray. Low shrinkage acrylic resin will be applied by means of the incremental technique[27] to involve the impression copings and connect them with the customized acrylic tray. Once the low shrinkage acrylic resin is cured, the impression copings are unscrewed and the model is removed from the oral cavity (Figs 24, 25).

The impression coping usually receives a layer of silicone, known as artificial gingiva, in the areas near the analogues



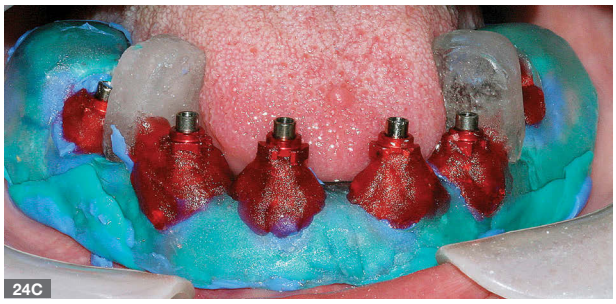


Figure 24: A) Second layer of functional silicone impression, using high flow addition silicone (Extrude Wash SDS Kerr). **B**) Removal of excess impression material overflowing the impression copings. **C**) Impression copings attached to the tray with low shrinkage acrylic resin (Pattern Bright, Kota) by means of the brush technique (Nealon).

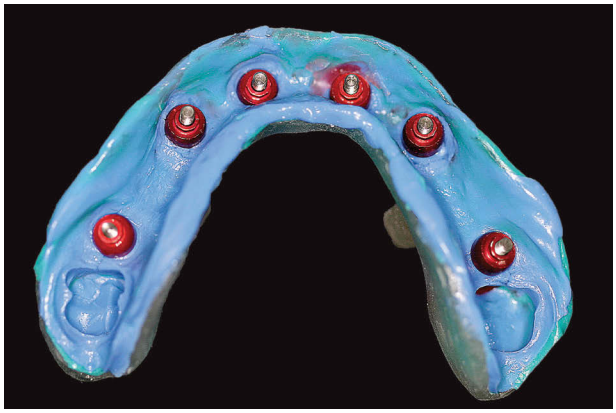


Figure 25: Lower jaw mold with two layers of impression. Partially edentulous patient.

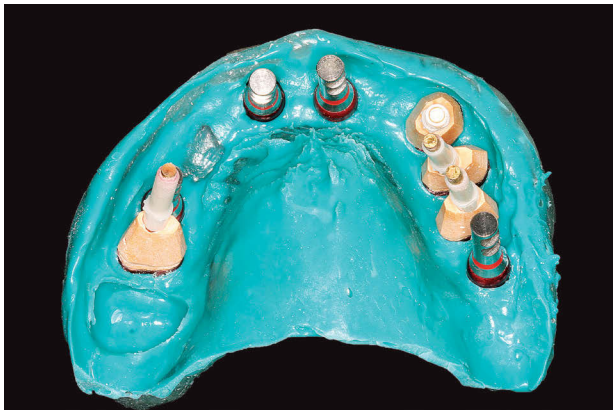


Figure 26: Impression with implant analogues and prepared dies properly positioned.

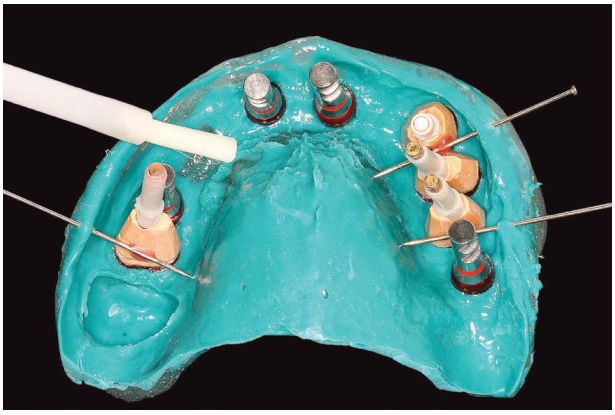


Figure 27: Application of silicone separator (Separator, Zhermack) to the mold.

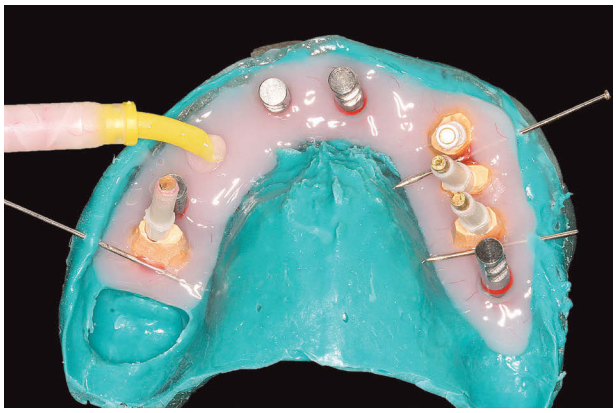


Figure 28: Injection of silicone for soft tissue fabrication at the interface between the analogues and the impression copings (Elite Gingifast, Zhermack).

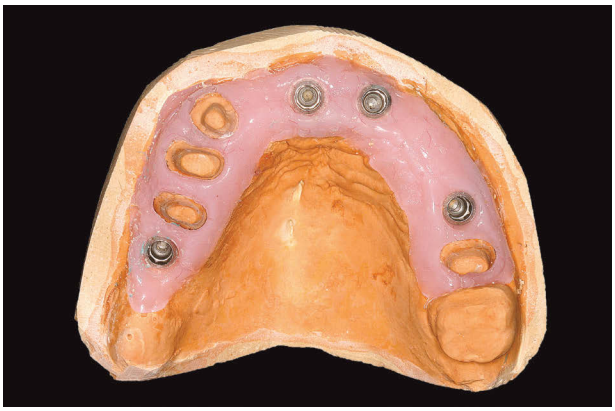


Figure 29: Functional model of a partially edentulous patient with special plaster cast type IV - Extra Hard (Rock Elite, Zhermack).

or impression copings so as to facilitate laboratory work. The laster cast used should be type IV (Figs 26 to 29).

EDENTULOUS ARCHES

Impression of edentulous arches basically follows the same characteristics of impression carried out with partially edentulous arches. Difference occurs in the anatomical impression, for which elastic material as well as anelastic material, such as compound and zincoeugenolic paste which are not indicated for patients with teeth, are used (Figs 30, 31). The use of this type of material allows a greater variety of consistencies (degree of fluidity), thus avoiding compression in the areas of impression (contact with the tray).

It is worth noting that, for anatomical impression, the material firstly loaded in the stock trays should provide great consistency, as it is the case of compound and putty silicone. This type of material favors appropriate removal of tissue for proper demarcation of the basal

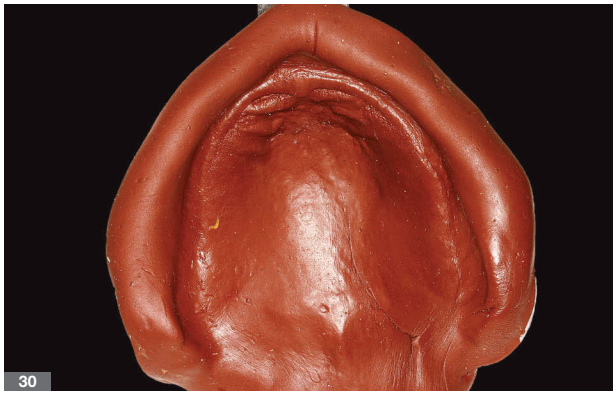
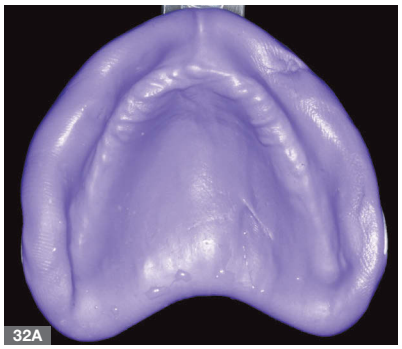


Figure 30: Anatomical impression of the upper jaw with compound (Godibar, Lysanda) in the first layer.
Figure 31: Functional impression of the upper jaw with zincoeugenolic paste (Lysanda, Lysanda) in the first layer.

area of the future prosthesis, however, it obviously promotes intense compression of tissues, which should be compensated with the use of more fluid material in subsequent layers. After the anatomical model is obtained, it should be poured with plaster type III for further manufacture of the customized acrylic tray (Fig 32 D).

The customized tray should have the same dimensions of a tray used for complete denture. In the areas with implants, openings must be created in the tray, so as to prevent it from touching the impression copings. Additionally, we must create clippings and correct the edges of the customized trays whenever the prosthesis planned for the patient is mobile.

Functional impressions of edentulous arches have the same characteristics of those fabricated for partially edentulous arches: there should be no contact between the impression copings and the customized tray; the model will be obtained with material of different consistencies and in



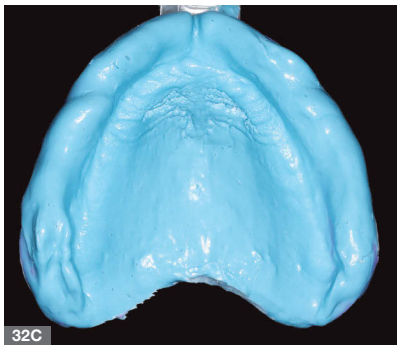
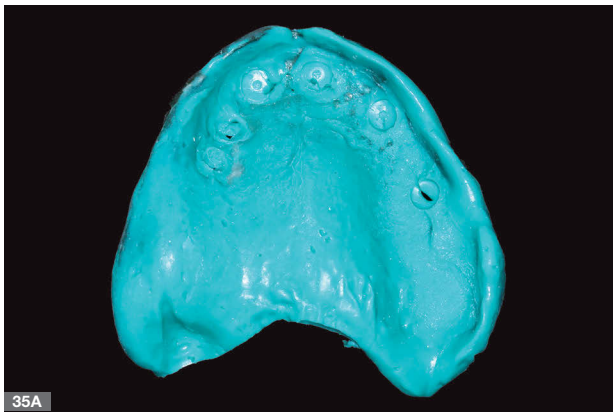
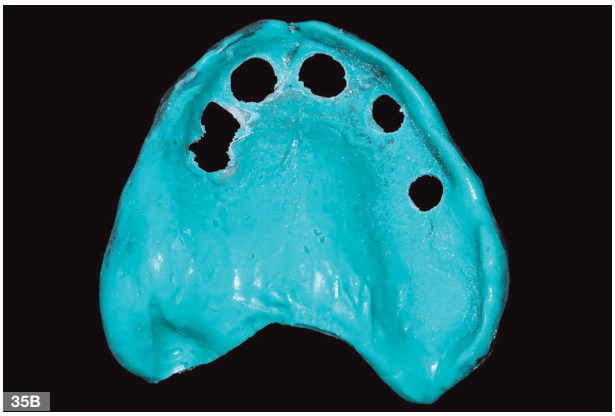


Figure 32: A) Anatomical upper jaw impression performed with putty addition silicone (AD Futura Dense DFL) in the first layer. **B**) Relief of putty addition silicone layer with the milling cutter for resilient materials (Edenta). **C**) Second layer of silicone added to complement the anatomical impression (AD Futura Light Fluid, DFL). **D**) Anatomical model of the upper jaw with dental stone cast type III (Herodent, Vigodent).





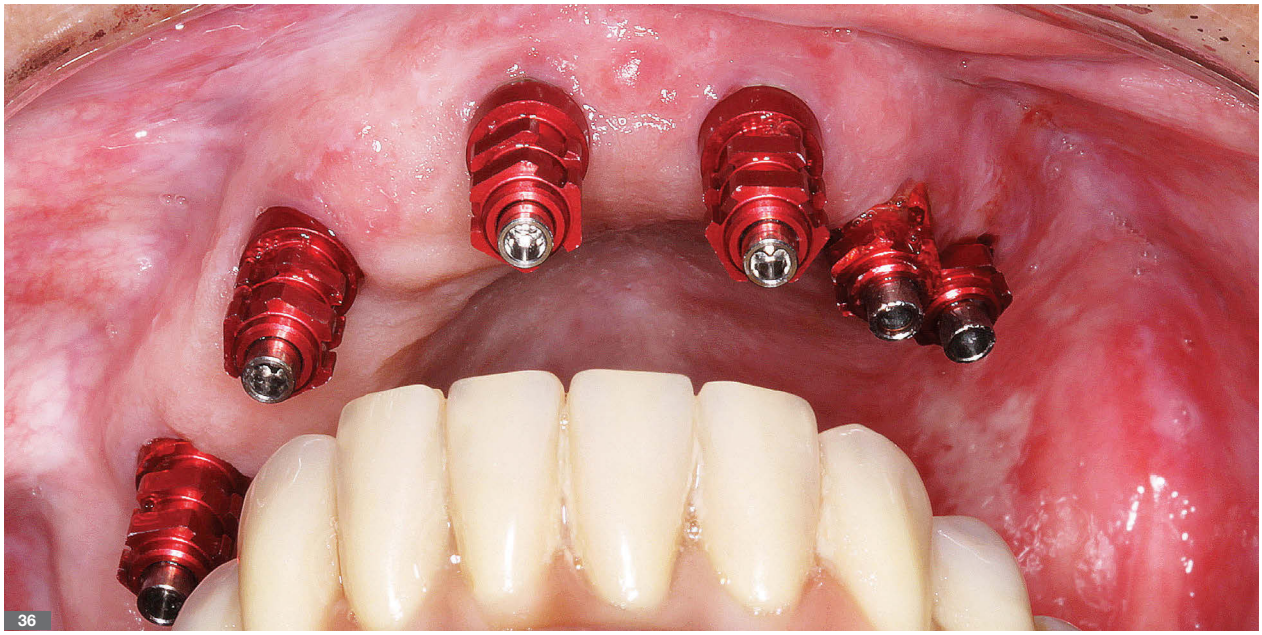
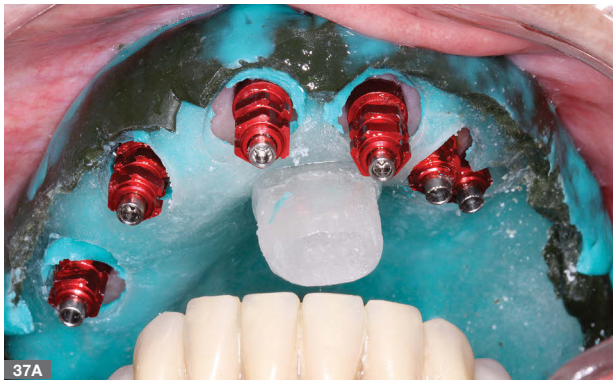
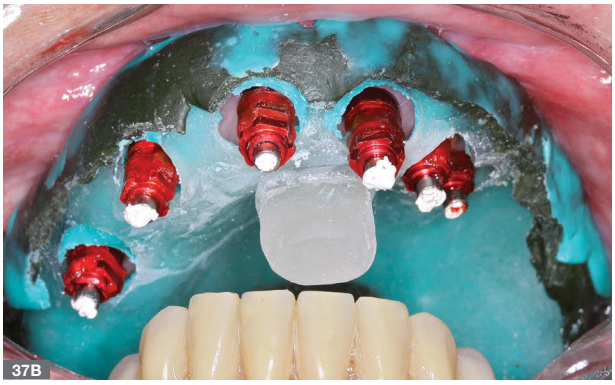
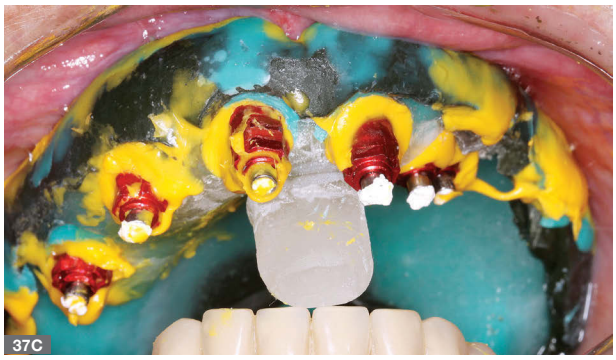
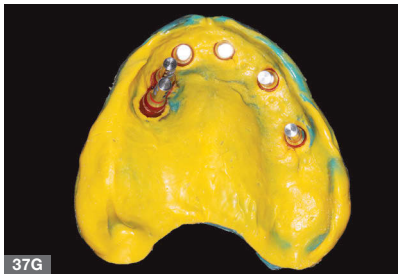


Figure 33: Upper jaw single tray positioned in the mouth with the fixed edges properly cut. **Figure 34:** Upper jaw single tray with correct edge (thickness) made with compound stick (SDS Kerr). Silicone adhesive must be applied before the completion of the impressions. **Figure 35: A**) First layer of functional impression made with medium flow addition silicone (Ultra LV Aquasil, Dentsply). **B**) Removal of impression material from the impression copings. **Figure 36:** Impression copings over implants.









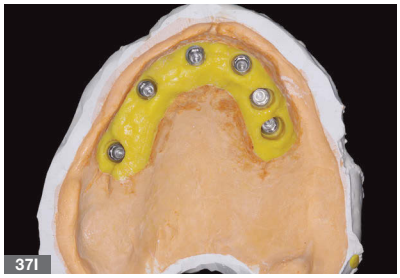


Figure 37: A) Mold with the first layer of silicone repositioned in the mouth. There should be no contact between the mold and the impression copings. **B**) Heads of screws sealed with Teflon tape to prevent the impression material from entering it. **C**) Second functional layer made with high flow addition silicone (XLV Ultra Aquasil, Dentsply). **D**) Removal of excess silicone overflowing the impression copings. **E**) Impression copings attached to the tray with low shrinkage acrylic resin (Pattern Bright, Kota) by means of the brush technique. **F**) Finished mold. **G**) Implant analogous porperly positioned. **H**) After isolating the mold with vaseline, the artificial gingiva was made with heavy silicone (Panasil Putty Soft, Kettembach) **I**) Upper model of fully edentulous patient, finished with a special casting plaster type IV - Extra Hard (Elite Rock, Zhermack).

different layers; there should be no contact between the customized tray and the tissues (compression areas); after curing the impression material, the excesses around the impression copings should be removed and the impression copings should be involved with low shrinkage acrylic resin so as to secure them to the customized acrylic tray; after the acrylic resin is cured, the impression copings will be unscrewed and the model removed from the oral cavity, the artificial gingiva will be prepared and the special model will be poured with plaster type IV (Figs 33 to 37).

DISCUSSION

According to the literature, the direct impression technique, without repositioning the impression copings, is more accurate than the indirect one.[2-18,20-24] In the direct technique, the impression copings can be screwed or embedded onto the implants / abutments. However, for the transfer of multiple implants, there is a preference for the screwed ones.[2-12,15-17,21-25] Most studies proposing the direct technique use customized trays made from acrylic resin[2-12,15-17,21-25] and, for this reason, we also recommend this type of tray.

Our technique is similar to that developed by Assif:[7] direct technique with impression copings screwed and fixed to the customized tray made of low shrinkage acrylic resin. The proper impression of soft tissues performed by our technique makes it different from others. Impression without soft tissue compression is essential for proper functioning of prostheses, whether fixed or mobile. It is worth noting that our technique of splinting the impression copings[7-12] is performed when we fix them to the acrylic resin tray. The acrylic resin is not secured to the impression copings, instead, there is a mechanical interlocking around the retention that comprise them. For this reason, care must be taken when cleaning the impression copings (excess molding material) and fixing the acrylic resin around them as well as around the customized tray.

FINAL CONSIDERATIONS

The anatomical and functional transfer of multiple implants is crucial for obtaining faithful models on which prostheses, which properly fit on implants with proper contact with soft tissues, are built, thus preventing potential injuries. Both polyether and addition silicone may be used, however, polyether is more suitable for edentulous arches. The use of screwed impression copings favors the adequate transfer of multiple implants to the working model.

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Histological evaluation of critical size bone repair treated with xenogen graft in rats induced to hypothyroidism

doi: http://dx.doi.org/10.1590/2237-650X.7.4.075-084.oar

Abstract / This study aimed at assessing bone repair of critical-size defects by comparing normal animals with hypothyroid animals, with or without bone graft (Bio-Oss® Geistlich Pharma AG, Wolhusen, Switzerland) at two times of evaluation (30 and 60 days). Forty-two Wistar rats were used and divided into two major groups, namely: Group 1: Euthyroid, without graft, 30 days (G1E30); euthyroid, without graft, 60 days (G1E60); hypothyroid, without graft, 30 days (G1H30) and hypothyroid, without graft 60 days (G1H60). Group 2: Euthyroid, grafted, 30 days (G2E30); euthyroid, grafted, 60 days (G2E60); hypothyroid, grafted, 30 days (G2H30) and hypothyroid, grafted, 60 days (G2H60). The animals were induced to hypothyroidism by propylthiouracil (PTU) diluted with drinking water. Critical-size defects were created by trephine burs in the rats' calvarium. Treatment was performed to prepare histological slides and analysis as well as to carry out statistical tests. 95% confidence interval ($P < 0.05$) was employed. Results revealed no statistically significant differences in cortical repair between hypothyroid and euthyroid animals at both times of evaluation. However, statistically significant differences were found in comparing 30 x 60 days (G1E60> G1E30, p = 0.01 G1H60> G1H30 and p = 0.01 G2h60> G2H30). Bone formation around graft particles was not statistically different when groups with the same time of evaluation were compared. Nevertheless, animals with hypothyroidism had bone formation associated with graft particles statistically greater 60 days after repair (G2H60> G2H30 P = 0.03). Based on the results of this study it is reasonable to conclude that the systemic condition did not significantly affect bone repair. Additionally, graft seemed to positively contribute to bone formation in induced animals. / Keywords / Bone repair. Hypothyroidism. Biomaterial.

Almiro de Almeida **Vasconcelos Neto**
MSc in Clinical Dentistry, Federal University of Bahia (UFBA).

Gardênia Matos **Paraguassu**
Doctorate student in Dentistry and Health, UFBA.

Maria Isabel Pereira **Vianna**
PhD in Public Health and Professor, UFBA.

Dario Augusto Oliveira **Miranda**
PhD in Implantology, São Leopoldo Mandic College of Dentistry. Professsor, UEFS and ABO—BA.

Luciana Maria Pereira **Ramalho**
PhD in Clinical Stomatology, Catholic University of Rio Grande do Sul (PUCRS). Professor, UFBA.

How to cite this article: Vasconcelos Neto AA, Vianna MIP, Ramalho LMP, Paraguassu GM, Miranda DAO. Histological evaluation of critical size bone repair treated with xenogen graft in rats induced to hypothyroidism. Dental Press Implantol. 2013 Oct-Dec;7(4):75-84. DOI: http://dx.doi.org/10.1590/2237-650X.7.4.075-084.oar

Submitted: August 11, 2013 - **Revised and accepted:** September 18, 2013

Contact address: Dario Augusto Oliveira Miranda
E-mail: darioperiodonto@hotmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

The patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

There has been an increasingly search for new techniques and/or technologies that not only promote bone repair, but also result in normal anatomic pattern and implant rehabilitation. After bone fracture/trauma, coagulum and a fibrin network form, filling the remaining spaces. Inflammatory cells migrate to the area and release chemical mediators as well as growth factors that activate osteoprogenitor cells. Therefore, repair is subjected to proper vascularization and mechanical stability, given that osteoblasts only secrete bone matrix in high-oxygen areas.[2] However, in cases of extensive loss, bone repair may prove impossible, defective or incomplete.[21]

Bone graft proves necessary to aid or optimize repair in some areas. Bone graft is classified into autogenous, when tissue derives from sources within the same individual; homogeneous, when tissue is grafted between members of the same species; alloplastic material, foreign and inert bodies implanted into tissues; and xenograft, tissue taken from a donor of one species and grafted into a recipient of another species.[7]

Inorganic bovine bone graft is an osteoconductor that stands out among other types of biomaterial. The most commonly used is Bio-oss® (Geistlich Pharma AG, Wolhusen, Switzerland). It consists of a mineral bone matrix obtained by removing organic compounds from medullary bovine bone. It is recommended for alveolar ridge augmentation and socket filling after extraction.[6]

It is important to notice that, despite the efforts made to develop bone inducing material that when associated with surgical techniques provide the best repair, this regeneration cascade directly depends on patient's systemic conditions.

Hypothyroidism is highlighted in this context. It is most prevalent among adult women and characterized by reduction in T3 and T4 hormone levels. It may result from an autoimmune process that leads to enlargement of the thyroid gland (goiter) or from a deficiency of thyroid gland stimulus in normal conditions (hypothalamic or pituitary disease and poor TSH stimulation).[13,23] Hypothyroidism in adult patients is associated with reduced bone turnover, which can promote osteosclerosis — often corrected by means of thyroid hormone therapy.[4] Deficient thyroid hormones result in several metabolism alterations and complications, among which is the difficulty in bone repair.[20]

This article aims at comparing bone repair of normal animals (euthyroid) and hypothyroid animals, associated with Bio-oss® biomaterial graft (Geistlich Pharma AG, Wolhusen, Switzerland).

MATERIAL AND METHODS

This study was conducted at the Vivarium of the State University of Feira de Santana (UEFS). It respected the ethical principles of animal testing as well as the rules established for the didactic-scientific practice of vivisection in accordance with Law 6.638/79. The research protocol was subjected to the university Ethics Committee on Animal Use. Histological slides were prepared and analyzed at the Pathology Laboratory (School of Dentistry — Federal University of Bahia / UFBA).

Forty eight adult, male, clinically healthy, 400-g Wistar rats — species *Rattus Norvegicus Albinus* and *Rodentia Mammalia* — were randomly selected from the university Vivarium. They were divided into eight experimental groups with two different times of evaluation, as shown in Table 1.

Hypothyroidism was induced by the daily use of Propylthiouracil (PTU) 100 mg (Biolab®, Taboão da Serra, SP, Brazil) diluted with drinking water (0.05 g / 100 mL – 02 tablets ground in 400 ml of water) during five weeks. The condition remained until the end of the experimental period.[24] The euthyroid group had water without PTU *ad libitum*. The induction group's containers were shaken up twice a day so as to avoid decantation. Biochemical/laboratory confirmation of hypothyroidism was obtained after blood collection. A random sample was collected by puncturing the animals' jugular vein at the time of evaluation (T3 and T4 dosage). Animals were weekly subjected to weight assessment from the first induction procedures until they were killed.

After a 12-hour fast, the animals were anesthetized by an intramuscular injection of ketamine hydrochloride (0.08 mL / 100 g body mass) and subjected to sedation

and analgesia by a single-dose intramuscular injection of xylazine hydrochloride (0.04 mL/100 g body mass). Subsequently, they were positioned in ventral decubitus. Hair removal was performed in the calvarium, followed by antisepsis of the surgical site with alcohol iodine. A V-shaped full-thickness incision was performed with the flap exposing the skull bone. Defects (diameter: 10 mm, width: 1.5 mm) were created in the middle portion of each rat's skull, between parietal bones, using a 6-mm trephine bur (3i-Implants) (Fig 1) mounted in counter-angle with 1:20 reduction, with the aid of an implant motor system (Driller BLM 600, SP, Brazil) at 1500 rpm, under external irrigation with 0.9% saline solution. The dura mater was preserved. Biomaterial was placed into the bone defect of animals comprising the biomaterial group (Bio-oss®; Geistlich Pharma AG, Wolhusen, Switzerland). The bone defect of animals comprising the non-grafted group was filled with blood coagulum (Figs 2A and 2B). The amount of biomaterial to be inserted into the bone defect had been determined by a pilot study in which the defect was filled without overflowing and exceeding the limits of osteotomy. This amount was established by weighing the biomaterial on a precision balance (50.56 dg). Tissues were sutured with 5-0 nylon wire (Procare®, SP, Brazil). Sutures were not removed. No antibiotic, analgesic or anti-inflammatory therapies were performed during the experiment.

The rats were randomly killed by overdose of anesthetics. The portion of the skull where defects had been created was removed, with superficial soft tissues preserved, using diamond discs in low rotation with irrigation. The surgical specimens were stored in a closed container filled with 10% formaldehyde solution for 7 days. The specimens were sent to the Laboratory of Oral Surgery Pathology, at the Department of Propaedeutics and Integrated Clinics of the School of Dentistry — Federal University of Bahia.

Table 1: Experimental groups at two different times of evaluation.

GROUP	NUMBER OF ANIMALS	DESCRIPTION
G1E30	6	Animals without hypothyroidism, without graft, 30 days.
G1E60	6	Animals without hypothyroidism, without graft, 60 days.
G2E30	6	Animals without hypothyroidism, grafted, 30 days.
G2E60	6	Animals without hypothyroidism, grafted, 60 days.
G1H30	6	Animals with hypothyroidism, without graft, 30 days.
G1H60	6	Animals with hypothyroidism, without graft, 60 days.
G2H30	6	Animals with hypothyroidism, grafted, 30 days.
G2H60	6	Animals with hypothyroidism, grafted, 60 days.

Figure 1: Trephine bur with inner diameter of 6 mm and outer diameter of 7 mm.

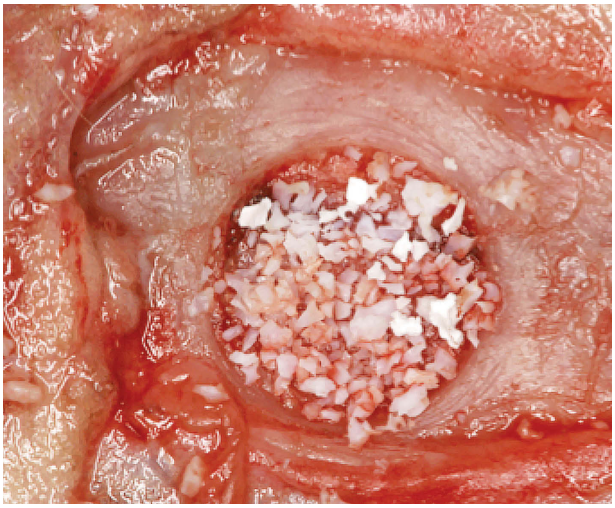

Figure 2A: Critical-size defect with biomaterial.

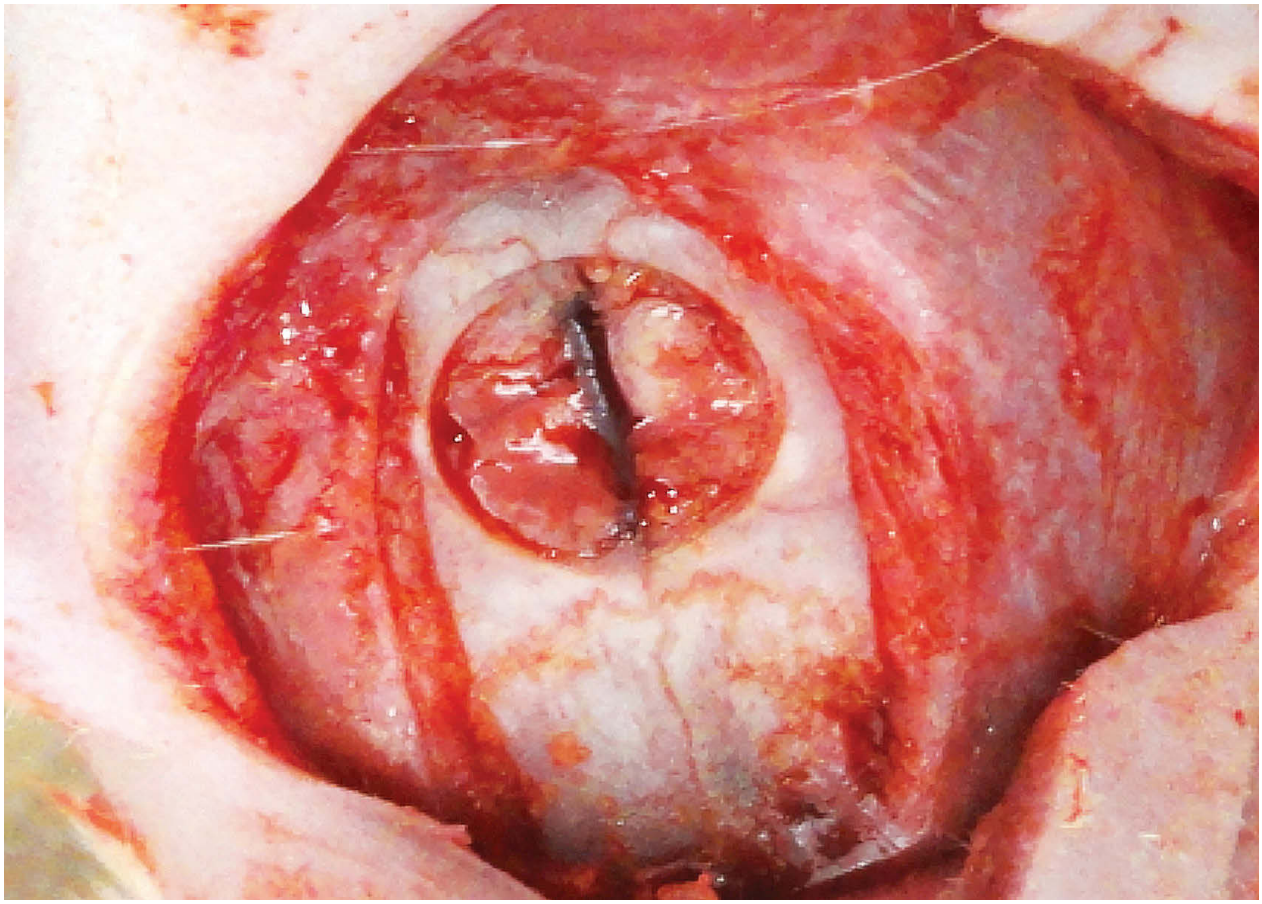

Figure 2B: Critical-size defect without biomaterial.

After fixation, they were decalcified with 5% nitric acid (two days). Histological slides were obtained through macroscopic sections performed by the same researcher in the region anterior to the eyes (snout) and laterally to the ears. A frontal section was also made to preserve the upper part of the brain and skull, with an axial section crossing the middle of the defect (Figs 3 and 4). Subsequently, the specimens were dehydrated in paraffin to obtain 5 µm histological sections. The sections were hematoxylin-and-eosin stained by Picrosirius staining.

The slides were analyzed by light microscopy performed by a skillful, blinded pathologist who read the slides recording their aspects according to the criteria established in a specific form.

Data were tabulated in Excel and statistically analyzed by Minitab®. Due to the sample size (4 to 6 animals per group), the nonparametric Fisher's exact test was employed with significance level set at 5% for intra as well as intergroup comparison.

RESULTS

With regard to bone neoformation, no statistically significant differences were found between groups for animals killed within 30 days ($P > 0.05$). Neoformation was clear in group G2E30, which yielded borderline results ($P = 0.08$) if compared to groups G1H30 and G2H30. However, no differences were found when G2E30 was compared to G1E30 (Table 1). Similar results were identified for animals killed within 60 days. This group did not yield borderline statistical results (Table 2) for disorders and graft, similarly to the 30-day group.

Data crossing between both times of evaluation revealed that greater bone neoformation was expected for the 60-day group. Statistically significant differences were found in 3 out of 4 comparisons. P-value was 0.03 for G1E60>G1E30, 0.01 for G1H60>G1H30 and 0.01 for G2h60>G2H30 (Table 3).

As for bone formation around the graft, no statistically significant differences were found between groups, which reveals that bone formation was not influenced by systemic disorders, whether at the initial or final phases of repair. Nevertheless, paired analyses revealed statistically significant differences between two groups: G2H60 > G2H30, $P = 0.03$ (Table 4).

DISCUSSION

Studies conducted with animal models contribute to performing trials on bone regeneration, given that the models allow variables to be properly controlled. Animal models in rats are suitable for studies on endocrine disorders, particularly those associated with the thyroid gland.[1,14,10,25]

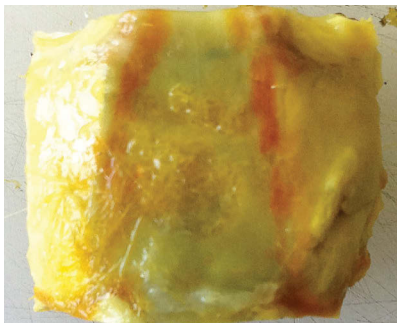

Figure 3: Macroscopic section: upper view. Note the central are with graft particles.

Figure 4: Axial section crossing the middle of the defect.

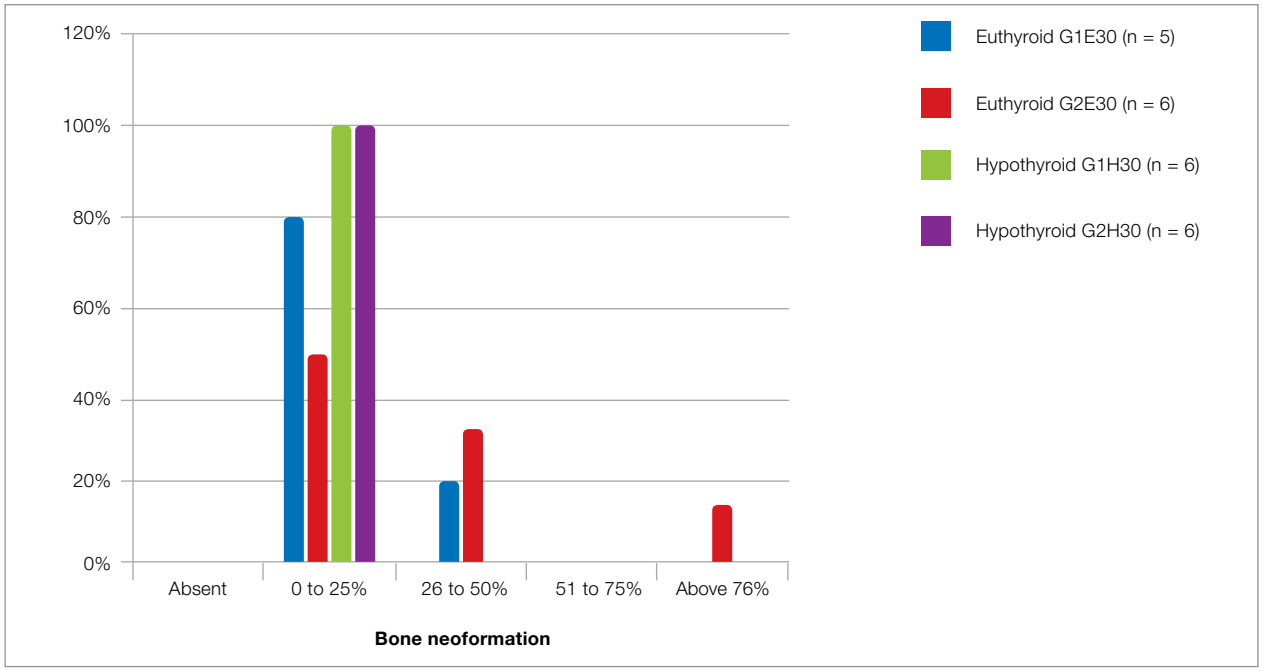

Figure 6: 30-day bone neoformation.

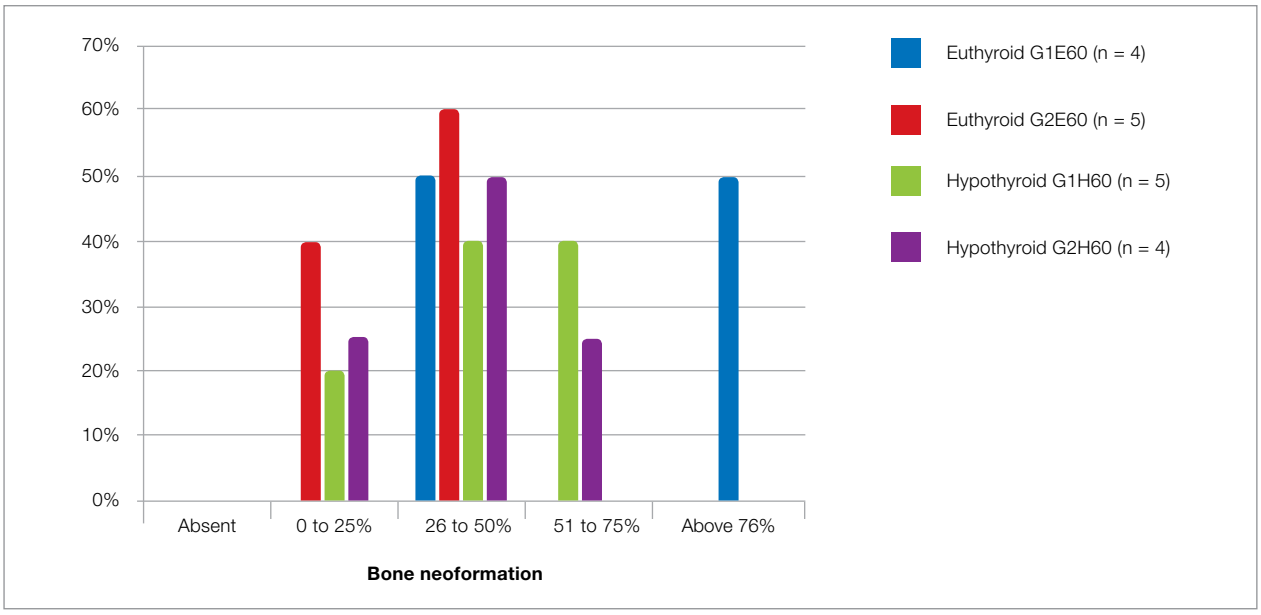

Figure 7: 60-day bone neoformation.

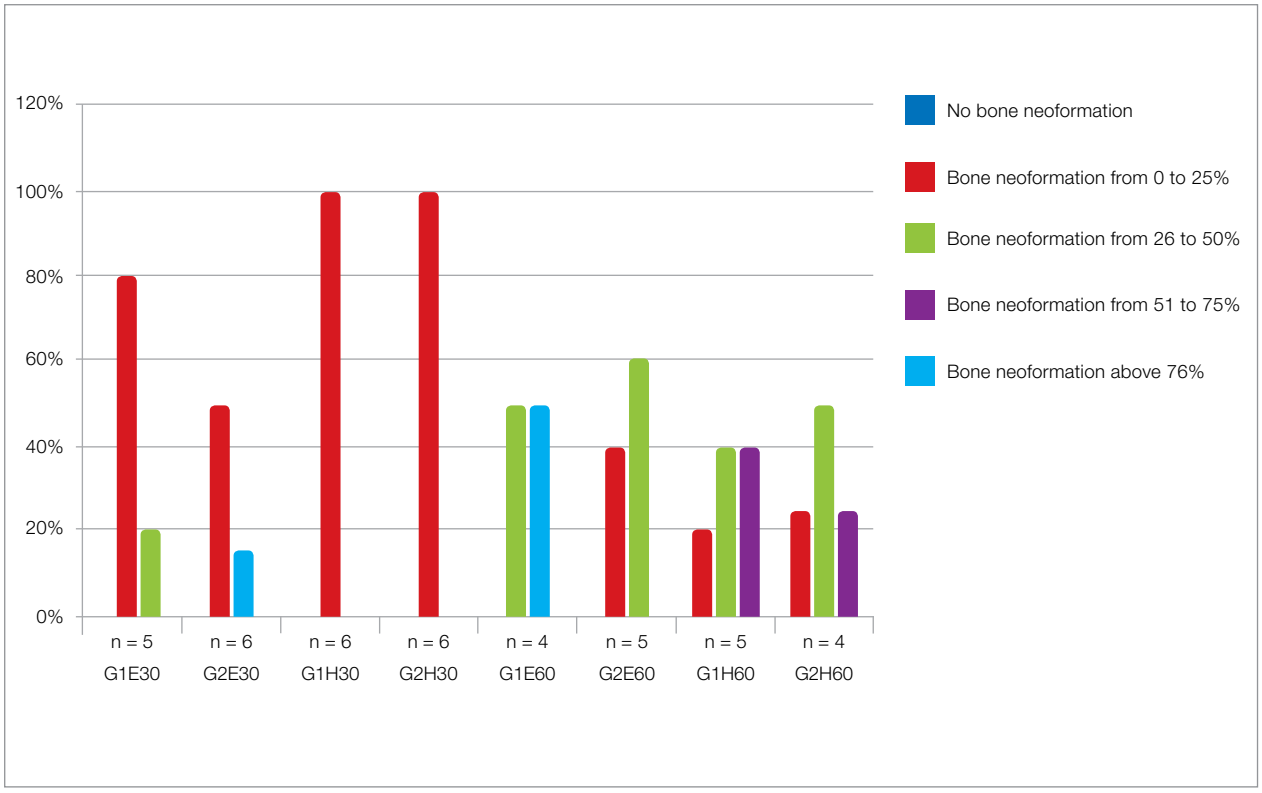

Figure 8: 30-day *versus* 60-day bone neoformation.

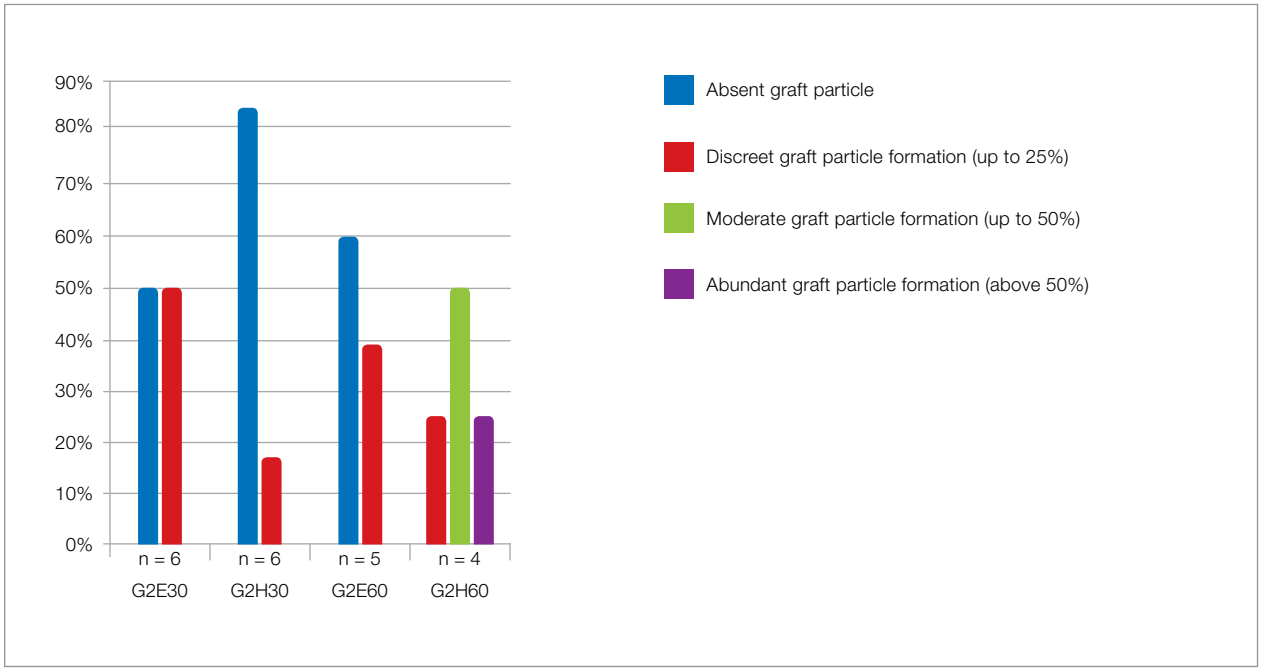

Figure 9: 30 *versus* 60-day bone formation around the graft.

Critical-size defects are those which an organism cannot spontaneously repair, unless an osteogenic, osteoinductive and/or osteoconductive material is added.[26] The defect investigated by this study is in accordance with the requirements[5] previously stated to evaluate bone regeneration. The authors[5] established that an experimental bone defect must be larger than the critical-size defects established for the species investigated; the implantation site must preferably include cortical and medullary bones; there must be local stability with a minimum risk of fracture; and that histological and radiographic analyses must be easily accessed. In the present study, a defect was created by a 6-mm trephine bur. By the end of the drilling process, the defect was 7-mm in diameter due to the thickness of the metal of which the bur was made.

The literature does not reach a consensus regarding the standard size of critical-size defects. Some authors[5,18,17] assert that critical-size defects in rats' calvarium are 5 mm in diameter, whereas others[8,19,22] defend a diameter of 8 mm. All researches evaluated revealed an inability to completely fill bone defect with bone tissue, which was also found by this analysis.

The weight assessment conducted by this study revealed a mean reduction in body weight of hypothyroid animals, associated with a general reduction in the growth of the group. This finding corroborates the literature regarding induced animal's slower development caused by low metabolism.[10,24] Some researches suggest that hypothyroidism be induced by removing the thyroid gland.[3,16] However, the removal of the thyroid gland is followed by the removal of parathyroid glands, which directly influences bone metabolism, making this protocol unfeasible for this study.

Analysis of euthyroid and hypothyroid animals control groups data revealed incomplete bone repair in the 30-day group. As for the 60-day group, euthyroid and hypothyroid animals presented statistically greater bone repair in comparison to the 30-day group (G1E60 > G1E30, P = 0.03 and G1H60 > G1H30, P = 0.01). However, the 60-day group presented incomplete bone neoformation. The defect was filled with collagenous fibers and inflammatory cell lineage. Microscopic evaluation data revealed that the defect used in the investigation was critical due to the absence of bone repair. The center part of the defect was filled with tissue other than bone.[5,9]

As for defects filled with regenerated bone tissue, this study does not reveal any statistically significant differences in bone repair 30 days after healing. Statistically significant differences were found when animals comprising the same group were compared. In other words, hypothyroid or euthyroid animals with or without graft, 30 days *versus* 60 days. Those results were already expected given the differences in repair time.

Comparison between hypothyroid and grafted animals, 30 days *versus* 60 days, was an exception. No statistically significant differences were found, which led us to conclude that graft contributed to the initial repair of normal

animals so as to be similar to the maximum repair time. These results corroborate the literature regarding bone repair hampered by hypothyroidism.[27] Fathabady et al[11] concluded that hypothyroidism-induced animals had delayed growth, development or bone repair. Feitosa[12] concluded that thyroid dysfunctions influenced cortical bone repair around titanium implants inserted in rats' tibia, and that hypothyroidism decreased the percentage of bone adjacent to the implant and within the limit of threads.

In case of biomaterial graft, euthyroid as well as hypothyroid animals had incomplete repair within 30 and 60 days. However, a larger amount of neoformed bone was found in the 60-day group, particularly in the hypothyroid group. In normal grafted animals, biomaterial sped up the initial repair process so as to prevent statistically significant differences between 30 and 60-day groups. This finding revealed that the hypothyroid animal model was more sensitive to graft, which considerably contributed to bone repair, in comparison to the euthyroid model (G2H60 > G2H30, P = 0.01).

This may be explained by the decreased bone resorption of animals comprising the hypothyroidism group. This finding may be associated to the fact that the decreased metabolism of hypothyroid animals may cause inflammatory cells to take longer and have difficulties in identifying the particles of the graft as foreign bodies.

Bone formation around the graft particle was absent or discreet in hypothyroid as well as euthyroid animals, thus demonstrating the biomaterial osteoconductive ability within the investigated times of evaluation. These data are confirmed by neoformed bone apposition directly related to the surface of the particle, which corroborates the findings of other authors assessing xenograft biomaterial.[15,28] Bone formation around the graft particle was not influenced by thyroid dysfunction when groups with the same time of evaluation were compared. However, as bone repair was established, bone formation was statistically greater for the 60-day hypothyroid group in comparison to other groups, including the euthyroid one (G2H60 > G2E60, P = 0.047).

This may be explained by the fact that, in this group, particles underwent decreased resorption, which caused them to remain in the site and, as a result, promote bone neoformation for a longer period of time.

CONCLUSIONS

The findings obtained for the model investigated in this study lead to the conclusion that:

- Cortical repair was incomplete for all the experimental groups assessed.
- Hypothyroidism did not significantly influence bone repair.
- Euthyroid rats' bone repair was not affected by xenograft.
- Hypothyroid rats' bone repair was affected by xenograft, with increased bone formation associated with the surface of graft particles within 60 days.

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Post-implant neuropathy

doi: http://dx.doi.org/10.1590/2237-650X.7.4.085-089.lit

Abstract / The use of dental implants in partial or total edentulous arches is considered the gold standard of oral rehabilitation. This procedure has high success rates mainly due to the advanced features of imaging exams such as cone beam computed tomography (CBCT). However, some intra- and postoperative complications may occur. One potential complication is post-implant neuropathy (PIN), a traumatic trigeminal neuropathy caused by direct or indirect nerve trauma. The most affected nerves are the inferior alveolar nerve and lingual nerve. This condition can be clinically reported as anesthesia, paresthesia, hypoesthesia, hyperesthesia and/or dysesthesia. PIN is not a frequent condition, but it significantly affects patient's social life. Additionally, it is very difficult to be diagnosed and treated. The aim of this article is to review the literature about PIN so as to clarify its concept, possible causes, as well as best diagnostic and treatment approach.
/ Keywords / Neuropathic pain. Post-implant neuropathy. Dental implants.

Carolina Ortigosa **Cunha**
Doctorate student of Applied Dental Sciences, School of Dentistry — University of São Paulo (USP).

Lívia Maria Sales **Pinto-Fiamengui**
Doctorate student of Applied Dental Sciences, School of Dentistry — University of São Paulo (USP).

Fernanda Araújo **Sampaio**
MSc in Dental Sciences, University of Medicine and Dentistry of New Jersey.

Jorge Francisco **Fiamengui-Filho**
Doctorate student of Applied Dental Sciences, School of Dentistry — University of São Paulo (USP).

Paulo César Rodrigues **Conti**
Full professor, Department of Clinical Dentistry, FOB-USP.

How to cite this article: Cunha CO, Pinto-Fiamengui LMS, Sampaio FA, Fiamengui-Filho JF, Conti PCR. Post-implant neuropathy. Dental Press Implantol. 2013 Oct-Dec;7(4):85-9. DOI: http://dx.doi.org/10.1590/2237-650X.7.4.085-089.lit

Submitted: August 15, 2013 - **Revised and accepted:** September 16, 2013

Contact address: Carolina Ortigosa Cunha
Email: carol.ortigosa@gmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION AND LITERATURE REVIEW

Orofacial neuropathic pain is defined as pain in the orofacial region initiated or caused by primary injury or central or peripheral nervous system dysfunction.[1] Peripheral traumatic neuropathy can occur after dental procedures such as tooth extraction, endodontic treatment and dental implants placement.[2,3]

Dental implant placement has been a common treatment option for reconstruction of simple or complex edentulous areas of the maxilla and mandible. Currently, due to an increasing number of resources providing diagnostic information, e.g., cone beam computed tomography, complications during implant surgeries are less common; however, some surgical complications may occur, among which the most common are associated with bleeding, damage to adjacent teeth, mandibular fractures and PIN mainly affecting the mandibular and maxillary division of the trigeminal nerve.[4]

In 2007, Libersa, Savignat and Tonnel[5] conducted a 10-year retrospective study about patients' complaints made to the French health insurance about lower neurosensory disorders of the inferior alveolar nerve, transient or permanent, after dental procedures. In this study, the percentage of risk of complications after implant placement was 0.008% and 0.006% for persistent lesions.

Post-implant neuropathy can be developed days, weeks or even months[2] after surgery, which may confuse the dentist. Because it is a condition of difficult diagnosis and treatment, of debilitating symptoms and high emotional impact, understanding neuropathic pain in the head and neck is essential. In the long run, this painful condition can directly affect the mechanisms of confrontation and response to stress, anxiety, depression and treatment expectations. Moreover, the condition involves procedures that usually do not cause pain or nerve damage, for this reason, many ethical and legal factors are involved.[6,7]

This article aims at reviewing the literature on postsurgical neuropathy after dental implant placement (PIN), and at suggesting a treatment protocol.

According to the literature, the risk of permanent neuropathic complications after dental implant placement is of 13%,[8] with the inferior alveolar nerve and the lingual nerve being most often affected.[9] These damages can be classified as direct or indirect. Direct damage is restricted to direct neural trauma such as those caused by the needle used for anesthesia, the bur and/or retractors used during the preparation of the surgical site or by the implant itself.[9] Indirect damage is restricted to postsurgical situations such as bleeding and pressure around the nerve,[2] action of chemical irritants during inflammation or infection of the peri-implant region, nerve compression by the trabecular bone after implant installation or during the osseointegration process.[9,10]

The sensory processing established during a neural injury or neuritis (nerve inflammation) alters the activity of different nerve fibers. As a consequence, these conditions are clinically presented in a variety of ways, namely: anesthesia, paresthesia, hypoesthesia, hyperesthesia and/or dysesthesia.[2,11] Anesthesia is the total absence of feeling, even the absence of pain sensation. Paresthesia ("formication") includes a wide variety of abnormal sensations such as the "pins and needles" sensation which may not be completely unpleasant. Hypoesthesia is the decreased sensitivity to stimulation, while hyperesthesia is an abnormal increase in sensitivity. Last but not least, dysesthesia is an abnormal and unpleasant sensation, induced or spontaneous, such as allodynia (pain caused by painless stimuli) and hyperalgesia (exaggerated and quick pain response caused by painful stimuli).[9] When there is minimum nerve damage, the inflammatory process primarily affects A-beta myelinated nerve fibers, causing a reduction in the detection threshold (i.e., hypersensitivity) to stimulus. Nerve damage itself affects all types of nerve fibers, A-beta, A-delta and C-fibers, causing increased detection threshold to stimulus, i.e., hyposensitivity.[12,13]

In 2012, Renton et al[7] published a prospective review of 30 cases of inferior alveolar nerve injury associated with dental implant placement surgery. All patients developed some kind of sign and/or symptom of neuropathy, 50% of cases had neuropathic pain, out of which 30% had mechanical and thermal allodynia. Paresthesia was reported by 47% of the cases. Anesthesia was reported by 40% of patients of which four cases reported anesthesia and pain, and four cases reported anesthesia and paresthesia. Eleven patients reported mechanical allodynia, 14 had mechanical hyperalgesia, 7 had cold allodynia and four had cold hyperalgesia.

DIAGNOSIS AND TREATMENT

The diagnosis of peripheral nerve injuries, such as PIN, is a challenge that partially occurs as a result of lack of valid complementary methods. Several studies suggest the use of quantitative sensory testing (QST) to access the sensory function of injured nerves.[14]

According to a literature review conducted by Juodzbalys et al, the QST can be classified as subjective or objective. Subjective tests are based on patient's response and are the most popular in clinical practice. They are subdivided into mechanical-receptive test which uses material such as toothbrush, brush and wooden sticks for sensory discrimination and two-point discrimination testing; and nociceptive tests performed with the aid of material, such as pins and heat, that trigger response of nociceptive fibers. Subjective tests also include diagnostic blockade of nerve by means of a local anesthetic. Conversely, objective tests assess the function of the nerve itself. They include trigeminal somatosensory test with evocation of neural action potentials, orthodromic action potential test of sensory nerves and the blink reflex test.

The safest option to avoid injury of this nature is based on the use of diagnostic imaging performed to accurately determine and safely correct three-dimensional positioning of an implant in relation to the nerve branches. Panoramic radiographs are commonly used for this purpose, however, in some cases, a single neurovascular bundle of the inferior alveolar nerve cannot be visualized. These vascular and nerve branches are more easily identified by computed tomography.[15] In addition, methods of preemptive analgesia —such as correct anesthesia and/or preoperative prescription of pain and inflammatory medication — used to prevent or reduce postoperative pain by decreasing the sensitization of peripheral nerves, has also proved shown effective against nerve injuries, such as neural disorders after dental implant placement.[16]

According to Alhassani and Alghamdi,[17] a proper understanding of the anatomy involved in implant placement, surgical procedures and implant systems combined with an appropriate treatment plan, reduces the chance of unpleasant complications. However, should nerve damage occur, an appropriate and prompt treatment approach is key to maximize the chances of recovery.

There is no current well-defined protocol aimed at treatment of post-implant neuropathies. For all cases of dental implant surgery, it is recommended that the dental surgeon contact the patient after the period of action of the anesthetic not only to ensure that the patient has recovered the feeling in the area, but also to assess whether there are symptoms of a potential neuropathy.[18] Should dentists suspect of a possible neural injury, they must conduct studies of sensory function, mapping and photographing the affected area for further monitoring.[9]

Hegedus and Diecidue[19] recommend that implants be immediately removed, suggesting that they be reimplanted a few days later. According to Khawaja and Renton,[18] early implant removal (within 36 hours after surgery) may decrease neuropathy and even fully recover sensory function in cases of direct damage to the nerve. Drug therapy is an additional treatment that favors prognosis. It should be based on the level of injury severity: in case of mild injury, the use of high doses of nonsteroidal antiinflammatory drugs (NSAIDs) is indicated; however, in case of moderate to severe injury, steroids should be administered orally; and in more complicated cases, other pharmacological agents, such as antidepressants and anticonvulsants, should be used.[9] Benoliel et al[2] suggest the use of tricyclic antidepressants and membrane stabilizers, such as gabapentin/pregabalin as the first choice of treatment in cases of traumatic painful trigeminal neuropathy.

Juodzbalys et al[9] suggest a sequence of treatment for injuries to the inferior alveolar nerve. The protocol consists of six steps: 1) Confirmation of nerve injury through clinical and radiographic examination; 2) Identification of potential risk factors which may be general (patient's age, nerve and mandibular canal anatomy); during the surgical procedure (visualization of the damage), or postoperative (injury severity and the time interval since the injury was caused); 3) Identification of the etiological factor; 4) Diagnosis of sensory disturbances in the region; 5) Treatment; and finally, 6) Monitoring.

Topical medication may also be used. They are capable of reducing continuous peripheral stimulation in the initial stage of neuropathy, thus minimizing the development of central sensitization or central neuropathy. These drugs have less adverse effects when compared to systemic

methods, which favors their use in systemically compromised patients and elderly patients.[20]

Monitoring the sensory changes is extremely important to analyze patient's prognosis of recovery. Improvements in neurosensory symptoms usually occur within two to three months.[21] Improvements or remission of neurosensory disorders will depend on how soon the clinician identifies the problem and makes the correct diagnosis and treatment. Thus, the earlier the diagnosis, the better the prognosis of the case.

CONCLUSION

In short, postoperative follow-up of patients undergoing surgery for dental implants is essential. Should any nerve injury occur, it may be treated as early as possible, which leads to a better prognosis. Dental implant removal is recommended for cases of direct injury to the nerve or cases in which this nerve is very close to the mandibular canal. The procedure must be carried out within 36 hours after surgery. Should direct neural injury not be the case, early administration of corticosteroids or NSAIDs is strongly recommended. In case of late diagnosis of PIN, medications that have an effect on the central nervous system, such as antidepressants and anticonvulsants, must be used.

It is worth noting that the prevention of nerve damage during implant placement is the best way to avoid potential postoperative complications. This prevention is a result of appropriate surgical planning performed with the aid of accurate and high definition radiography. Additionally, in case of post-implant neuropathy, the clinician's main role is to identify the problem and refer the patient to a specialist in orofacial pain who will perform a multidisciplinary treatment.

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Biomechanical study of prosthetic interfaces: A literature review

Abstract / Implantology has improved its biological and mechanical characteristics. However, the big challenge nowadays is to offer esthetic rehabilitation treatment that is durable and, at the same time, enables maintenance of the surrounding structures, such as bone and mucosa, where this balance depends on several factors, including the type of prosthetic interface. The first implants were developed by superimposing external hexagonal interface, however, several reports have described clinical complications that resulted in loosening of screws, as well as fractures of implants and prosthetic components. To reduce these failures, mechanical connections — hexagonal, triangular, octagonal or conical — were developed with internal fitting. With the advent and the several options of prosthetic interfaces available for rehabilitation planning, greater knowledge about their biomechanical characteristics and longevity is required.
/ Keywords / Dental implants. Biomechanics. Prosthesis failure.

Angelo Marcelo Tirado dos **Santos**
PhD resident in Dentistry - UNOPAR.

How to cite this article: Santos AMT. Biomechanical study of prosthetic interfaces: A literature review. Dental Press Implantol. 2013 Oct-Dec;7(4):90-7.

Submitted: May 13, 2013 - **Revised and accepted:** November 25, 2013

Contact address: Angelo Marcelo Tirado dos Santos
Rua Espírito Santo, 410 – CEP: 86010-510 – Londrina/PR – Brazil — E-mail: angelomarcelosantos@bol.com.br

The author informs he has no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION

One of the major challenges of present Implantology is to obtain an implant-prosthesis connection system that meets biomechanical and esthetic needs, that is easy to handle, resists masticatory functional loads and has acceptable clinical performance. Due to the wide variety of implants and prosthetic interfaces, it is up to the clinician to choose the most suitable according to each treatment plan, taking into account the biomechanical characteristics of the dental implant system, his experience, personal preference and final costs to the patient.

After osseointegration of the implant, the prosthetic connection of choice is responsible for stabilizing the prosthesis and such stabilization is, in turn, responsible for implant and prosthetic treatment longevity.[1] The design of the prosthetic implant platform should: (1) facilitate the physiologic development of the gingival contour and, as a result, yield a natural look for the prosthetic crowns; (2) achieve acceptable final aesthetic results; (3) have clinical longevity; and (4) promote functional restorations that resemble natural teeth.[2]

Biological, aesthetic, functional and mechanical factors are among the risk factors involved in osseointegrating implants. Biological failures are complications that can lead to lack of osseointegration of implants and inflammation of the peri-implant mucosa. Non-osseointegration results in peri-implant mobility, pain and/or bone loss of multifactorial etiology. It may be a result of bacterial contamination, poor bone quality or quantity, traumatic surgery, excessive forces on the implant during osseointegration, among others. Inflammation of the mucosa surrounding the dental implants can result in mucositis and peri-implantitis. Mucositis occurs due to poor control of peri-implant plaque and when there is bone loss associated with pathogenic flora, a condition known as peri-implantitis.[3] Functional failures are associated with phonation and lingual position, when the air passage between teeth /denture can create phonetic difficulties and implant-supported prostheses in the mandible or maxilla with infrastructure involving the tongue space can lead to discomfort.[4]

Determining the etiology of implant and prosthetic components fracture as well as their treatment can be complex. The causes are divided into three categories:[5] (1) defects in implant design or material; (2) prostheses without passive fit and (3) physiological or pathological masticatory overload. In implants with an external prosthetic interface, the screw often loosens before failures occur in the retention system, moreover, angular bone loss is frequently observed around the fractured implant. Mechanical failures have been associated with instability of the implant /prosthesis junction where, according to some authors, biomechanical complications may shorten the life of implant-supported prosthesis and dental implants. Most of these complications are observed in single restorations both in the anterior and posterior region.[1,6] In this context, this literature review discusses the biomechanical characteristics of dental implants using external and internal prosthetic interfaces.

LITERATURE REVIEW

Implant with external prosthetic interface

In early 60's, Per-Ingvar Brånemark and colleagues began to develop a system of endosseous dental implant of which function and clinical longevity depended on "direct" anchorage to the bone known as osseointegration.[7] This type of implant, from which the current dental implant systems derive, have two main components: an implant of cylindrical or conical shape made of commercially pure titanium, and a prosthetic component that supports the prosthesis. Over the years, rehabilitation with endosseous dental implants became a safe and fairly predictable treatment modality for partially or fully edentulous patients. The use of implant systems with external hexagon connections became popular and widely used in Implantology, perhaps, for being the precursor system of osseointegration and the most widespread type of implant, making it popular among dentists (Fig 1).

The following are among the advantages of this type of interface: the possibility of performing treatment at two surgical stages; the presence of an anti-rotational mechanism; reversibility and, especially, compatibility of insertion platforms of different brands. The main disadvantages include micro-movements due to the low height of the hexagon, or loosening or fracture of the

prosthetic screw (Fig 2); space between the implant and abutment enabling the percolation of fluid of microorganisms which, in turn, causes bone resorption around the cervical region of the implant (Fig 3). Clinical studies[5,8-11] found that 30.7% to 49% of prosthetic screws tend to loosen in external interface implants.

Implant of internal prosthetic interface

With the advent of internal prosthetic interfaces (hexagonal, triangular, octagonal and cone-screw), there was a better fit between connectors as a result of the interposition between the prosthetic abutment and the implant, which offers greater stability and anti-rotational effect. Additionally, increased strength

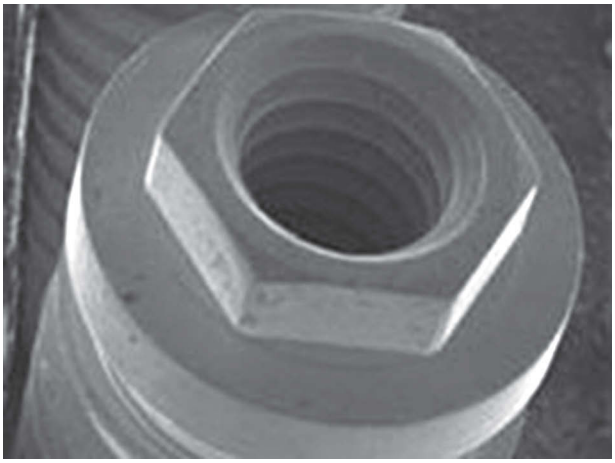

Figure 1: External hexagonal implant interface.

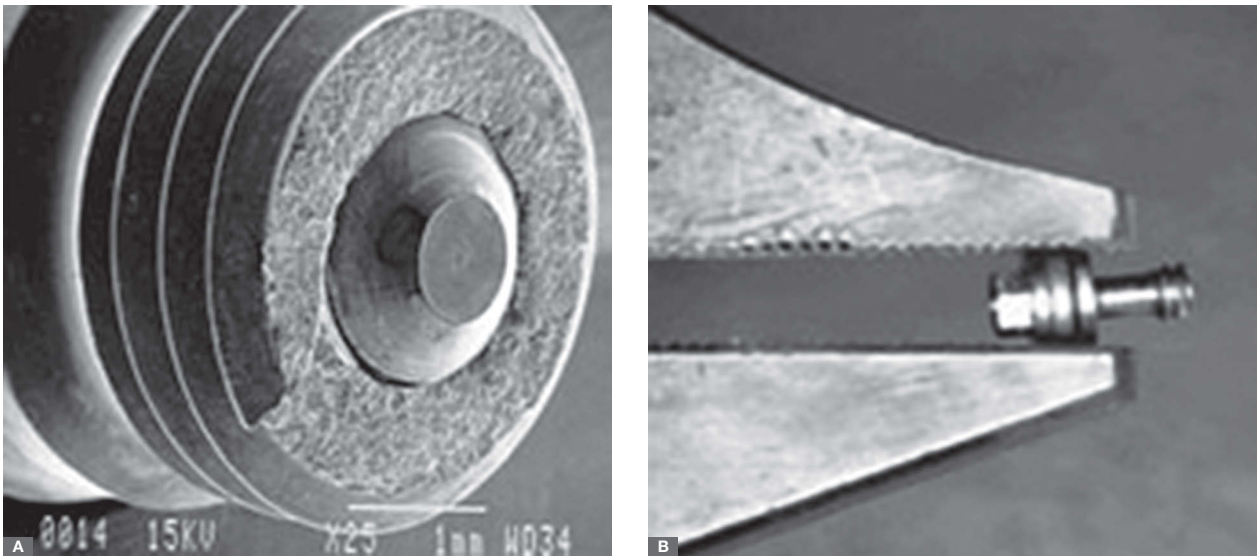

Figure 2: Implant fracture (**A**) and prosthetic abutment (**B**) (Source: Balshi,[5] 1996).

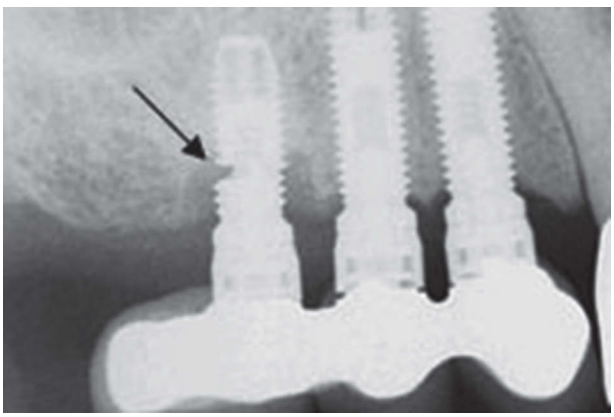

Figure 3: Bone loss around the implant platform and implant fracture (Source: Balshi,[5] 1996).

and distribution of occlusal loads were also observed, making them more suitable for single restorations than external connections. The following are considered as disadvantages of implants of internal prosthetic interface: fragility of implant walls; difficulties in adjusting angle divergence between implants at the time of rehabilitation; and prosthetic screw loosening on the internal hexagonal connections[4,12,13,14] (Fig 4).

The Morse Taper internal interface is based on the mechanical principle of "cone in a cone", which provides great contact friction between the surfaces and is often used in Engineering and Health Sciences. This connection system was developed by Stephen Ambrose Morse in 1864. The Morse Taper system was introduced in Implantology in 1985 by Thomas D. Driskell, by the Bicon™ Company in the United States. Some authors[15,16] have studied its biomechanical behavior. The prosthetic component / implant junction is achieved by means of a compressive force that is applied to the abutment, intruding it into the implant where stability of the whole system is achieved by friction, also known as a cold weld (a mechanical property defined as an increase in the loosening torque in relation to the tightening torque).

Since 1997, the Brazilian Technical Standards Association (ABNT) regulates connections and mechanical equipment, including those using the Morse Taper system, under Normative Instruction 1119 which states that to be considered a Morse Taper, the sum of the internal angles of the components must be less than 3.014º of divergence.[17] Thus, the system of conical dental implants presenting prosthetic interface angles smaller than 3.014° are considered "real" Morse Taper systems which do not use screws to support the prosthetic retention (Fig 5). Conical prosthetic interface implants with angulation greater than 3.014° are considered cone-screw, as they need a screw for prosthesis retention[17,18] (Fig 6).

Morse Taper implant systems are known as self-locking because they use exclusively frictional retention to give stability and prosthetic retention. They are represented by Bicon Dental Implants System™ (Boston, USA); Leone™ (Italy); Mac™ (Italy), Axiom™ (France) and Sistema Friccional Biológico KOPP® (Curitiba, Brazil), with the latter having 2.54° conicity between its walls and the inner cone with 3 mm in length, both of which lead to the retention frictional effect of the prosthetic component (Fig 7).

Figure 4: Internal hexagonal implant interface (Source: Kim et al,[14] 2011).

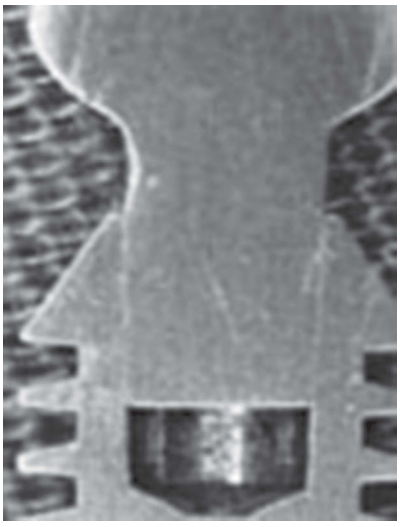

Figure 5: Implant of conical prosthetic interface – Morse Taper (Source: Urdaneta and Marincola,[16] 2007).

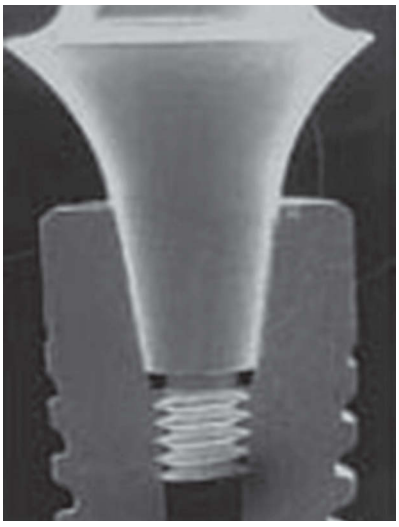

Figure 6: Implant of conical prosthetic interface – cone-screw (Source: Nentwig,[11] 2004).

The systems of internal conical connection, cone-screw and Morse Taper have shown better clinical performance. These interfaces favor the positioning of the abutments, offer greater stability and anti-rotational effect, provide greater strength and distribution of occlusal loads. Several authors[2,14,19,20,21] assessed cone-screw implants and concluded that loosening was between 3.6% to 14%. Little attention has been given to the Morse Taper system in relation to other types of connections.

However, among the studies carried out to investigate the topic, most of them report resistance to loosening of prosthetic components,[22-25] transmission of micro-movements of the implant / abutment connection in trials with finite elements and clinical studies covering mechanical complications.[16,26,27] Table 1 presents some prospective and retrospective clinical studies assessing the duration of single prosthetic rehabilitation using external interfaces, cone-screw and Morse Taper implants.

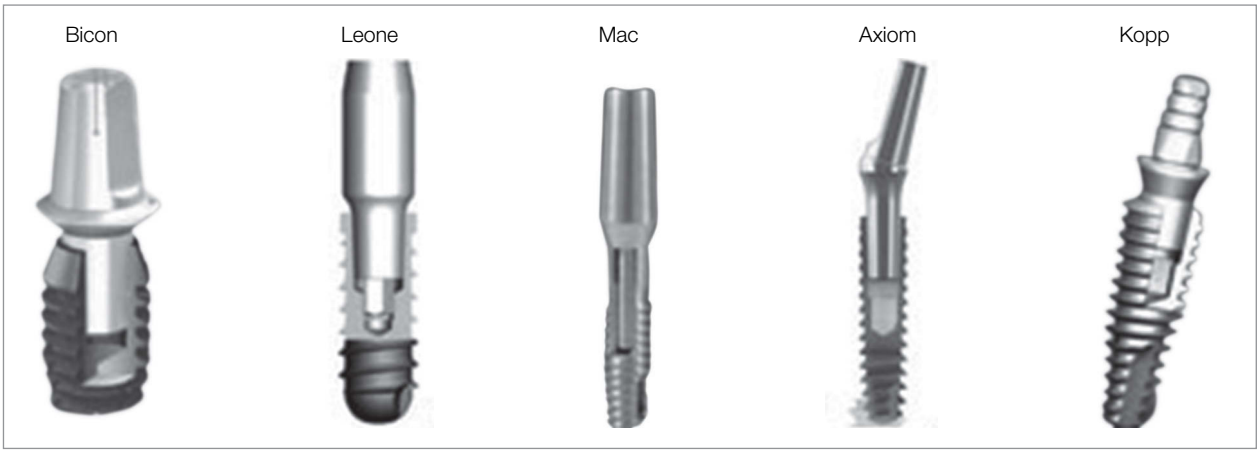

Figure 7: Trademarks of implants of conical prosthetic interface - Morse Taper.

Table 1: Comparison of clinical studies focusing on dental implants with external/internal prosthetic interfaces: cone-screw and Morse Taper.

References	Study	Implant system	Interface	Follow-up (years)	Success/ Duration	Screw/abutment loosening
Jemt[9]	R	Brånemark	EH	1	98.1%	30.7%
Jemt et al[10]	R	Brånemark	EH	1	98.6%	20.8% a 49%
Levine et al[19]	R	ITI	CS	0.5	97.7%	3.6% a 8.7%
Brägger et al[20]	R	ITI	CS	4 to 5	-	6.8%
Mericske-Stern et al[21]	R	ITI	CS	8	99.1%	14%
Muftu, Chapman[27]	P	Bicon	MT	4	93.51%	0.74%
Mangano, Bartolucci[26]	P	Mac	MT	3.5	-	1.25%
Mangano et al[23]	P	Leone	MT	1 to 4	98.4%	0.66%
Mangano et al[24]	P	Leone	MT	6	97.5 a 99.5%	0. 37%
Mangano et al[25]	P	Leone	MT	5	98%	0%

(EH = external hexagon; CS= cone-screw; MT = Morse Taper); Study (R = retrospective and P = prospective).

Morse Taper implants have some advantages: simple prosthesis fabrication technique, as a result of the absence of a screw connecting the implant to the prosthetic system; a prosthetic component (solid pin) that can be customized and prepared as if it were a tooth ready to receive a conventional cemented prosthesis or an aesthetic material, making it a crown-pin-anchored prosthesis.[16,28] The cervical profile of the prosthetic component is smaller than the implant platform (switching), which allows the prosthetic emergence profile to be customized similarly to the dental element, thus providing better gingival aesthetic on the emergence profile of the prosthesis.[29] According to some authors,[29] the major biomechanical advantage of implants with platform switching configuration in dental implants include reduced stress at the cervical level of the implant, which results in better distribution of masticatory forces to the bone tissue. A prospective study[28] assessed bone crest height around dental implants with platform switching, and revealed significantly less bone loss when compared to implants of standard configuration, characterizing less bone remodeling on the implants (Fig 8).

Other authors[30] evidenced a decrease in the infiltration of microorganisms in the implant-abutment interface, which reduces unpleasant odor and potential bone remodeling around the implant platform. Although masticatory forces generate occlusal movements of flexion and traction, which may negatively influence the retention of the abutment, the occlusal compressive force acts in the direction of insertion of the prosthetic abutment, favoring self-activation in conical interface implants.[12]

Figure 8: Bone remodeling around EH implant (arrow) and less bone remodeling with platform switching (Source: Fickl et al,[31] 2010).

DISCUSSION

Unscrewing and fracturing of prosthetic components are generally attributed to occlusal overload and malpositioned prosthetic abutments, with most of these complications being found in the systems with external connection. The internal conical connection system has a lower incidence of these problems, since they are based in an implant/abutment junction with pressure within the implants, which gives them the status of a more secure connection.[13]

Wear, loosening and fracture of prosthetic screws are the most frequent mechanical failure of implant-supported prostheses of external prosthetic interface. Loosening of screws can vary from 30.7% to 49% in maxillary or mandibular dentures, being more significant in the maxilla.[9,10] Most patients have prosthetic screws loosened before the occurrence of fracture.[5] Other authors[8] report that the length of the external hexagon may influence the strength and stability of the implant connector interface. Thus, external hexagon of greater length showed better resistance to mechanical stress and improved mechanical stability of dental implants.

In a retrospective study[19] where 174 ITI cone-screw implants were installed (Straumann™) for single reconstruction of teeth, it was found an incidence of 8.7% in loosening of prosthetic screws and only 3.6% of occurrence in loosening of conical solid abutments. Another study[11] assessed the installation of 5439 Ankylos cone-screw implants (Friadent™) and revealed that 943 implants were inserted in areas of single tooth loss. About six years later, during post-treatment follow-up, there were 13 cases of failure, and a success rate of 98.7%. In a follow-up clinical study investigating 233 single dental implants with Ankylos cone-screw prosthetic interface (Friadent™) and a 5-year control, loosening was observed in 1.3% of abutments.[2]

Some authors[16] conducted clinical evaluations and reported that implants with conical interface decreased the problem of loosening of prosthetic components

and proved satisfactorily high performance over time, reaching 99% of success within 10 years for single tooth restorations. Others,[23] evaluated 307 Morse Taper implants for single rehabilitation in a follow-up period of 4 years and observed two cases of abutment loosening (0.66%) with a survival rate of 98.4%. In prospective studies[23,24] with Morse Taper implants used for a period of 5 to 6 years, the loosening of prosthetic components was 0.37%.

CONCLUSION

External connection implants have their historical value and indicative of implant supported prosthetic planning, especially in fixed prostheses, however, studies have proved the need to review some concepts regarding the biomechanical flaws and instability of peri-implant tissues. Conical prosthetic interface systems meet the needs for obtaining a balance between biological and mechanical characteristics of dental implants.

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Using synthetic biomaterial to fill peri-implant defects (gap) in immediate implants

Abstract / Osseointegrated implant placement requires proper bone volume, however, tooth extraction requires different standards of bone resorption and bone remodeling. Alveolar ridge resorption has been considered an inevitable consequence of tooth extraction and may be a significant issue for Implantodontics. Despite immediate implant placement, the edentulous site of the alveolar process undergoes substantial bone remodeling, with reduction in the dimensions of the alveolar crest after tooth extraction. After implant placement in a fresh extraction site, a gap is often formed between the ridge and the implant surface. With a view to overcoming this issue and to favor bone formation within the gap, several grafting procedures have been employed in association or not with barrier membranes as well as several types of bone substitutes. In this context, this article aims at conducting a literature review to discuss the use of synthetic biomaterial to fill the gaps that form around implants placed in fresh sockets. Nevertheless, no biomaterial available to date provides the desirable properties. Additionally, residual bone volume must be assessed before tooth extraction in order to allow the dental surgeon to employ different techniques with a view to preserving the alveolar bone.
/ Keywords / Dental implants. Bone transplant. Biocompatible material.

Daniela **Colet**
Specialist in Oral and Maxillofacial Surgery and Traumatology, State University of Western Paraná (UNIOESTE).

Fernando Angelo **Neiss**
Specialist in Implantodontics, Brazilian Dental Association (ABO) – Cascavel.

Ricardo Augusto **Conci**
PhD resident in Oral and Maxillofacial Surgery and Traumatology, Catholic University of Rio Grande do Sul (PUC-RS).

Geraldo Luiz **Griza**
Full Professor, Department of Dentistry, State University of Western Paraná (UNIOESTE).

How to cite this article: Colet D, Neiss FA, Conci RA, Griza GL. Using synthetic biomaterial to fill peri-implant defects (gap) in immediate implants. Dental Press Implantol. 2013 Oct-Dec;7(4):98-105.

Submitted: August 18, 2013 - **Revised and accepted:** November 25, 2013

Contact address: Daniela Colet
Rua Basílio Hereciuk, 103 – Centro. Guaraniaçu/PR – CEP: 85400-000 – Brazil — Email: dani_colet@hotmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION

Physiological hard and soft tissue loss after tooth extraction often causes bone deformities in the alveolar ridge, which, as a result, hinders ideal implant placement as well as esthetics and speech.[1]

The search for esthetic as well as predictable functional results yielded within a shorter period of time; a better understanding of repair processes established around implants; and the development of new implant designs and surfaces allowed new surgical techniques to be developed and favor immediate implant placement after extraction in fresh sockets. This procedure has been recommended as a therapeutic protocol aiming at reducing bone resorption after extraction. It is considered an inexorable technique that reduces treatment time and costs.[2] On the other hand, it has the disadvantage of forming a gap around the implant as a result of morphological differences between the implant and the dimensions of the post-extraction socket, which is of greater diameter in comparison to the implant. Furthermore, the extraction socket is not usually round-shaped, as the implant to be placed normally is.[3] According to Botticelli et al,[4] the space formed between the implant and the bone or adjacent soft tissue is known as gap. Experimental studies report that a large gap favors the formation of connective tissue between the coronal portion of the implant and the peri-implant bone tissue. On the other hand, little gaps between the implant and the bone are normally filled with neoformed bone, with or without bone graft or biological barriers. Modifying the implant shape and filling the gaps with bone substitutes can solve the issue of gap formation.[3] In this context, the use of bone graft prevents potential changes in fresh socket morphology, thus keeping its dimensions. Preserving the amount of gingival tissue is another important factor, given that successful immediate implant placement is also associated with complete implant coverage.

Autograft is still considered as the gold standard of graft procedures, however, the search for the ideal grafting material that reduces or eliminates the need for a donor site led to advances in researches on the theme. For this reason, several bone substitutes have become increasingly popular. They include alogenous, heterogeneous and alloplastic material used alone or in combination with bone. In this context, this article aims at conducting a literature review to discuss the use of synthetic biomaterial to fill the gaps that form around implants placed in fresh sockets.

LITERATURE REVIEW

Extraction socket healing relies on a series of factors, including blood clot formation, which is replaced by bone tissue while the alveolar walls undergo resorption and are gradually remodeled.[5] The major reactions affecting the alveolar process occur within the first 3 months after tooth extraction and lead to bone resorption, especially in the buccal-lingual direction. Studies conducted with animals assessed the changes in the dimensions of the ridge crest after tooth extraction. The remodeling process is described in two phases: During the first phase, bone is remodeled and replaced by recently-formed bone tissue, which reduces the vertical ridge. In the second phase, the buccal surface of the alveolar crest is remodeled and causes horizontal volume reduction as well as additional vertical volume reduction.[1] Residual alveolar process remodeling is progressive and chronic, and results in atrophy and reduction in the residual crest. As a result of tooth extraction and lack of support, bone is resorpted and formed into a smooth contour, causing bone structures to become thinner.[6] Bone loss after extraction is quick during the first 6 months. It is followed by gradual bone remodeling as well as remodeling of the remaining bone, which reduces alveolar bone height in 40% and thickness in 60% within the first 6 months.[7] Bone loss is more severe in the vestibular direction of the alveolar process, in comparison to the buccal/palatal direction.[8]

Initially, it was suggested that implant placement in fresh extraction sockets could prevent bone remodelling.[9] Other authors state the hypothesis that implant placement cannot be associated with alveolar crest remodeling, given that buccal-lingual thickness normally reduced within 4-6 months after extraction, regardless of implant placement.[10] Another study assessing a potential association between immediate implant placement and bone remodeling revealed that implant placement in fresh extraction sockets caused significant changes in height and thickness of the buccal-lingual walls.[6] Even though the cause of bone loss around immediately placed implants is not clear, many studies have highlighted the role the following factors play: socket positioning, buccal alveolar crest thickness, gap between the implant and the alveolar wall, and implant surface notopography.[11,12,13]

After implant is placed in a fresh extraction site, a gap is often formed between the ridge and the implant surface. With a view to overcoming this issue and to favor bone formation within the gap, several graft procedures have been employed in association or not with barrier membranes. Additionally, it has also been suggested that hard tissue healing depends on the size of the defect, as well as on the properties, the technique and the material used.[4] Small bone peri-implant defects can be completely repaired without employing guided bone regeneration (GBR) procedures, given that gaps greater than 2 mm must be filled.[14]

Another research assessing immediate implant placement focuses on the influence of the type of implant surface treatment over peri-implant bone healing. Treated-surface implants were compared with machined-surface implants placed in sockets of dog's mandibles with gaps ranging from 1 to 1.5 mm. The study revealed better filling of bone defect as well as greater implant-bone contact for treated-surface implants.[15]

The search for material that eliminate the need for a donor site led to advances in research on biomaterial and, during the last few years, to the development of several bone substitutes. Bone substitutes or biomaterial are natural or synthetic material used in humans or animals as substitutes of all types of tissue or body functions. However, their biocompatibility has not been fully proved, for this reason, their use is restricted.[16] Biocompatibility is the ability of biomaterial to exert a desired function during therapy without inducing undesired local or systemic effects, but producing more beneficial cell and tissue response and optimizing the relevant clinical responses of the given therapy.[17] Thus, biomaterial are biocompatible when they are inserted into the bone cavity and, after bone repair, remain incorporated to the neoformed bone. Furthermore, they are biocompatible because they act for a given purpose and, even though they are not incorporated by the organism, they do not cause any injuries and are not toxic.

Biomaterial are important additional products that aid tissue regeneration. For this reason, they are key for Dentistry, given that their chemotactic action can speed up or order bone repair process. They fill the bone bed with a sponge-like structure that forms a porous area that induces the formation of osteoblasts which, later on, will form bone tissue.[18] At present, due to technological advances in biomaterial associated with advances in biological knowledge on bone tissue, it is possible to selectively influence bone formation and, as a consequence, control the quality and quantity of bone inside oral structures. Nevertheless, researches on the ideal implant material used to replace autograft remain as a daunting challenge in modern Dentistry. There is a wide variety of biomaterial, synthetic or biological, available on the market. They vary in the size of their particles and are classified according to their mechanism of action: osteoconduction, osteoinduction or osteogenesis.[19]

Biomaterial are primary used to recruit cell populations, carry growth factors, attract, stimulate and favor the growth of specific cells, and provide cell and tissue growth structures that allow biomaterial to interact as well as promote homeostasis and integration with regenerated tissues.[18]

In the case of peri-implant gap filling, particulate biomaterial are confined within the bone walls, and demineralized or mineralized material, bioactive glass and particulate autogenous bone can be used. Autograft is considered a gold standard procedure due to its potential of osteogenesis, osteoinduction and osteoconduction; however, its increased morbidity leads clinicians and researchers to search for alternative biomaterial. The grafting biomaterial available on the market have different physical and chemical properties: particle size; porosity; crystallinity and chemical composition, all of which affect the *in vivo* behavior of these material. It is essential that clinicians know the physical and chemical characteristics of biomaterial available on the market, so as to choose the best material for a given application. According to the aforementioned characteristics, biomaterial must present biocompatibility; osteoconductivity; surface area that provides proper revascularization for the receiving site; high porosity that allows the material to be completely incorporated by the new bone; and mild resorption that allows bone remodeling over time. Furthermore, biomaterial must also have physical and chemical characteristics that are ideal for bone regeneration, namely: particle size between 0.25 and 1.00 mm, porous particles and low crystallinity.[20]

With a view to developing new biomaterial that aim at enhancing bone healing, some researchers have focused their studies on synthetic graft. Among them, biphasic calcium phosphate (BCP) has been increasingly used as a bone substitute in Orthopedics as well as for buccal and maxillofacial purposes.[21] Biphasic calcium phosphate is chemically similar to human bone and it consists of a combination of hydroxyapatite (HA) and tricalcium phosphate (TCP), i.e., it is a two-phase matter. TCP dissolution offers the basic material for calcium and phosphate ions, which sets off a mineralization process. At the same time, HA also keeps the framework for osteoblasts adhesion and new bone formation, which favors volume maintenance necessary against excessive resorption. Histological evaluations revealed that biphasic calcium phosphate promotes osteoblastic activity and induces osteogenesis. Thus, the Havers system and a remodeling process were observed after 12 weeks. In comparison to other grafting material, TCP revealed significantly greater osteogenic capacity, and seems to be as safe and efficient as autograft.[22] As a consequence, when grafted in bone defects, biphasic calcium phosphate (BCP) proves to be biocompatible, bioactive and osteoconductive.[23]

Hydroxyapatite (HA) is another synthetic material used to fill gaps. Chemically speaking, HA crystals are the main components of bone mineral phase. It is a calcium and phosphate –based matter gleaned from natural sources, such as coral reefs, as well as by means of synthetic methods. HA is currently available on the market as resorbable and non-resorbable particulate or block material. Resorbable hydroxyapatite is more widely used in maxillofacial reconstruction. Its porous structure — low density, with less organized crystals in comparison to non-resorbable hydroxyapatite — and the presence of secondary substances allow dissolution in physiological means, however, at very slow rates. HA is a biocompatible, osteoconductive matter with bioactive surface that allows chemical interaction between its surface and the receiving bone. It has been widely researched for orthopedic and dental purposes for more than 20 years.[24,25]

Bioactive glass (BG), also known as bioglass, was first developed in the early 70s as ceramic biomaterial capable of establishing direct adhesion to bone tissue. Its particles vary between 300 and 355 μm and consist of a mixture of oxides, in which silicone oxide, calcium and phosphate are predominant.[30] When bioglass is grafted, its surface interacts with body fluids, promoting alkaline ions exchange as well as deposition of a surface calcium and phosphate layer that chemically bonds to the tissue. The outer layer gradually dissolves and reveals an inner silica gel layer that is absorbed by macrophages. Its particles progressively excavate, which allows bone deposition to occur inside and outside the framework of particles that are reabsorbed and replaced by neoformed bone. Studies using BG for bone reconstruction yield results that vary from complete bone neoformation, with excavated granules filled with neoformed bone tissue; to results in which the material is wrapped up by fibrous tissue of low bone formation rate.[22]

Beta tricalcium phosphate (β-TCP) is a ceramic resorbable biomaterial that differs from hydroxyapatite in terms of the calcium/phosphate ratio. The main clinical characteristic that differs β-TCP from HA is the solubility of the former in a physiological environment. Differently from HA and bioactive glass, β-TCP is easily and quickly reabsorbed by the chemical dissolution produced by osteoclasts. Similarly to HA, β-TCP resorption is determined not only by the solubility of its components, but also by the morphology of its crystal as well as by its porosity. The main disadvantage of β-TCP is its lack of predictability regarding maintenance of bone volume after resorption. Many studies demonstrate that the material is quickly reabsorbed and replaced by a variable amount of bone tissue. Such discrepancy has not been fully explained, but it is believed that accelerated resorption contributes to loss of neoformed bone. With a view to decreasing biomaterial resorption rate, biphasic substances with β-TCP + HA have been developed. In this association, HA, which has lower solubility in comparison to β-TCP, acts to keep grafting material volume, while β-TCP is reabsorbed and replaced by neoformed bone.[26]

DISCUSSION

Remodeled alveolar process can hinder prosthetic therapy performed with conventional or implant-supported prostheses. This fact highlights the importance of preserving the alveolar process of which most important esthetic objectives are maintenance or improvement of buccal and interproximal gingival contour and interproximal papilla height. Soft tissue color, consistency and contour are key factors that influence the esthetic results

yielded by this type of procedure. In short, alveolar process preservation minimizes residual crest resorption, provides maintenance of crest volume after extraction, allows ideal implant placement in terms of bone and gingival tissue, minimizes or eliminates the need for grafting procedures during implant placement and avoids hard and soft tissues loss, all of which provide the patient with the best esthetic results possible.[1]

Alveolar ridge remodeling after extraction follows a time-dependent standard procedure, with alveolar crest resorption and remodeling. The longer the time interval after extraction, the greater the resorption. To maintain proper bone height and achieve rehabilitation within a shorter period of time, immediate implant placement is recommended. The literature discloses positive results yielded by this procedure without further complications. Experimental studies reveal that gap formation between the implant and the socket is inevitable even if the difference between them is not greater than 2 mm.[27] After extraction, vertical and horizontal bone loss occur regardless of immediate implant loading. Since the technique is used to replace lost teeth in the anterior maxilla, where esthetic results are of paramount importance, buccal wall resorption may negatively affect esthetic results.[28] For this reason, graft placement inside the residual gap between the implant and the buccal bone wall is recommended. If a gap forms between the implant and the socket, bone bridge formation may be incomplete or delayed, which hinders osseointegration. Experimental studies conducted with animals confirm such hypothesis.[28] The use of regenerative material prevents connective and epithelial tissue cells from migrating, thus favoring bone regeneration. The use of regenerative material is recommended when residual bone defect is greater than 1-2 mm of horizontal space between the implant surface and the buccal wall.[29] Nevertheless, this value has not been conclusively proved. For this reason, some studies suggest that residual bone defect satisfactorily heal without bone regeneration procedures or grafting material.[29]

The study conducted by Barone[13] confirms that dimensional alterations occur in the alveolar crest even after implants are placed in fresh extraction sockets, regardless of regenerative procedures and peri-implant, marginal lacunae being completely filled 3 months after bone formation. Nevertheless, bone resorption was observed in grafted sockets, especially on the buccal side, and, in that case, the regenerative procedure may have limited alveolar bone remodeling.

Biomaterial are natural or synthetic material used to treat, enhance or restore the function of injured or lost biological tissues. They are classified according to their origin, mechanism of action and physiological behavior. Ideally, they must not cause any physical harm to the receiving tissue, must be pharmacologically inert, must not cause allergic or foreign body-type reactions, and must be enough to fill the bone defect. Furthermore, biomaterial must present proper biomechanical, biological, physical and chemical properties.[30]

Ideal grafting material must not cause reduction in bone volume after extraction, and must remain *in situ* until bone formation is completely achieved. Bone substitutes must allow osteogenesis onset and must function as a bed for cell penetration, thus favoring bone formation. Several grafting osteoinductive and/or osteoconductive material, including autogenous, allogeneic, xenograft and alloplastic bone, were used in the attempt to preserve the alveolar crest. Should the alveolar bone walls be undamaged, only osteoconductive grafting material can be used, which eliminates the need for barrier membranes. Conversely, should the alveolar bone walls be damaged, regenerative techniques, osteoinductive grafting material and/or barrier membranes must be used.[1]

Osteogenesis, osteoinduction and osteoconduction are mechanisms by means of which bone substitutes act in contact with the organism. Osteogenesis is the formation and development of bone tissue. Osteogenic grafting material is gleaned from tissue involved with bone growth and repair. Osteoinduction is the process by which osteogenesis is induced. It is an active process that represents the ability of graft to induce bone formation in the receptor tissue. Osteoconduction occurs when a physical matrix functions as a framework for the formation of new bone. It is a passive process that represents the ability of graft to allow invasion of blood and cells from the receptor site. It basically relies on the number and size of canals going through the graft. All bone substitutes have at least three mechanisms of action.[31]

According to Araújo et al,[32] biomaterial must meet the following criteria in order to be used as grafting material: 1. Ability to form bone by cell proliferation of transplanted osteoblasts or cell osteoconduction over the graft surface; 2. Ability to form bone by osteoinduction of recruited mesenchymal cells; 3. Ability to remodel immature bone in mature lamellar bone; 4. Maintenance of mature bone without loss of function; 5. Ability to promote implant stabilization after implants are concurrently placed with graft; 6. Have low infection risk; 7. Be effective; 8. Have a high safety level.

Autograft remains as the "gold standard" of biomaterial due to its osteoinductive, osteoconductive and osteogenic properties as well as for being immunologically inert and, as a result, allowing bone formation. Nevertheless, potential accidents (paresthesia, infections, etc.) associated with the techniques employed to harvest autogenous bone have encouraged the search for a substitute. In this context, allogeneic, xenograft and alloplastic material play an important role in aiding or promoting bone tissue reconstruction.[18] Choosing an appropriate bone substitute basically depends on its purpose and detailed understanding of the biological mechanisms established around it. Particulate bone substitute is used to fill alveolar and sinus cavities or small bone defects with at least three remaining bone walls that provide stability.[18] Unlike block graft, in which stability is provided by the use of screws, particulate bone substitute needs at least three remaining bone walls or a framework that provide stability and keep the osteoconductive properties of this type of material.[16]

With a view to optimizing osseointegration in critical-sized lacunae, several bone substitutes have been used to stimulate bone growth. This type of material present osteoconductive properties and function as a framework for cell adhesion and proliferation, which favors gap filling.[23,33] Additionally, different types of biomaterial have been used in association with implants, thus yielding successful results.[34]

No biomaterial available to date provides the following desirable properties: biocompatibility; previsibility; clinical application; absence of intra-operative risks or sequelae; and patient's acceptance. Xenograft material, such as inorganic bovine bone, as well as alloplastic material, such as synthetic hydroxyapatite, are bone substitutes that favor bone repair as a result of high osteoconduction. Thus, this type of material has been recommended in cases of periodontal repair, maxillary sinus lifting and socket filling.[35]

Recovery of crack defects depends on the implant surface and on the size of the bone defect. Osseointegration of implants placed in gap sites is influenced by the characteristics of the implant surface. For instance, calcium phosphate-coated implants yield more favorable bone response. Studies focusing on the healing process of bone defects of different dimensions reveal that healing was strongly impaired in bigger bone defects.[3]

Circumferential defects heal without the use of regenerative therapy, provided that buccal bone is undamaged and the defect is not critical-sized. Lacunae with width not greater than 1-1.25 mm and depth not greater than 5 mm around rough implant surfaces are better filled and have less marginal bone resorption than machined implant surfaces. Nevertheless, cases in which buccal bone is removed or the defect is greater than 1.25 mm require additional regenerative therapy. A wide variety of regenerative therapies are used to treat circumferential defects. The use of barrier membrane as bone substitute yielded the most favorable results.[3]

It is worth noting that the aforementioned biomaterial are used in very specific cases, within the limitations of such cases and without demanding unreal biological outcomes such as bone neoformation as a result of biomaterial use. Bone neoformation is a biological process happening solely as a result of osteblastic activity. The quality of neoformed bone tissue in the presence of biomaterial (bone substitutes)is not uniform and depends on the following: (1) material; (2) material origin; (3) clinical conditions of the receptor site; (4) indications and surgical technique.[19]

The material constitutive, structural, physicochemical, degradation surface, absorption and resorption properties are responsible for the bioconductive and bioinductive abilities of biomaterial. The aforementioned concepts are the basis of current and future researches, and aid professionals in the attempt to choose among different products available on the market. Thus, the clinical use

of any type of biomaterial must be essentially based on previous research which include scientific evaluation, *in vivo* laboratory trials and longitudinal clinical studies conducted with humans.[18]

Choosing the most appropriate biomaterial depends on whether or not it exerts the desired functions of filling, regeneration or both. One should consider the material osteoconductive and osteoinductive properties, as well as its provenance (homogenous or allogeneic, heterogeneous or xenograft, or synthetic). Resorption time, whether slow or quick, must also be taken into account. Bone substitutes must provide stability and protection achieved by the use of barrier membranes, in addition to avoiding contamination that hinders bone repair.[18]

CONCLUSIONS

Tooth extraction requires different standard procedures of bone resorption and bone remodeling. Thus, residual bone volume must be assessed before extraction in order to allow the dental surgeon to employ different techniques with a view to preserving the alveolar bone. Nevertheless, clinical assessment of critical-sized bone defect (> 2 mm) remains limited and, for this reason, no biomaterial has provided all the ideal properties.

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Abstracts of articles published in important Implantology, Prosthodontics and Periodontics journals from around the world

Is furcation involvement in maxillary molars a predictor for subsequent bone augmentation prior to implant placement? A pilot study

Walter C, Dagassan-Berndt DC, Kühl S, Weiger R, Lang NP, Zitzmann NU. Clin Oral Implants Res. 2013 Oct 21.

Aim: The aim of this pilot study was to analyze the interfurcal bone height in relation to the possible need for subsequent sinus floor elevation in patients with advanced periodontitis and furcation involvement of first and / or second maxillary molars. **Material and Methods:** Seventeen dentate patients, who received cone beam computed tomography (CBCT) for detailed preoperative diagnosis and planning of surgical interventions at periodontally involved maxillary molars (17 first and 15 second molars), were consecutively recruited for the study. The minimal bone height in the interfurcal region was measured from CBCT and related to furcation involvement, residual bone above the root tips, and the clinical probing pocket depth (PPD). **Results:** The minimal interfurcal bone height measured 4.1 ± 2.6 mm on average with 75% of maxillary molars having ≤ 6 mm and almost 60% having only ≤ 4 mm bone height left below the sinus floor. A higher risk for reduced interfurcal bone height of ≤ 4 mm was given when residual PPD of ≥ 6 mm was remaining at two or more tooth sites (OR 0.10; 0.11). **Conclusions:** The majority of periodontally involved maxillary molars had a substantially reduced interfurcal bone height, particularly with at least two sites with residual PPD ≥ 6 mm. This was a predictor for a subsequent need for sinus floor elevation when tooth replacement with a dental implant is desired.

Long-term results of implant-supported over-dentures retained by double crowns: a practice-based retrospective study after minimally 10 years follow-up

Frisch E, Ziebolz D, Rinke S. Clin Oral Implants Res. 2013 Dec;24(12):1281-7.

Background: Different concepts regarding the number of implants and attachment systems for the preparation of implant-supported over-dentures (IODs) have been discussed. Nonetheless, long-term results for double-crown-retained IODs with an observational period of more than 10 years are still rare in the literature. **Objective:** The aim of this practice-based study was to retrospectively evaluate the long-term clinical outcome (success / survival rates, technical / biological complications) of IODs retained by double crowns. **Material and Methods:** In a private practice, 36 non-smoking edentulous patients were restored between 1991 and 2002 with double-crown-retained IODs supported by 2-6 implants. For the retrospective evaluation of implant and prosthetic survival (in-situ criterion) and success (event-free observational period), only those patients were included who regularly (at least once a year) participated in a professional maintenance programme and who had a functional period for the restoration of more than 10 years. **Results:** Twenty-two patients (12 women / 10 men, mean age 60.1 ± 9.8 years) with 89 implants supporting nine maxillary and 13 mandibulary dentures (mean number of implants/prosthesis = 4) met the inclusion criteria. The mean follow-up period was 14.1 ± 2.8 years. One implant failed after 4.9 years (cumulative-survival rate: 98.9%). Seven implants in two

patients showed peri-implantitis (prevalence: patient-based = 9.1% / implant-based = 8%). Five dentures were renewed (prosthetic-survival rate 77.3% Maintenance procedures (i.e. screw loosening or acrylic fractures) were required at a rate of 0.31 / year and patient. **Conclusion:** This study indicates that IODs retained with double crowns offer predictable long-term performance with a limited incidence of biological and technical complications.

Implants of 6 mm vs. 11 mm lengths in the posterior maxilla and mandible: a 1-year multicenter randomized controlled trial

Guljé F, Abrahamsson I, Chen S, Stanford C, Zadeh H, Palmer R. Clin Oral Implants Res. 2013 Dec;24(12):1325-31.

Background and Aim: In cases with limited bone height, short implants could be a good alternative to augmentation procedures. The aim of this randomized controlled trial was to compare the clinical performance of implants of 6 mm or 11 mm in length in the posterior region. **Materials and Methods:** In this multicenter trial (six study sites), 95 subjects were included. Subjects were randomly allocated to receiving implants with lengths of either 6 or 11 mm both with a diameter of 4 mm (OsseoSpeed(™) 4.0 S; Astra Tech AB; Mölndal, Sweden). In all cases, there had to be sufficient bone height to allow placement of an implant of at least 11 mm in length. Two or three implants were placed per subject using one-stage surgery with a 42-48 days' healing period before loading. They were restored with a screw-retained splinted fixed prosthesis. Clinical and radiographic examinations were performed preoperatively, post-surgery, at loading, and 6 and 12 months after prosthesis placement. **Results**: A total of 208 implants were inserted in 49 subjects receiving 6-mm implants (test) and in 46 subjects receiving 11 mm implants (control). Two 6-mm implants failed before loading and one 6 and 11 mm implants failed before 1-year evaluation. From loading to the 12 months' follow-up, a mean marginal bone gain of 0.06 mm in the 6 mm group and 0.02 mm in the 11 mm group was found (P = 0.478). Soft tissue behavior was equal in both groups (Bleeding and plaque [P = 1.0] probing depth [P = 0.91]). **Conclusion:** One-year data indicate that treatment with the 6 mm implants is as reliable as treatment with the 11 mm implants. This provides a good treatment option in situations with limited bone height in the premolar and molar regions. Whether or not short implants provide a predictable treatment alternative to bone augmentation procedures remains to be investigated in the future randomized controlled clinical trials.

Quality assessment of systematic reviews on short dental implants

Elangovan S, Mawardi HH, Karimbux NY. J Periodontol. 2013 Jun;84(6):758-67.

Background: Critical analysis of published systematic reviews may help in understanding their strengths and weaknesses and identifying areas that need improvement. Short dental implants are becoming an important addition to the existing dental armamentarium. The aim of this overview is to analyze the quality of published systematic reviews focused on short dental implants using established checklists such as the assessment of multiple systematic reviews (AMSTAR). **Methods:** A search was conducted to retrieve reviews that used a systematic approach in article selection focusing on short dental implants in humans. Based on a set of inclusion and exclusion criteria, a total of 10 reviews were selected. Two independent reviewers appraised the quality of the selected reviews using AMSTAR and the checklist proposed by Glenny et al in 2003. Each article was given a total score based on the number of criteria that it fulfilled. **Results:** Six reviews satisfied ≤4 of the 11 AMSTAR items, and only two reviews satisfied nine of the 11 items. This study shows that published systematic reviews on short dental implants exhibit significant structural and methodological variability. Quality assessment using the Glenny checklist further confirmed the variability in the way systematic reviews were conducted and/or reported. A high correlation was observed between the two checklists' scores. **Conclusions:** Uniformity in the way systematic reviews are conducted and / or reported will increase the validity and clinical applicability of future reviews.

Plasma rich in growth factors in human extraction sockets: a radiographic and histomorphometric study on early bone deposition

Farina R, Bressan E, Taut A, Cucchi A, Trombelli L. Clin Oral Implants Res. 2013 Dec;24(12):1360-8.

Objectives: To determine whether and to what extent the additional application of plasma rich in growth factors (PRGF) to an extraction socket may influence the early bone deposition, as assessed by micro-computed tomography (micro-CT) scan as well as histomorphometric markers. **Material and methods:** Twenty-eight patients (age range: 34-74 years) contributing 36 extraction sockets were included in the study. Sockets were either treated with PRGF (PRGF group; 18 sites in 11 patients) or left to spontaneous healing (control group; 18 sites in 17 patients). Radiographic and histomorphometric analysis was performed on bone cores trephined from each healing socket after 4-6 (T1) or 7-10 (T2) weeks of healing. **Results:** Patients treated with PRGF application showed (i) similar bone volume and tissue mineral content, (ii) a trend, although not statistically significant, toward a greater number of CD68+ cells (at T1 and T2) and vVW+ cells (at T1), and (iii) a similar OCN staining score throughout the study, when compared with control group. **Conclusions:** Plasma rich in growth factors-treated group did not show any enhancement in early (4 and 8 weeks) bone deposition compared with control group.

Piezoelectric vs. conventional drilling in implant site preparation: pilot controlled randomized clinical trial with crossover design

Canullo L, Peñarrocha D, Peñarrocha M, Rocio AG, Penarrocha-Diago M. Clin Oral Implants Res. 2013 Oct 21.

Objective: To compare implant stability throughout osseointegration, peri-implant marginal bone loss, and success rates of implants placed with conventional and mixed drilling / piezoelectric osteotomy. **Materials and methods:** A pilot randomized-controlled trial was performed on 15 patients. Each patient received two implants in the mandibular molar region. All sites were prepared with conventionally up to the 2.8 mm wide drill. Osteotomies were randomly finalized with a 3 mm diameter drill (control group) or with two consecutive ultrasonic tips (2.8 mm and 3 mm wide, respectively) (test group). Resonance frequency analysis measurements were taken at implant placement and after 1, 3, 8, and 12 weeks. Peri-implant marginal bone loss 12 months after loading was calculated using periapical radiographs. Wilcoxon test for related samples was used to study differences in implant stability and in peri-implant marginal bone loss between the two groups. **Results:** Twenty-nine of 30 implants osseointegrated successfully (one failure in the control group). Stability was significantly higher in the test group at the 8th week assessment; differences were non-significant at all other time-points. Longitudinally, differences were observed between the patterns of implant stability changes: in the test group stability increased more progressively, while in the control group an abrupt change occurred between the 8th and 12th weeks assessments. No difference was found in peri-implant marginal bone loss between the groups. All 29 implants were functionally successful at the 15-month visit. **Conclusions:** Within the limit of this pilot study (small sample size, short follow-up), data suggested that implant stability might develop slightly faster when implant site osteotomy is performed with a mixed drilling/ultrasonic technique.

Analysis of occlusal stresses transmitted to the inferior alveolar nerve by multiple threaded implants

Sammartino G, Wang HL, Citarella R, Lepore M, Marenzi G. J Periodontol. 2013 Nov;84(11):1655-61.

Background: Potential nerve injury or loss of sensation can occur after mandibular implant placement or loading. To avoid this type of damage, it is critical to determine the proper distance from implants to the mandibular nerve. Hence, the purpose of this study is to use biomechanical analyses to determine the safe distance from multiple implants to the inferior alveolar nerve. **Methods:** Using the boundary element method, a numerical mandibular model was designed to simulate a mandibular segment containing multiple threaded fixtures. This model allows assessment of the pressure, as induced by occlusal loads, on the trigeminal nerve. Such pressure distribution was evaluated against different distances from the fixtures

to the mandibular canal, against the possible lack of the central fixture in a three-abutment configuration, and against different levels of implant osseointegration. All the simulations considered a canal that is orthogonal to the implant axis. **Results:** Nerve pressure increased quickly when the implant-canal distance decreased in the range studied. Lack of the central implant to support the central abutment caused major increases in nerve pressure. **Conclusions:** This study suggests a minimal implant-canal distance of 1 mm to prevent inferior alveolar nerve damage caused by three connected implants. For clinical safety, an additional 0.5 mm is recommended as a cushion, so a 1.5-mm minimal distance should be planned to avoid potential nerve injury.

The frequency of peri-implant diseases: a systematic review and meta-analysis

Atieh MA, Alsabeeha NH, Faggion CM Jr, Duncan WJ. J Periodontol. 2013 Nov;84(11):1586-98.

Background: The peri-implant diseases, namely peri-implant mucositis and peri-implantitis, have been extensively studied. However, little is known about the true magnitude of the problem, owing mainly to the lack of consistent and definite diagnostic criteria used to describe the condition. The objective of the present review is to systematically estimate the overall frequency of peri-implant diseases in general and high-risk patients. **Methods:** The systematic review is prepared according to the Meta-analysis of Observational Studies in Epidemiology statement. Studies were searched in four electronic databases, complemented by manual searching. The quality of the studies was assessed according to Strengthening the Reporting of Observational Studies in Epidemiology, and the data were analyzed using statistical software. **Results:** Of 504 studies identified, nine studies with 1,497 participants and 6,283 implants were included. The summary estimates for the frequency of peri-implant mucositis were 63.4% of participants and 30.7% of implants, and those of peri-implantitis were 18.8% of participants and 9.6% of implants. A higher frequency of occurrence of peri-implant diseases was recorded for smokers, with a summary estimate of 36.3%. Supportive periodontal therapy seemed to reduce the rate of occurrence of peri-implant diseases. **Conclusions:** Peri-implant diseases are not uncommon following implant therapy. Long-term maintenance care for high-risk groups is essential to reduce the risk of peri-implantitis. Informed consent for patients receiving implant treatment must include the need for such maintenance therapy.

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