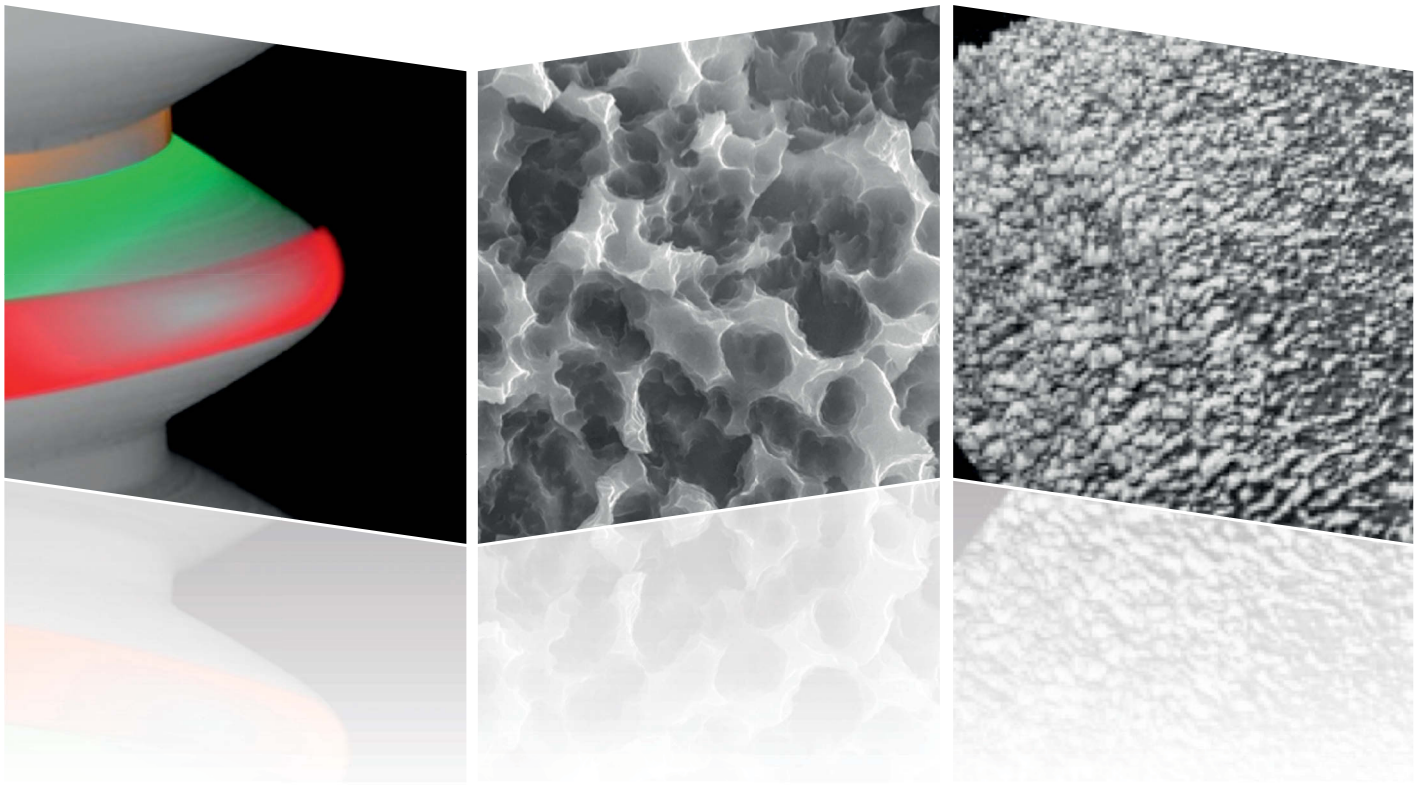
Dental Press Implantology

Volume 6
Number 2
April / May / June 2012



ISSN 2237-650X

DentalPress PUBLISHING

Dental Press Implantology

Dental Press Implantology. 2012 Apr-June;6(2):1-112

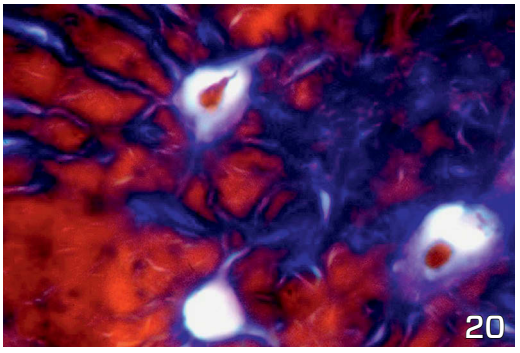
ISSN 2237-650X

Dental Press
Implantology

V. 6, N. 2 - April / May / June - 2012

Interview

Explanations and Applications



Ask the Expert

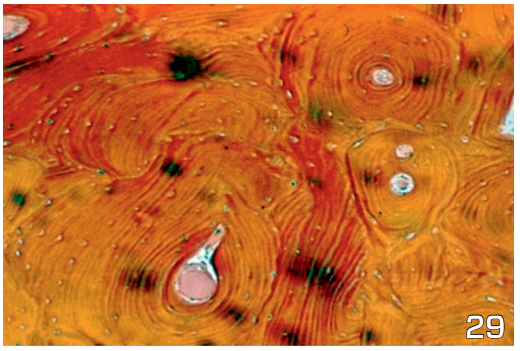


Image and Science

Observatory

EDITORS
Carlos Eduardo Francischone - FOB-USP/Bauru, São Leopoldo Mandic
Alberto Consolaro - FOB-USP/Bauru, FORP-USP/Ribeirão Preto

EDITOR EMERITUS
Maurício Guimarães Araújo - UEM/PR

ASSISTANT EDITORS
Carina Gisele Costa Bispo - UEM/PR
Cleverson de Oliveira e Silva - UEM/PR
Dario Augusto Oliveira Miranda - UEFS/BA
Flávia Sukekava - FO/USP
Franklin Moreira Leahy - Clínica Particular/BA
Luis Rogério Duarte - UFBA/BA

PUBLISHER
Laurindo Z. Furquim - UEM/PR

EDITORIAL CONSULTANTS
André Pelegrine - SLMandic/SP
Angelo Menuci Neto - ABO/RS
Bruno Salles Sotto-Maior - USC/SP
Carlos Eduardo Francischone Junior - Clínica Particular/SP
Carlos Nelson Elias, Instituto Militar de Engenharia/RJ
César Augusto Magalhães Benfatti - UFSC/SC
Clovis Mariano Faggion Jr. - Universidade de Heidelberg, Alemanha
Cristiane Ap. de Oliveira - UPF/RS
Eduardo Feres - UFRJ/RJ
Elaine Cristina Escobar - FMU – SP
Érica Del Peloso Ribeiro - FOUFBA/EBMSP/BA
Fabio Valverde Rodrigues Bastos Neto - Clínica Particular/SP
Fernanda Vieira Ribeiro - UNIP/SP
Flávia Matarazzo - UEM/PR
Francisco A. Mollo Jr. - UNESP – SP
Giuseppe Alexandre Romito - FUNDECTO – USP/SP
Gustavo Jacobucci Farah - UEM/PR
Hugo Nary Filho - USC/SP
Isabella Maria Porto de Araujo Britto - FO-USP/SP
Jean-Paul Martinet - Universidade de Buenos Aires - Argentina
Jessica Mie Ferreira Koyama Takahashi - USC/SP
João Carlos Cerveira Paixão - Universidade de Pádua - Itália
Jorge Luis Garcia - Clínica Particular - Argentina
José Cícero Dinato - UFRGS/RS
José Valdívia - Clínica Particular - Chile
Juan Carlos Abarno - Universidade Católica do Uruguai - Uruguai
Luciana Salles Branco de Almeida - UNICEUMA/MA
Luciene Cristina de Figueiredo - UnG/SP
Luis Lima - USP/SP
Luiz Antonio Salata - FORP/USP
Luiz Guilhermo Peredo Paz - Bolívia
Luiz Meirelles - Universidade de Gotemburgo - Suécia
Marco Antonio Bottino - UNESP/SP
Mario Groisman - UNIGRANRIO/RJ
Marly Kimie Sonohara Gonzales - COR - Argentina
Mauro Santamaria - FOP/UNICAMP
Patrícia Furtado Gonçalves - UFVJM/ MG
Paulo Maló - Clínica Particular - Portugal
Paulo Martins Ferreira - FOB/USP
Paulo Sérgio Perri de Carvalho - FOB-USP e FOA-UNESP
Rafael dos Santos Silva - UEM/PR
Reinaldo Brito e Dias - FOUSP
Ricardo de Souza Magini - UFSC/SC
Ricardo Fisher - UERJ/RJ
Ronaldo de Barcelos Santana - UFF/RJ
Sandro Bittencourt - Esc. Bahiana de Medicina e Saúde Pública/BA
Sidney Kina – Clínica Particular - Maringá/PR
Vanessa Tubero Euzebio Alves - FO-USP/SP
Verônica Carvalho - UNINOVE/SP
Waldemar Daudt Polido - Clínica Particular - Porto Alegre/RS
Wellington Bonachela - FOB/USP

DIRECTOR Teresa R. D'Aurea Furquim - **EDITORIAL DIRECTORS** Bruno D'Aurea Furquim e Rachel Furquim Marson - **MARKETING DIRECTOR** Fernando Marson - **INFORMATION ANALYST** Carlos Alexandre Venancio - **EDITORIAL PRODUCER** Júnior Bianco - **GRAPHIC AND ELECTRONIC PRODUCTION** Andrés Sebastián, Diego Ricardo Pinaffo, Gildásio Oliveira Reis Júnior, Michelly Andressa Palma, Tatiane Comochena - **INTERNET** Adriana Azevedo Vasconcelos, Fernanda de Castro e Silva, Fernando Truculo Evangelista - **DEPARTMENT OF COURSES AND EVENTS** Ana Claudia da Silva, Rachel Furquim Scattolin - **DEPARTAMENTO COMERCIAL** Roseneide Martins - **SUBMISSION OF ARTICLES** Adna Miranda - **LIBRARY/STANDARD** Simone Lima Lopes Rafael - **REVIEW** Ronis Furquim Siqueira, Wesley Nazeazeno - **ACCOUNTING DEPARTMENT** Roseli Martins, Cléber Augusto Rafael, Lucyane Plonkóski Nogueira - **STOCK** Diego Matheus Moraes dos Santos - **SECRETARY** Rosane Aparecida Albino.

Dental Press Implantology (ISSN 2237-650X) is a quarterly publication (four issues per year) of the Dental Press Ensino e Pesquisa Ltda. - Av. Euclides da Cunha, 1.718 - Zona 5 - Zip code: 87.015-180 - Maringá/PR - Brazil. All materials published are solely of responsibility of their authors. Opinions expressed therein do not necessarily correspond to the opinions of the Journal. Advertising service is of responsibility of advertisers.

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

INDEXING:

Dental Press Implantology is indexed by BIREME, on **BBO** basis- 2007.

International Cataloging-in-Publication (CIP) Data

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

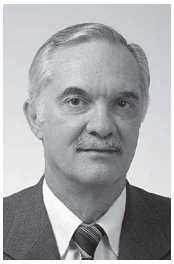
Trimestral
Continuação de: Revista Dental Press de Periodontia e Implantologia (v. 1, n. 1 – 2007-2011 – ISSN 1980-2269)

ISSN 2237-650X

1. Periodontia. Implantologia (Odontologia) – Periódicos I. Dental Press International. II. Título.

CDD. 617.643005

Editors



Prof. Dr.
Carlos Eduardo
Francischone

Prof. Dr.
Alberto Consolaro

Every day, bone biology supports clinical practice and implants are improved to optimize the relationship with the tissues, cells and molecules. As an example, there is a series of works by Márcio Borges Rosa, Tomas Albrektsson, Carlos Eduardo Francischone, Humberto Osvaldo Schwartz Filho and Ann Wennerberg on the micrometric characterization of surfaces.

The osteocyte increasingly assumes the role of primary cell or element of fundamental importance in the regulation of bone biology, as it is discussed in the section *Explanations and Applications*. On the other hand, the role and implications of BMP in Implantology were explored in Ask the Expert section, with "Guidelines for clinical use of BMP".

The present edition is characterized by the variety of information-rich works, applied to the clinician and clinical practice. Plus, to the delight of the eyes and induction to reflections, we have a picture of the *Image and Science section* and the selectivity of the *Observatory* on literature.

In the III International Congress of Implantology, from September 13th to 15th, we will live with many of our collaborators revealing closely their latest findings and discuss them with experts and other researchers. It will be a great opportunity to experience this scientific environment. In late May, we'll also have the II Regional Meeting of Osseointegration to attend in Salvador. This meeting represents a preamble, with its theme on *Osseointegration Scientific Evidences: Paradigms and challenges*.

Let's enjoy this!

Carlos Eduardo Francischone and Alberto Consolaro

© 2012 Dental Press Implantology

III International Congress of IMPLANTOLOGY

Promotion

FOB - Faculdade de Odontologia de Bauru - USP
FO - Faculdade de Odontologia da USP
FORP - Faculdade de Odontologia de Ribeirão Preto - USP

Bauru
São Paulo
Brazil

13 - 15 - September 2012

50 ANOS 1962 - 2012 FOB USP

www.congressoimplantologia.com.br

Speaker


Ann Wennerberg


Gavriel Chaushu


Georg Watzek


Giovanni Cricchio


Jean Pierre Bernard


John E. Davies


Tomas Albrektsson


Torsten Jemt

Support

FUNORP Fundação Odontológica de Ribeirão Preto

PRCEU pró-reitoria de cultura e extensão universitária USP

Organization

OXFORD assessoria em eventos A marca do conhecimento 18 anos

PABX: 55 16 3967 1003
congressoimplantologia@oxfordeventos.com.br

S. I. N.
Sistema de Implante

Nosso propósito é desenvolver produtos que mudam a vida, os sorrisos e a autoestima das pessoas. Fazemos isso através do investimento contínuo em relacionamentos, conhecimento e pesquisas que nos ajudam a produzir soluções práticas, cada vez melhores e mais completas junto à comunidade odontológica.

www.sinimplante.com.br

0800 770 8290

Carlos Nelson Elias

Historically, and by definition, Dentistry is a profession belonging to the health sciences, which takes care of human health, studies and treats the stomatognathic system, comprising the face, neck and oral cavity, including bones, masticatory muscles, joints, teeth, tissues, vessels and nerves.

Engineering is a profession that is part of the exact sciences, to acquire and apply mathematical, scientific and technical knowledge in the creation, development and implementation of utilities, such as materials, structures, machines, devices, systems or processes that perform a particular function or purpose. In creation processes, development and implementation, Engineering combines many expertise in order to enable the utilities, taking into account society, technology, economy and environment.

As in Dentistry, Engineering is also a very comprehensive science, comprising a range of more specialized branches, each one with a more specific emphasis on certain fields of application and certain types of technology.

In Brazil, over the past 20 years of osseointegration, it has been observed a marked and growing association between these two distinct areas, making Dentistry and Engineering to exchange information and use cross-terminologies to name, define and better understand some classic phenomena widely studied in literature.

Dental Press Implantology brings to this interview one of the greatest scholars, competent professional and responsible for this healthy interaction: The Metallurgical Engineer, MSc and PhD in Materials Science from the Military Institute of Engineering (IME), a scientist and researcher, Prof. Dr. Carlos Nelson Elias. He discusses various issues related to the Brazilian Dentistry and contemporary Implantology, where he has played an important role and still participates decisively in the development of materials, designs and surfaces of implants used in the national market. An enlightening exhibition revealing the great history of osseointegration in Brazil.

He is, currently, an Associate Professor of IME, twice selected as "Scientist of the state of Rio de Janeiro" (2004 and 2008), a researcher at the Research Foundation of the State of Rio de Janeiro (FAPERJ) and fellow researcher level 1C of the National Council for Scientific and Technological Development (CNPq). Dr. Carlos Nelson Elias is also collaborator of the courses of Orthodontics – UFRJ, Endodontics – UERJ, Metallurgy – UFF and Endodontics – Estácio de Sá. He has experience in Metallurgy and Materials Engineering, with an emphasis in Physical Metallurgy, working on coronary stents, dental materials, development of dental implants, surface modification of dental implants, endodontic instruments, orthodontic appliances, coloring of titanium and simulation.

Our interviewee has 185 articles published in scientific journals, one book, 17 book chapters, 230 papers presented at national and international conferences, 40 from MSc and 14 from PhD. Consultant of the journal Acta Biomaterialia, American Journal of Orthodontics, Clinical Implant Dental Research, Implant News, Indian Journal of Dental Research, Journal of Biomedical Materials Research Part B, Journal of Mechanical Behaviour of Biomedical Materials, Journal of Nanomedicine, Materials Research, Materials Science and Engineering: C, Revista Brasileira de Engenharia Biomédica, Revista Gaúcha de Odontologia, Surface and Coating Technology. Besides having a patent application in the Brazilian PTO, related to the surface treatment of implants.

With this vast experience, it is common to hear in the background of the Brazilian Implantology that the recognized researcher and professor Dr. Tomas Albrektsson (University of Gothenburg) is to Sweden and to the world as respected as the researcher and professor Dr. Carlos Nelson Elias (Military Institute of Engineering – IME) is to Brazil and to the world. Science and research are thankful to them!

Luiz Rogério Duarte

How to mention this section: Elias CA. Interview. Carlos Nelson Elias. Dental Press Implantol. 2012 Apr-June;6(2):8-18.

Submitted on:03/23/2012
Reviewed and approved: 03/26/2012

Your basic graduation is in Engineering. What is the sub-area and how did you began working with Dentistry?

My graduation is in Metallurgical Engineering with MSc and PhD in Materials Science.

After the doctorate (1990) I was invited to be a teacher in the Militar Institute of Engineering (IME) and minister the discipline "Failure analysis of materials". At the end of this course, students presented an experimental work. When defining the work for the students, an endodontist came to the IME (Dr Hélio Pereira Lopes) with a fractured endodontic instrument. Dr Hélio wanted to know the cause of the fracture. I forwarded the mission to the best student in the class. My surprise was that the explanations and mechanisms involved in the failure of the Gates bur were similar to an axis of a tank, with a diameter of 2 inches. This intrigued me and I did the work myself to check. The conclusion was that the failure mechanisms of materials are similar and independent of the size of the piece. This happened 22 years ago and even today Dr Hélio conducts researches in the IME every Wednesday.

We got used to hearing comments that you are almost a dentist. How do you, Sir, see this statement and how did you got used to so many different terms from the fields of Orthodontics, Implantology and Dental Prosthesis?

Being almost dentist is a joke from my friends. Dentistry is much more complex than engineering. For example, students, when they get in our laboratory to do some mechanical testing, they bring 30 samples. It's hard to convince them, as well as their supervisors, that in the materials area the "N" is 5. The behavior of materials is predictable, while the predictability of the performance of the organism involves variables which have no control. Here is the beauty of Materials Science, to develop biomaterials that have predictable interactions with the organism. We are no longer making adjustments to the materials used in other areas. The titanium alloy itself was developed to another area and is widely used as a biomaterial.

As for the different terms, I and Dr Hélio talked over 2 years without understanding each other. Yet it is still difficult to accept some terms like "shear bond strength", "brittle", "wire gauge" and others.

When did your involvement begin in the production of implants in Brazil? What is your participation in this governmental policy of industrial technical development?

The beginning of my activities in implant was not planned. Dr José Henrique Cavalcanti introduced me to Dr Rodolfo C. Alba 18 years ago (Conexão Sistemas de Prótese). On the occasion, Dr Rodolfo produced prosthetic components, wanted to produce implants and had many problems with the production process.

The first job was to develop an Au-Pd alloy for screws. Using the phase diagrams was possible to select the color and chemical composition of the alloy. This alloy is still used to make the connection gold screws for prostheses. The second work that I received from Conexão seemed to me very simple: "Washing implants and removing manufacturing oils". When I started studying dental implants I found that the problem was complex and the surface could not have any contaminants influencing the success of treatment. To solve the immediate problem and save some time, we used carbon tetrachloride. This material requires a lot of care when using it and its use was ceased soon after we develop another method, which is used nowadays.

© 2012 Dental Press Implantology

The first works occurred in an era when the imported implants prevailed in the national market. Some practitioners had a craft production with low quality. We cannot deny that the company Conexão was a major responsible for the development of the national market. Since the first congresses, there has always been the participation and interaction of teachers and users of all systems. The goal has always been to "develop the national market with quality."

Considering that Conexão was one of the first companies to manufacture implants in Brazil on an industrial scale and I participated in this challenge, I admit that I had a small part in the development of the market. After my participation in the industrial production, they started sending me invitations to seminars, conferences and participation in ABNT to create the technical standards. These activities allowed the transmission of new concepts, so far ignored by professionals.

Militar Institute of Engineering – Rio de Janeiro, Brazil.

In how many graduation courses do you work as a collaborator today? What is your work routine at the IME?

I do not know the number of post-graduation courses that I cooperate. Many students come to me and I do not know their origin. Students showing interest in researching, developing scientific knowledge and not just doing a job for a diploma will always be welcome.

I work at the IME as a teacher in Biomaterials but I have to make many trips to attend courses, seminars, conferences and demand of resources for research. In 2011 there were 34 trips, working about 50 hours / week to monitor the work of our dentists students from MSc and PhD in Materials Science.

Talking specifically about implants, how do you see the quality of evaluation of these products by the companies? What methods of control does the dentist have on these products in terms of market and government?

Firms have great difficulty in the analysis of their products. This is due to the lack of qualified laboratories and costs of analyzes. Only the best companies make the product evaluation for validation and registration at ANVISA. Some companies refuse to provide products for studies or they do not request proof test, fearing there will be information transfer to other companies. Among researchers there is an ethic in which the results of the work belong to the company concerned and cannot be disclosed without permission. Still, when we analyze the implants from major national companies we have observed that some present similar quality to the imported implants.

Professionals find it difficult to assess the quality of implants since there is the need for electron microscopy.

© 2012 Dental Press Implantology

Indirectly, the quality can be evaluated by the product presentation, visual finish, with adaptations components, surgical instruments resistance and ease to handle. Also, making records and monitoring of patients.

The implant surfaces development is much studied by companies in terms of marketing. How to assess whether the product really works the way it is said?

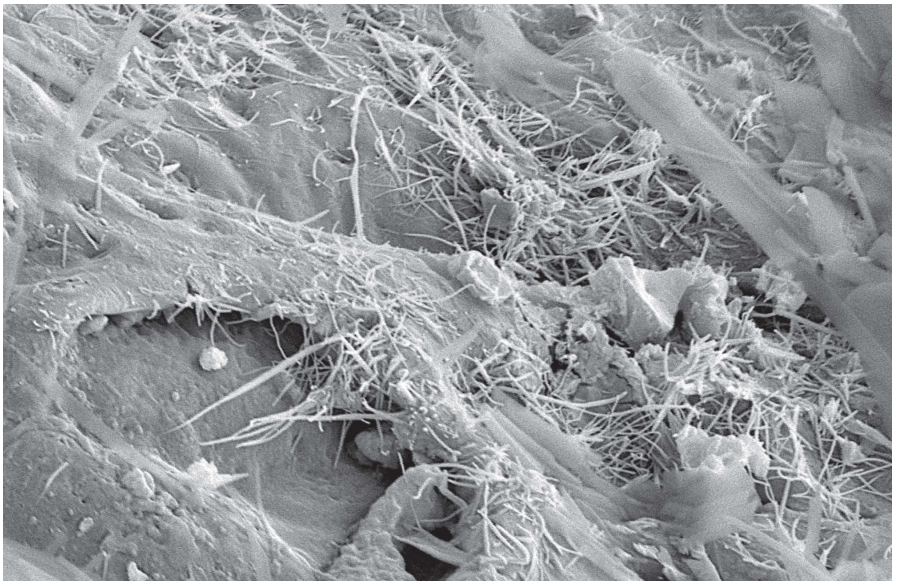
The surface treatment is one of the parameters used as company marketing since it is essential in the selection of surgical technique, site of installation and for osseointegration. The quality evaluation can be done by controlling the rate of success and analysis of causes of errors, except the spurious losses due to the product. The company itself has an interest in these data.

We know that you have developed a surface that has shown excellent results. How was the experience and how long did it take to be on the market?

The development of surface treatments involves *in vitro* and *in vivo* trials. We begin by selecting the treatment methodology (acid-etching, abrasive blasting, anodizing, particle deposition or combination). After obtaining the samples of different treatments it is made the surface analysis in a scanning electron microscope (SEM) for selecting the treatment conditions that showed the best roughness, homogeneity, cavities size and other parameters. Based on the experience gained over the years, through the SEM image it is possible to know whether a particular surface have or not properties suitable for osseointegration. Following, we cultured cells (osteoblasts, fibronectin, etc.). The last step requires the cooperation of surgeons to animal testing. We repeated the tests with guinea pigs at least 3 times to guarantee the results. The development takes about 5 years. The last phase is the clinical proof which is controlled by the company. At the end of all this process, comes the frustration knowing that another company made the commercial launch already.

You are a senior researcher of CNPq. What is the importance of this fact in your research? Do you, Sir, have had support in this regard?

I am a level I researcher at CNPq. To be held in this position there is a curriculum evaluation by the partners. Less than 10% of researchers have this classification. Being level I does not have big advantages since we have to take more students, publications, projects, the responsibility to evaluate about 25 projects per year, reviewing the work of dozens of different



Interaction of osteoblasts with titanium surface.

© 2012 Dental Press Implantology

scientific journals and worse, CNPq refuses to help the participation in international congresses.

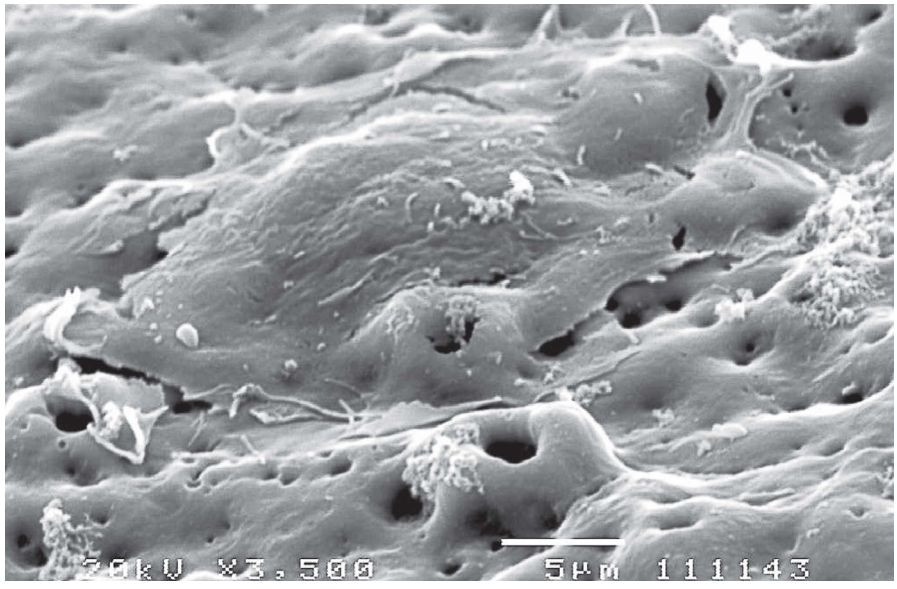
The advantage is that government agencies promoting research (CNPq, CAPES, FINEP, FAPERJ) consider the curriculum as an assessment item of the project to obtain resources.

What lines of research currently occupy your department? Is there a new trend that could influence the market?

In the EMI we have MSc and PhD in Materials Science. The course is free and most students have scholarship. Several dentists students who had attended our courses are in prominent position in universities. Nowadays, we have dentists working in Endodontics, Orthodontics, Prosthodontics, Periodontics and with implants. The works involve the characterization of materials and products, as well as development of biomaterials. All teachers in the Program of Materials Science at IME do research with dual application. Today we have researches on metals (implants and Ti, Cr, Co and Inox prostheses), polymers (biodegradable and bioabsorbable), ceramic (bioglasses, synthetic hydroxyapatite, scaffold) and composites (adhesives with nanoparticles).

Currently, our chief concern is to set the proper torque for implant placement. This work is developed with the guidance of Prof. Paulo Perri de Carvalho, which is consistent with the idea that the implant installation does not require high torques. The installation torque should be enough to get primary stability. High torques can increase the primary stability but the result is not worth the injuries to the bone and the implant. Excessive torque compresses the bone, reduce the local blood vascularization, creating cracks in the bone and require more time for osseointegration.

We are used to hear that all imported product are better than the national ones. Regarding dental implants, do you agree with this statement?



Osteoblast during cell spread contacting the surface of the implant.

No. There are Brazilian companies that offer excellent products. I've done consulting for an European company, which to reduce costs changed the manufacturing process, did not analyze the influences on product quality and had significant increasing in implant loss. So there are good products in the national and international market, as well as low quality products. Professionals should be aware of the company's infrastructure, monitoring quality control of products, whether there are investments in research, qualification of assessors, publications with

reputable scientific evidence and developments. Companies encourage visits to their facilities and provide the information permitted to evaluate.

How many theses have you oriented? What areas does your research cover today?

I have oriented 40 master students and 18 doctoral students. For being an army officer I worked with shields and explosives until 1994. From this date on, only in the biomaterials area. This work resulted in 240 publications in journals and 280 conference presentations. Biomaterials researches involve applications in dentistry, cardiology and orthopedics. I try to do basic research that can be harnessed for the development of products. In most cases there is participation of companies.

What is your experience about nanotechnology? Do you believe that this level of greatness can improve cell behavior regarding to osseointegration?

It is defined nanometric dimensions as those having size less than 100 nanometers. When making the implant surface analysis it shows that all have some characteristics with nanometric size. The difference is in the fact that this feature arose due to treatment with the goal of obtaining morphology with micrometer dimension or is derived from a specific treatment to create nanoscale features. Even the machined implant surfaces and with no treatments have nanoscale microcavities. There are implants which are processed to form nano surface roughness and others with deposition of nanoparticles in the surface (hydroxyapatite and other phosphates). These implants present some evidences that the surface improves the healing process and differentiation of mesenchymal cells. The explanation is not yet known, it was only found, because there are several researches on this topic.

What countries dominate the titanium processing technology as raw material? What is Brazil's position in this area?

The development of titanium occurred for applications in the military area (fighter aircraft and military weapons). Therefore, only warlike countries (United States, Germany, France, Britain, China and Russia) and Japan dominate the production of titanium metal.

In spite of Brazil having several deposits of titanium ore to produce titanium oxide in particulate form, it does not produce metallic titanium. The main Brazilian titanium ore mine in exploitation is located on the northeastern coast, right on the coast of Paraíba, immediately south of the border of the Rio Grande do Norte state, in a place called Guaju, in the county of Mataraca, approximately 125 km from João Pessoa. Around 95% of global exploitation of deposits of titanium ore is consumed by the pigment industry. The titanium pigment has high whiteness power, covering, brightness and opacity, being superior to other white pigments, such as lead carbonate, sulfates of barium and zinc, and zinc oxide. The pigments in particulate titanium oxide are used in the plastics, rubbers, textiles, inks, leather, paper and cosmetic.

Is titanium difficult to machine? What influence does this item have on the final quality of the product?

Titanium has a hexagonal crystal structure and this makes it difficult to be deformed and cut. During cutting, tools pluck pieces of titanium without cutting it. Plus, titanium has exothermic reaction when in contact with oxygen and during machining of implants there is the need of much cooling with special oils to prevent fire from lathes. All these factors make it difficult to machining, the surface finishing and manufacturing of implants.

© 2012 Dental Press Implantology

We have young talent in research, as Prof. Luiz Meirelles (University of Rochester - USA) who ended up living and working abroad. Do you think that Brazil loses important manpower by not opening space for these people?

Our manpower market is big, with lack of qualified people to work. Only in 2011, CREA allowed up to 20,000 engineers to work in Brazil. On the other hand, there are some people like Prof. Meirelles, who are extremely skilled in one area and find it difficult to be placed. Brazil has a high investment in training doctors abroad and we don't take this people back. The cost to train a doctor abroad is approximately U$50,000.00. Universities take the largest number of doctors. Only big companies hire doctors to research activities, since other industries are unaware of the potential of doctorate professionals and employ them in other functions.

Zirconia became a headache in the esthetic cases in Implantology. What level of knowledge do we have to believe in the durability and strength of this material?

For 15 years zirconia was used in orthopedic prostheses and it presented some problems. Many researches were made and it was found that the purity, particle size and process influence the degradation of zirconia. Based on these results all the processing and the raw material were changed.

For the use of zirconia in dental prostheses there are certain limitations, mainly the thickness of the prosthesis, the size of the connectors, cantilever arm of multiple prosthesis, and the more critical one: hardness of the material. Moreover, it is observed the occurrence of chipping of the ceramic coating. We still have some problems that hinder its use in esthetic areas.

To work with zirconia is needed specific expertise from professionals. The preparation of zirconia and behavior is very different from alumina that is dominated by the prosthetic and prosthetists.

You were also recognized for your mathematical explanations about the biomechanics affecting dental implants. What is the most important on this premise: The theory or practice?

The performance of implants can be predicted by applying the concepts of biomechanics. All our implants developments are started by finite element simulations. In the simulations we employ the same equations that control the phenomena of metallic structures known for decades. Through these mathematical equations it is possible to determine the maximum resistance of implants and components, changing geometries and propose new ways. After the simulations, prototypes are produced for testing and validation of mechanical simulations.

Despite all this effort and conditions assumptions with critical loads, there are still cases of fracture implants. We found that the shapes of implants undergo changes, and surgical techniques, as well as prosthesis planning remain unchanged. For each new implant, training is necessary for the correct use.

In this context, the theory must be supported by the clinic. The theory provides the appropriate data that sometimes are not feasible in clinical application.

Returning to the surfaces of implants, how is the industrial processing of them? Do companies acquire this knowledge or outsource this service? Is there some sort of ANVISA control over them?

© 2012 Dental Press Implantology

Most companies acquires the methods of surface treatment of implants. Few outsource or develop these treatments. When the company control this process it defines in detail the steps to be followed and validates the methodology. With the generated documents it requests the registering. ANVISA controls the company's infrastructure, analyzes the description of the treatment methodology and the existence of process and employees validation but does not analyze the quality of the final product.

Most Brazilian companies use surface treatments already recognized internationally by other companies. Does the type of surface treatment, alone, ensures the roughness pattern obtained?

If there is process validation and complete observance of treatment methodology, all implants of the same company have a high probability of being similar. This is not enough, though. The process may be standardized at the company, but the characteristics of morphologies may be not the most appropriate. Just because the company uses a particular treatment process, for example, acid-etching, it does not mean that the surfaces of the implants are similar. Companies use different acid, concentrations, time and temperature. Again, it is important to conduct research and clinical evidence.

Prof. Tomas Albrektsson and Prof. Carlos Nelson Elias during XIV CIOBA in Salvador – Brazil, (2006).

Studies have shown that the surface roughness with a S_a between 0.85 and 1 µm would be ideal for bone repair and this finding is not well spread by companies, in general. How to know if we are making use of an implant with this roughness?

In the past machined implants were marketed and coated with plasma spray. The firsts had a roughness around 0.75 µm, anisotropic surface and machining marks. The latter had higher roughness, around 2.5 µm, which does not influence the behavior of cells and were also removed from the market. The two surfaces had major limitations for employment for not having adequate roughness; were not suitable for low density bone or immediate loading. Research has shown that treatments with acid-etching or abrasive blasting create roughness around 1.0 µm. The difficulty is to get the same homogeneity and roughness over the surface. The best implants have surface roughness in the range mentioned, from 0.85 to 1.0 µm.

To find out the efficiency of the surface, the professional must be based on scientific publications of products, more than in marketing documents.

What is the real influence of a suitable surface treatment in non-standard cases, such as: Short implants and grafting area?

The surface treatment influences the primary, secondary and tertiary stability. After osseointegration, implants with treated surfaces are capable of oral load

distribution more efficiently. This is very important as in critical situations for short implants, regenerated bone sites and in patients considered critical.

What is already proven on the effect of nanostructures in accelerating and improving the repair process?

There are only proofs that it improves performance, but it is still lacking explanations of the mechanisms involved in the process of osseointegration.

How about the incorporation of ions on the surface or even its polarization?

This is proven. The incorporation of phosphate nanoparticles, atoms of Ca, P, Mg and F improve the biocompatibility of titanium. Treatment of polarization, also known as anodization, electrochemical and oxidation, allows the incorporation of any type of particle on the surface of the implant to increase its efficiency.

As an expert in biomaterial, how would you classify titanium? Biocompatible, inert or bioactive?

There are two classifications of biomaterials regarding the biological behavior. The first one classifies them as biotolerant, bioinert and bioactive. The second classifies biomaterials in bioinert, bioactive and bioreactive.

The apparent discrepancy in the terms used in the classification of biomaterials does not exist. The two classifications are equivalent. A biomaterial considered biotolerant (stainless steel alloys and Co-Cr) is considered as bioinert in the other criteria. Titanium is considered bioinert in a classification and bioactive in the other one. The most important thing is the criteria used to classify biomaterials.

Biotolerant or bioinert: The implants are separated from the adjacent bone by a layer of soft and fibrous tissue. It is not observed contact in osteogenesis. Almost all synthetic polymers and the vast majority of metals and ceramics observe this category. Examples: gold, Co-Cr alloys, stainless steel, zirconia, alumina, polyethylene, polyamide, polymethacrylate, polytetrafluoroethylene and polyurethane.

Bioinert or bioactive: The implants are in direct contact with bone cells, with participation in osteogenesis. Despite not observing a chemical reaction between the implant and bone tissue, occurs the connection with the biomaterial and bone cells, characterizing osseointegration. Among these biomaterials, it is highlighted the commercially pure titanium, tantalum and niobium.

Bioactive or bioreactive: In this case there is interaction between the implant and the bone tissue with influence in the mechanisms involved in osteogenesis. There is ions exchange with the tissues; there are chemical bonds between the biomaterial and the tissues, promoting osteoconduction. Among this biomaterials class are the tricalcium phosphate, tetracalcium phosphate, bioglasses and hydroxyapatite.

Currently, several companies have used titanium alloys in the manufacturing of implants. Would there be some loss in bone response?

Currently, there are only three metals that present osseointegration: Commercially pure titanium, niobium and tantalum. It is understood as osseointegration the definition of ISO 16443, according to which "osseointegration is the contact of the bone cells with the biomaterial surface." The Ti-6Al-4V alloy has no osseointegration and the example is the mini-implants used for orthodontic anchorage. However, when

© 2012 Dental Press Implantology

the implants of Ti-6Al-4V are subjected to surface treatment to have a predominance of titanium oxide, there is osseointegration. For those ceramic and other metal alloys a treatment promoting osseointegration is still not known.

The most part of the effort has focused on the relationship of the implant surface with the bone, with remarkable progress. However, very little has been developed to improve their relationship with the soft tissues. Would this not be the time for focusing in this area? What is the current status of research regarding this?

In the past, treatment with dental implants aimed at the restoration of masticatory ability and the success of the treatment was assessed by osseointegration. Today, the patient wants immediate restoration, followed by esthetics. In this case, the biological sealing is important. Few studies examine the interaction soft tissue with prosthesis material, being that we constantly observe in patients a gingival retraction showing the metal parts, damaging esthetics. There is a dichotomy between the esthetic and the sealing. Not always the biomaterial that has the best esthetics (ceramic), presents the best biological sealing and mechanical strength.

For the manufacture of ceramic prosthesis we use materials that were developed for other applications (alumina and zirconia).

We need to research materials for specific application with mechanical strength, biocompatibility and ability to allow the adhesion of fibroblasts. This area still has a gap.

At last, we would like to know about future trends. Which are the new ways of osseointegration in terms of biomaterials?

Researches are focused on the development of implants where it is possible to incorporate patient's own cells to accelerate osseointegration. We have already conducted researches with fibronectin which presented good results in *in vitro* assays. The adhesion of RGD also gives good results. There is difficulty in incorporating BMP.

All these procedures are performed in very small scale and with control. To transform these researches in products we need to run through many obstacles, including the incorporation of cells and keep them active for long times, even after sterilization. Incorporate controlled amount of different products. The risk is to incorporate something that will be removed by osteoclastic activity.

COORDINATORS

Luis Rogério Duarte

» PhD in Implantology, São Leopoldo Mandic School of Dentistry.

» E-mail: luisrogerioduarte@mac.com

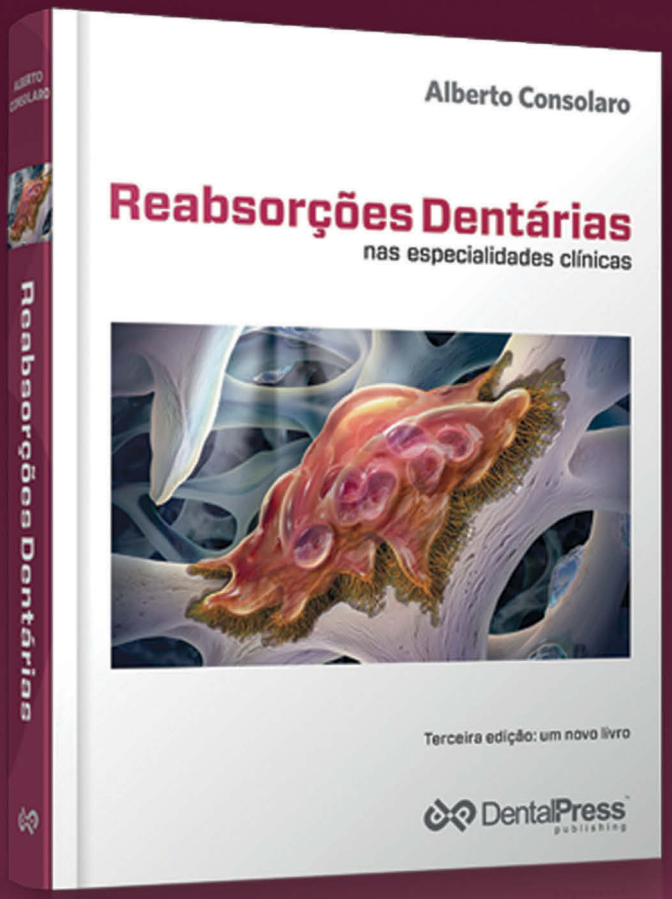
Franklin Moreira Leahy

» PhD student of Implantology, São Leopoldo Mandic School of Dentistry.

» E-mail: franklinleahy@mac.com

© 2012 Dental Press Implantology

lançamento



3ª edição: um novo livro

Não é nave espacial
Não é uma arraia...
é um clasto!

- Mais de 800 páginas em 27 capítulos.
- Atualizado e com muitas imagens e casos novos.
- Referências online atualizadas constantemente.
- Uma obra de arte gráfica para o clínico.

Reabsorções Dentárias
nas especialidades clínicas

www.**dentalpress**.com.br/reab2012

Osteocytes: On the central role of these cells in osseous pathobiology

Alberto **CONSOLARO***

Abstract

The main targets for the comprehension of bone pathobiology were focused in osteoblasts and clasts, but in recent years it has shifted to the osteocytes — as mechanotransductors of the bone tissue, from the three-dimensional network, by interconnecting its extensions linking a cell to other 20 to 40, like a neural network. By mechanotransduction and from mediators as sclerostin and RANKL, the osteocytes may influence bone pathobiology by interfering with the activity of osteoblasts and clasts. When more bone is necessary, osteocytes release less sclerostin, when it is necessary to inhibit bone formation, osteocytes release more sclerostin. RANKL is connected to local osteoclastogenesis in order to have more cells capable of reabsorbing the mineralized matrix. New therapeutic ways of controlling the metabolic bone diseases have been targeted at these mediators. Studying the presence and the specific effects of sclerostin and RANKL in osseointegration can lead to greater detailing of their biological phenomena.

Keywords: Osteocytes. Mechanotransduction. Bone biology. Sclerostin. RANKL.

How to mention this article: Consolaro A. Osteocytes: On the central role of these cells in osseous pathobiology. Dental Press Implantol. 2012 Apr-June;6(2):20-8.

» The author informs that he does not have any associative, commercial, intellectual property or financial interests representing a conflict of interest, in products and companies described in this article.

Submitted on: 03/20/2012
Reviewed and received on: 03/28/2012

*Full Professor, FOB, and professor of Post-Graduation course, FORP-USP.

Correspondence address

Alberto Consolaro
consolaro@uol.com.br

© 2012 Dental Press Implantology

Introduction

In bone biology and comprehension of associated diseases, osteocytes for long were rejected to a secondary role, because it was believed that they were included in the mineralized bone matrix and did not participate in bone metabolism and in responses to stimuli and aggression.

As shown in numerous studies from the last five years, there is a strong influence of osteocytes in bone remodeling and, for this reason, they must participate in the mechanism of initial osseointegration and its maintenance over the years of dental implants use.

The dendritic shape of the osteocyte makes it comparable to a neuron, putting it in contact with up to 40 to 50 cells simultaneously, generating a three dimensional network among themselves communicating very efficiently. In any deformation the bone may suffer from deflections resulting from compression and tractions, the osteocytes of this communicative network will act as mechanotransductors by excellence. Osteocytes also participate in the control of bone metabolism by releasing mediators that reach the bone surfaces, strongly influencing the activity of osteoblasts and clasts in trabecular and cortical areas.

The osteocytes are derived from osteoblasts

Osteoblasts, which originate osteocytes, are cells with mesenchymal origin that differentiate by stimulation of mediators still in the embryo or fetus. The main mediator of differentiation and synthesizing activity in this intrauterine phase are the BMPs, or osteomorphogenetic proteins. The mediators that determine the shape of organs and structures in the embryonic stage can also be identified as morphogens, such as bone morphogenetic proteins.

In an environment of osseodifferenciation and synthesis of bone matrix, most of the molecules of stimulating mediators of these phenomena are eventually included in the extracellular bone matrix to be mineralized later. Thus, one can say that any mineralized bone matrix has naturally bone morphogenetic proteins in its composition, in a greater or lesser amount as part of its natural composition.

Once the skeleton is formed and adulthood is established, osteoblasts and osteocytes remain present in the bone environment. In bone surfaces many osteoprogenitor cells remain along with pre-osteoblasts and tissue stem cell, formerly named undifferentiated mesenchymal cells. In the bone marrow, contained and protected by cortical and trabecular there are many tissue stem cells, which give rise to new bone cells almost infinitely.

Osteoblasts on the surfaces of trabecular and cortical bone are polyhedral cells arranged next to each other like a real fence, railing or lattice. Its polyhedral shape, with several facets or sides, allows the production of bone matrix in one of its sides; in another one, receptors are exposed to mediators located in adjacent connective tissue or marrow tissue. At the same time, osteoblasts laterally contact themselves and interact with other osteoblasts to form a real layer of cells coating on bone surfaces.

In certain conditions, osteoblasts synthesize and mineralize the bone matrix; in other ones, as in inflamed and stressed areas, mediators can induce osteoblasts to move from the bone surface. Before leaving the surface, osteoblasts release enzymes such as collagenase, to remove the last bone layer deposited by them and still not mineralized. Although osteoblasts move from the surface, they remain close and command the activity of clasts within an osteoremodeling unit, or BMU.

In this bone matrix deposition many osteoblasts eventually end up included in gaps called osteoplasts (Fig 1, 2 and 3). It was believed for many years that these cells would be trapped, almost by a passive mechanism,

© 2012 Dental Press Implantology

as if they had lost the moment to depart, and got involved in the newly deposited matrix. The passive role of osteocytes was proved untrue. On the contrary, these cells seem to perform a central role in controlling bone remodeling and opposite reactions to certain stimuli.

Osteocytes: morphology and functions

Osteocytes represent from 90 to 95% of the bone cells in an adult. 15 These cells are included in the mineralized bone matrix (Fig 1, 2 and 3) and now, as with osteoblasts and clasts, we also have greater knowledge about the osteocytes and their functions.

The osteocytes are regularly distributed within bone matrix gaps, also known as osteoplasts, and communicate with the cells of the bone surface through extensions in the tubules at 100 to 300 nm thickness.[3,4,5] They form a web with their extensions, a network comparable to the neural network in the central neural system (Fig 1, 2, 3).

Within these tubules, where the cytoplasmic processes of each cell are (Fig 1, 2 and 3), circulates a fluid tissue that carries nutrients and mediators. These canaliculi with its working fluid and its extensions communicate the osteocytes with each other and interconnected with the surface cells of cortical and trabecular bone, in addition to resident cells of the bone marrow.[10] This communication can be cell-cell by means of specialized junctions or mediators (Figs 1, 2 and 3).

The concept of mechanotransduction

Cells have a cytoskeleton, one scaffold responsible for maintaining normal cell shape, movement and migration. The cytoskeleton is composed of well-structured proteins, divided into three main groups, according to their molecular weight and spatial structure: microtubules, microfilaments and intermediate filaments.

In any system, the balance provided by the annulation of all its intrinsic strength results in a force equal to zero and it is called tensegrity. The shape of a cell tends to be the same, as a result of the balance of internal and external forces. To this state of equilibrium or stability is given the name cellular tensegrity.

When tensegrity is lost by compression, the cytoskeleton, like any other natural system, tends to return to its previous state, spurring a series of events for this purpose. The release of chemical mediators to induce cellular and tissue phenomena in itself or around it, is part of the process by which cells tend to restore their tensegrity. This determines stable shape, the morphology pattern of an object or system, especially of a cell.

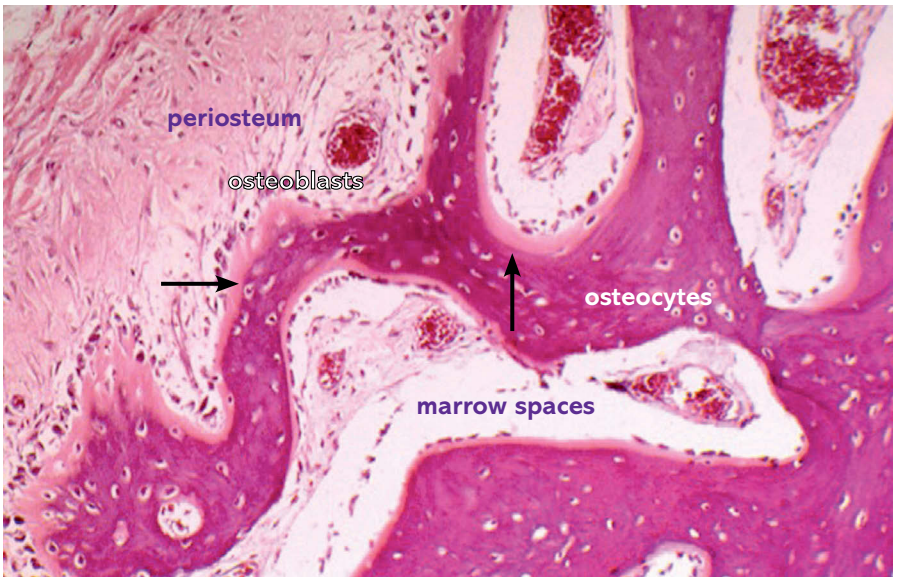


Figure 1 - The osteocyte network participates of the cellular functional control on bone surface, such as the clast and osteoblasts. The cytoplasmatic prolongations arrive at the canaliculi and make contact with the surface cells or act via mediators (HE; 40X).

The breaking of tensegrity modifies the permeability of the cell membrane and results in the activation of intracellular metabolic pathways, releasing substances that act as mediators that induce phenomena of cellular, tissue and / or vascular nature. These substances are cytokines, growth factors and arachidonic acid products. By this mechanism, a physical event, such as forces, turns into biochemical and biological events: this transformation is known as mechanotransduction.

Bone Mechanotransductors: Osteocytes

The osteocytes network form a very sensitive 3D system that uptakes bone deformities. Any change in bone form during skeleton function can be captured by this sensitive network or web of osteocytes, and extensions or mechanotransduction detection system. Exercise can increase bone structure by mechanical stimuli, initially, on this network scavenging strain.

The osteocytes individually pick up signals by mechanical deformation of their cytoskeleton. At the same time, the network in which each osteocyte participates, distributed throughout the bone structure, picks up deformations, overloads, deflections and limitations of nutrients. The deformation of the cytoskeleton, the restriction of oxygen and of nutrient stress the osteocytes, which release mediators to communicate with other osteoblasts and clasts on the bone surface and induce them to reactive or adaptive phenomena.

When we deform, compress or strain the bone as happens during orthodontic movement, we put the osteocytes in mechanical stress and, thus, it increases the production of secreted and circulating mediators through the fluid that circulates in the canaliculi (Fig 1, 2 and 3) and from there to the respective periodontal and bone surfaces. Although included in the mineralized bone matrix in their osteoplasts, the osteocytes and its communicating network — by direct contact or mediators — can stimulate or inhibit bone formation and bone resorption in the "distant" cortical bone surface (Fig 3). The osteocytes in the bone marrow inside the bone, can influence the higher or lower production of clastic cells, or osteoclastogenesis.

The osteocytes therefore have strong influence in function of bone adapting its shape as functional demand determination, transforming the mechanical stimuli into biochemical events, a phenomenon known as mechanotransduction.[13] The osteocytes have also function in regulating mineral metabolism[9] and also induce changes in the properties of the bone matrix around it[12] — but these functions were already better known.

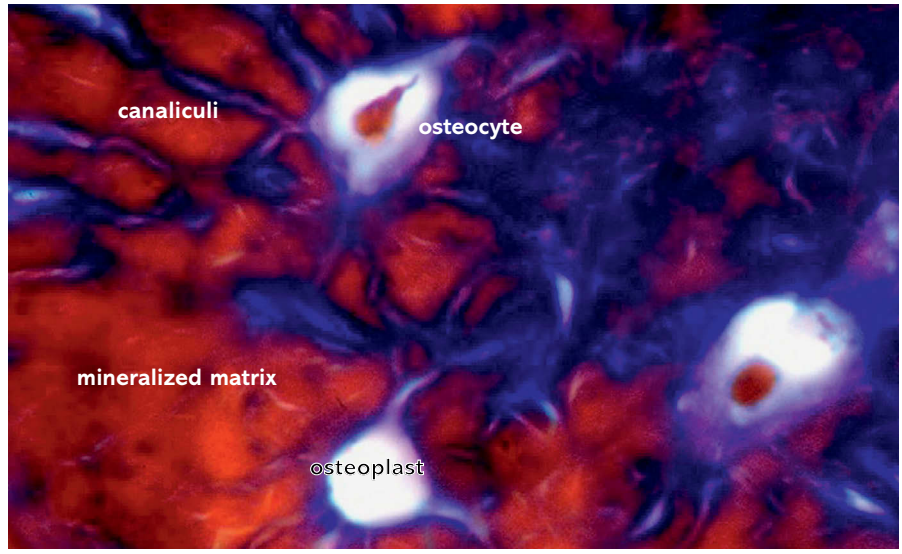


Figure 2 - The osteocytes have many cytoplasmatic prolongations, which intercommunicate with the mineralized matrix with other 20 to 40-50 cells and they detect minimal structural deformations and act as mechanotransductors. They occupy lacunnae known as osteoplasts and the prolongations spread out as canaliculi, where mediators circulate in a tissue fluid, which performs ionic Exchange with the mineralized extracellular matrix. (Mallory; 100X).

© 2012 Dental Press Implantology

The skeleton is able to continuously adapt to mechanical loads by the addition of new bone to increase the ability to resist or remove bone in response to a lighter load or lack of use.[6,8] The osteocytes have a high interconnectivity and are considered the bone mechanotransductors.

Osteocytes increases glucose-6-dehydrogenase phosphatase after a few minutes of load,[18] a marker for increased metabolism, as it occurs in cells associated with bone surface. Seconds after the applied load on the osteocytes, nitric oxide prostaglandins and other molecules such as ATP[1] are increased.

Therefore, osteocytes, when facing induced loads, have the ability to release mediators, which stimulate the precursors of clasts or osteoclastogenesis to differentiate into new clasts increasing the rate of resorption. Among these mediators the M-CSF or stimulating factor of colonies for macrophages and RANKL should be highlighted.[14] It can be argued that osteocytes can command the activities of the clasts on bone surfaces according to functional demand. The set or lacunocanalicular osteocyte system can be seen as a real endocrine body.[4]

Osteocytes, implants and osseointegration

In micro-bone lesions that occur daily, osteocytes die by apoptosis or necrosis. Osteocytes die for having finished their natural life cycle stimuli or by external agents such as heat or dryness in the bone tissue during surgical procedures. Apoptosis is a cell death controlled by specific genes of the cell itself, while necrosis is cell death by external agents, tearing it, crumpling it or taking their nutrition by breaking vases. Some environmental factors and mediators can induce cell apoptosis.

The death of osteocytes in areas with 1-2 mm damage, such as microfractures, can generate mediators that stimulate clasts, especially RANKL,[7] a group TNF cytokine. Preserving the osteocytes is to prevent bone reabsorption and clinicians should know this information to take better care of the surgical margins in bone surfaces. In orthodontics many procedures are surgical.

In Implantology, the preparation of stores for receiving the dental implants must follow protocols for maximum preservation of the viability of biological bone cells in cutting areas. Preserving the osteocytes in bone surgical margins involves avoiding any need for prior resorption of mineralized matrix before starting the osseointegration. Whenever the osteocytes are dead in their gaps,

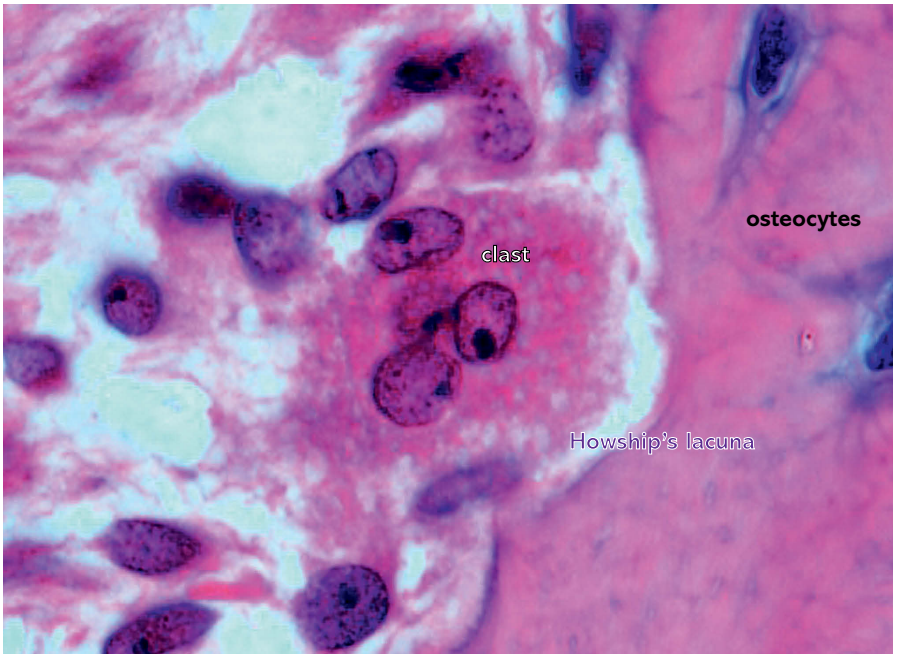


Figure 3 - The network of osteocytes participates in the control of cell function in bone surface as clasts in the context the BMUs. The cytoplasmic processes make contact with surrounding and superficial cells or also act via mediators (HE, 40X).

© 2012 Dental Press Implantology

the mineralized bone matrix of the surrounding region should be resorbed and renewed; preserving them, this phase will not happen and osteogenesis will be able to start soon.

An example of osteocyte preservation can be the divided flap technique in periodontal treatments, which preserves the periosteum attached on the surface. The source of nutrients in the bone are vessels of the periosteum. Preserving the periosteum means to keep alive the osteocytes so that its death does not induce the thin cortical alveolar bone resorption, leading to an undesirable dehiscence or fenestration. Opening the periosteum inevitably leads to the death of the most superficial osteocytes, for they do not receive nutrients from broken vessels during this surgical procedure.

When the osteocytes die in bone remodeling tissue this area will inevitably be reabsorbed. Thus, the osteocytes should be preserved in the bony walls of the cavity prepared earlier to place the implants, avoiding excessive heat or improper manipulation of surfaces, since the death of osteocytes will lead to increased bone resorption at the site, which can disrupt osseointegration.

Probably some orthopedic facial responses can be explained by bone deformities produced. The responses controlled by the osteocytes can change the shape and size of the bone to adapt to new functional demands. This increasingly requires further studies.

The areas close to bone implants remodel themselves constantly, but do not take over the organization and patterns prior to implant placement. The masticatory load on the implants represents stimuli and "aggression" to the bone components, especially to the osteocytes, which capture the surrounding peri-implant deformations as mechanotransductors, releasing mediators that stimulate or inhibit phenomena such as apposition and resorption.

More recently the sclerostin was discovered, a mediator secreted by osteocytes, that circulates the fluid spaces of bone, especially in tubules with cytoplasmic

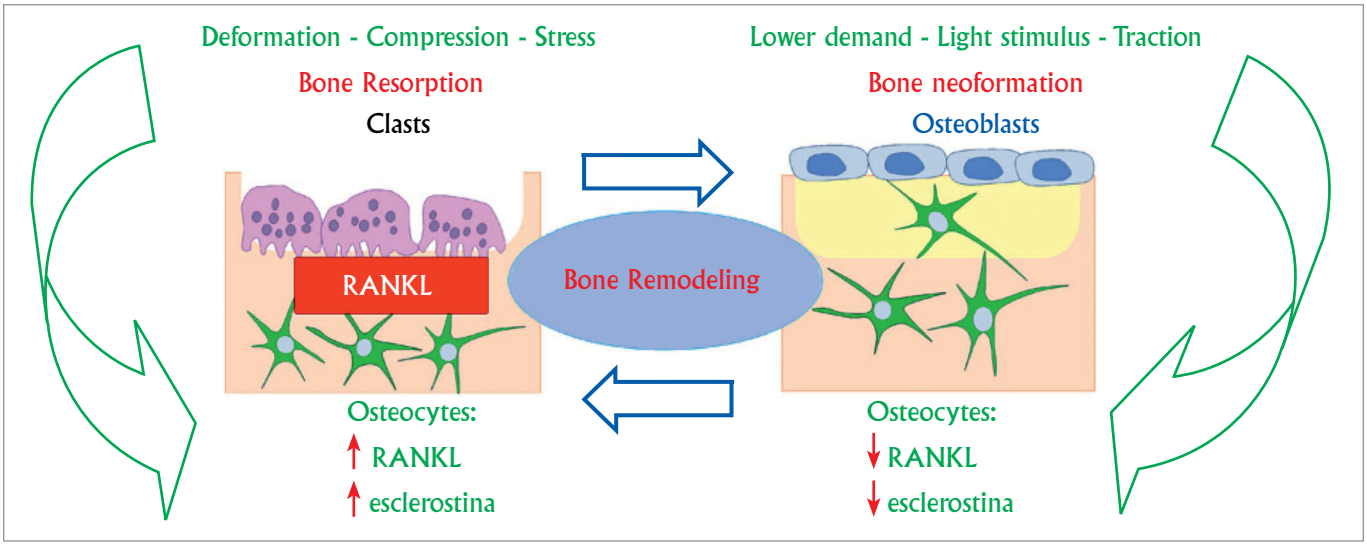


Figure 4 - The osteocytes capture the shape and volume changes increasing or decreasing the release of mediators of the phenomena of bone formation or resorption. Thus, bone remodeling meets the functional demands, changing and adapting structurally (modified de Nakashima et al[14], 2011).

© 2012 Dental Press Implantology

osteocites extensions.[16] It represents a regulatory molecule: If you need more bone, osteocytes release less sclerostin if you need to inhibit bone formation, osteocytes release more sclerostin.

The osteocytes seem to play a central role in bone remodeling.[2] On induced tooth movement there are bone deformations and deflections for each activation devices, especially in the interdental bone crest and free surfaces. When moving a particular tooth to the lingual or buccal, it is known that on the outside, bone is deposited on the cortical surface.[17]

As a true intercommunicating network, stimuli are probably brought to the surface of the outer cortical bone region with periosteal implications by increasing or reducing the thickness of the cortical, which implies in the increase or decrease the bone volume area.

When there is overload on dental implants, excessive forces may induce stress or death of osteocytes. In the periphery of the affected region, probably, osteocytes survivors release mediators that stimulate subjacent and peripheral osteoclastogenesis, such as RANKL, while release more sclerostin to inhibit bone formation at the site. All these peri-implant phenomena can lead to mobility and loss of the implant over time. These increasingly detailed knowledge about bone pathobiology end up enriching and refining surgical techniques and protocols, but especially emphasizing the importance of precise planning in implantology.

These discoveries in bone biology have led to search for new therapeutic alternatives for the bone metabolic problems. Some substances are death inhibitors of osteocytes on the skeleton as a whole and so promote less resorption, for example, estrogens and their modulators, bisphosphonates, calcitonin, CD40 ligand and others.[2] There are still anti-sclerostin to help control bone loss in

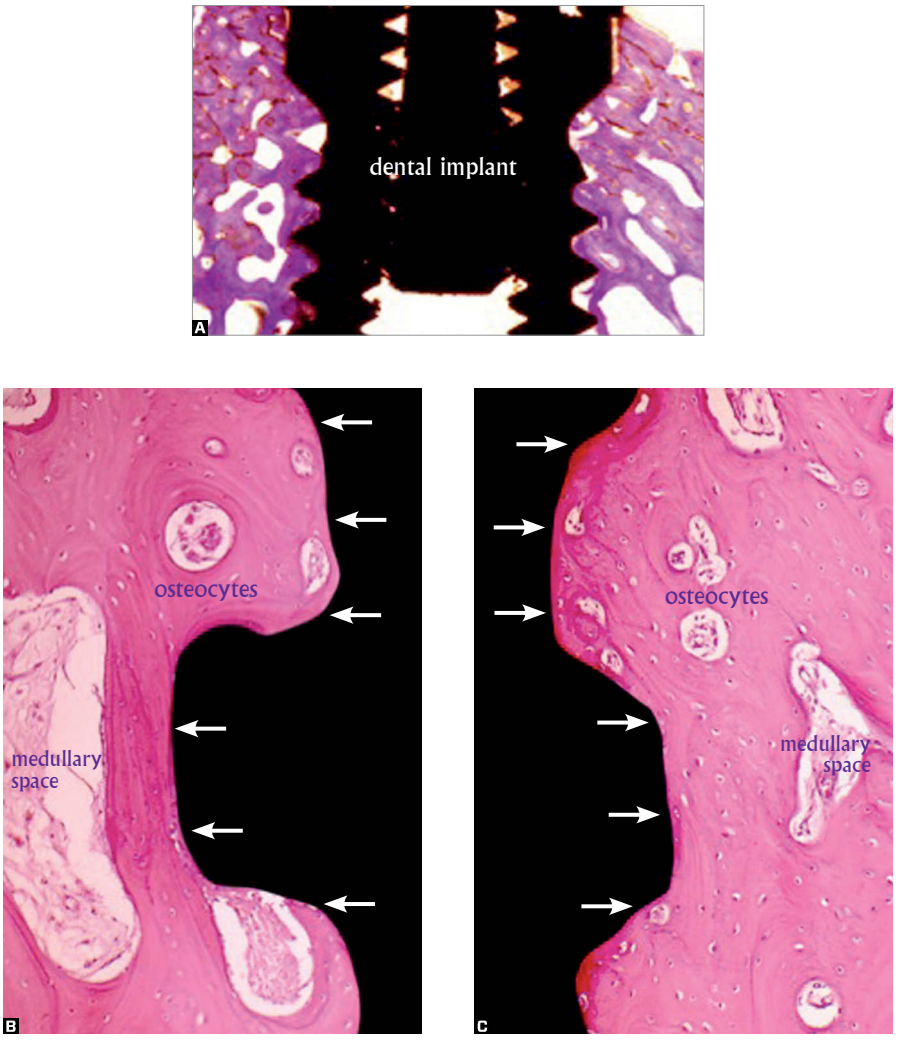


Figure 5 - On the implant surface also is found a network of interconnected osteocytes that capture the forces applied as compressions and deformations due drifts to which the bone is subjected neighbor. The osteocytes mediate phenomena of resorption and bone formation construed in accordance with the functional demands, as appropriate, excessive or minimal (HE; **A** = 10X, **B** e **C** = 25X).

© 2012 Dental Press Implantology

osteopenia and osteoporosis, the most common manifestations of various metabolic bone diseases.

The dental implants are also applied in patients with metabolic bone diseases controlled or undiagnosed, the same way that patients with implant may acquire thi disease during life. One way or another, it is also required that the implantologist know not only the advances of pathobiology bone and its implications for osseointegration, but also its impact on the therapy of metabolic bone diseases.

Conclusions

1. The main targets for the understanding of bone pathobiology used to focus on the osteoblasts and clasts. In recent years, attention has shifted to the osteocytes and their role as bone tissue mechanotransductors. The three-dimensional network formed by interconnections of its extensions can connect a cell with other 20 to 40, something comparable to a neural network.
2. From mediators such as sclerostin and RANKL, osteocytes can greatly influence bone biology, by interfering with the activity of osteoblasts and clasts in trabecular and cortical surfaces. The importance of their role has led many researchers to compare the set of osteocytes to a real endocrine body. When more bone is needed, osteocytes release less sclerostin and when it is necessary to inhibit bone formation, osteocytes release more sclerostin. RANKL, in turn, is connected to local osteoclastogenesis, in order to have more cells capable of reabsorbing the mineralized matrix.
3. New therapeutic ways of controlling the metabolic bone diseases have been targeted at these mediators and their producers: the osteocytes. To study the presence and the specific effects of sclerostin and RANKL in the bone integration can lead to greater detailing of their biological phenomena.

© 2012 Dental Press Implantology

REFERENCES

1. Bakker AD, Soejima K, Klein-Nulend J, Burger EH. The production of nitric oxide and prostaglandin E2 by primary bone cells is shear stress dependent. J Biomech. 2001;34(5):671-7
2. Baron R, Hesse E. Update on bone anabolics in osteoporosis treatment: rationale, current status, and perspectives. J Clin Endocrinol Metab. 2012;97(2):311-25. Epub 2012 Jan 11.
3. Bonewald, Lynda F. Mechanosensation and transduction in osteocytes. Bonekey Osteovision. 2006;3(10):7-15.
4. Bonewald, Lynda F. Osteocytes as multifunctional cells. J Musculoskelet Neuronal Interact 2006;6(4):331-3.
5. Bonewald, Lynda F. The amazing osteocyte. J Bone Miner Res. 2011;26(2):229-38.
6. Burr DB, Robling AG, Turner CH. Effects of biomechanical stress on bones in animals. Bone. 2002;30(5):781-6.
7. Crockett JC, Rogers MJ, Coxon FP, Hocking LJ, Helfrich MH. Bone remodelling at a glance. J Cell Sci. 2011;124(Pt 7):991-8.
8. Ehrlich PJ, Noble BS, Jessop HL, Stevens HY, Mosley JR, Lanyon LE. The effect of in vivo mechanical loading on estrogen receptor alpha expression in rat ulnar ostecytes. J Bone Miner Res. 2002;17(9):1646-55.
9. Feng JQ, Ward LM, Liu S, Lu Y, Xie Y, Yuan B, et al. Loss of DMP1 causes rickets and osteomalacia and identifies a role for osteocytes in mineral metabolism. Nat Genet. 2006;38(11):1310-5. Epub 2006 Oct 8.
10. Kamioka H, Honjo T, Takano-Yamamoto T. A three-dimensional distribution of osteocyte processes revealed by the combination of confocal laser scanning microscopy and differential interference contrast microscopy. Bone. 2001;28(2):145-9.
11. Krstic RV. Human microscopic anatomy. Berlin: Springer-Verlag; 1994.
12. Lane NE, Yao W, Balooch M, Nalla RK, Balooch G, Habelitz S, et al. Glucocorticoid-treated mice have localized changes in trabecular bone material properties and osteocyte lacunar size that are not observed in placebo-treated or estrogen-deficient mice. J Bone Miner Res. 2006;21(3):466-76.
13. Lanyon LE Osteocytes, strain detection, bone modeling and remodeling. Calcif Tissue Int. 1993;53(Suppl):S102-6, S106-7
14. Nakashima T, Hayashi M, Fukunaga T, Kurata K, Oh-Hora M, Feng JQ, et al. Evidence for osteocyte regulation of bone homeostasis through RANKL expression. Nat Med. 2011;17(10):1231-4. doi: 10.1038/nm.2452.
15. Parfitt AM. The cellular basis of bone turnover and bone loss: a rebuttal of the osteocyticresorption-bone flow theory. Clin Orthop Relat Res. 1977;(127):236-47.
16. Poole KE, van Bezooijen RL, Loveridge N, Hamersma H, Papapoulos SE, Löwik CW, et al. Sclerostin is a delayed secreted product of osteocytes that inhibits bone formation. FASEB J. 2005;19(13):1842-4. Epub 2005 Aug 25.
17. Raab-Cullen DM, Thiede MA, Petersen DN, Kimmel DB, Recker RR. Mechanical loading stimulates rapid changes in periosteal gene expression. Calcif Tissue Int. 1994;55(6):473-8.
18. Skerry TM, Bitensky L, Chayen J, Lanyon LE. Early strain-related changes in enzyme activity in osteocyte following bone loading in vivo. J Bone Miner Res. 1989;4(5):783-8.

© 2012 Dental Press Implantology

Orientations for clinical use of BMP

Dario Augusto Oliveira **MIRANDA***

What is the origin of BMPs and how extensive is the synonymy employed to identify them?

The morphogenetic proteins of the bone are responsible for signaling to induce bone formation. BMPs (bone morphogenetic proteins) represent a family with more than 20 reported proteins, which are part of the transforming growth ß factor family (TGF-ß), activating and inhibiting the differentiation and growth factors (GDF). They are involved in embryonic development and in the formation of the skeleton. Since the work of Urist[3] in 1965, demonstrating that the demineralized bone matrix could induce the formation of cartilage and bone in ectopic sites, many researchers have endeavored to clarify the activity of matrix components.

Minimal amounts of these proteins are present in the mature skeleton, participating in their maintenance and repair of bone fractures. Urist[3] demonstrated that, by placing portions of demineralized and lyophilized allogeneic bone matrix in the muscle of mice, there was bone formation, i.e., bone matrix had agents capable of inducing osteoblasts formation (Fig 1).

Urist and Strates,[5] in 1971, through extensive laboratory research observed and identified these agents, naming BMPs. Although the exact function and interrelation of each BMP are not yet completely understood, evidences indicate its role as part of a complex number of factors regulating cell differentiation, increasing the expression of chondroblasts and osteoblasts in injured bone sites. The possible evolutionary conservation of structural and functional BMPs genes suggests critical regulatory roles in the process of differentiation during development (Tab 1).

What does "recombinant BMP" mean from the point of view of nomenclature, origin, advantages and disadvantages?

As a result of a long process of purification of the bones, insignificant amounts of BMP were obtained. Later, the rhBMP-2 molecule (recombinant human bone morphogenetic protein) was sequenced and cloned by Wozney,[2] in 1988, and this technology now allows its production on a large scale to be used clinically and in the laboratory.

How to mention this article: Miranda DAO. Orientations for clinical use of BMP. Dental Press Implantol. 2012 Apr-June;6(2):29-34.

» The authors inform that they do not have no associative, commercial, intellectual property, or financial interests representing a conflict of interest in products and companies described in this article.

Contact address

Dario A. O. Miranda
Av. Garibaldi, 1133 S/1107 – Graça
Zip Code: 40.170-130 – Salvador/BA – Brazil
E-mail: darioperiodonto@hotmail.com

Submitted on: 23/03/2012
Reviewed and received on: 26/03/2012

* PhD in Implantology, São Leopoldo Mandic. MSc in Periodontics and Implants, Illinois University, Chicago. Professor of Buccal Diagnosis, UEFS-BA.

© 2012 Dental Press Implantology

Figure 1 - Allogenic demineralized and lyophilized bone matrix that has been isolated by Urist. The photograph is courtesy of Dr. Neil Blumenthal, who had the opportunity to work with Dr. Urist in the Department of Orthopaedics at the University of California (UCLA), Los Angeles. This was one of the matrices used in the article of Urist.[3]

Table 1 - Function and synonymy of BMP types.

BMP Types	Functions
BMP-2	Osteoinductive, apoptosis, differentiation of osteoblasts
BMP-3	Inhibits osteogenesis (Osteogenin)
BMP-4	Osteoinductive, lung development and ocular system
BMP-5	Chondrogenesis
BMP-6	Chondrogenesis, differentiation of osteoblasts
BMP-7	(OP-1) Osteoinductive, liver development
BMP-8	(OP-2) Osteoinductive
BMP-9	Hepatogenesis, neural system development
BMP-10	Heart development
BMP-11	Morphogenesis of neural system and mesodermal origin organs
BMP-12	Development of tendons and iliac bones
BMP-13	Development of tendons and ligaments
BMP-14	Chondrogenesis
BMP-15	Modifies the activity of FSH

When placed in a proper medium, rhBMP-2 induces bone formation. The start of the process does not necessarily proceed by introduction of bone forming cells. Rather, rhBMP-2 acts locally to concentrate in the site mesenchymal host cells and influence their differentiation into bone forming cells. It has mitogenic activity, but selectively. In order to have an effect which can be observed clinically, "super-physiological" doses are required, around 200,000 times the estimated physiological concentration of BMP-2 naturally found in bone. A variety of complications associated with surgery or the use of rhBMP-2 may occur alone or in combination. Some of them can be serious and affect its outcome. Additional surgery may also be needed to correct these complications.

Some possible complications include:

- Allergic reaction.
- Death.
- Development of respiratory problems.
- The formation of exuberant and / or ectopic bone.
- Edema.
- Erythematosus tissue.
- Fetal development complications.
- Hematoma.
- Incisional complications.
- Infection.
- Inflammation.
- Pain.
- Formation of scars.
- Damage to tissues or nerves.

The recombinant human BMP-2, through a carrier, has demonstrated clinical relevance in the induction of bone formation for some maxillofacial / oral indications. However, the carrier, or vehicle, is the "Achilles heel" of rhBMP-2.

The development of research focused on the formulation of carrier systems for BMPs is proven to be necessary, in a therapeutic perspective. The use of collagen

© 2012 Dental Press Implantology

and carrier systems associated with collagen, although widespread, is related to some disadvantages. Among these disadvantages are included the poor mechanical stability, the immune response and the potential for transmission of viral antigens.

The ideal carrier substrate would fulfill the following requirements: Relative insolubility in physiological conditions, being biodegradable, protect against proteolytic activities, act as a substrate for cell adhesion and proliferation, immunologically inert, maintain the BMP bioavailable through controlled biological degradation and having mechanical stability to promote the union of bone defects.

What are the commercial products available in the national and global market containing BMP alone or combined with other substances?

All biomaterials which may have bone origin contain BMP. However, the industry does not usually quantify in the packings. The regulator agency American Food and Drugs Administration (FDA) has approved first, in 2002, the use of the product Infuse® Bone Graft for spine orthopedic surgery (lumbar spinal fusion) and in 2004, as a bone graft to reduce long bone fractures with loss of substance. Only in March of 2007 was authorized its use in surgery of maxillary sinus lifting and alveolar defects correction. In 2008, this procedure was released in Brazil by the National Sanitary Surveillance Agency, Anvisa. The BMP-7 t(OP-1®; Stryker) is only sold in the USA.

What are the indications and contraindications of these products?

Patients with bone loss in the upper and lower arches can use rhBMP-2 to repair it. It is a procedure that generates less trauma and provides better chances to success, when compared to other regenerative therapies, including those that use the patient's own bone (autogenous bone). Any patient in need of increased bone structure can use rhBMP-2. However, there is contraindication for pregnant women. Additionally, it is recommended that women who received this therapy do not become pregnant within a year after treatment. The use of rhBMP-2 is also not suitable for lactating women, to patients with infection near the incision area and people who are under radiation therapy, chemotherapy, and steroids therapy.

Adverse effects can be observed for cases where the patient has hypersensitivity to rhBMP-2 or bovine collagen type 1, which is the sponge where is carried the protein.

What are the biological effects of BMP as a mediator in the repair process?

When an adequate concentration of rhBMP-2 is placed on an absorbable collagen sponge (ACS) and implanted in the body it is induced new bone tissue at the implantation site.

The mesenchymal stem cells, around the tissues of the implanted area, come into contact first with the rhBMP-2/ACS. The collagen sponge degrades or dissolves, and these stem cells begin to differentiate into osteoblastic cells, initiating the formation of trabecular bone or cartilage. The blood vessel formation (angiogenesis) is also observed at the same time.

The first step in the process of bone formation induced by rhBMP-2/ACS is the migration of bone forming cells to the area. Chemotaxis involves stimulation of cell migration in response to a chemical signal. Mesenchymal stem cells and osteoblasts from bleeding bone, muscle, and the periosteum infiltrate the rhBMP-2/ACS implant. In-vitro studies have shown that rhBMP-2 can stimulate the specific chemotactic migration of bone-forming cells, promoting in its surrounding the

© 2012 Dental Press Implantology

proliferation of several multi-potent cell lines, which are capable of differentiating into osteoblasts. This differentiation of mesenchymal stem cells into bone-forming osteoblasts plays an essential role in the induction of new bone, which was also demonstrated in preclinical studies. The rhBMP-2 binds to specific receptors on the surface of the MSC and causes them to differentiate into bone-forming cells.

Pre-clinical studies have supported that the bone formation initiated by rhBMP-2/ACS is a self-limiting process, forming a predictable volume of bone. The bone formation process develops from the outside of the rhBMP-2/ACS implant towards the center until the entire implant is replaced by trabecular bone. The ability of rhBMP-2 to induce new bone formation is dependent upon its concentration. The rate of bone formation, the amount of bone formed, and the density of the resulting bone are positively correlated with both the concentration of rhBMP-2 and the length of time that rhBMP-2 is present at the implant site.

Remodeling of the trabecular bone induced by rhBMP-2/ACS occurs in a manner that is consistent with the biomechanical forces placed on it. Radiographic, biomechanical, and histologic evaluation of the induced bone indicates that it functions biologically and biomechanically as native bone. Furthermore, pre-clinical studies have indicated that the bone induced by rhBMP-2/ACS can repair itself, if fractured, in a manner indistinguishable from native bone healing (Fig. 2, Table 2).

Besides its role in the processes of repair of bone tissue, the strongest evidences for the involvement of BMPs in embryogenesis derive from isolating mRNAs for BMPs in several tissues, suggesting multiple functions in both morphogenesis and in formation pattern outside the skeleton. In situ hybridization showed that the mRNA of BMP-2 is expressed during development of members, heart, teeth, eyes and craniofacial mesenchyme.

In the commercial form of presentation, the product retains these properties and characteristics?

In the United States are offered six types (sizes) of different kits, in Brazil only three. The kit should be single use and their biodegradation takes about two hours. It is expected that the Infuse Bone Graft® maintains the properties and features promised by the industry and recommended by the manufacturer, provided that it is accurately targeted and used for the proposed purpose.

How can the professional purchase rhBMP and what are the necessary precautions regarding the quality and reliability of the product?

In Brazil, the recombinant human bone protein is commercialized in São Paulo, by an authorized representative. Provided that the biomaterial is bone, it will always have BMP in its composition. However, we do not know the percentage of BMP contained in the product, because the industry omits the information and does not quantify that percentage. Thus, we, surgeons and clinical professionals, most of the time work entirely in the dark, only believing that in the end everything will be all right.

In the beginning of the osseointegration advent, it was of paramount importance to deeply research to the pre-commercialization of any new product. An extraordinary time was consumed before these biomaterials were used. In the contemporary system, economic power and "commercial greed" of industry reversed the whole process to the point where new products are routinely presented to the profession with an inadequate and insufficient investigation. Clinicians are more often exposed to try new devices and report on its

© 2012 Dental Press Implantology

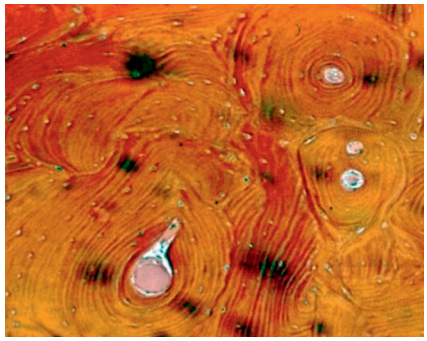


Figure 2 - Photomicrograph of an alveolar defect filled with rhBMP-2/αBSM, showing new lamellar bone formation and Haversian systems (4x)

Table 2 - RhBMP-2 mechanisms of action in absorbable collagen sponge (ACS).

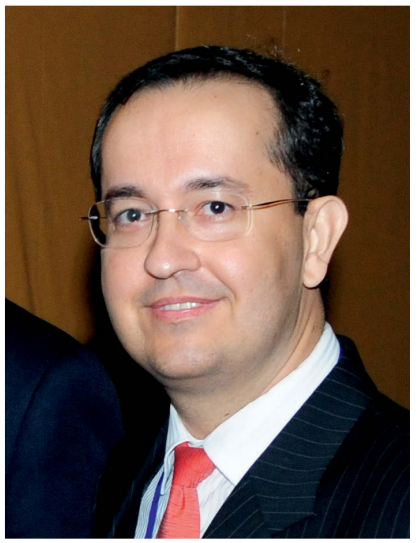
1	Implantation	rhBMP-2/ACS is implanted
2	Chemotaxis	Migration of Mesenchymal Stem Cells and other bone-forming cells to the site of implantation
3	Proliferation	rhBMP-2/ACS provides an environment where stem cells multiply prior to differentiation
4	Differentiation	rhBMP-2 binds to specific receptors on the stem cell surface inducing them to differentiate into osteoblasts
5	Bone formation and Angiogenesis	Osteoblasts respond to local mechanical forces to produce new mineralized tissue within the ACS. New blood vessel formation is observed at the same time
6	Remodeling	Body continues to remodel bone in response to the local environmental and mechanical forces, resulting in normal trabecular bone

performance and success, but without communicating the patient about the empirical "research". It is a very dangerous and not scientifical approach, which does not predict any good for the implantodontists. The off-label use (when the clinician chooses to use the therapy with new products which were insufficiently evaluated or which the "risk-benefit ratio" is uncertain) needs to be reconsidered when the surgeon makes use of these products especially in cases where there is no scientific evidence attesting or certifying their effectiveness, such as in surgery in craniomaxillofacial reconstruction of mandibular defects after mandibular resections, alveolar ridges reconstruction for subsequent prosthetic rehabilitation and reconstruction of alveolar clefts. In studies and multicenter randomized clinical trials level 1 in humans, only the commercially titled product Infuse Bone Graft® has been shown by means of microscopic tissue sections, growth of new bone.

REFERENCES

1. Blumenthal NM, Koh-Kunst G, Alves ME, Miranda D, Sorensen RG, Wozney JM, Wikesjö UM. Effect of surgical implantation of recombinant human bone morphogenetic protein-2 in a bioabsorbable collagen sponge or calcium phosphate putty carrier in intrabony periodontal defects in the baboon. J Periodontol. 2002 Dec;73(12):1494-506.
2. Wozney JM, Rosen V, Celeste AJ, Mitsock LM, Whitters MJ, Kriz RW, et al. Novel regulators of bone formation: molecular clones and activities. Science. 1988; 242(4885):1528-34.
3. Urist MR. Bone: formation by autoinduction. Science. 1965;150(3698):893-9.
4. Miranda DA, Blumenthal NM, Sorensen RG, Wozney JM, Wikesjö UM. Evaluation of recombinant human bone morphogenetic protein-2 on the repair of alveolar ridge defects in baboons. J Periodontol. 2005 Feb;76(2):210-20.
5. Urist MR, Strates BS. Bone morphogenetic protein. J Dent Res. 1971;50(6):1392-406.

© 2012 Dental Press Implantology



Dario Augusto Oliveira Miranda is a professor at the Dental Clinic of the State University of Feira de Santana, Bahia, since 1995. MSc in Dentistry in the areas of Periodontics and Implantology by the University of Illinois at Chicago – College of Dentistry, under the guidance of Professor Neil Blumenthal. In 1999, he started researching on growth factor together with Professor Ufl Wikesjö (Atlanta, USA) and John Wozney (Harvard), studying the rhBMP (recombinant human bone morphogenetic protein), which has the property to induce the bone tissue formation in areas of resorption. He has presented preliminary results of this research during the meeting of the American Academy of Periodontology, being selected among the eight best works to represent the latest advances in research in Periodontics, in Orban Competition.

He attended the meeting of the Midwest Society of Periodontology, held in Chicago, Illinois, and obtained the first place certificate.

In the presentation at the Osseointegration Academy of Dallas, Texas, he also got the first place among 60 other studies assessed, of Canadians, Swedes, Japanese, Swiss and American researchers.

Traditional research colleges participated in these competitions, such as Harvard University, University of Boston, University of Michigan, University of Texas, among others.

Professor Dario Miranda is diplomate by the American Academy of Osseointegration.

Balint Orban Memorial Competition, American Academy of Periodontology (AAP) - Pennsylvania.

The Midwest Society of Periodontology - Chicago.

Honour Award to the most successful of the year. Dr. Dayn C. Boitet, president of the AO (Academy of Osseointegration), welcomes Dr. Dario A. Miranda, who won the award for Best Oral Presentation Summary - Dallas.

© 2012 Dental Press Implantology

Influence of external geometry of Morse dental implant on stress distribution

Roberto Brunow **LEHMANN***
Carlos Nelson **ELIAS****
Marco Aurélio **ZUCARELI*****

Abstract

Objective: To evaluate two proposals of external geometry of dental implants observing the influence on the stress distribution. **Methods:** It was performed the evaluation by finite elements of prototypes of dental implants with different external geometric shapes submitted to different conditions of loading (axial, inclined to 15° and inclined to 30°). **Results:** The stress increased as the loading became more inclined. The conical geometry showed itself more stable and transmitted less stress to the bone. **Conclusions:** I) The system with conical dental implant transmits lower stress to the bone and to the dental implant; II) the safety factor of the implants is high suggesting it supports loadings more aggressive in intensity and direction; III) as the loading becomes more inclined, i.e., the components of the lateral forces increase, the stresses on the bone and on the prosthetic components increase; IV) for all simulations, the systems behaved appropriately so there is no indication of deformation or fracture on the prosthetic components or even bone resorption due to overload.

Keywords: Computer simulation. Dental implant. Finite element analysis.

How to mention this article: Lehmann RB, Elias CN, Zucareli MA. Influence of external geometry of Morse dental implant on stress distribution. Dental Press Implantol. 2012 Apr-June;6(2):35-43.

» The authors inform that they do not have no associative, commercial, intellectual property or financial interests representing a conflict of interest, in products and companies described in this article.

Contact address

Roberto Brunow Lehmann
Rua Lourenço Leal, nº 77– Tambasco
Zip Code: 27.700-000 – Vassouras/RJ – Brazil
Email: rbrunow@gmail.com

Submitted on: 12/19/2011
Reviewed and received on: 03/06/2012

* Post-Doctorate in Development of Implants and Components, Laboratory of Computational Biomechanics. Federal Fluminense University.
** MSc and PhD in Sciences of Materials, Laboratory of Biomaterials. Militar Institute of Engineering – IME-RJ.
*** Engineer of materials, Engineering of products – Development of Implants and Components, Conexão Sistemas de Prótese.

© 2012 Dental Press Implantology

Introduction

The Finite Elements Method (FEM) is regularly used for stress analysis in works of Dentistry.[1,2,3] Through computational tools it is possible to foresee the error as well as its location from the conditions of contour imposed on the model. The facility for obtention of results as well as its promptitude makes the FEM interesting in several departments as Dentistry, Implantology and Periodontics. There are works in literature[4,5,6] that evaluate the geometric variation of the screw threads of the implant. It was observed significant differences on the stress levels with the geometric variation. The results show that implants with slight curvature and lower depth threads present lower stress level[4] and there is greater concentration of stress on the first thread of the screw.[5,6] From the mechanical point of view, the analysis of the efforts transmitted on the interface bone-implant is essential to foresee the success of the osseointegrable dental implants. The overload may cause bone resorption or even failure.[7,8,9] On the other hand, a low intensity load may cause atrophy and subsequent bone loss.[7,9] The higher levels of bone stress are located on the marginal region of the implant, being considerate a critical region.[1,2,3] In the present study it was performed the analysis by finite elements through the three-dimensional models of dental implants prototypes [AR-Torq and Flash] and with variation on the direction of the equivalent loading to observe the behavior of both systems. Each one of these systems has different characteristics on its external geometry of the dental implant and, through the variation of loading, it is intended to evaluate the mechanical behavior of both systems.

Material and Methods

For the performance of the simulations it was used a microcomputer with Pentium Quad Core 6550 processor, RAM memory of 8GB and hard drive of 1,75TB. All dimensions used for the dental implants and prosthetic components were provided by Conexão Sistemas de Prótese (Arujá, Brazil) and refer to the prototypes that were in development with trade name AR Torq and Flash. Its characteristics can be followed on Table 1. The implant Ar-Torq is cylindrical self-threading, has indexed Morse, double screw and conical apex (Fig 1A). The Flash implant has cone Morse indexed and it is conical, has progressive thread with high cutting power and according to the manufacturer, it increases the superficial area and primary stability in relation to conventional implants (Fig 1B). Normally, the wall thickness of implants with internal connections limits the insertion torque and the axial loads supported are lower. The diameters of the evaluated implants were of 5 mm and length of 10 mm.

The cortical and medullary bones were modeled on the program ANSYS Workbench, version 11. The simplified dimensions of the bone were the available in literature[10-13]. Each component (implant, pillar, fixation screw of the pillar, cortical bone and trabecular bone) was modeled separately to allow the independent visualization and to verify the level of stress based on the color scale provided by the program. According to procedure adopted on the simulations by finite elements, it was considered the following simplifying hypothesis:

Table 1 - Differences of systems used on simulation.

Implant	Ar-Torq	Flash
Screw	Double	Double
Screw profile	Triangular	Trapezoidal
Pitch of screw	0.6	0.8
Apex	Conical	Conical
Body	Cylindrical	Conical
Coronary	Coronary	Micro partial screw
Mills ammount	4	2
Mills profile	Parallel	Helical

© 2012 Dental Press Implantology

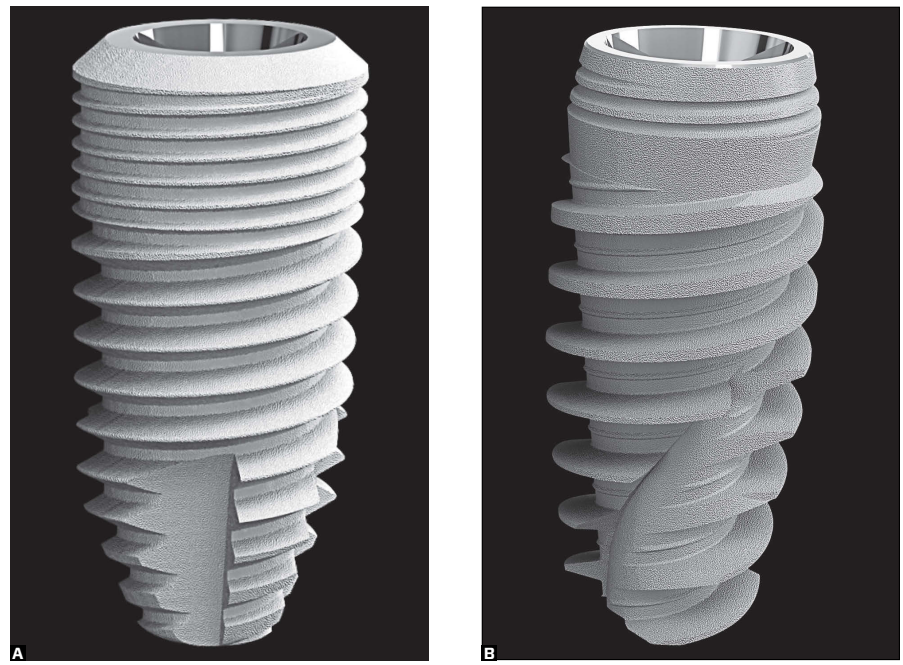


Figure 1 - Implant with NP platform used in simulation: **A**) Ar-Torq and **B**) Flash.

The materials were considered homogeneous, isotropic and linearly elastic. It was considered the implants manufactured in titanium commercially pure ASTM, degree 4 (ASTM F67); the pillar in titanium commercially pure ASTM, degree 2 (ASTM F67); and the fixation screw of the pillar in titanium, degree 5 (ASTM F136). The properties of the cortical and trabecular bones were the available in literature[10-13], which are displayed on Table 2. For analysis of results, the company Conexão Sistemas de Prótese released the technical information of the titanium provider on different categories of purity.

Table 2 - Mechanical properties of materials used.

Material	Modulus of elasticity (GPa)	Poisson's ratio
Titanium	110.00	0.35
Cortical bone	13.70	0.30
Trabecular bone	1.37	0.30

For the creation of the mesh, it was used the automatic system of the program with some changes on preprogrammed definitions by Ansys. The growth factor of the element was altered to prevent distortions on numeric results, besides proceeding to a local refining on the region of the interface implant-bone, considered a critical point. The finite element used was tetrahedral type. The contacts were defined as "bonded", i.e., it does not allow relative motion between pieces. The purpose of this choice was to determine a rigid union between volumes of the model. Regarding the number of elements and knots of the models, there was respectively 32988 and 63317 for the Ar-Torq system and 33671 and 61220 for the Flash system. According to data in literature,[1,2,3,10,14-19] the loadings used in the present work were of 100N[1,2,3,10,15-19] applied in three directions: axial, inclined to 15°[15,16] and 30°[20] in relation to longitudinal axis of the implant.

© 2012 Dental Press Implantology

Besides the loading on the system, it was also applied the torque of 30N/cm of threading of the fixation screw of the pillar (pre-load), following the protocol suggested by the company. The simulation was multi-step, i.e., first it was applied the torque on the screw and then it was applied the loading on the system. The constraint to motion was implemented on external areas of the cortical bone (Fig 2, in blue) to allow liberty of the system (implant and component). From the definitions, it was possible to use the program to calculate Von Mises equivalent stress on bones and on components of the implants systems.

Results

For analysis of results, it was used Von Mises equivalent stress. The stress values calculated on simulations are shown on Table 3. It was determined the maximum stress transmitted to the bone as well as maximum stress on implants and components (pillar and fixation screw of the pillar).

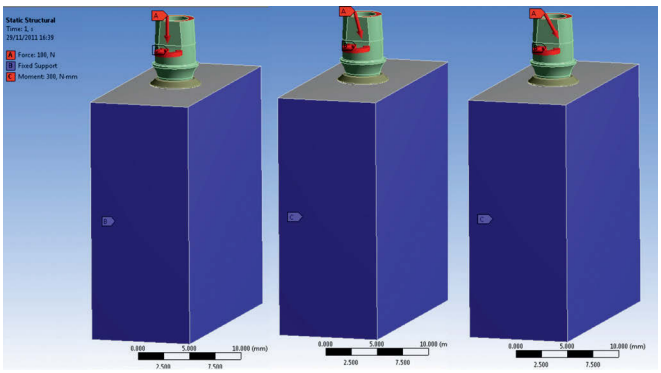


Figure 2 - Loads and restriction of simulated models.

On figures 3 to 5, it will be shown only images with stress distribution to the implant, cortical bone and trabecular bone on three different directions of loading. On the top of the images, it is found the results for the Ar-Torq system and on the bottom the results for the Flash. All figures were organized so that on the first column are the results for the axial loading, on the second column for the inclined to 15° loading and on the third column for the inclined to 30° loading.

To analyze the possibility of fracture of the implants and components, it was proposed to create a safety factor (SF) for different conditions of analysis. The SF is calculated through the relation between the value of stress in each point (σ_L) divided by the outflow limit (σ_e) of the material used on manufacturing. Using these criteria it was created figures that show values of the relation local stress and outflow limit (SF = σ_e / σ_L). It is shown on Figure 6 the values of SF calculated for different regions of the implant with loading inclined to 30°, this is the loading that presented the most critical condition.

Table 3 - Values of von Mises maximum stress (MPa) calculated on simulations of loading of several components of the models used.

	Direction of the applied force					
	Axial		Inclined 15°		Inclined 30°	
Platform	Ar-Torq	Flash	Ar-Torq	Flash	Ar-Torq	Flash
Implant	172.4	143.41	196.1	146.84	226.9	169.71
Pillar screw	350.2	350.3	350.7	354.62	351.2	358.54
Pillar	115.6	230.18	119.6	274.22	144.7	316.19
Cortical bone	15.3	13.79	17.9	16.49	23.6	20.16
Trabecular bone	2.2	1.48	2.7	1.56	3.2	1.85

© 2012 Dental Press Implantology

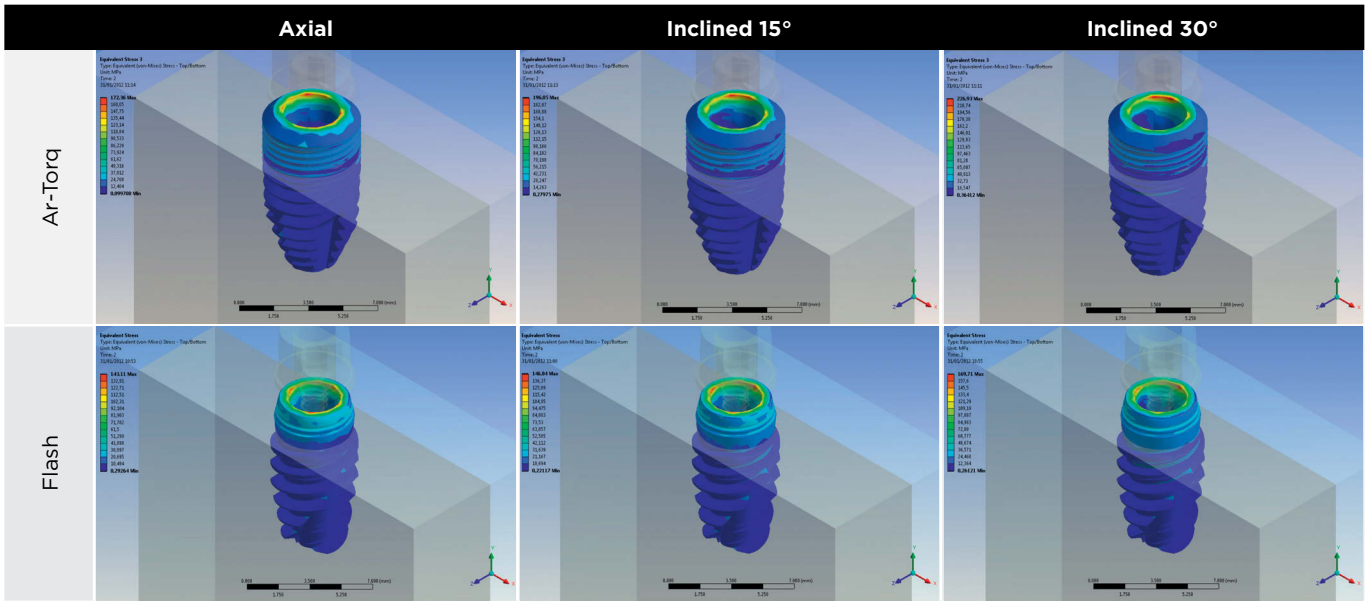


Figure 3 - Von Mises stress on implant with platform Ar-Torq and Flash on three directions.

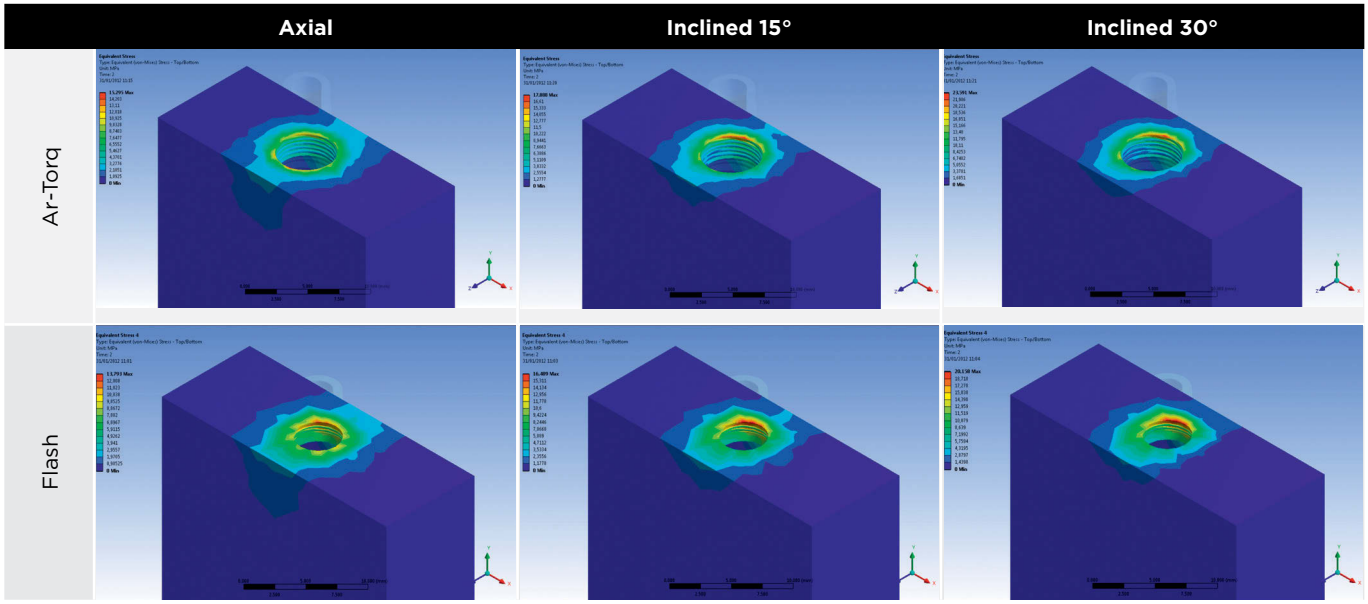


Figure 4 - Von Mises stress on cortical bone on the system with implant Ar-Torq and Flash on three directions.

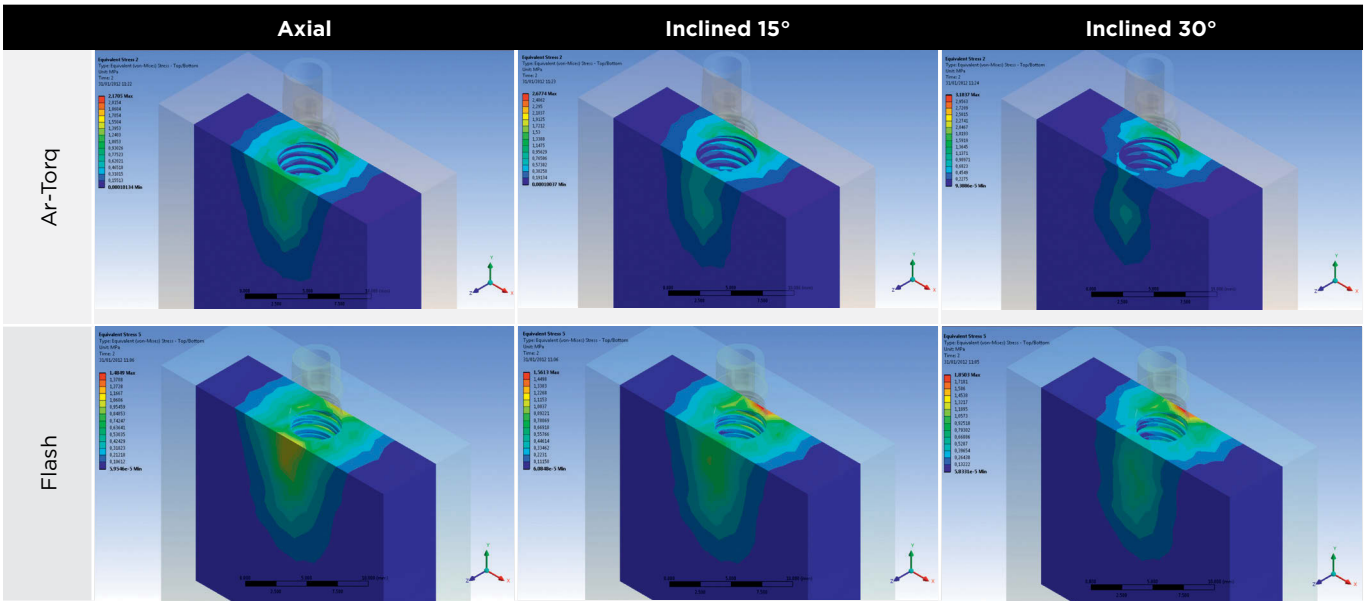


Figure 5 - Von Mises stress on trabecular bone on the system with implant Ar-Torq and Flash on three directions.

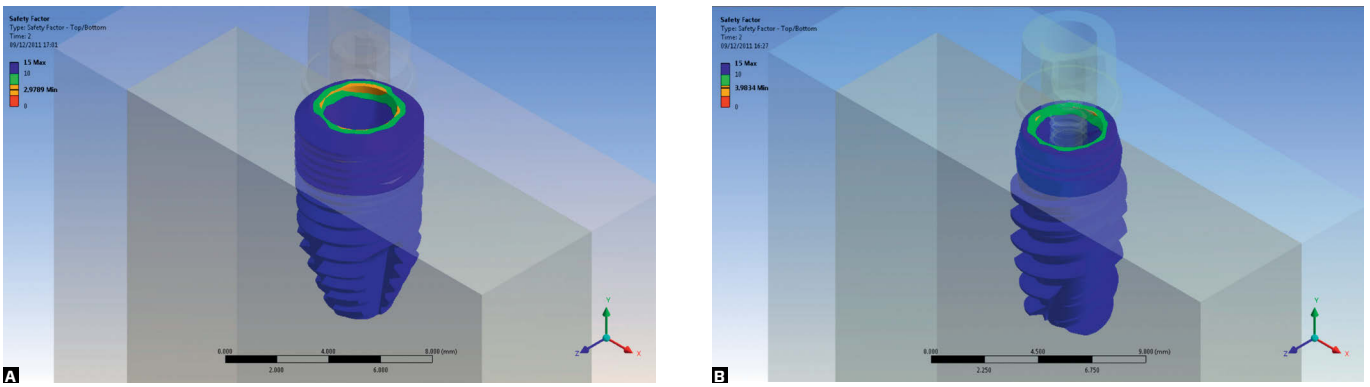


Figure 6 - Safety factor for implants (**A**) Ar-Torq and; (**B**) Flash.

Discussion

Considering that the dimension of the implants with internal prosthetic connections are more critical than conventional implants with external hexagon, on the present work the simulations were performed with implants with trade name Ar-Torq and Flash that contain internal hexagon. The intention to verify the influence of external geometric variation of dental implant is proven justified in previous work where it was used an asymmetric two-dimensional model to study the influence of the screw thread shape in relation to stress levels. It was found significant differences

showing that the geometric variation of the model does influence on the distribution and on stress levels, proving that the ideal is to use implants with threads with slight curvature and lower depth.[21] The study of the differences of geometry and loadings applied was also explored in another work[22] that compared five systems of commercial implants. It was concluded that the error occurs on the marginal region of the implant, on the cortical bone and in compression. From the loading point of view, on literature it is possible to find experimental values of the bite force determined with electric extensometer.[14] It is known that this force increases during period of adaptation of the prosthesis. For computational simulation, most works presented in literature consider axial loadings[1,2,3,10,15-19] of 100N but some works consider the inclination of the equivalent loading to 15°[15,16] and 30°.[20] Literature presents study with simulation of finite elements where the model was submitted to a variation on the cusp inclination.[23] It was concluded that it is better to have a lower inclination of the cusp to obtain lower stress on the system bone-implant due to reduction of the force lateral components. This way, the choice of loading used in this work is relevant in relation to its intensity and direction. Through the use of simulations it is possible to observe the mechanical behavior of the prosthesis and estimate the success of the components before being commercialized. It is always sought to obtain values of stress lower than the material outflow limit to guarantee that there will not be plastic deformation of the components. Literature shows that the bone must be submitted to maximum stress of 167Mpa, this is the limit value to initiate the bone reabsorption.[24] This way it is possible to evaluate quantitatively the error possibility and qualitatively through figures with color gradient, the location of error occurrence of the implants systems. Regarding the evaluated prosthetic systems in the present work, it was not observed values superior to the limit of material outflow, showing that there will not be plastic deformation or fracture of the implants or any other component for loads of 100N on three implemented directions. It was also evidenced on figures 3,4 and 5 that the inclination of equivalent loading has influence on the stress distribution, as well as on its intensity. It was possible to observe on figures 4 and 5 that the values of the stress transmitted to the bone varies according to the loading used and to the type of dental implant evaluated. As the loading becomes more inclined, i.e., the components of the lateral forces increase, the stress on the bone and on the system also increase. Besides the method of finite elements, study involving photoelasticity was implemented to evaluate implants with different geometries.[25,26] It was verified that for loading with components of lateral forces, the stress are greater than for vertical loadings. This is due to reduction of bending moment created. In relation to the two types of dental implant evaluated, the Flash system transmits lower stress to the cortical bone, trabecular bone and to the dental implant. The fixation screw of the pillar had very similar behavior. For the pillar the behavior was the opposite, i.e., there was a greater effort on this component for the system with the implant Flash, however, in imposed conditions for this model, this effort does not influence the loss of component once the stresses were inferior to the limit of this material outflow. For analysis of safety factor, it was observed that both systems have high safety factor and would need a loading of 3 or 4 times more intense to begin to deform or components of laterality greater than 30° to intensificate the shear stress. According to what is shown on figure 6, for the loads used in this work, both systems presented high mechanical efficiency and the stress distribution was very similar for loadings on the same direction. For all simulations performed, the levels of stress show that there will not be bone resorption due to overload for being below the limit indicated on literature.[24]

© 2012 Dental Press Implantology

Conclusion

Based on the performed computational simulations, it can be concluded that:

1. The system with dental implant Flash transmit lower stress to the bone and dental implant.
2. The safety factor of the implants is high suggesting it supports loadings more aggressive in intensity and directions.
3. As the loading becomes more inclined, i.e., the components of the lateral forces increase, the stress on the bone and on the prosthetic components increase.
4. For all simulations performed, the systems behaved appropriately so there is no indication of deformation or fracture on the prosthetic components or even bone resorption due to overload.

REFERENCES

1. Lehmann RB, Elias CN. Uso de simulação 3D no desenvolvimento de implantes e sistemas protéticos com pilares retos e angulados. ImplantNews. 2010;7(1):113-20.
2. Lehmann RB, Elias CN, Teixeira MF. Efeito da oclusão cêntrica em um sistema rígido de esplintagem dos implantes para carga imediata pelo método de elementos finitos. Rev Bras Implant. 2009;15(1):6-10.
3. Lehmann RB, Elias CN. Tensões em implantes cônicos com hexágono externo e com hexágono interno. Rev Dental Press Periodontia Implantol. 2008;2(2):91-9.
4. Hansson S, Werke M. The implant thread as a retention element in cortical bone: the effect of thread size and thread profile: a finite element study. J Biomech. 2003;36(9):1247-58.
5. Alkan I, Sertgo A, Ekici B. Influence of occlusal forces on stress distribution in preloaded dental implant screws. J Prosthet Dent. 2004;91(4):319-25.
6. Tada S, Stegaroiu R, Kitamura E, Miyakawa O, Kusakari H. Influence of implant design and bone quality on stress / strain distribution in bone around implants: A 3-dimensional finite element analysis. Int J Oral Maxillofac Implants. 2003;18(3):357-68.
7. Sahin S, Cehreli MC, Yalçin E. The influence of fuctional forces on the biomechanics of implant-supported prostheses - a review. J Dent. 2002;30(7-8):271-82.
8. Stanford CM, Brand RA. Toward an understanding of implant occlusion and strain adaptive bone modeling and remodeling. J Prosthet Dent. 1999;81(5):553-61.
9. Vaillancourt H, Pillar RM, McCammond D. Factors affecting crystal bone loss with dental implants partially covered with a porous coating: a finite element analysis. Int J Oral Maxillofac Implants. 1996;11:351-9.
10. Lehmann RB, Elias CN. Simulação da distribuição de tensões em implante dentário curto (5,7mm x 5,0mm) com carregamento axial em corticais com diferentes espessuras. Dental Press Implantology. 2011;5(4):46-54.
11. Caglar A, Bal BT, Aydin C, Yilmaz H, Ozkan S. Evaluation of stresses occurring on three different zirconia dental implants — three-dimensional finite element analysis. Int J Oral Maxillofac Implants. 2010;25(1):95-103.
12. Cruz M, Wassall T, Toledo EM, da Silva Barra LP, Cruz S. Finite element stress analysis of dental prostheses supported by straight and angled implants. Int J Oral Maxillofac Implants. 2009;24(3):391-403.

© 2012 Dental Press Implantology

13. Silva GC, Mendonça JA, Lopes LR, Landre J Jr. Stress patterns on implants in prostheses supported by four or six implants: a three-dimensional finite element analysis. Int J Oral Maxillofac Implants. 2010;25(2):239-46.
14. Iplikçioglu H, Alça K. Comparative evaluation of the effect of diameter, length and number of implants supporting three-unit fixed partial prostheses on stress distribution in the bone. J Dent. 2002;30:41-6.
15. Schrotenboer J, Tsao YP, Kinariwala V, Wang HL. Effect of platform switching on implant crest bone stress — a finite element analysis. Implant Dent. 2009;18(3):260-9.
16. Lee CC, Lin SC, Kang MJ, Wu SW, Fu PY. Effects of implant threads on the contact area and stress distribution of marginal bone. J Dent Sci. 2010;5(3):156-65.
17. Li T, Kong L, Wang Y, Hu K, Song L, Liu B, et al. Selection of optimal dental implant diameter and length in type IV bone: a three dimensional finite element analysis. Int J Oral Maxillofac Surg. 2009;38(10):1077-83. Epub 2009 Aug 4.
18. Bujtár P, Sándor GK, Bojtos A, Szucs A, Barabás J. Finite element analysis of the human mandible at 3 different stages of life. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;110(3):301-9. Epub 2010 May 1.
19. Ao J, Li T, Liu Y, Ding Y, Wu G, Hu K, et al. Optimal design of thread height and width on an immediately loaded cylinder implant: A finite element analysis. Comput Biol Med. 2010;40(8):681-6.
20. Eser A, Tonuk E, Akca K, Cehreli MC. Predicting time-dependent remodeling of bone around immediately loaded dental implants with different designs. Med Eng Phys. 2010;32(1):22-31. Epub 2009 Nov 1.
21. Hansson S, Werke M. The implant thread as a retention element in cortical bone: the effect of thread size and thread profile: a finite element study. J Biomech. 2003;36(9):1247-58.
22. Bozkaya D, Muftu S, Muftu A. Evaluation of load transfer characteristics of five different implants in compact bone at different load levels by finite elements analysis. J Prosthet Dent. 2004 Dec;92(6):523-30.
23. Moraes MCCB, Moraes EJ, Elias CN. Análise de tensões em implantes osseointegrados por elementos finitos: variação da inclinação da cúspide e largura da mesa oclusal. Rev Bras Implant. 2002;8(2):21-6.
24. Ciftçi Y, Canay S. The effect of veneering materials on stress distribution in implant supported fixed prosthetic restorations. Int J Oral Maxillofac Implants. 2000;15(4):571-82.
25. Gross MD, Nissan J, Samuel R. Stress distribution around maxillary implants in anatomic photoelastic models of varying geometry Part I. J Prosthet Dent. 2001;85(5):442-9.
26. Gross MD, Nissan J. Stress distribution around maxillary implants in anatomic photoelastic models of varying geometry Part II. J Prosthet Dent. 2001;85(5):450-4.

© 2012 Dental Press Implantology

Micrometric characterization of implant surfaces of the five largest companies in the Brazilian market. Part II: Biomet 3i BoneLike implants

Márcio Borges **ROSA***
Tomas **ALBREKTSSON****
Carlos Eduardo **FRANCISCHONE*****
Humberto Osvaldo **SCHWARTZ FILHO******
Ann **WENNERBERG*******

Abstract

Introduction: The quality of the bone-implant interface is directly influenced by implant surface roughness and a roughness average, with the S_a between 1 to 2µm, has demonstrated better clinical and laboratory results. In Brazil, are installed more than two million implants per year, where 79% are manufactured by domestic companies. However, very little is known or published about the characterization of surfaces of these implants, on the micrometer level. **Objective:** The aims of this study are to evaluate and characterize numerically the surface of the implants BoneLike, of Biomet 3i do Brasil company, one of the five largest companies in the Brazilian market. **Methods:** Were evaluated a total of 6 implants, purchased directly on the market, of two different designs (BoneLike-HE and BoneLike-CM) and different batches, using light interferometry. Were performed 9 measurements randomly chosen for each unit, 3 on the tops, 3 on the valleys and 3 on the flanks of the threads. The same pattern was followed for evaluation by scanning electron microscope. **Results:** The analyzed implants from this company showed S_a values of 0.47µm for BoneLike-HE and 1.01µm for BoneLike-CM. Comparing the batches, both designs showed statistically significant differences between them. **Conclusions:** The roughness values found herein categorize the surfaces of BoneLike–HE implants as smooth, and BoneLike–CM implants as moderately rough, with S_a values quite close to a smooth surface.

Keywords: Dental implant. Brazilian implants. BoneLike implants. Implant surface. Roughness.

How to cite this article: Rosa MB, Albrektsson T, Francischone CE, Schwartz Filho HO, Wennerberg A. Micrometric characterization of implant surfaces of the five largest companies in the Brazilian market. Part II: Biomet 3i BoneLike implants. Dental Press Implantol. 2012 Apr-June;6(2):35-46.

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

Contact address:

Márcio Borges Rosa
Av. do Contorno 4849, 4º andar – Bairro Serra –Belo Horizonte/MG – Brazil
Zip Code: 30.110-100 – E-mail: marcio@implantare.com.br

Submitted: 03/10/2012
Revised and accepted: 03/ 20 /2012

* Specialist. PhD student in Implantology, São Lepoldo Mandic. Private Clinic, Belo Horizonte, Brazil.
** MSc and PhD. Head of Department of Biomaterials, University of Gothenburg.
*** MSc and PhD. Full Professor, School of Dentistry of Bauru-USP. Coordinator of PhD in Implantology, São Leopoldo Mandic.
**** MSc. PhD student in Implantology, Unesp.
***** MSc and PhD. Head of the Department of Prosthodontics, Faculty of Malmö, Sweden.

© 2012 Dental Press Implantology

INTRODUCTION

An important parameter for the clinical success of osseointegrated implants is the formation of direct contact between implant and surrounding bone[1,2]. The quality of the bone-implant interface is directly influenced by the roughness of the implant surface[3-8] which was identified as one of six particularly important factors for the incorporation of implant into the bone from the beginning of the 80's.[3]

Both morphology and surface roughness have an influence on the proliferation, cell differentiation, extracellular matrix synthesis, local production factors and even on the cell shape.[8,9] Fixing mechanisms used by cells on the implant surface determine its shape and the transmission of signals through their cytoskeleton resulting in the expression of specific phenotypes. Furthermore, the shape of the cell regulates the growth, gene expression, protein secretion, differentiation and apoptosis.[10]

The osteoblast adhesion on the implant surface is not sufficient for obtaining the osseointegration, or even improves it, but it is necessary particularly for the cell to receive signals in order to induce their proliferation.[8] Moreover, roughnesses do not only facilitate the retention of osteogenic cells, but they allow them to migrate on the implant surface by osseoconductivity.[11] A faster and stronger bone formation provides higher stability during the repair process, allowing even a faster loading of the implant.[5,6,7]

The oral implants surfaces have measurable structures in macrometric scale in millimeters (mm), micrometric scale in micrometers (μm) and nanometric scale in nanometers (nm).[5,7,8,12,13,14] The objective of several publications and studies in this recent years is how these structures influence the repair.[6,13,15-18]

So far, the certainties are limited to the influence of implant design and roughness in micrometric scale. A screw-shaped design and a surface with a mean roughness, Sa of 1-2μm show better results.[6,7,8,12] Studies have shown titanium implants with appropriate roughness can improve the bone-implant contact[19] and also increase the force of the extraction torque.[19,20] On the other hand, increasing the surface roughness higher than 2μm of S_a causes an impaired and unreinforced bone response.[5-8]

Over the past 20 years, a high number of implant systems with different surface topographies was added.[17] Oral implants are an example of the close binding between research and industry, as the laboratory findings often become clinical applications.[1]

Brazil is currently one of the largest implant markets of the world with an annual consumption estimated at 2,000,000 (two million) units which 79% are manufactured by national companies (Survey on the Status of Implantology in Brazil — ImplantNews, Survey 2010). Biomet 3i do Brasil (São Paulo, Brazil), is one of the five largest companies in Brazil.

But it is disclosed or known very little about the physicochemical characteristics of the surface of their implants, thus limiting the information contained in the leaflet and in its catalog.

This study aims to characterize the surfaces of two different Bonelike implants designs (external hex and morse taper) and describe them within the international standard developed by Wennerberg and Albrektsson[5]. Data found will bee described and evaluated with the expectation for the treatment utilized, comparing them with SLA® implants, made by Straumann, used as reference since they use the same type of treatment and have solid publishing in worldwide literature.

Material and Methods

Methodology used to evaluate the implant surface was proposed by Albrektsson and Wennerberg in 2000[5], and became a worldwide pattern for evaluating the implant surfaces.

© 2012 Dental Press Implantology

Therefore, three measurements were carried out in different areas for each implant, from the tops, valleys and flanks of the threads (Fig 1), with a total of nine measurements for each unit. Furthermore, three samples were evaluated in different batches for each implant to permit evaluation of the regularity of production process, and they are separated in samples 1, 2 and 3. Following this pattern, three implants of each of the following designs made by Biomet 3i do Brasil, were purchased directly in the market: BoneLike-HE, external hex (Fig 2) and BoneLike-CM, morse taper (Fig 3).

Scanning electron microscopy images were also performed (Quanta 200) from top, flank and valley of threads in the upper, middle and lower thirds, with a total of 9 areas assessed. Magnifications of 65X, 350X, 1,000X, 3,000X and 5,000X were used.

The objective of those images was to undertake a qualitative analysis of the modifications achieved by the surface treatments, by observing the roughness characteristics and whether they upheld the same pattern throughout the entire body of the implant.

In addition, one of samples of the implants was cut transversely for polishing metal and underwent the EDS analysis, the energy dispersive spectroscopy, which is used to identify the elements present in the surface and was used to ensure the titanium used by the company, checked that described in the leaflet.

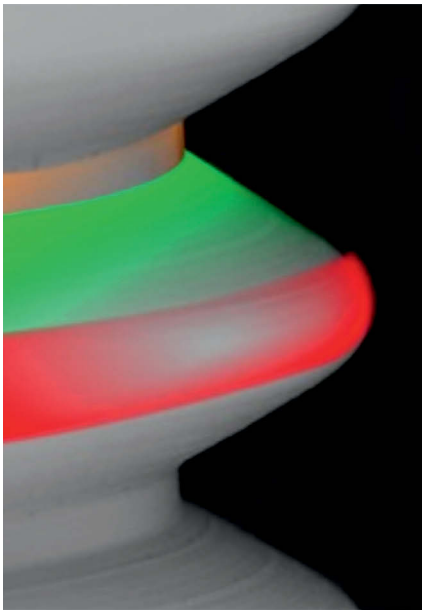


Figure 1 - Red = top; green= flank; orange= valley

Figure 2 - 3i BoneLike-HE (external hex) implant (Lot 1 – 6653 JB; Lot 2 – 8489KB/1; Lot 3 – 2659KB).

Figure 3 - 3i BoneLike-CM (Morse Taper) implant (Lot 1 - 03064LB, Lot 2 - 04963LB, Lot 3 - 03079LB).

© 2012 Dental Press Implantology

Surface treatment

The surfaces of BoneLike implants are treated by a blasting combination followed by acid conditioning which has a commonly used technique for the surface treatment during recent years. The reason for the combination of methods is the blasting process hypothetically reaches an optimal roughness and mechanical fixing, while the conditioning softens some peaks and may add a high frequency component in the implant surface, with potential importance to the protein adhesion which is considered important to the early bone healing process.[6]

Surface characteristics obtained by deformation depend on the type of particle used, its hardness, its size and impact velocity. Blasting process usually per- formed by titanium (TiO_2) or alumina (Al_2O_3) particles allows a good control on the size of microcavities obtained. However, some remaining particles may be embedded and contaminate the implant surface.[8]

The acid conditioning removes some atomic layers from the deformed surface and part of the residual tension in surface reduces the possibility of contamination of the surface by remaining blasting particles because it also acts in cleaning the surface. These processes create microcavities superposed on the pre-blasted rough surface.

Each manufacturer has its own acid conditioning method for concentration and temperature of acids, as well as the exposure time which is a trade secret and we have no access. In general, we have the double acid conditioning which is performed by the first immersion of implants in HCl + H_2SO_4, HNO_3 + HF or HNO_3 solutions. Then, implant is again immersed in an aqueous HNO_3 solution for stabilizing the titanium oxide layer.[6,8]

3i BoneLike implants are manufactured using Ti_6AL_4V titanium alloy, considered grade 5. The type of titanium directly influences the roughness values obtained by surface treatments since metal hardness affects treatment efficiency.

We will use the SLA surface as reference to compare Straumann documented clinically with positive results with 5-years follow-up by Bornstein et al.[21]

Surface analysis

Implant surfaces were evaluated using a light Interferometer (MicroXAMTM, Phaseshift, USA) is indicated to evaluate roughness of the implant with threads at micrometric level[5]. We use an objective of 50X and a zoom of 0.62. The measured area was 264 X 200µm, while the average height of measures ranged between 80µm and 100µm. The maximum resolution of this technique is 0.30µm horizontally and 0.05µm vertically.

To be able to adequately describe the roughness obtained with the treatment, the undulations of machining process and shape are considered separately. A standard filtering process using a Gaussian Filter of 50 X 50µm was used to perform this separation and assessment of the micrometric roughness (Fig 4-7). For this, the Surfascan software (Somicronic Instrument, Lyon, France) is used, which also provides visual images and numerical descriptions.

For the numerical description of the surface topography which should preferably be in 3D, the following parameters are used:

a) S_a: Represents the arithmetic mean for height of peaks and valleys, surface roughness in the median plane.
b) S_{ds}: Represents the density, in other words, number of peaks per area unit.
c) S_{dr}: Hybrid parameter representing the increase in area obtained.

Implants can be divided into 4 different categories, depending on the surface roughness measured by the value

© 2012 Dental Press Implantology

of S_a: 12 smooth (S_a < 0.5µm); minimally rough (S_a between 0.5–1.0µm), moderately rough (Sa between 1.0–2.0µm); Rough (S_a >2.0µm).

Statistical analysis

Implants were evaluated for significant differences in surface topography at micrometric level. Statistical analyzes were performed using GraphPad Prism 5.0 (GraphPad Software, San Diego, USA). Results were analyzed using Kruskall-Wallis test with significance level of $p<0.05$, and Dunn's multiple comparison test was applied, also at a significance level of $p<0.05$.

Results

Characterization of the surface

Table 1 shows the values obtained, as well as the implant used as reference for comparison to the values found and published by Svanborg et al.[14]

In Figures 5 images of interferometer analysis generated by the Surfascan Software were observed along with the obtained in the scanning electron microscope with a magnification of 3.000X. Images were selected from the flanks of the thread in the middle third of the implants.

The Figures 7 to 9 are detailed SEM images, at three different magnifications, of the three evaluated BoneLike implants made by Biomet 3i do Brasil, as well as of the Straumann SLA® implant used as reference.

Comparing the different lots

Analysis was performed separately for each design, because herein does not fit any comparison between them. In addition to this, comparison will be made only regarding the S_a and S_{dr}.

BoneLike–HE

These implants showed statistically significant differences in S_a values between Lot 01 (S_a = 0.41µm), and Lot 03 (S_a = 0.53µm) (Fig 10). Despite considerable numerical

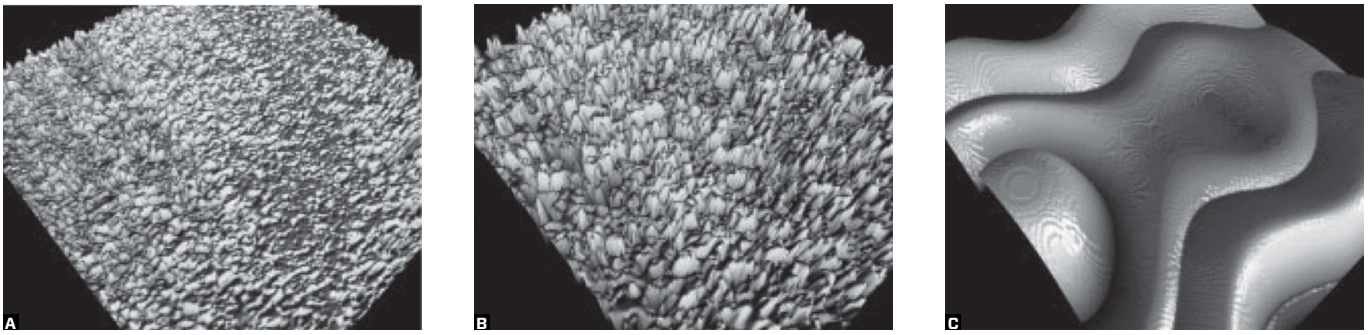


Figure 4 - Sequence of filters in which the undulations and shapes are removed. **A**) Original Nanotite, **B**) Nanotite with 50X50µm Gaussian filter, **C**) Nanotite with 50X50µm Gaussian filter (low pass)[14].

Table 1 - Numerical description of the surface topography of 3i implants BoneLike in micrometer level.

	S_a (µm)	S_{ds} (mm²)	S_{dr} (%)
3i BoneLike – HE	0.47 ± 0.06	187.053 ± 37.143	33.98 ± 21.61
3i BoneLike – CM	0.53 ± 0.12	174.539 ± 30.456	40.20 ± 41.56
SLA® Straumann	**1.53 ± 0.19**	**129.04 ± 22.67**	**74.52 ± 33.34**

© 2012 Dental Press Implantology

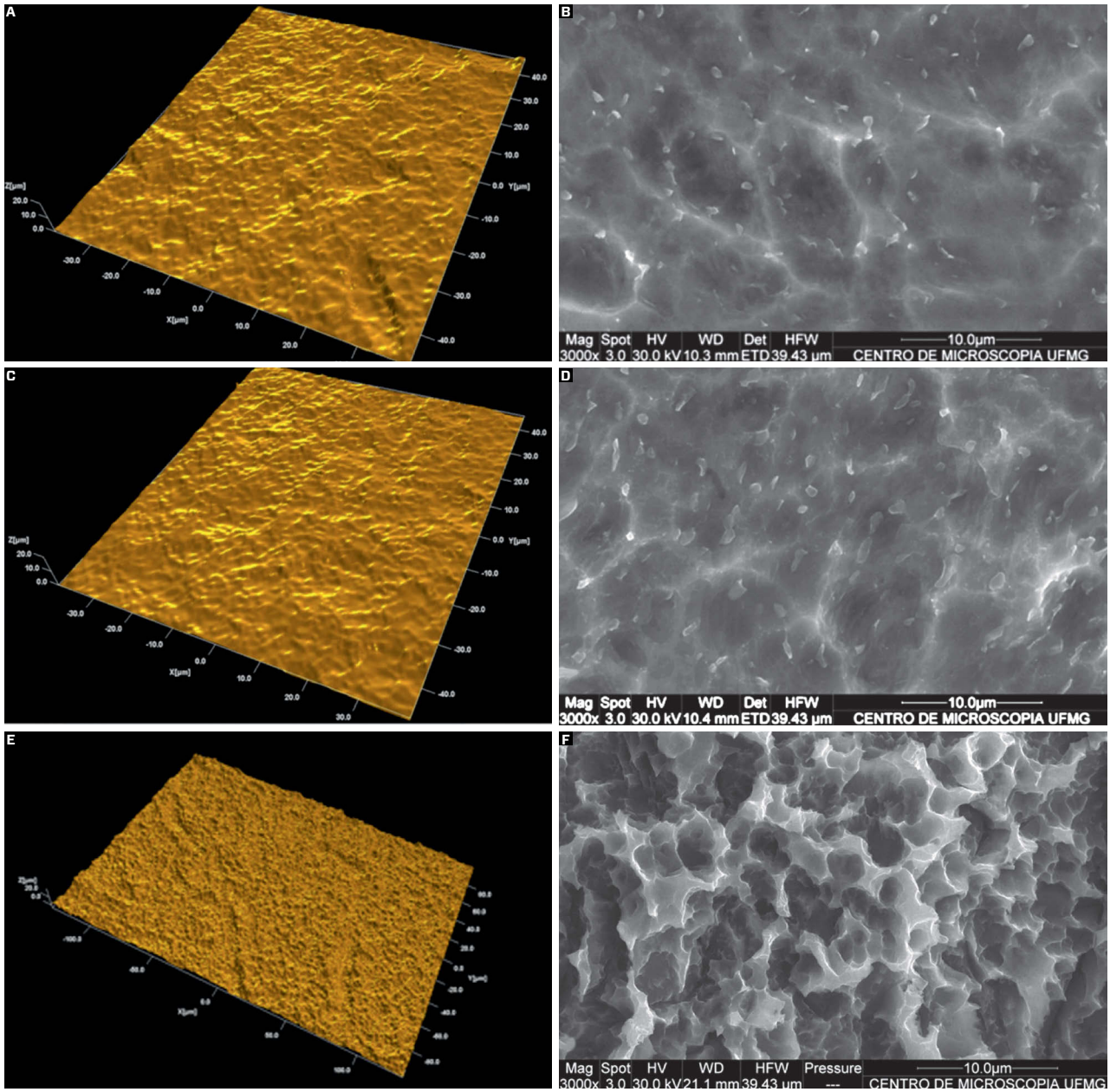


Figure 5 - **A**, **B**) BoneLike–HE; **C**, **D**) BoneLike–CM; **E**, **F**) SLA® Straumann.

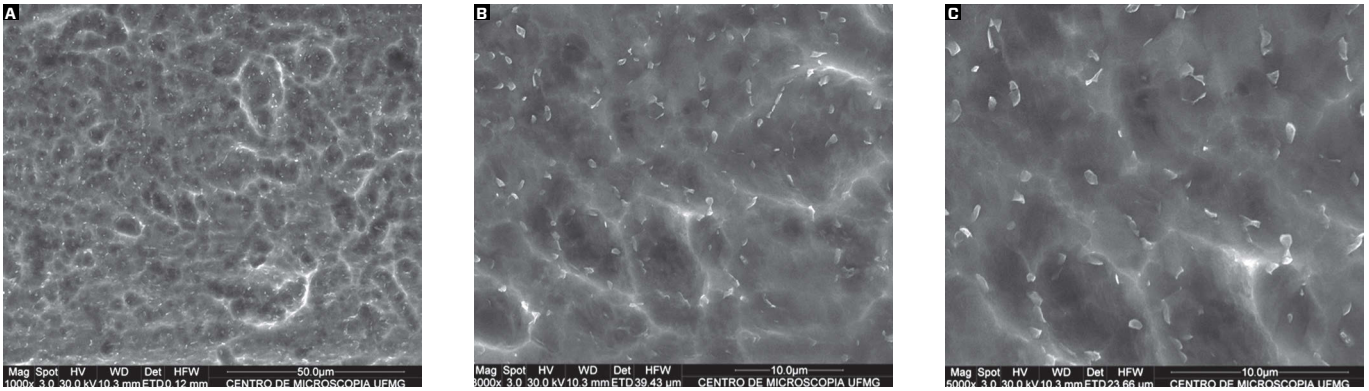


Figure 6 - SEM images of BoneLike implants – CM (A: 1000x, B: 3000x e C: 5000x).

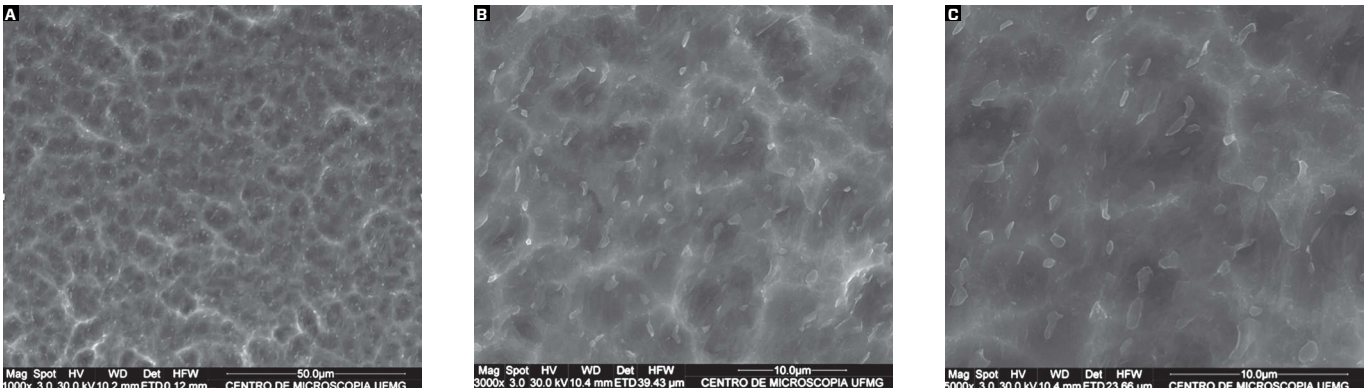


Figure 7 - SEM images of BoneLike implants – HE (A: 1000x, B: 3000x e C: 5000x).

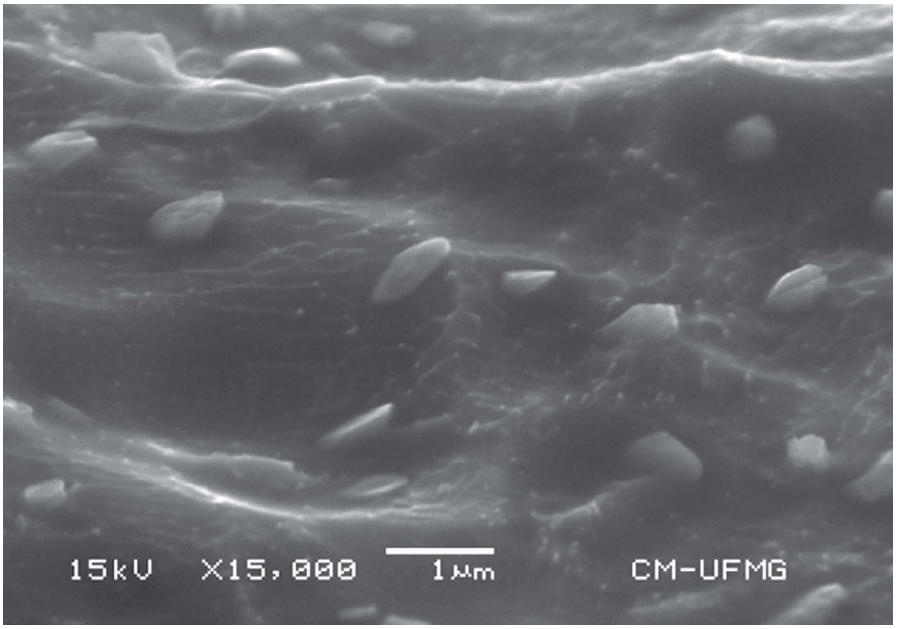


Figure 8 - Image with highest magnification (15000x) showing the particles present on the surface of the BoneLike implants.

differences between values for Sdr - 27% for Lot 01, 38% for Lot 02 and 36% for Lot 03 (Fig 11), no statistically significant differences were found in this parameter.

BoneLike-CM

This implant design displayed statistically significant differences in S_a values between Lot 02, with 0,39µm, and Lot 03, with 0.67µm (Fig 12). Despite the significant numerical differences between S_{dr} values, especially in Lot 03, with 72%, Lot 01, with 28%, and Lot 02, with only 19% (FIg 13), no statistically significant differences were found in this parameter.

EDS of the implants

The EDS analysis results for both implant designs from Biomet 3i do Brasil showed an identical pattern and indicated the use of titanium alloy Ti_6Al_4V grade-5 (ASTM F-136), which is fully in accordance with the specifications given in the product description. Figure 14 presents the spectrum of the BoneLike-HE implant, and will serve

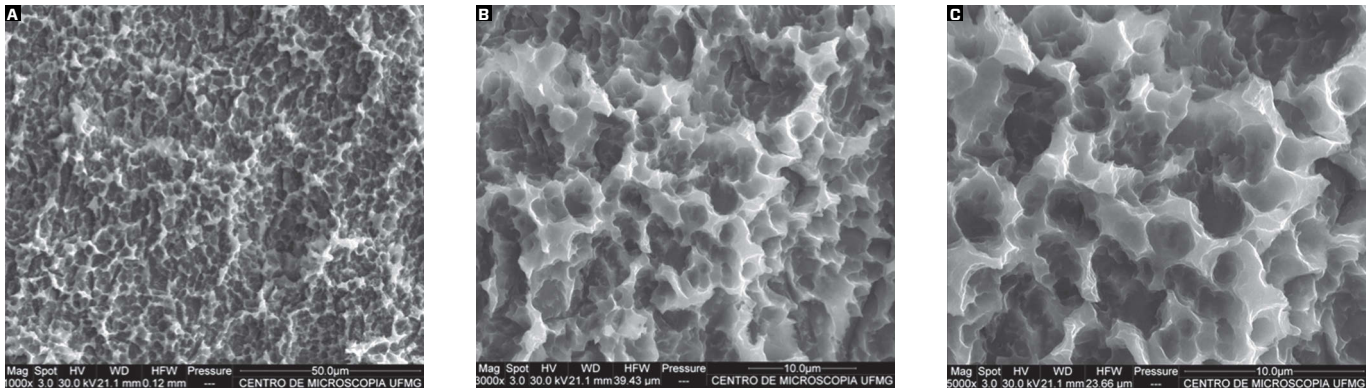


Figure 9 - SEM images of Straumann SLA® implants (**A**: 1000x, **B**: 3000x and **C**: 5000x).

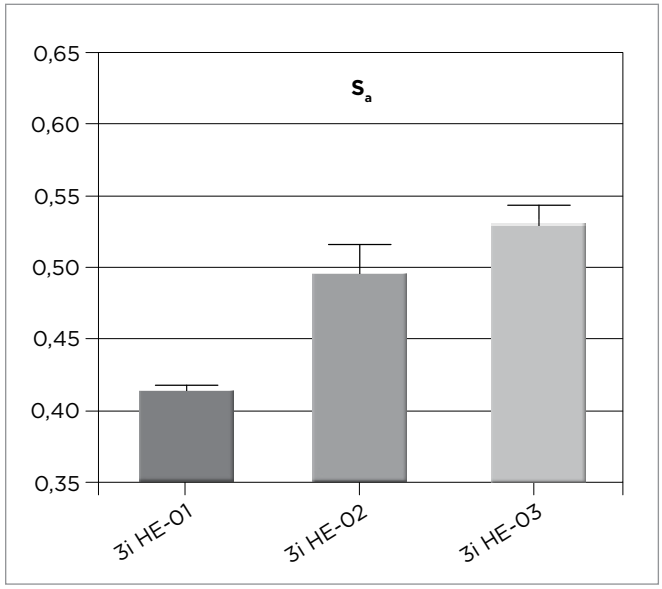


Figure 10 - S_a comparison between lots of BoneLike –HE implants.

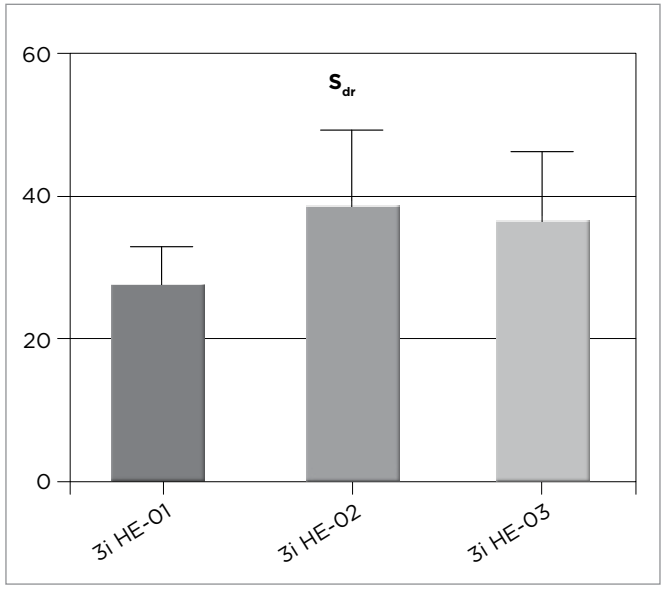


Figure 11 - S_{dr} comparison between lots of BoneLike –HE implants

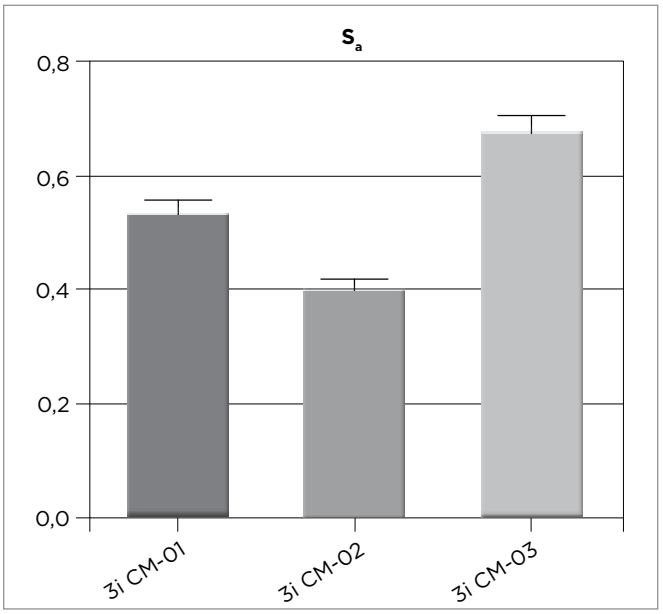


Figure 12 - S_a comparison between lots of BoneLike–CM implants.

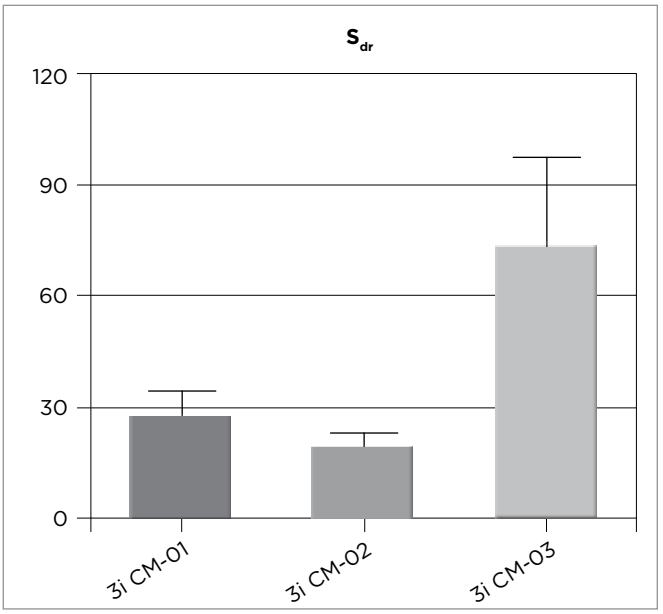


Figure 13 - S_{dr} comparison between lots of BoneLike–CM implants.

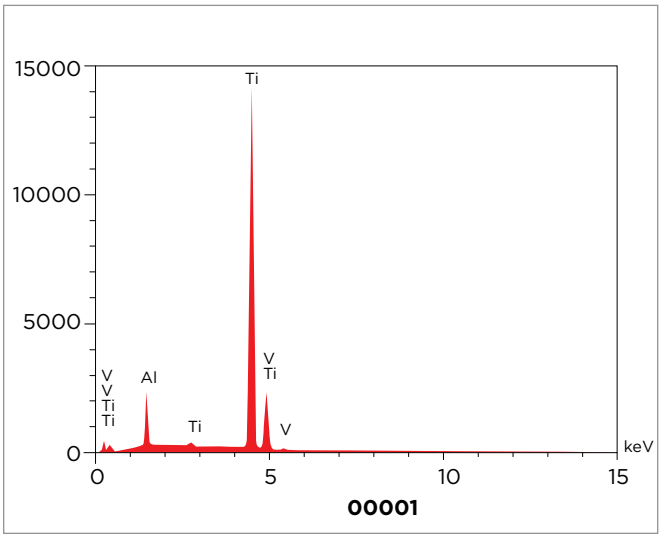


Figure 14 - EDS analysis of the sample of 3i BoneLike–HE implants, evidencing the use of titanium alloy Ti_6Al_4V.

to demonstrate the chemical composition of both evaluated implants from Biomet 3i.

Discussion

When the implants started to be manufactured in Brazil, most companies chosen designs and implant surface treatments established, with extensive scientific publication and strong presence in the Brazilian market. Although its U.S. headquarters used only acid etching to treat the surfaces of its implants, Biomet 3i do Brasil chose to use blasting followed by acid etching as the standard treatment for its implants manufactured in Brazil One way to evaluate the obtained results is to compare them with the values obtained from reference implants, using the same standards and backed by vast scientific evidence. In this case, Straumann SLA® implants were used as reference, as they apply the same type of treatment.

Among the parameters evaluated, the most representative ones for the analysis of a surface are S_a, representing the arithmetic mean of peak and valley heights of

© 2012 Dental Press Implantology

the surface roughness in 3D and S_{dr} representing the increase in surface area obtained with treatment. Analysis of these factors and previous knowledge of its influence on the repair processes allows a behavior signaling of certain surface.[7,12,22]

Generally, in blasting treatments followed by acid at- tack, moderately rough surfaces with S_a, between 1.0 and 2.0μm[12], are obtained. These two types of treat ment, even alone, have many variables and may have different surfaces according to patterns adopted. In blasting, both the type of particle used, such as its size, and impact velocity are directly responsible for the results obtained. In acid conditioning, type of acid, exposure time and temperature are critical factors for the characterization of the surface.[8]

The surface of BoneLike-HE implants presented an S_a of 0.47μm, being therefore considered a smooth surface[12], whereas the BoneLike-CM had S_a of 0.53μm, making it theoretically a minimally rough surface. The SLA implants, from Straumann, used as reference for this type of treatment, have a S_a of 1.53μm, and they are considered to be moderately rough.[12] It should be noted these values are lower than even those found in machined Brånemark implants whose surface was previously considered to be smooth, but after the development of surface assessment technology and significant increase in capacity of the equipment used showed in fact to be a minimally rough surface, [12] presenting a S_a of 0.90μm.[7]

The use of Ti_6Al_4V titanium alloy in the manufacture of BoneLike implants, classified as grade 5 and harder than the others and certainly resulted in the low roughness obtained. Nevertheless, the treatments employed must be adequate for the material used, in order to obtain the desired roughness. When analyzing the S_{dr} values, in other words, increased surface area obtained, 34% for BoneLike-HE and 40% for BoneLike-CM were found. Reference SLA implant provides a S_{dr} of 74%.[14] S_{dr} values of around 50% provide and produce a stronger contact between bone and implant.[12,23-26] Therefore, the implants from Biomet 3i showed values below what is considered ideal for this parameter as well.

Analyzing both the interferometer and SEM images, it is evident a surface of low roughness, especially when compared images of the Straumann SLA® implant (Fig. 9). The SEM analysis showed the presence of particles smaller than 1μm spread throughout the implant surface (Fig 8). Due to its size and characteristic, these particles are not from the process of blasting. A more detailed analysis, through appropriate equipment or a company's position on the subject, would be appointed to ensure greater security for its users. Since these particles are not related to the primary purpose of this study, and in evaluate the standard of the surface roughness, as yet not been made any more specific analysis on them. The company was contacted, but despite having knowledge of the presence of these particles, further alleged to be investigating their origin and composition.

As with the methodology employed, EDS analysis allows to state only on the percentage of chemical elements found, which are fully consistent with the leaflet of the implants, and they point to the use of titanium alloy, Ti_6Al_4V (ASTMF F-136), grade 5 in their manufacture. In this analysis, it is not possible to make any consideration on the existence or absence of contamination or any metal or material on the surface of the implants. contamination or any metal or material on the surface of the implants.

In comparing among batches, as parameter for the regularity of the surface treatment process, the statistical difference found confirms the variability of this type of treatment, as well as the need of characterization of each design and each implant trademark to check the

© 2012 Dental Press Implantology

result obtained. According to the methods employed, the assessment of two more samples from the batch 01 of the BoneLike-HE implant and from batch 02 of the Bonelike-CM implant. For this, the company was contacted in order to concede these implants for further analysis. However, as those stock batches were no longer found, the company sent 03 new samples from the same batch for each design distinct from those first evaluated. Herein, it is noteworthy that the implants of the first assessment were acquired directly in the market. The results showed no significant differences in S_a and S_{dr} values between the new batches evaluated, for all two designs. Mean S_a values were 0.50µm for BoneLike-CM implants and 0.46µm for BoneLike-HE. For Sdr values, BoneLike-CM implants showed 34% and BoneLike-HE, 35%. These values are consistent and showed no statistically significant differences compared to the values found in the first assessment.

To know what these differences really may represent, further investigations are required. It can state the similar treatments do not show the same results.[7] Even only machined surfaces may vary considerably in roughness, as well as blasted surfaces with acid conditioning or anodized. Many studies and companies omit the topographic characterization of the surface because they believe the treatment alone will determine the optimum roughness of this surface.[6,7]

As it was already stated,[6,7] when the macrometric topography of a certain surface is changed, the micrometric and chemical characteristics may be changed at the same time, even accidentally. Therefore, it is essential the surface treatments are appropriate for each implant design in order to obtain the desired roughness.

The values and variations found in the micrometric characterizations of the implant surfaces evaluated showed how sensitive are the techniques used for this treatment.

Conclusions

In addition of course, to conduct clinical studies both prior as to subsequent releases of their implants, to validate its effectiveness and evaluate their influence on osseointegration, success rate and longevity, especially when there are changes not only in the design but also in the type of titanium used.

In addition of course, to conduct clinical studies both prior as to subsequent releases of their implants, to validate its effectiveness and evaluate their influence on osseointegration, success rate and longevity.

© 2012 Dental Press Implantology

REFERENCES

1. Shalabi MM, Wolke JG, Jansen JA. The effects of implant surface roughness and surgical technique on implant fixation in an in vitro model. Clin Oral Implants Res. 2006;17(2):172-8.
2. Fröjd V. On Ca 2+ Incorporation and nanoporosity of titanium surfaces and effect on implant performance. Malmo- Sweden: Malmo University; 2010.
3. Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. ActaOrthop Scand. 1981;52(2):155-70.
4. Cooper LF. A role for surface topography in creating and maintaining bone at titanium endosseous implants. J Prosthet Dent. 2000;84(5):522-34.
5. Wennerberg A, Albrektsson T. Suggested guidelines for the topographic evaluation of implant surfaces. Int J Oral Maxillofac Implants. 2000;15(3):331-44.
6. Wennerberg A, Albrektsson T. Effects of titanium surface topography on bone integration: a systematic review. Clin Oral Implants Res. 2009;20 Suppl 4:172-84.
7. Wennerberg A, Albrektsson T. On implant surfaces: a review of current knowledge and opinions. Int J Oral Maxillofac Implants. 2010 Jan-Feb;25(1):63-74.
8. Elias CN, Meirelles L. Improving osseointegration of dental implants. Expert Rev Med Devices. 2010;7(2):241-56.
9. Anselme K, Bigerelle M. Topography effects of pure titanium substrates on human osteoblast long-term adhesion. Acta Biomater. 2005;1(2):211-22.
10. Brunette MD. Principle of cell behaviour on titanium surfaces and their application to implanted devices. In: Brunette DM TP, Textor M, Thomsen P, editor. Titanium in Medicine. Berlin: SpingerVerlag; 2001. p. 485–512.
11. Braceras I, De Maeztu MA, Alava JI, Gay-Escoda C. In vivo low-density bone apposition on different implant surface materials. Int J Oral Maxillofac Surg. 2009;38(3):274-8.
12. Albrektsson T, Wennerberg A. Oral implant surfaces: Part 1--review focusing on topographic and chemical properties of different surfaces and in vivo responses to them. Int J Prosthodont. 2004;17(5):536-43.
13. Albrektsson T, Wennerberg A. Oral implant surfaces: Part 2--review focusing on clinical knowledge of different surfaces. Int J Prosthodont. 2004;17(5):544-64.
14. Svanborg LM, Andersson M, Wennerberg A. Surface characterization of commercial oral implants on the nanometer level. J Biomed Mater Res B ApplBiomater. 2010;92(2):462-9.
15. Elias CN, Oshida Y, Lima JH, Muller CA. Relationship between surface properties (roughness, wettability and morphology) of titanium and dental implant removal torque. J Mech Behav Biomed Mater. 2008;1(3):234-42.
16. Mendonca G, Mendonca DB, Aragao FJ, Cooper LF. Advancing dental implant surface technology--from micron- to nanotopography. Biomaterials. 2008;29(28):3822-35.
17. Sul YT, Johansson C, Albrektsson T. Which surface properties enhance bone response to implants? Comparison of oxidized magnesium, TiUnite, and Osseotite implant surfaces. Int J Prosthodont. 2006;19(4):319-28.
18. Chang PC, Lang NP, Giannobile WV. Evaluation of functional dynamics during osseointegration and regeneration associated with oral implants. Clin Oral Implants Res. 2010;21(1):1-12.
19. Wennerberg A. On Surface Roughness and Implant Incorporation. Göteborg: University of Göteborg; 1996.
20. Sul YT, Johansson CB, Jeong Y, Wennerberg A, Albrektsson T. Resonance frequency and removal torque analysis of implants with turned and anodized surface oxides. Clin Oral Implants Res. 2002;13(3):252-9.
21. Bornstein MM, Schmid B, Belser UC, Lussi A, Buser D. Early loading of non-submerged titanium implants with a sandblasted and acid-etched surface. 5-year results of a prospective study in partially edentulous patients. Clin Oral Implants Res. 2005;16(6):631-8.
22. Shalabi MM, Gortemaker A, Van't Hof MA, Jansen JA, Creugers NH. Implant surface roughness and bone healing: a systematic review. J Dent Res. 2006;85(6):496-500.
23. Wennerberg A, Albrektsson T, Andersson B. Bone tissue response to commercially pure titanium implants blasted with fine and coarse particles of aluminum oxide. Int J Oral Maxillofac Implants. 1996;11(1):38-45.
24. Wennerberg A, Albrektsson T, Andersson B, Krol JJ. A histomorphometric and removal torque study of screw-shaped titanium implants with three different surface topographies. Clin Oral Implants Res. 1995;6(1):24-30.
25. Wennerberg A, Albrektsson T, Johansson C, Andersson B. Experimental study of turned and grit-blasted screw-shaped implants with special emphasis on effects of blasting material and surface topography. Biomaterials. 1996;17(1):15-22.
26. Wennerberg A, Albrektsson T, Lausmaa J. Torque and histomorphometric evaluation of c.p. titanium screws blasted with 25- and 75-microns-sized particles of Al2O3. J Biomed Mater Res. 1996;30(2):251-60.

© 2012 Dental Press Implantology

Influence of tissue biotype in the morpho-esthetic-functional behavior of the peri-implant tissue: A literature review

Ordener Miranda Martins de **SOUZA***
Jamille Freitas de Andrade **NERI****
Ludmila **TOPÁZIO****
Rafaela Carneiro **DONADONE*****
André Carlos de **FREITAS******
Maurício Andrade **BARRETO*******

Abstract

Introduction: The current focus of Implantology is the planning of a rehab contemplating, besides the function, the esthetical success. The expectation is to create an esthetic restoration that is indistinguishable from the natural tooth, as well as returning the contour of peripheral structures (peri-implant mucosa and papilla) that resemble the same contralateral structures. It is a field of multiple variables in which the identification of tissue biotype is a factor that competes for the achievement of such success. **Objective:** The purpose of this present work was to review the influence of gingival biotype on morpho-functional and esthetic behavior of peri-implant tissues, indicating protocols of diagnosis and management of these tissues. It was used as source of research the data base of PubMed, selecting articles published from March 2008 to June 2011. **Conclusion:** Within the limits of this review, it was possible to conclude that tissue biotype has influence on the esthetic in the therapy with implants, specially on the facial peri-implant mucosa levels; presenting the thin biotype greater susceptibility to recession. In this condition, the conversion of a thin biotype into a thick biotype, through grafting of conjunctive tissue seems to positively influence on the level of facial marginal mucosa. On the other hand, the tissue biotype showed little influence on the height of the interproximal papilla.

Keywords: Dental implant. Biotypology. Periodontics.

How to mention this article: Souza OMM, Neri JFA, Topázio L, Donadone RC, Freitas AC, Barreto MA. Influence of tissue biotype in the morpho-esthetic-functional behavior of the peri-implant tissue: A literature review. Dental Press Implantol. 2012 Apr-June;6(2):56-66.

» The authors inform that they do not have no associative, commercial, intellectual property, or financial interests representing a conflict of interest in products and companies described in this article.

Contact address

Ordener Miranda Martins de Souza
Av. Reitor Miguel Calmon, 1210 – Sl 705 – Vale do Canela
Zip Code: 40.110-100 – Salvador/BA – Brazil
Email: ordenermiranda@gmail.com

Submitted on: 12/14/2011
Revised and accepted on: 01/31/2012

* Specialist in Periodontics, PUC-MG. Specialization student of Implantology, Federal University of Bahia.
** Graduation student of Dentistry, Escola Bahiana de Medicina e Saúde Pública.
*** Graduation student of Dentistry, Escola Bahiana de Medicina e Saúde Pública. Scholar of Scientific initiation by FAPESB. Integrant of Tutorial Education Program of the Brazilian Ministry of Education.
**** PhD in Bucco-Maxillofacial Surgery, PUC-RS. Professor, School of Dentistry of Federal University of Bahia. Coordinator of the course of Specialization in Implantology, chool of Dentistry of Federal University of Bahia. Head of Residency in Bucco-Maxillofacial Surgery, Federal University of Bahia/OSID.
***** MSc and PhD in Implantology, USC-Bauru. Adjunct Professor, Escola Bahiana de Medicina e Saúde Pública.

© 2012 Dental Press Implantology

Introduction

Albrektsson et al[1] and Smith and Zarb[2] proposed the criteria of success and survival for dental implants extremely relevant on the evaluation of the osseointegration. Today, with the high survival rates and success of therapy with implants, the objective has been to create an esthetic restoration that is indistinguishable from the natural tooth and that is stable through the years.[3,4,5] The periodontal and peri-implant mucosa and interproximal papillae must keep the same peculiarity of shape and color with one another.[6] Multiple variables compete to achieve the desired esthetic success on rehabs by implants. The peri-implant tissues are directly or indirectly affected by five main large groups of determinants: 1 - Surgical (surgical trauma, implant position, use of graft or bone substitute and period of insertion); 2 - Prosthetic (type of provisionalization, shape, manipulation of components); 3 - Geometry of implants (macrogeometry, interface implant/abutment and surface); 4 - Systemic (smoking, diabetes, chemotherapy); 5 - Local factors (hygiene, maintenance, bone quantity and quality, periodontal disease, radiotherapy, type of edentulism, smoking and periodontal biotype)[7-10], (Fig 1).

Even though these factors work together, over the last years it has been published studies with the purpose of establishing if there are factors with higher degree of importance, or that can be considered critical. In this context, it has been studied the influence of the tissue biotype on the morphology of the peri-implant esthetic and on its long term stability.[3,11,12] For that, many concepts were brought from Periodontics, such as basic description of two categories of gingival biotypes: Thick and flat biotype and thin and scalloped biotype (Fig 2 A and B).[13]

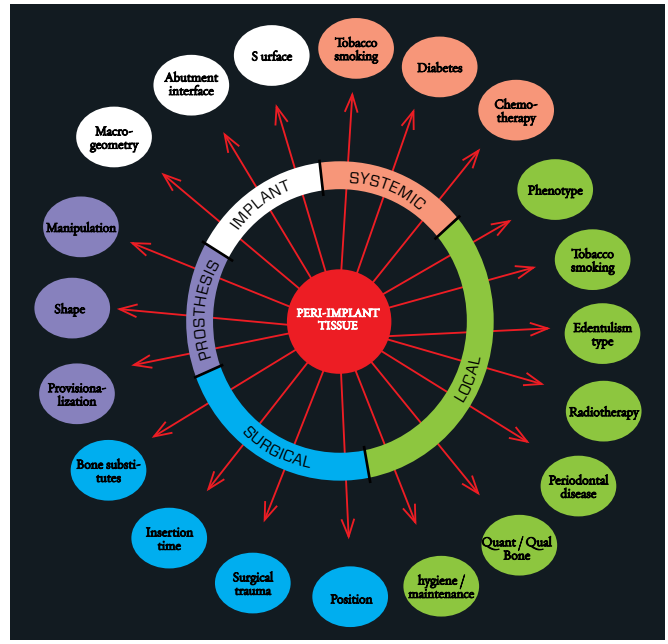


Figure 1 - Determinants of peri-implant morphology.

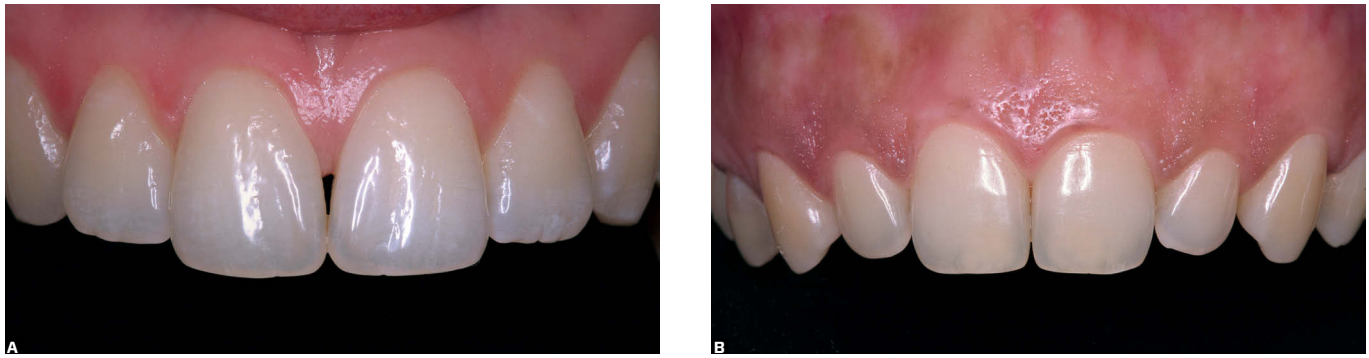


Figure 2 - Clinical illustration of patients with different periodontal biotypes. **A**) Thin scalloped biotype: Observe the high triangular shape of the papillae. **B**) Biotype thick and flat: Observe the low triangular shape of the papillae.

© 2012 Dental Press Implantology

The thin biotype has been related to a higher risk of recessions in buccal area,[14] greater difficulty to papillary filling,[15] translucency creating transgingival metallic appearance, greater susceptibility of bone loss, fenestration and dehiscence (Kao and Pasquinelli).[16] It was also observed that there was a gain of soft tissue after procedure of crown lengthening in patients with thick gingiva when compared to patients with thin gingiva.[17] This observation coincides with a greater prevalence of gingival recession reported before by Olsson and Lindhe.[18] The gingival biotype has also been described as one of the key elements for the success of restorations on implants.[19] Particularly, the presence of papilla between immediate single implant and adjacent teeth was significantly correlated to a thick peri-implant mucosa.[20] The tendency of greater gingival recession in immediate single restorations on an implant in patients with a thin peri-implant mucosa was also described.[21]. Similarly, the gingival recession was most found after the regenerative surgery in patients with thin gingiva.[22,23] These observations show that the discrepancies on the treatment esthetic result may come as consequence of the variability of the tissue response to surgical trauma. Especially patients with thin and scalloped biotype seem to have higher risk of esthetic failure and therefore need to be identified precisely. The purpose of this work is to review the literature about the influence of the gingival biotype on the morpho-functional and esthetic behavior of the peri-implant tissues, indicating protocols of diagnosis and management of these tissues that privilege the esthetic success and its stability on partial rehabs.

Literature review

It was performed a bibliographic research on PubMed data base using the keywords "periodontal biotype", "peri-implantar biotype", "peri-implantar esthetic" and "dental implants". It was selected articles published from March 2008 to June 2011.

Characterization and identification of tissue biotypes

Kao et al[24] in 2008 described their observations around the comparison between thick and thin gingival biotype as key determinant on the dental implants treatment plan. They related the thin biotype to a scalloped, delicate and friable architecture; minimum gingiva inserted; subjacent bone characterized by dehiscence and fenestrations; and respond to trauma and to the periodontal disease with gingival recession. On the other hand, related the thick biotype to a healthy, fibrous periodontium, with large zone of gingive inserted; a flat architecture and thick bone, as well as more resistant to trauma; respond to periodontal disease with formation of pockets and intraosseous defects; the healing and stabilization of the soft and hard tissues contours post-surgical trauma are more predictable than on thin biotype. They concluded that the surgeon must use periodontal and surgical procedures to minimize the alveolar resorption and provide a better quality tissue for the installation of implants. Januario et al[25] described a method of visualization and measurement of soft and hard tissues through Cone-Beam computerized tomography (CBCT). Therefore, it was selected three patients with different gingival biotypes, and they were submitted to two tomographic takes of the same site. The first take (CBCT) was performed conventionally of the maxilla. The second take (ST-CBCT) was performed the same way as the first one but with the use of lip retractor and asked to retract the tongue to the mouth floor. From the ST-CBCT they registered the measurements of the distance from gingival margin to cemento-enamel juction and thickness of buccal gingiva. They concluded that the described method is necessary and of great value on the evaluation of the dimensions and relations between the several periodonto structures and the complex of dentogingival insertion. De Rouck et al[12] revised the method of transparency of periodontal probe in a transverse study (n=100), aiming identify the different gingival biotypes.

© 2012 Dental Press Implantology

The gingival thickness was evaluated introducing a periodontal probe in the buccal gingival sulcus of the two upper central incisors (UCI); if the probe turned transparent through the gingiva of the two UCI, this would be categorized as score 0; if it could not be seen through the gingiva of only one of the central incisors, it would be categorized as score 1; and if it could not be seen through any of the two UCI gingivae it would be score 2. Crossing the morphometric data, it was identified three groups: Group A1, with thin and scalloped biotype, small zone of keratinized gingiva and crowns with delicate form (37%); Group A2, with thick biotype and same characteristics of the crowns on group A1 (34%); and Group B, with thick and flat biotype, large zone of keratinized gingiva, low papillae, greater probing depth and quadrangular crowns (29%). The authors also concluded that the method of transparency of probe for dentification of gingival biotype is simple and reproducible. Eghbali et al[26] in 2009, performed transverse study (n=100) to evaluate the efficiency of the visual method on the identification of the several gingival biotypes. Participated in the work: 5 prosthetics (Group R); 5 periodontists (Group P) and 5 students of odontology (Group S). To all groups it was requested that, through standardized photographs, categorized the gingival biotypes in: Thin-scalloped or thick-flat or thick-scalloped. There was coincidence with a gold standard: 52% of the thin-scalloped biotypes identified by Group R; 61% by Group P; and 57% by Group S. The thick-flat biotype was more easily identified with mean of 73% for Group R; 70% for Group P and 51% for Group S. The thick-scalloped biotype was more rarely identified with 45% for Group R; 26% for Group P and 43% for Group S. Intra-examiners the accuracy ranged from 57% and 78%. Inter-examiners the reproducibility ranged from 34% to 72%. They concluded that the visual inspection cannot be a reliable method on the identification of gingival biotype, for its main error occurs on the identification of the thin biotype which can be tragic for its high risk of esthetic complications after surgery or restorative therapy. Kan et al[27] performed transverse study (n=48) evaluating the reliability of the visual methods of identification of gingival biotype, comparing to the method of direct measurement through adapted gauge thickness. The method of simple visualization was efficient when the gingiva was 0.6 mm thick for thin biotype and >1.0 mm for thick biotype; still on the visual method, in the interval between 0.7 mm and 1.0 mm there was a predisposition for classification in thick biotype. Now on the visual method of transparency of probe it was efficient on thin biotypes when the gingiva was 0.6 mm thick and on thick biotypes when it was >1.2 mm thick. The authors concluded that the method of simple visualization is not sufficient for a diagnosis and an appropriate esthetic planning.

Papilla height and peri-implant mucosa recession

Kan et al[3] (2009) reported a case series (n=20) where they evaluated the effects of increasing soft tissues using subepithelial conjunctive tissue grafts (SCTG) with immediate single implant. It was observed that there was no statistically significant difference between the obtained results on the level of marginal bone of patients with thick biotypes and patients with thin biotypes. On the measurement of facial gingival levels (FGL) it was also observed absence of statistically significant difference between the several tissue biotypes. Their observations indicate that, with the appropriate three-dimensional positioning of the implant, bone graft in the gap between the alveolar wall and implant, and graft of conjunctive tissue may contribute to the maintenance of the marginal gingiva levels, independently of initial gingival biotype. That is, thin gingival biotype can be converted in thick, on its morphology and behavior through these procedures. Chow and Wang[15] in 2010 performed a literature review

evaluating the factors that affect the appearance of the peri-implant papilla. The research on MEDLINE was the base for their study, identifying articles published until September 2007, related to esthetic in implants as peri-implant papilla. The study suggests that thicker gingival tissue, not only resists better to physical trauma and subsequent to gingival recession, but also allows a better management of the tissues (Fig 3), facilitating the filling of the interproximal niche by the papilla and makes the surgical result more predictable. The authors concluded that the gingival thickness as much as other factors as: Bone crest height, interproximal distance, teeth size and width of the keratinized gingiva zone affected the appearance of the peri-implant papillae. Nisapakultorn et al[14] in 2010 performed a transverse study (n=40) to determine the factors that may affect the facial marginal mucosal level and the papilla level around single implants on the anterior maxilla.

Characteristics	Gingiva	Peri-implant mucosa	
		Thin	Thick
Soft tissue interface	Hemidesmosomes and basal lamina (reduced enamel epithelium).	Hemidesmosomes and basal lamina (oral adjacent epithelium).	
Junctional epithelium and connective tissue	Collagen fibers inserted perpendicularly to the cementum	Fewer amount of collagen fibers parallel and circular	Greater amount of parallel and circular collagen fibers
Tissue quality	Lower proportion of collagen	Lower proportion of collagen	Higher proportion of collagen
Connective Tissue Composition	Higher proportion of fibroblasts	Delicate and fine	Dense and fibrotic
Vascular provision	Increased vascularization	Smaller vascularization	
		Smaller blood supply	Increased blood supply
Biological distance	Junctional epithelium – 1 mm	Junctional epithelium – 2 mm	
		Connective tissue – 1 mm	
	Connective tissue attachment – 1 mm	Lower thickness of connective tissue	Higher thickness of connective tissue
Probing depth	≤ 3 mm	2.5 – 5.0 mm	
		Trend to gingival recession	Gingival recession resistance. Trend to formation of peri-implant pocket
Bleeding on probing	Clear sign of inflammation	No indication of inflammation	
Proprioception	Provided by the presence of periodontal ligament	No proprioception	
Profile	Determined by the tooth size.	Determined by the implant position, abutment profile, shape of the crown, the implant platform	
		Scalloped soft tissue	Relatively flat soft tissue
		Hard tissue with fenestrations and dehiscences	Hard tissue with thick edges

Figure 2 - Characterization and differentiation between gingiva and peri-implant tissue on thin and thick biotype (adapted from Chow[15]).

© 2012 Dental Press Implantology

It was performed clinical measurements on the implants and on contralateral teeth, especially with periodontal probe obtaining probing depth, as well as the categorization of gingival biotype. They concluded that there is no relation between peri-implant tissue biotype and interproximal papilla level; on the other hand the association between peri-implant biotype and facial marginal mucosal level was positive with risk of greater recession of peri-implant mucosa on thin biotypes. Wiesner et al,[28] on a randomized clinical trial (n=10), evaluated the effectivity of conjunctive tissue grafts used on the placement of implants on the increase of volume of the peri-implant soft tissues. On one side of the lower dental arch of each patient it was performed the installation of implant with increase of soft tissue with conjunctive tissue graft removed from the palate; on the other side only installation of implant. For the measurement of results, factors such as thickness of soft tissues and esthetics, among others, were considered and evaluated using standardized levels of evaluation and digital intraoral radiographs. This study shows that the side with graft obtained a mean of 1.3 mm of increase on the thickness of the soft tissue. The authors concluded that the use of conjunctive tissue graft is efficient on the increase of the thickness of peri-implant tissue, improving the esthetic results. Grunder[29] in a case series evaluated the buccal thickness of peri-implant soft tissues on the installation of immediate implants after extraction, with and without subepithelial graft. Therefore it was installed 24 implants of which 12 received subepithelial tissue graft and 12 did not received graft at all. It was performed clinical measurements with the use of periodontal probe on the moment of insertion of the implant and after 6 months of healing. These measurements showed that on the group that did not received graft, there was an average reduction in volume of 1.063 mm. On the other hand, on the group that received conjunctive graft, it was obtained an average gain in volume of 0.34 mm. It was observed a greater gingival recession on cases where it was not used the conjunctive graft, concluding that, providing a thicker gingival biotype, compensates the loss of gingival volume expected and keeps fine esthetic results. Tsuda et al[30] in 2011 reported a case series (n=10) aiming to evaluate the response of the peri-implant tissue after the installation of immediate implant after extraction with bone graft in the gap between buccal bone wall and implant (Bio-Oss®), immediate provisionalization and subepithelial conjunctive tissue graft. In this study it was evaluated, clinical and radiographically, after 3, 6 and 12 months since performed the surgery. After one year, it was observed a mean marginal bone alteration of 0.10 mm and a change on the facial gingival mean level of -0.05 mm. It was concluded that the favorable responses of the bone tissue and the peri-implant facial gingival level can be achieved and kept when the implant is well positioned and if bone and conjunctive grafts are performed properly. Raes et al[31] in 2011 performed a clinical study (n=39) to evaluate the dynamic of facial soft tissues after treatment with immediate single implants (IIT) and treatment with conventional implants (CIT) on the anterior maxilla. All patients received implants on ideal position; flapless surgery for the IIT group and conventional surgery with full-thickness flat elevation for group CIT and immediate provisionalization. On the aspect of papilla height, it remained stable. However regarding the gingival margin level, the results on the last evaluations were: On group IIT the levels remained relatively stable with loss of over 1 mm in 7% of the cases. On the other hand on group CIT the same loss was observed in 43% of the cases. Besides, it was also observed a gain of tissue height in over 1 mm on group IIT in 13% of the cases. The authors concluded that the technique used on group IIT showed itself effective on the preservation of the peri-implant soft tissues contours, as long as the selected patients have thick gingival biotype, and the flapless technique is used. They also concluded that

© 2012 Dental Press Implantology

the greater gingival recessions occurred on group CIT explained by the technique of full-thickness flat elevation, with no differences between thin or thick gingival biotype. Fu et al[32] in 2011 proposed the "PDP triad management": Implant position (P), implant design (D) and prosthesis design (P), as a way to increase the soft tissue thickness around implants. The PDP triad management suggests the use of implant design with parallel walls and switching platform, the use of implants with smaller diameter with its positioning more palatine and apical, and the concave prosthesis design. This preserves the buccal bone thickness, allows growth of soft tissue around the abutment level, increasing the soft tissue thickness and minimizing the potential to recession of the peri-implant mucosa. Although the tissue biotype is a characteristic that varies from patient to patient, this can be converted through an accurate management of PDP triad so that the desired esthetic result is achieved. Kan et al[33] in 2011 performed a prospective study (n=35) with assistance from 2 to 8 years in which evaluated the peri-implant response after the installation of immediate single implants in esthetic zone of the maxilla and the effects of gingival biotype on peri-implant tissues. It was observed that sites with a thick gingival biotype showed slighter changes on gingival levels when compared to sites of thin biotype both on first year of assistance (-0.25 mm versus -0.75 mm respectively) as on recent exams (-0.56 mm versus -1.50 mm respectively). The authors concluded that the effects of gingival biotype seem to be limited to facial gingival recession, being greater in thin biotypes, on the other hand, not affecting the height of the interproximal papilla or on the proximal marginal bone levels (Fig 4).

Discussion

Diagnosis and description of gingival biotype.

Some works that were mentioned in this literature review emphasize the importance of identification of gingival biotype, for its decisive impact on the morpho-functional and esthetic behavior of peri-implant tissues.[3,21,24] This way, methods have been used with this purpose: Method of direct visualization,[13] method of transparency of periodontal probe,[11] direct measurement,[27] transgingival probing[29] and Cone Beam Computerized Tomography – CBCT.[25] The method of direct visualization seems to be non-reliable as shown on the work of Eghbali et al,[26] 2009. The same way, Kan et al[27] in 2010 did not recommend the method of direct visualization, however, said that the method of transparency of periodontal probe is appropriate and reliable for diagnosis, surgery planning and restorative procedures; these observations agree to the conclusions of De Rouck et al,[12] 2009 that asserted it is yet a simple and reproducible method. The CBCT method, however, showed itself accurate, non-invasive, since performed with appropriate lip and tongue retraction; on the other hand, has as disadvantage: High cost, necessity of prepared technician and high doses of radiation.[32] Before this, it is extremely important the identification of gingival biotype by, at least simplified, the method of transparency of probe and, when possible, through the CBCT.

Recession of peri-implat mucosa

The thick gingival biotype has been related to a healthy periodonto, with large gingiva inserted, flat architecture and thick bone; resistant to surgical trauma. On the other hand, the thin gingival biotype has been related to scalloped architecture, delicate and friable, minimum gingiva inserted, subjacent bone characterized by dehiscence and fenestrations; and greater tendency to gingival recession. These characteristics of thin tissue biotype carry an unpredictability on post-surgical esthetic results.[24] From these observations, it seems to be feasible the indication of subepithelial conjunctive tissue graft , especially on areas of thin biotype, aiming to prevent recession of peri-implant mucosa.[3,29,30,33]

© 2012 Dental Press Implantology

Author/year	Type of study	Time	Sample	Technique	Conclusions
Januário et al[25]	Technique description	–	3 patients	Two tomographic takes: One with lip retractor and one without	The method described is necessary and of great value on the evaluation of dimensions and relations between several periodontium structures and the complex of dentogingival insertion.
Kan et al[3]	Case series	2 to 2,9 years	20 patients 20 implants	Single implant +immediate provisionalization + conjunctive tissue graft	The thin gingival biotype can be converted to thick on its morphology and behavior through conjunctive tissue graft
De Rouck et al[12]	Tranverse study	–	100 patients	Use of transparency of probe aiming to identify groups with different morphometric combinations of soft tissues	The method of transparency of probe for the identification of gingival biotype is simple and reproducible
Eghbali et al[26]	Transverse study	–	100 patients	To evaluate the efficiency of the visual method on the identification of the several gingival biotypes through photographs	The visual insertion can not be a reliable method of identification of gingival biotype, for its main error occurs on the identification of the thin biotype
Nisapakutorn et al[14]	Transverse study	–	40 patients 40 implants	Measurements of heights of the clinical crowns of implants and contralateral teeth	There is no relation between tissue biotype and interproximal papilla level; however the association between biotype and facial marginal mucosal level was positive
Kan et al[27]	Transverse study	–	48 patients	Direct measurement comparing to visual methods of identification of gingival biotype	The simple visual method is not sufficient for a diagnosis and esthetic planning, on the other hand, the method of transparency of probe showed itself appropriate and reliable
Wiesner et al[28]	Randomized clinical trial	1 year	10 patients 20 implants	Implant + Conjunctive tissue graft	The use of conjunctive tissue grafts is efficient on the increase of thickness of peri-implant tissue, improving esthetic results
Grunder et al[29]	Case series	6 months	24 patients 24 implants	Immediate implant + Conjunctive graft	Use of conjunctive grafts can provide a thicker gingival biotype, achieving a fine esthetic result
Tsuda et al[30]	Case series	1 year	10 patients 10 implants	Immediate implant + Immediate provisionalization+ Bio-Oss graft+ Conjunctive tissue graft	Favorable responses can be achieved when the implant is well positioned and if bone and conjunctive grafts are performed
Raes et al[31]	Clinical trial	52 months	39 patients 39 implants	Immediate single implants (IIT) and conventional implants (CIT)	The technique used on group IIT showed itself effective on the preservation of the soft tissue contours. Greater gingival recession occurred on group CIT with no difference between tissue biotypes
Kan et al[33]	Prospective study	2 to 8 years	35 patients 35 implants	Immediate implant+Immediate provisionalization	The gingival biotype seems to affect the facial gingival level, however has little impact on the height of the interproximal papilla

Figure 4 - Summaries of the main experimental articles related to periodontal and peri-implant biotypes.

These works suggests that the thin gingival biotype can be converted in thick, on its morphology and behavior, through conjunctive graft, achieving more favorable esthetic results. On the other hand, it is still not very well documented the stability of this grafted tissue in the long-term. Still aiming to increase the thickness of the peri-implant mucosa, Fu et al,[32] 2011 proposed the PDP triad management, which is based in: Concave abutment and profile of the crown, design of the narrower implant, and three-dimensional positioning of the implant more apical and palatal. Thus, with the increase of the mucosa thickness it is possible to maintain the margin levels. The authors Kan et al,[3] 2009 and Tsuda et al,[30] 2011 similarly, in study about immediate implants, defended the appropriate positioning of the implant (to palate), as well as the performance of bone grafts on eventually gap between alveolar wall and implant, and conjunctive tissue graft to achieve more favorable responses on bone levels and peri-implant mucosa levels. The observations of Raes et al,[31] 2011 suggests that flapless surgery can also prevent peri-implant recessions, on the technique of immediate implants installation, as long as selected the patients with thick biotype; however, the same authors refer the high risk of recession of the peri-implant mucosa, on the installation of immediate implants in patients with thin tissue biotype. Thus, it seems recommendable a more apical and palatal positioning of the implant, as well as contraindicate immediate implants in patients with thin biotype, in order to prevent recession of peri-implant mucosa. The flapless surgery suggested by Raes et al[31] shows it self efficient, however demands accurate technique and preparation from the surgeon.

Height of peri-implant papilla

The papillary filling of the interproximal niche seems to be related to several factors: Gingival biotype, bone crest height, interproximal distance, teeth size and width of the keratinized gingiva zone. A thick tissue biotype was described as more resistant to surgical trauma, making the result more predictable.[15] On the other hand, Kan[33] in 2011 did not find statistically significant difference when evaluated the papilla heights in different gingival biotypes. Similarly, Nisapakultorn[14] in 2010 also did not find relation between tissue biotype and papilla height, confirming the conclusions by Raes[31] in 2011. The papilla behaves with extremely sensibility to trauma and it is fundamental on the composition of the peri-implant morpho-functional and esthetic complex; therefore, it is suggested that each and every trauma must be avoided: On the moment of extraction or of reopening surgery.

Conclusions

Within limits of the present literature review, it was concluded that:

1) The identification of tissue biotype is necessary for better restorative surgical planning on therapy with implants.
2) The thin biotype presents a higher risk of recession of the peri-implant mucosa.
3) The conversion of a thin tissue biotype into thick biotype, through conjunctive tissue graft seems to affect positively the facial marginal mucosal level.
4) The tissue biotype seems to have little influence on the height of the interproximal papilla.
5) It is still necessary long-term control studies establishing the relation between biotype.

© 2012 Dental Press Implantology

REFERENCES

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR.The long-term efficacy of currently used dental implants: a review and proposed criteria of success, 1986;1(1):11-25.
2. Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. J Prosthet Dent. 1989;62(5):567-72
3. Kan JY, Rungcharassaeng K, Morimoto T, Lozada J. Facial gingival tissue stability after connective tissue graft with single immediate tooth replacement in the esthetic zone: consecutive case report. J Oral Maxillofac Surg. 2009;67(11Suppl):40-8.
4. Koutrach M, Nimmo A. Preservation of existing soft-tissue contours in the transition from a tooth to an implant restoration in the esthetic zone using a flapless approach: a clinical report. J Prosthodont. 2010;19(5):391-6. Epub 2010 Mar 15.
5. Tymstra N, Raghoebar GM, Vissink A, Meijer HJ. Dental implant treatment for two adjacent missing teeth in the maxillary aesthetic zone: a comparative pilot study and test of principle. Clin Oral Implants Res. 2011;22(2):207-13.
6. Belser UC, Schmid B, Higginbottom F, Buser D. Outcome analysis of implant restorations located in the anterior maxilla: a review of the recent literature. Int J Oral Maxillofac Implants. 2004;19 Suppl:30-42.
7. Armitage GC, Lundgren T. Avaliação de Risco de Pacientes Candidatos a Implantes. In: Lindhe J, Karring T, Niklaus P, editores. Tratado de Periodontia Clínica e Implantologia Oral. 5a ed. Rio de Janeiro: Guanabara Koogan; 2010. p. 609- 25.
8. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. Int J Oral Maxillofac Implants. 2004;19 Suppl:43-61.
9. Levin L, Schwartz-Arad D. The effect of cigarette smoking on dental implants and related surgery. Implant Dent. 2005;14(4):357-61.
10. Barreto M, Sydney R, Rocha H, Leal M. Aspectos limitantes da estética peri-implantar. In: Tunes U, Dourado M, Bitencourt S. Avanços em Periodontia e Implantodontia. Paradigmas e Desafios. 1ª ed. Nova Odessa: Napoleão; 2011. p. 92-121.
11. Kan JY, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. J Periodontol. 2003;74(4):557-62.
12. De Rouck T, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingival. J Clin Periodontol. 2009;36(5):428-33.
13. Ochsenbein C, Ross S. A reevaluation of osseous surgery. Dent Clin North Am. 1969;13(1):87-102.
14. Nisapakultorn K, Suphanantachat S, Silkosessak O, Rattanamongkolgul S. Factors affecting soft tissue level around anterior maxillary single-tooth implants. Clin Oral Implants Res. 2010;21(6):662-70. Epub 2010 Apr 5.
15. Chow YC, Wang HL. Factors and techniques influencing peri-implant papillae. Implant Dent. 2010;19(3):208-19.
16. Kao RT, Pasquinelli K. Thick vs. thin gingival tissue: a key determinant in tissue response to disease and restorative treatment. J Calif Dent Assoc. 2002;30(7):521-6.
17. Pontoriero R, Carnevale G. Surgical crown lengthening: a 12-month clinical wound healing study. J Periodontol. 2001;72(7):841-8.
18. Olsson M, Lindhe J. Periodontal characteristics in individuals with varying form of the upper central incisors. J Clin Periodontol. 1991;18(1):78-82.
19. Kois JC. Predictable single-tooth peri-implant esthetics: five diagnostic keys. Compend Contin Educ Dent. 2001;22(3):199-206; quiz 208.
20. Romeo E, Lops D, Rossi A, Storelli S, Rozza R, Chiapasco M. Surgical and prosthetic management of interproximal region with single-implant restorations: 1-year prospective study. J Periodontol. 2008;79(6):1048-55.
21. Evans CD, Chen ST. Esthetic outcomes of immediate implant placements. Clin Oral Implants Res. 2008;19(1):73-80. Epub 2007 Oct 22.
22. Anderegg CR, Metzler DG, Nicoll BK. Gingiva thickness in guided tissue regeneration and associated recession at facial furcation defects. J Periodontol. 1995;66(5):397-402.
23. Baldi C, Pini-Prato G, Pagliaro U, Nieri M, Saletta D, Muzzi L, et al. Coronally advanced flap procedure for root coverage. Is flap thickness a relevant predictor to achieve root coverage? A 19-case series. J Periodontol. 1999;70(9):1077-84.
24. Kao RT, Fagan MC, Conte GJ. Thick vs. thin gingival biotypes: a key determinant in treatment planning for dental implants. J Calif Dent Assoc. 2008;36(3):193-8.
25. Januário AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: the mensurement of gingival tissue and the dimensions of the dentogingival unit. J Esthet Restor Dent. 2008;20(6):366-73; discussion 374.
26. Eghbali A, De Rouck T, De Bruyn H, Cosyn J. The gingival biotype assessed by experienced and inexperienced clinicians. J Clin Periodontol. 2009;36:958–63.
27. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival biotype assessment in the esthetic sone: visual versus direct measurement. Int J Periodontics Restorative Dent. 2010;30(3):237-43.
28. Wiesner G, Esposito M, Worthington H, Schlee M. Connective tissue grafts for thickening peri-implant tissues at implant placement. One-year results from an explanatory split-mouth randomized controlled clinical trial. Eur J Oral Implantol. 2010;3(1):27-35

© 2012 Dental Press Implantology

29. Grunder U. Crestal ridge width changes when placing implants at the time of tooth extraction with and without soft tissue augmentation after a healing period of 6 months: report of 24 consecutive cases. Int J Periodontics Restorative Dent. 2011;31(1):9-17.
30. Tsuda H, Rungcharassaeng K, Kan JY, Roe P, Lozada JL, Zimmerman G. Peri-implant tissue response following connective tissue and bone grafting in conjunction with immediate single-tooth replacement in the esthetic zone: a case series. Int J Oral Maxillofac Implants. 2011;26(2):427-36.
31. Raes F, Cosyn J, Crommelinck E, Coessens P, De Bruyn H. Immediate and conventional single implant treatment in the anterior maxilla: 1-year results of a case series on hard and soft tissue response and aesthetics. J Clin Periodontol. 2011;38(4):385-94.
32. Fu JH, Lee A, Wang HL. Influence of tissue biotype on implant esthetics. Int J Oral Maxillofac Implants. 2011;26(3):499-508.
33. Kan JY, Rungcharassaeng K, Lozada JL, Zimmerman G. Facial gingival tissue stability following immediate placement and provisionalization of maxillary anterior single implants: A 2- to 8-year follow-up. Int J Oral Maxillofac Implants. 2011;26:179-87.

© 2012 Dental Press Implantology

08 | 09 | 10 | NOV | 2012 | EXPONOR | PORTO | PORTUGAL

PORTO NOV. 2012

XXI CONGRESSO
ORDEM DOS MÉDICOS DENTISTAS
PORTUGUESE DENTAL ASSOCIATION ANNUAL MEETING

CONFERENCISTAS CONVIDADOS

PIERPAOLO CORTELLINI | IT	PERIODONTOLOGIA | BIOMATERIAIS
RICARDO MITRANI | MEX	REABILITAÇÃO ORAL
DENNIS TARNOW | USA	IMPLANTOLOGIA
SERGIO KUTLER | USA	ENDODONTIA
RONALD JUNG | CH	PRÓTESE FIXA E IMPLANTES
MICHAEL NORTON | UK	REGENERAÇÃO ÓSSEA
MARGA REE | NED	ENDODONTIA
JACQUES NOR | BR	ODONTOPEDIATRIA
FRANK SHWARTZ | GER	IMPLANTOLOGIA

www.omd.pt

ORGANIZAÇÃO

PLATINUM SPONSOR

PIERRE FABRE ORAL CARE

GOLD SPONSOR

Inibsa LABORATÓRIOS · ASTRA TECH DENTAL Get inspired · straumann · camlog · 3M ESPE · ACORES

SPONSORS

ACE · Nobel Biocare · KLOCKNER implant system · Abbott A Promise for Life · BIOMET 3i · AXA redefinimos / standards

Determining the prognosis: When to treat and when to extract?

Érica Del Peloso **RIBEIRO***
Sandro **BITTENCOURT***
Tila Fortuna **COSTA****
Paula Regina do Espírito Santo **BRAGA****
Lyla Prates de **ANDRADE*****

Abstract

Introduction: The advent of implants revived the discussion of one of the great dilemmas of clinical dentistry, which is the identification, based on prognosis, of when a tooth must be extracted or when other treatment options can be considered. Periodontal, endodontic and restorative characteristics must be carefully evaluated to determine prognosis and treatment predictability and consequent development of the treatment plan. **Objective:** Due to the relevance of this topic, the objective of this work is, by means of a literature review, to assist the dentist in evaluating clinical situations requiring decision making between keeping or extracting a tooth, establishing a correct prognosis. **Results:** Findings in the literature show that authors disagree among more conservative approaches and implant placement. Factors that can distinguish those cases are the technical and scientific knowledge and professional experience, commitment to their patient's oral hygiene, as well as its systemic, dental and financial conditions. However, there is a consensus in the literature regarding the sovereignty of one technique over another for the treatment of different clinical situations. **Conclusion:** What will guide the clinician's choice is a critical and scientific analysis of the cost-benefit to establish an individualized, multidisciplinary and with greater predictability treatment plan.

Keywords: Prognosis. Dental implants. Prosthesis and implants.

How to mention this article: Ribeiro EDP, Bittencourt S, Costa TF, Braga PRES, Andrade LP. Determining the prognosis: When to treat and when to extract? Dental Press Implantol. 2012 Apr-June;6(2):68-79.

» The authors inform that they do not have no associative, commercial, intellectual property, or financial interests representing a conflict of interest in products and companies described in this article.

Contact address

Tila Fortuna Costa
Av. Ibirapitanga, 745, casa 58
Zip Code: 41.680-360 – Patamares – Salvador/BA – Brazil
E-mail: tilafortuna@gmail.com

Submitted on: 09/21/2011
Reviewed and received on: 10/31/2011

* PhD in Periodontics, FOP/Unicamp. Adjunct Professor of Dentistry, BAHIANA.
** DDS, BAHIANA.
*** Specialist in Periodontics, BAHIANA.

© 2012 Dental Press Implantology

Introduction

The development of a treatment plan which is predictable to achieve long-term success requires careful evaluation of many factors which will influence the prognosis of involved teeth and the possible choice of keep them or not in the oral cavity.[3]

Keeping this in view, Iqbal and Kim suggested a classification to identify clinical situations that are a dilemma to the dentist. They define compromised tooth as a complex clinical syndrome, which can result of any structural and pathologic disorder that prevent the tooth of working properly without making any kind of restoration — it includes placement of prosthetic restoration and the possibility of endodontic treatment. Now, the tooth in terminal stage was defined as in a pathologic state or structural deficiency which cannot be repaired successfully by reconstructive therapies. Treatment strategies for this type of tooth include extraction and function rehabilitation with placement of fixed or removable prosthesis, or implants installation.[17]

The main causes of dental loss described in literature are caries and periodontal disease, however during the process of decision-making between extract or not a tooth, must identify the local and systemic clinical attributes, that can affect the functional maintenance of the tooth.[46]

The factors that can distinguish the extraction causes from the more conservative possible treatments involves a technical-scientific knowledge and professional experience, the patient's commitment with its oral hygiene, as well as its systemic, dental and financial conditions.[3]

Against the relevance of theme, this review aims to assist the dentist to evaluate clinical situations where it's necessary the decision-making between extract or keep a tooth, establishing for this a correct prognosis.

Literature Review

One of the biggest dilemmas on dental clinic is the identification of when a tooth by the unfavorable prognosis and low predictability of other therapeutic options is indicated to extraction. It is important to highlight that the item in question is controversial, polemic and involves a wide range of factors that should be analyzed with care and knowledge.[24]

Accordingly, the planning becomes a extreme important stage to the correct execution of a treatment and for that, must include all of the necessary stages to the achievement of proposed therapy. Thus, the clinician must establish the diagnosis, the etiology, and determine the remaining teeth prognosis, taking into account the needs and desires of the patients,[3,8] since losing a tooth has a significant functional and psychological impact.[11]

The development of this treatment plan requires a careful evaluation of many factors that can influence the prognosis of compromised teeth, as well as require preview of complete dental rehabilitation, of functional and aesthetic results, always putting as priority the possibility of keeping a stricken tooth, basing on risks and benefits of treatment options.[8,11]

According to Ávila et al, the main factors that determine the decision-making of extract or not a tooth include the patient expectation, the finances, the commitment of the patient which the treatment and esthetic.[2] These are factors that cannot be measured objectively, but have critical relevance on developing the treatment plan. Other factor that influence the compromised teeth's prognosis, such as periodontal features, endodontics and restoratives, also should be carefully evaluated during the development of planning, for the treatment to be predictably a long-term success. All of these factors, whether local or systemic, must be identified in clinician initial evaluation (Table 1).[3]

© 2012 Dental Press Implantology

In some cases, one only factor can be critical in determining to keep or not a tooth, however there are still cases in which this decision is based in accumulated factors. It should also take into account the predictability of therapeutics for the compromised tooth. In the survey of these factors, the clinician must be impartial, in other words, should not have preference in therapeutic decision, due its abilities, experiences or interests.[7,11]

In the presentation of all these factors will be cited peculiarities that must be considered in different specialties of dentistry for the decision-making of extract or keep a tooth.

Periodontal considerations

Function, comfort, aesthetic, cost and time of treatment are relevant for the evaluation of periodontally

Table 1 - Local and general risk factors.

Factors	Unfavorable prognosis	Favorable prognosis
GENERAL		
General state of patient	Present risk factors	Good health
Medical history	Significant factors detected	None detected
Smoker	Yes	No
Genetic test	Positive	Negative
Immune system	Immunosuppressed	Normal
Medications	Cyclosporin, phenytoin	None
Nutritional state	Protein deficiency	Normal
Medication dependency	Yes	No
LOCALS		
Bacterial flora	Present pathogens	Normal flora
Loss of insertion	Greater than 50%	Less than 50%
Pocket activity	Bleeding, exudates	Normal
Amount of bone loss	Greater than 50%	Less than 50%
Speed of disease progression	Fast	Slow
Furcation involvement	Yes	No
Mobility	High	Normal
Plaque control	Inadequate	Adequate
Residual teeth	Little quantity, isolated	Most present
Crown/root proportion	Inadequate	Adequate
Occlusal trauma	Present	Absent
Parafunction	Present (bruxism)	Absent
Dental alignment	Bad	Good
Root morphology	Unfavorable	Favorable
Caries	Present	Absent
Restorations	Bad	Good
Endodontic considerations	Complicated	Favorable

Source: Modified from Davarpanah et al.[8]

© 2012 Dental Press Implantology

compromised teeth. It is important at the moment of decision, take into account not only the tooth in question, but the global planning of case, as evaluate if the conservation of the tooth will interfere in adjacent teeth of if it will important or not for the prosthetic rehabilitation of the patient.[24,27]

In relation to the severity of periodontal disease, one must consider the probing depth and the clinical attachment level, since this evaluation shows the amount of support periodontal tissue lose. The degree of dental mobility will be related to the severity of bone loss, so cases of third degree mobility has poor prognosis, including in function of discomfort caused to the patient.[4]

The pattern of bone loss is an important factor in determining the prognosis, because clearly interferes on the predictability of periodontal therapies. The most common patterns of bone loss are horizontals and this also imposes greater difficulty to the periodontal regeneration. The vertical or angular defects are those that occur in oblique direction, forming a bone defect.[29]

In this context, Ávila et at consider the furcation lesion as one of the most challenging clinical situation to the periodontists.[2] There's no doubt that the first degree defects can be properly treated of the teeth kept, already in cases of furcation lesion of second degree the decision of treatment becomes more uncertain,[5] as well as the prognosis of the tooth. In these cases, it's important to highlight that the predictability of periodontal therapy surgical or not, in interproximal furcation lesions of second degree, is worse when compared to the predictability of periodontal treatment of these furcations in free surface.[40] Del Peloso Ribeiro et al, when evaluated the effect of non-surgical periodontal therapy with or without iodine in furcation lesions of second degree in free surface, showed that the majority of them can be treated only with subgingival instrumentation, without posterior surgical therapy (Fig 1 and 2).[39] Finally, the third degree lesions have unfavorable prognosis,[7,15] once the regeneration of this defect is not predictable in most of clinical situations.[15]

It is already known that the presence of roughness on the root surface compromises the plaque control in the furcation region and others anatomic variations,[41] such as cervical projections of enamel, enamel pearls (most frequent on posterior teeth)[14] and root grooves (lateral superior incisive and first superior bicuspid), irrespective of its location, represent a challenge during the therapeutic or maintenance procedures.[2]

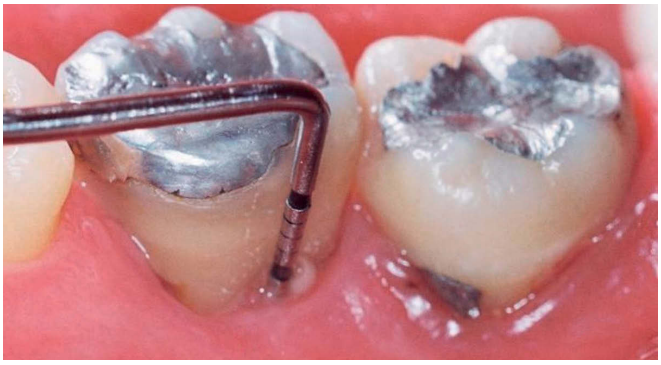


Figure 1 - Furcation lesion of second degree on lingual side of #46 associated to probing depth of 8 mm before treatment.

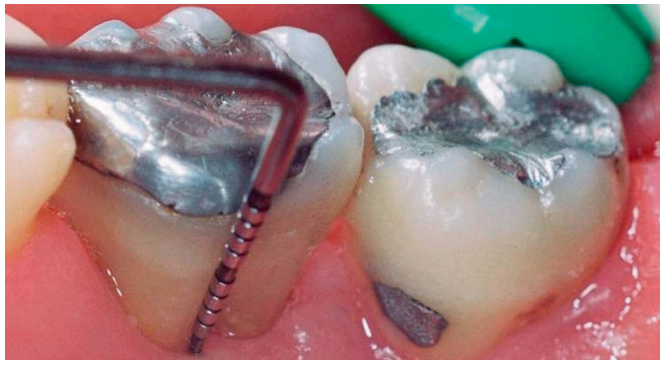


Figure 2 - Furcation lesion of second degree on lingual side of 46 associated to probing depth of 4 mm, 6 months after non-surgical periodontal treatment.

© 2012 Dental Press Implantology

Root proximity is another relevant factor, once it has been found in literature the absence of adequate bone support (interdental bone thickness < 0.8 mm) favors the progression of periodontal disease.[22] In situations of non-treatable root proximities, the indication is extraction.[2]

Beyond all of these local factors associated to the dental biofilm, others deeply related to the host immuno-inflammatory response seems also to interfere in progression of periodontal disease and, therefore in determining the prognosis. Is known that habits as smoking and many systemic conditions, immune suppression, hematological and genetic disorder (neutropenia and interleukin 1 polymorphism) and stress have a significant impact in progression of periodontal disease and bone remodeling, being smoking and diabetes mellitus considered real risk factors.[23]

On tooth, from the periodontal standpoint, according to McGuie, can be classified as having a bad, doubtful or good prognosis.[30] Becker et al defined one tooth as condemned (bad prognosis), when it shows bone support loss greater or equal to 75%, pocket depth greater or equal to 8 mm, involvement of third degree furcation, crown-root improper relationship, root proximity with little bone between roots and frequent abscess.[6] Dental elements in this situation lead to a complex planning (Fig 3).

In the group of teeth with doubtful prognosis, two factors must be considered: if its preservation or not is going to put in risk the adjacent teeth and if it is important or not to the rehabilitation of the patient. Teeth with insertion loss between 50% and 75%, not necessarily have to be removed, since it shows clinical aspects of normality, absence of bleeding on probing, absence of exudates and mobility between the acceptable limits of patient (Fig 4). In the group of teeth with good prognosis, teeth with favorable periodontal prognosis and that can be kept in the mouth are found.[24]

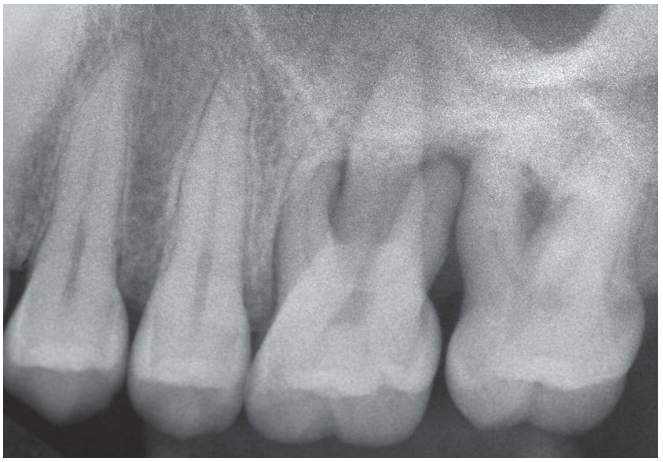


Figure 3 - Periapical radiography of unit 26 with bad prognosis due the presence of furcation lesion of third degree (vestibule-mesial, vestibule-distal, mesiodistal), more than 75% of bone loss on distal root and great root proximity between the distal root of #26 and mesial root of #27.

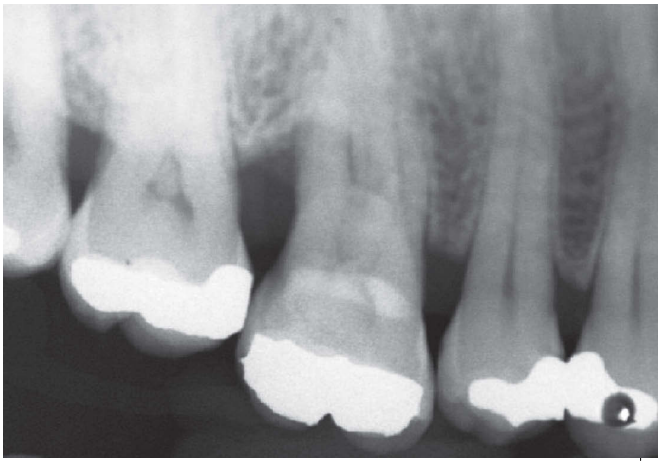


Figure 4 - Periapical radiography of unit 16 with doubtful prognosis, due the presence of furcation lesion of second degree on distal side and bone loss between 50 and 75% on distal root.

© 2012 Dental Press Implantology

Endodontic considerations

Specialists indicate that in cases with pulp involvement, the firs to be realized in clinic is rather the endodontic treatment or retreatment, when the involved tooth shows a favorable prognosis to this kind of therapy. However, in cases of tooth with insufficient coronary structure and/or periodontal involvement from moderate to severe, the time and cost that will be applied in the canal treatment must be questioned as well as the replacement of these by implants.[1,32]

Iqbal and Kim[17] in a systematic review, concluded that there is no difference in predictability between the treatment of endodontic compromised teeth and the replacement of these by implants, based thus the choice of therapeutic modality in other factors.[18] Furthermore, it is noteworthy that endodontically treated teeth keep the original proprioceptive mechanisms of natural teeth, while the implants are deprived of periodontal ligament and the skill of functional perception, as well as impact absorption.[11]

In determining the prognosis of teeth that require endodontic treatment, the clinician must attempt to: presence/absence of periapical lesions since researches show that the absence of these lesions increases the rate of success of this type of therapy; type of endodontic treatment, because the technique to be used should be adequate to its respective case; post-endodontic restorative situation, because the clinical situation implies that not all endodontically treated teeth are restorable, but the ones that are have similar rate of success to the implants.[19]

The rate of success that have been described in literature for the endodontic treatment after 8 to 10 year is over 95%.[42] However, a rate of until 100% can be seen when the method of evaluation used is the microscopic visualization.[3]

The complications after canal treatment, even minimal, can happen, such as bacterial micro-infiltration, caries and periodontitis. Papers demonstrate that most parts of causes of tooth extraction due endodontic treatment failure is due the poor coronal sealing of these teeth after concluding the therapeutic, shown a good predictability of endodontic therapy.[13] A retrospective study of Iqbal and Kim, about factors associated to periapical health of restored and endodontically treated teeth, concluded that the good quality of root and coronal border sealing improve the endodontic therapy prognosis.[18]

Ng et al[34] identified in systematic review four conditions that can increase significantly the survival of endodontic treated teeth, citing in descending order: (1) tooth restoration after treatment; (2) teeth with proximal mesial and distal contacts; (3) buttress functionless teeth for fixed and removable prosthesis; e (4) type of tooth, specifically not molars.

Restorative aspects

Many authors profess that one of the fundamental objective of restorative practice is the maintenance of healthy natural dentition of patient.[18,32,44] For the restorative procedure succeed, the involved tooth must have its normal function reestablished and its aesthetic must be acceptable. To make it possible we need to consider and analyze the occurrence of: fractures and failed restorations; extensive caries; proportion crown-root and core and prosthetic crown.[2]

The presence of defective restorations is not a determining factor in the process of decision-making between extract or not one tooth since although the excesses in restoration been associated directly or indirectly to the loss of tissue insertion, these can be easily corrected in most cases. However, it's important to evaluate its presence and relationship with the caries lesion and/or endodontic involvement, before taking any decision.

© 2012 Dental Press Implantology

The same line of reasoning is applied on evaluation of fractured teeth, where the clinician must do the best judgment by evaluation of type and location of fracture to determine if the tooth can be or not restored.[2]

As well as fractures, an extensive caries lesion that extends beyond or in the level to the alveolar bone represents a challenge to the clinician in restorative terms and for the patient due the substantial increase of treatment cost. If in these cases the tooth can be restored, a surgical or non-surgical clinical crown lengthening is usually necessary to reestablish the biological distances,[2] what makes the treatment's final cost similar to the implants.[32]

However, the clinical crown lengthening are indicated only after careful analysis of crown-root proportion, since the maintenance in long term of a tooth with a non-favorable proportion, can be challenging, due the inadequate alveolar bone support, which may lead to the increasing of mobility, and the risk of fracture.[31] One tooth with a non-favorable crown-root proportion may also not be useful as an ideal buttress (Fig 5). The proportion 1:1 have been defined as a minimal acceptable proportion for a healthy periodontium and one controlled occlusion.[12]

In cases of extensive dental structure loss, the use of core/pin is one of the available options, which allows an appropriate coronal restoration. However, we should evaluate: the need of an endodontically treated canal, which reduces the survival of the tooth in long-term; and the patient's occlusion, since the presence of parafunctional habits also reduces the pin/core restored tooth's survival.[32]

Discussion

The hard task of knowing when to preserve or extract a tooth remains a challenge in dental practice, however with the preservation of the natural dentition as a fundamental principle have been widely followed. Root resections, apicoectomies and pin and core manufacturing are some of many periodontal, endodontic and restorative procedures realized to try the natural tooth's preservation.[27] Nevertheless, the extraction for implants placements have been also a good treatment alternative, even less conservative.

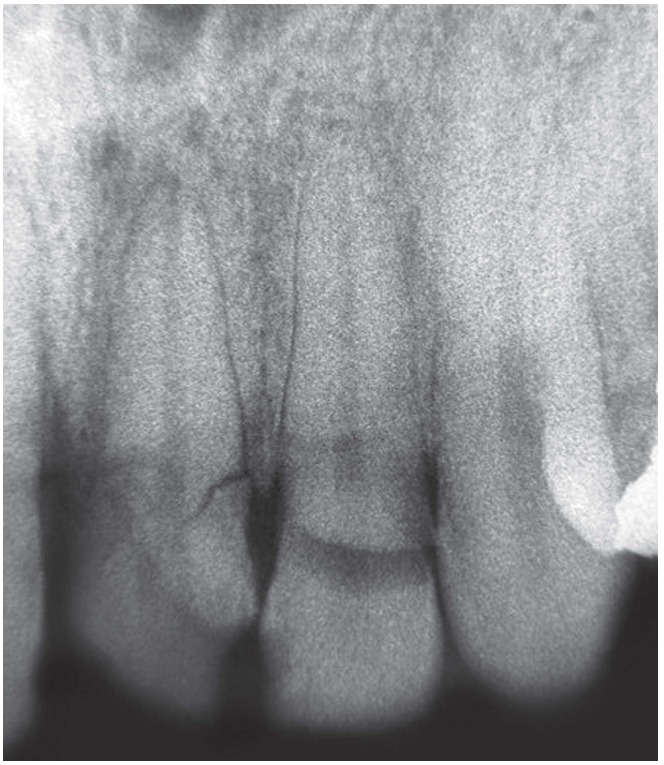


Figure 5 - Periapical radiography of fractured unit 21. The level of fracture requires crown augmentation to the reestablishment of biological space, however the analysis of crown/root proportion contra-indicates the procedure.

The Periodontal American Academy profess that every patient must be informed about the risks of failures and the alternative therapy to the implants. The high rates of implants success, as showed by Levin et al[26] of 92.6%, may be a dangerous mark if compromised teeth start to be extracted.[33]

This decision-making requires a deep knowledge about prognosis and predictability of the different therapeutic modalities. From the periodontal perspective, the mechanical instrumentation produces satisfactory results in

© 2012 Dental Press Implantology

most cases. It was confirmed by Ludgren et al[29] in some clinical cases up to 30 years of following, when demonstrating that the periodontal therapy limiting to the scaling and root planning (SRP), requiring or not one surgical flap, showed efficient in periodontal disease control, since the patient is motivated and involved in his treatment. Agreeing with this positive result, Dannewitz et al concluded in a retrospective study that the periodontal therapy results in good prognosis for molar in at least 5 years.[7]

A 10-years prospective study, associating periodontally treated teeth and implants, found a rate of dental survival of 95% and concluded that the rate of progression of insertion loss of teeth and implants is similar in the same patient.[20]

Furcation lesions of molars respond less favorable to SRP providing thus a greater risk to periodontal disease progression, in response to the complex anatomy of the area.[2] Although, Huynh-Ba et al in a systematic review find authors who defends the non-surgical therapy as been effective on prevention of progression of interradicular disease between teeth with first degree furcation involvement. These authors obtained survival rate of 90.7% to 100% in treated teeth only with SRP that had been accompanied of 5 to 9 years. The review also addresses authors who additionally to the SRP defends the idea of treat the second and third degree furcation lesions with tunneling, where was found a survival of 42.9% to 92.9% in one period of observation of 5 to 8 years. In resection and/or root splitting procedures, the survival rate on the evaluated studies was 62% to 100% in an average of 5 to 13 years of accompaniment.[16]

It is clear there are many alternatives for the treatment of furcation lesions that are almost always related to the degree of lesion and then, therefore, its presence is not synonymous of needing of extraction, since when well indicated the success of treatment can be similar to the implant.[21] Among the procedures most commonly used to the treatment of furcation involvements we can cite: the subgingival scaling with or without surgical flap, furcation plasty, tunneling, root hemisection and resection and guided tissue regeneration (GTR).[16] The adjacent alveolar bone level must be considered a critical factor to the therapy's choice, mainly regenerative therapy to furcation lesions of first and second degree. There will be greater predictability of this therapy when the level of interproximal bone is coronally located.[37]

A GTR has been a major goal of treatment of furcation lesions, however, not even all lesions can be regenerated with predictability,[9] which makes the respective procedures, used for more than 50 years, remain with significant procedures on periodontal therapy of these lesions. The review of Huynh-Ba et al also evaluates the survival rate of GTR associated with SRP in the period of 5 to 12 years, been this of 83.3% to 100%. It, one more time shows that the adequate indication together with the patients cooperation will be the greatest responsible of success of any therapy.[16]

In 2001 Fugazzoto[10] in a retrospective analysis evaluated records of patients treated by the root resection technique, by the same dentist, independent of these patients realize periodic maintenance visitation or not. It is concluded that the realization of root resection seems to be more attractive choice (if one tooth already had endodontic treatment) than its removal and implant installation. These findings agree with the study of Warren's et al,[46] that also observed that patients who already realized some investment in procedures to treat a determined tooth, chose to alternative therapies in order to keep, once had already done a financial investment. However, one tooth that requires extensive treatment and yet would present a compromised prognosis must have a extraction as one alternative of therapy to be considered, after analysis of determining factors of already cited prognosis.[10,36]

© 2012 Dental Press Implantology

By endodontic perspective, the treatment on canal system shows a good index of success in long term. In the retrospective study of Lazarki et al,[25] that evaluated more than 110.000 endodontically treated teeth accompanied for period of 3.5 years, the rate of success found was 94.44%. Salehrabi and Rotstein[42] evaluated more than 1.1 millions of patients during 8 years and found 97% of success. In this way, a systematic review found rates between 86% and 93% of survival of endodontically treated teeth of 2 to 10 years of accompaniment.[35]

A prospective study of 2 to 4 years of accompaniment found a rate of 95% of survival to the 858 teeth that received endodontic treatment and with no difference of rate of first time treated canals.[34] High rate after endodontic retreatment also had been demonstrated in the 5 years study of Salehrabi and Rotstein.[43] Thus, in cases of failure of endodontic treatment, the retreatment must be always considered, since the cause of failure is diagnosed. for this, must pay attention to the root length for an adequate apical sealing, possibility of incomplete vertical fracture or presence of occlusal forces contributing to the failure of the treatment.[36]

The author O'Neal and Butler suggest that the cost and amount of visitations the patient needs to accede a conservative treatment as the root retreatment and the installation of core/pin and crown is significantly greater than the implants rehabilitation alternative.[36] Anson[1] in a literature review professes the installation of implants over core/pin or crown rehabilitation, once the implants are not susceptible to root fractures and failure on endodontic treatment. However, most of dentistry treatments, when realized under ideal conditions of indication and execution, present high level of success. Thus, even implants are liable of failure when the clinic and biological challenge is high.

In a comparative review about treatment of endodontically treated teeth and implants, Iqbal and Kim[17] concluded that although implants are good therapeutic alternatives for endodontically compromised teeth they promote surgical pain/inflammation, are double the price of the therapy of non-surgical canals, are associated to greater intervention after treatment, and do not have better survival than endodontic treatment. Thus, assert teeth that can be treated endodontically must not have implants as a routine therapy, being these reserved only in cases of "terminal stage" teeth.

Related to restorative aspects, surgical clinic crown augmentation should be avoided in aesthetic areas, because it will result in gingival recession and consequent aesthetic defect. In these cases, the orthodontic traction even if slower and more expensive might be a viable alternative. Evaluation also needs to be done when the subgingival extension of preparation, according to the root length, so after the procedure of clinic crown augmentation the relation crown/root does not become unfavorable.[11]

Greenstein et al,[11] in their literature review, cite authors who comment the magnitude of evaluate the functional load that will impact over the restored tooth. Some studies show fixed partial prosthesis that use endodontically treated teeth as buttresses tends to fail more frequently than having vital teeth as buttresses. Lundgren et al[29] observed that in modern dentistry both professional and patients have preferred the fixed rehabilitations than removable. Comparing with fixed partial prosthesis, the greater benefit of using implants is avoiding the preparation of healthy teeth adjacent to themselves.

Recently a longevity of teeth and implants have been focus of several reviews and what is been observed on literature is that dental implant does not overtake the tooth in terms of survival.[13] Even though a compromised tooth by the loss of vitality and periodontal insertion is comparable to an implant, if this tooth obtained success on its treatment (Table 2).[28] By his systematic review,

Tomasi et al[45] concluded that in patients clinically well maintained the survival rates of teeth are higher than implants, as well as changes in bone levels seem to be smaller in teeth than in implants after a minimum of 10 years of accompaniment, highlighting the difficulty of comparison due the heterogeneity between the studies. In this context, it is important to remember that the longevity of osseointegrated implants might be compromised by infections in the tissues that lay on and support in function (peri-implant mucositis and peri-implantitis) and by occlusal overload.[44] In study of Karoussis's et al,[21] compared the survival rate, of implants success and the incidence of peri implantitis in patients who lost their teeth due periodontal disease or other reasons as, for example, root fracture. The survival rate of implants, in patients with history of periodontitis, was 90.5%, whereas the group of patients without history of periodontitis obtained 96.5%. In the group of compromised patients by periodontal disease, there was a greater incidence of peri-implantitis (28.6%) than the group of healthy patients (5.8%).

Thus, although the implants are placed in the middle of the relatively healthy tissues, complications and failures occurs even before the osseointegration of implant (early loss of implant), or after one well succeed osseointegration (later implant loss).[38] From the problems that can attack the implants, the failure in osseointegration is the most relevant of these, once it directly influences the success of treatment. Furthermore, the preparation and positioning of implants are procedures of surgical nature that carry common risks to the surgical procedures, including: bleeding, neurosensitive disturb and the possible devitalization of adjacent tooth.[44] Therefore, as far implants as dental treatments shows their limitations.

There isn't in literature a consensus in respect to the sovereign of one technique over another for the treatment of different clinical situations. The consensus is to make the adequate indication for each technique for each situation and for each patient, as well as its insertion on maintenance therapy aiming the success of long-term implemented therapy.

Table 2 - Summary of results found in the studies.

Study	Type	Treatment	#	Follow up (years)	Survival
Dannewitz et al[7]	R	PT-molars	505	≥ 5	87%
Fugazzoto[10]	R	RR-molars	701	≥ 15	96.8%
		IP	1472	13	97%
Karoussis et al[20]	P	PT	179	10	95%
		IP	179		95%
Lazarski et al[25]	R	ET	110.000	3.5	94.44%
Salehrabi, Rotstein[42]	R	ET	1.4 million	8	97%
Salehrabi, Rotstein[43]	R	ER	4.744	5	89%
Ng et al[34]	P	ET	759	2 a 4	95.4%
		ER	856		95.3%
Karoussis et al[21]	P	IP	112	10	90.5 a 96.5%
Levin et al[26]	R	IP (molar unit)	81	0.5 a 10	92.6%

R = retrospective study. P = prospective study. PT = periodontal treatment. IP = implants placement. RR = root resection. ET = endodontic treatment. ER = endodontic retreatment.

© 2012 Dental Press Implantology

Conclusion

The hard task of deciding to extract or keep a tooth involves several factors, objectives and subjectives, that should be analyzed carefully, aiming to attend the different therapeutic needs and individualize the treatment plan. This must be a critical analysis grounded on scientific evidence. In this way, it is responsibility of the dentist to present de case prognosis and all therapeutic possibilities as well as the predictability of each to the patient, enabling them to participate on decision-making.

REFERENCES

1. Anson DDS. The changing treatment planning paradigm: save the tooth or place an implant. Compendium. 2009;30:506-18.
2. Ávila G, Galindo-Moreno P, Soehren S, Misch CE, Morelli T, Wang H. A novel decision-making process for tooth retention or extraction. J Periodontol. 2009;80:476-91.
3. Bader HI. Treatment planning for implants versus root canal therapy: a contemporary dilemma. Implant Dent. 2002;11(3):217-23.
4. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. J Periodontol. 1984;55:505-9.
5. Becker W, Becker BE, Mellonig J, Caffesse RG, Warrer K, Caton JG, et al. A prospective multi-center study evaluating periodontal regeneration for Class II furcation invasions and intrabony defects after treatment with a bioabsorbable barrier membrane: 1-year results. J Periodontol. 1996;67(7):641-9.
6. Becker W, Berg L, Becker BE. The longterm evaluation of periodontal treatment and maintenance in 95 patients. Int J Periodontics Restorative Dent. 1984;4(2):54-71.
7. Dannewitz B, Krieger JK, Hüsing J, Eickholz. Loss of molars in periodontally treated patients: a retrospective analysis five years or more after active periodontal treatment. J Clin Periodontol. 2006;33(1):53-61.
8. Davarpanah M, Martinez H, Tecucianu JF, Fromentin O, Celletti R. To Conserve or Implant: Which Choice of Therapy? Int J Periodontics Restorative Dent. 2000;20:413-22.
8. DeSanctis M, Murpgy KG. The role of resective periodontal surgery in the treatment of furcation defects. Periodontol 2000. 2000;22:154-68.
10. Fugazzoto PA. A Comparison of the success of root resected molars and molar position implants in function in a private practice: results of up to 15-plus years. J Periodontol. 2001;72:1113-23.
11. Greenstein G, Cavallaro J, Tarnow D. When to save or extract a tooth in the esthetic zone: a commentary. Compendium. 2008;29:136-46.
12. Grossmann Y, Sadan A. The prosthodontic concept of crown-to-root ratio: a review of the literature. J Prosthet Dent. 2005;93:559-62.
13. Holm-Pedersen P, Lang NP, Müller F. What are the longevities of teeth and oral implants? Clin Oral Implants Res. 2007;18 Suppl 3:15-9.
14. Hou GL, Tsai CC. Cervical enamel projection and intermediate bifurcational ridge correlated with molar furcation involvements. J Periodontol. 1997;68:687- 93.
15. Hovey LR, Jones AA, McGuire M, Melloning JT, Shoolfield J, Cochran DL. Application of periodontal tissue engineering using enamel matrix derivative and a human fibroblast-derived dermal substitute to stimulate periodontal wound healing in Class III furcation defects. J Periodontol. 2006;77(5):790-9.
16. Huynh-Ba G, Kuonem P, Hofer D, Shimid J, Lang NP, Salvi GE. The effect of periodontal therapy on the surgical rate and incidence of complications of multirootted teeth with furcation involvement after an observation period of at least 5 years: a systematic review. J Clin Periodontol. 2009;36(2):164-76.
17. Iqbal MK, Kim S. A review of factors influencing treatment planning decisions of single-tooth implants versus preserving natural teeth with nonsurgical Endodontic therapy. J Endod. 2008;34(5):519-29.

© 2012 Dental Press Implantology

18. Iqbal MK, Kim S. For teeth requiring endodontic treatment, what are the differences in outcomes of restored endodontically treated teeth compared to implant-supported restorations? Int J Oral Maxillofac Implants. 2007;22 Suppl:96-116.
19. Kao RT. Strategic extraction: a paradigm shift that is changing our profession. J Periodontol. 2008;79(6):971-7.
20. Karoussis IK, Muller S, Salvi GE, Heitz-Mayfield LJ, Brägger U, Lang NP. Association between periodontal and peri-implant conditions: a 10-year prospective study. Clin Oral Implants Res. 2004;15(1):1-7.
21. Karoussis IK, Salvi GE, Heitz-Mayfield LJ, Brägger U, Hämmerle CHF, Lang NP. Long-term implant prognosis in patients with and without a history of chronic periodontitis: a 10-year prospective cohort study of the ITI® Dental Implant System. Clin Oral Implants Res. 2003;14(3):329-39.
22. Kim T, Miyamoto T, Nunn ME, Garcia RI, Dietrich T. Root proximity as a risk factor for progression of alveolar bone loss: the veterans affairs dental longitudinal study. J Periodontol. 2008;79(4):654-9.
23. Kinane DF. Periodontitis modified by systemic factors. Ann Periodontol. 1999;4(1):54-64.
24. Lascala Junior N, Jardini MAN, Melo Filho AB. Quais são os fatores que indicam ou contraindicam a exodontia de dentes portadores de doença periodontal para colocação de implantes osseointegrados? In: Lotufo RFM, Lascala NT. Periodontia e Implantodontia: desmistificando a ciência. 1a ed. São Paulo: Artes Médicas; 2003. p. 463-90.
25. Lazarski MP, Walker WA 3rd, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. J Endod. 2001;27(12):791-6.
26. Levin L, Laviv A, Schwartz-Arad D. Long-term success of implants replacing a single molar. J Periodontol. 2006;77(9):1528-32.
27. Lewis S. Treatment planning: teeth versus implants. Int J Periodontics Restorative Dent. 1996;16(4):366-77.
28. Lindh T. Should we extract teeth to avoid tooth-implant combinations? J Oral Rehabil. 2008;35 Suppl 1:44-54.
29. Lundgren D, Rylander H, Laurell L. To save or to extract, that is the question. Natural teeth or dental implants in periodontitis-susceptible patients: clinical decision-making and treatment strategies exemplified with patient case presentations. Periodontol 2000. 2008;47:27-50.
30. McGuire MK. Prognosis versus outcome: a long-term survey of 100 treated periodontal patients under maintenance care. J Periodontol. 1991;62(1):51-8.
31. McGuire MK, Nunn ME. Prognosis versus actual outcome. II. The effectiveness of clinical parameters in developing an accurate prognosis. J Periodontol. 1996;67(7):658-65.
32. Morris MF, Kirkpatrick TC, Rutledge RE, Schindler WG. Comparison of nonsurgical root canal treatment and single-tooth implants. J Endod. 2009;35:1325-30.
33. Müller HP, Eger T. Furcation diagnosis. J Clin Periodontol. 1999;26:485-98.
34. Ng Y-L, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of non-surgical root canal treatment: part 2: tooth survival. Int Endod J. 2011;44(7):610-25
35. O'Neal RB, Butler BL. Restoration or implant planning quandary. Periodontol 2000. 2002;30:111-22.
36. Pontoriero R, Lindhe J. Guided tissue regeneration in the treatment of degree II furcations in maxillary molars. J Clin Periodontol 1995;22:756-63.
37. Quirynen M, Abarca M, Van Assche N, Nevins M, van Steenberghe D. Impact of supportive periodontal therapy and implant surface roughness on implant outcome in patients with a history of periodontitis. J Clin Periodontol. 2007;34(9):805-15.
38. Ng Y-L, Mann V, Gulabivala K. Tooth survival following non-surgical root canal treatment: a systematic review of the literature. Int Endod J. 2010;43:171-89.
39. Ribeiro EDP, Bittencourt S, Ambrosano GMB, Nociti FH, Sallum EA, Sallum AW, et al. Povidone-iodine used as an adjunct to non-surgical treatment of furcation involvements. J Periodontol. 2006;77(2):211-7.
40. Ribeiro EDP, Bittencourt S, Nociti FH, Sallum EA, Sallum AW, Casati MZ. Comparative study of ultrasonic instrumentation for the non-surgical treatment of interproximal and non-interproximal furcation involvements. J Periodontol. 2007;78(2):224-30.
41. Roussa E. Anatomic characteristics of the furcation and root surfaces of molar teeth and their significance in the clinical management of marginal periodontitis. Clin Anat. 1998;11(3):177-86.
42. Salehrabi R, Rotstein I. Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. J Endod. 2004;30:846-50.
43. Salehrabi R, Rotstein I. Epidemiologic evaluation of the outcomes of orthograde endodontic retreatment. J Endod. 2010;36:790-2.
44. Tang CS, Naylor AE. Single-unit implants versus conventional treatments for compromised teeth: a brief review of the evidence. J Dent Educ. 2005;69(4):414-8.
45. Tomasi C, Wennstrom JI, Berglundh T. Longevity of teeth and implants: a systematic review. J Oral Rehabil. 2008;(35 Suppl 1):23-32.
46. Warren JJ, Hand JS, Levy SM, Kirchner L. Factors Related to Decisions to Extratct or Retain At-risk Teeth. J Public Health Dent. 2000;60(1):39-42.

© 2012 Dental Press Implantology

Innovated approach in late failure of osseointegrated implant: Minimally traumatic implant explantation (Part 1)

Maurício Clavijo **BELTRÁN***
Verônica Beltrán **CLAVIJO****
Fernando Rodrigues **PINTO*****
Guilherme da Gama **RAMOS******

Abstract

Introduction: The minimally traumatic retrieval implant technique is a treatment that uses a tapered screw counterclockwise device. This tool can break the osseointegration and retrieve the implant easily. **Objective:** The aim of this paper is to show a clinical case report where this technique was used in implant failure and to show the advantages and disadvantages of other treatment alternatives. **Conclusions:** This new approach suggests that this explantation can preserve the peri-implant bone tissue and the adjacent teeth, there is a reduction of treatment time and in the morbidity associated with bone reconstruction. It seems an effective technique for removal of implants, ensuring predictability to retreatment.

Keywords: Dental implants. Retreatment. Device removal.

How to mention this article: Beltrán MC, Clavijo VB, Pinto FR, Ramos GG. Innovated approach in late failure of osseointegrated implant: Minimally traumatic implant explantation (Part 1). Dental Press Implantol. 2012 Apr-June;6(2):80-90.

» The authors inform that they do not have no associative, commercial, intellectual property, or financial interests representing a conflict of interest in products and companies described in this article.

Contact address

Maurício Clavijo Beltrán
Rua Marechal Deodoro, 857 – Centro
Zip Code: 80.060-010 – Curitiba/PR – Brazil
Email: maucbeltran@gmail.com

Submitted on: 09/12/2011
Reviewed and received on: 01/10/2012

* Graduated in Dentistry, FOP-UNICAMP. Specialist in Dental Prosthesis, FOB-USP. Specialist in Implantology, APCD-Piracicaba.
** Graduated in Dentistry, UFPR. Specialist in Periodontics, FOP-UNICAMP. Specialist in Implantology, APCD-Piracicaba.
*** PhD in Dental Clinic and Periodontics, FOP-UNICAMP. Professor of Specialization in Implantology, APCD-Piracicaba.
**** MSc and PhD in Dental Clinic and Dental Prosthesis, FOP-UNICAMP. Professor of Specialization in Implantology, APCD-Piracicaba.

© 2012 Dental Press Implantology

Introduction

Implant-supported restorations provide a predictable tooth replacement treatment because success rates are high.[1] However, failures can occur in implant treatments.[2,3] For adequate management and retreatment is necessary to identify the causing factor of the failure, to try to fix it with a different approach.

Late failures occur after total or partial osseointegration of the implant surface subjected to occlusal load[4] and jeopardize patient satisfaction and aesthetic function.[5] Among the causes are peri-implantitis, occlusal overload,[3] prosthetic problems, inadequate three-dimensional positioning of the implant and deficient tissue volume that was previously uncorrected.

The treatment selection comes with a difficult decision: maintaining the implant or not. For a long time the maintenance of the implant was the first option of treatment, since the implant retrieve with late failure is complicated and traumatic, can lead to consequences that jeopardize the function and esthetic results.[6]

Broadly used in histological research to obtain *in vivo* samples, the trephine drill is also used in explantation in a peri-implant bone-wear technique.[7] The drawbacks of this technique are the excessive bone wear, which may put in risk the adjacent teeth, leading to further required bone grafting; difficulty in cooling the drill, and causing overheating bone necrosis; and the increased time for the rehabilitation of the supported implant, due to waiting for the bone healing after grafting.

Nowadays there is a dental device which disrupts the osseointegration, unscrewing the implant with or without minimal bone damage.[6] It consists of a conical screw counterclockwise which connects inside of the implant, and when rotated, with the aid of a ratchet, attaches to the implant, removing easily with minimal trauma.

The aim of this article is to discuss different treatment options in late failure implants, showing the advantages, disadvantages, indications and contraindications of each technique, and present a new treatment option: a minimally traumatic explantation.

Case report

Male patient came to private clinic with complaints about the aesthetic result of previous treatments (Fig 1). The patient was partially edentulous, with chronic periodontitis and had an implant crown in the region of tooth 21, where there was great loss of vestibular tissue volume. The periodontal biotype was intermediate and smile line was average. Peri-implant bone loss was observed, radiographically and tomographically, (Fig 2 and 3) in the region of 21. There was no spontaneous bleeding or oozing in this area.

This patient began treatment with periodontal therapy. Old restorations were removed and provisional crowns were made in an attempt to provide an esthetic result that would satisfy the initial aspirations of the patient (Fig 4). The crown on the implant of 21 was removed, in an attempt to cover it with soft tissue for

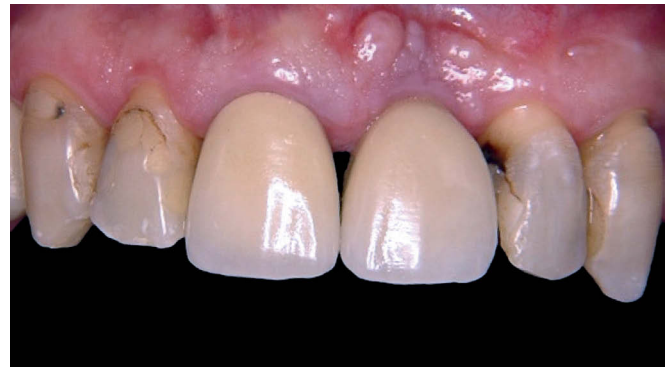


Figure 1 - Clinical case initial image.

© 2012 Dental Press Implantology

a period of three weeks. After concluding this set of provisional crowns, a great deficiency of previously uncorrected soft tissue, the presence of a large space between the roots of the 11 and 22 and the gingival level variation of teeth 11, 22 and 23 were observed in the region of the implant (Fig 5-7).

We decided to restore the ideal gingival contour with a clinical crown augmentation surgery followed by an implant removal in the region of tooth 21 with simultaneous alveolar bone regeneration and the correction of the tissue deficiency with connective submucosal tissue graft.

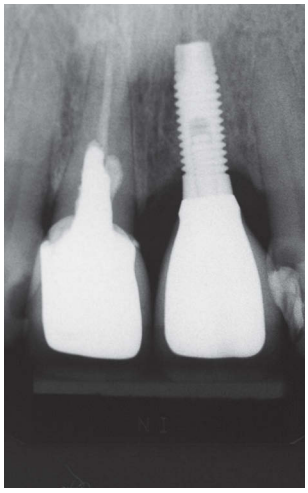


Figure 2 - Radiographic and tomographic initial images of the clinical case.

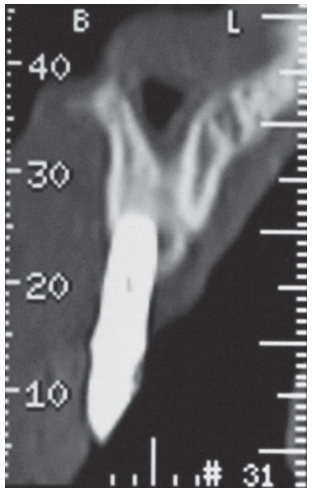


Figure 3 - Radiographic and tomographic initial images of the clinical case.

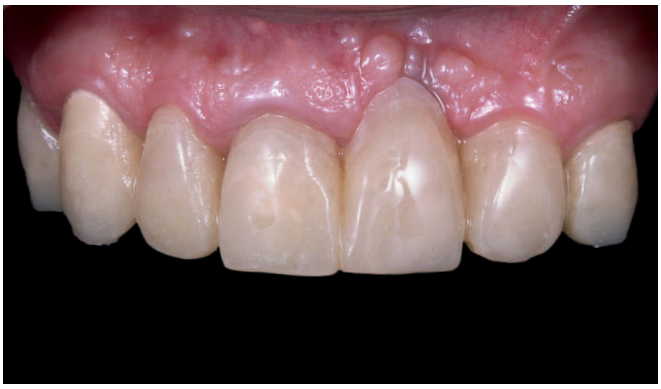


Figure 4 - Clinical case after the provisional crowns.

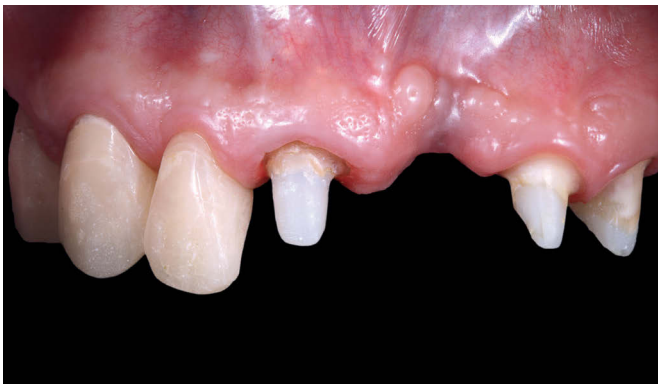


Figure 5 - It can be observed the large deficiency in the implanted tissue, the presence of a wide diameter between teeth 11 and 22 and the gingival ideal level variation of teeth 11, 22, and 23.

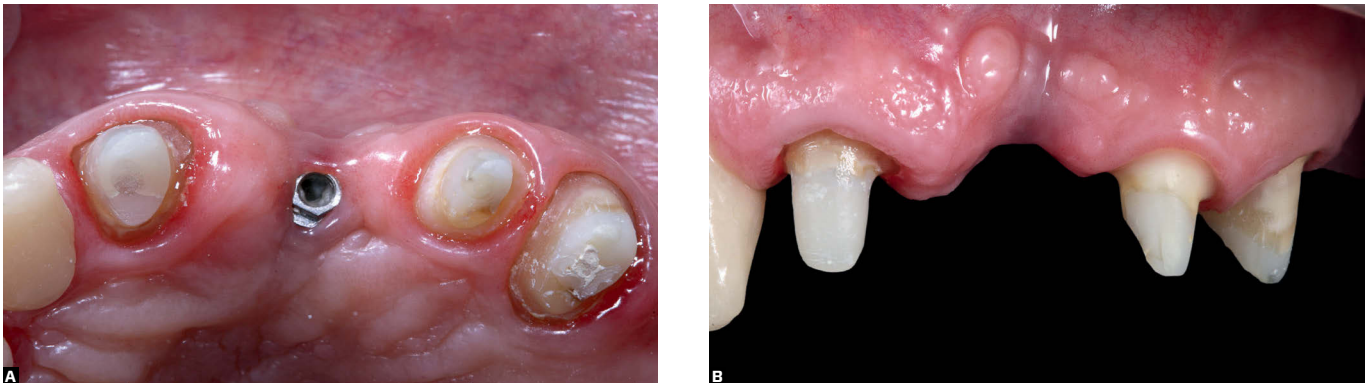


Figure 6 - Again, it can be observed the large deficiency in the implanted tissue, the presence of a wide diameter between teeth 11 and 22 and the gingival ideal level variation of teeth 11, 22, and 23.

© 2012 Dental Press Implantology

In an attempt to decrease the cost, time and number of interventions in the treatment of the patient, primarily, we tried to accomplish the minimally traumatic explantation. If this procedure fails, a conventional procedure would be performed with drills, trephines and forceps.

Intrasulcular incisions followed by internal bevel incisions were made to remove the excess of gingival tissue (Fig 8 and 9) and flapless osteotomy was performed in the adjacent teeth of the implant with provisional crowns in place. A supracrestal incision mildly shifted toward the palate was held between the dihedral angles of the teeth 11 and 22 (Fig 10). The flap was folded, making ideal conditions for visualization of the implant (Fig 11). The conical retrieval was inserted into the implant screwing it in a counterclockwise direction, and this set was connected to the ratchet. Counter-torques are given in the ratchet until it breaks osseointegration and enable the implant to be removed progressively (Fig 12, 13 and 14).

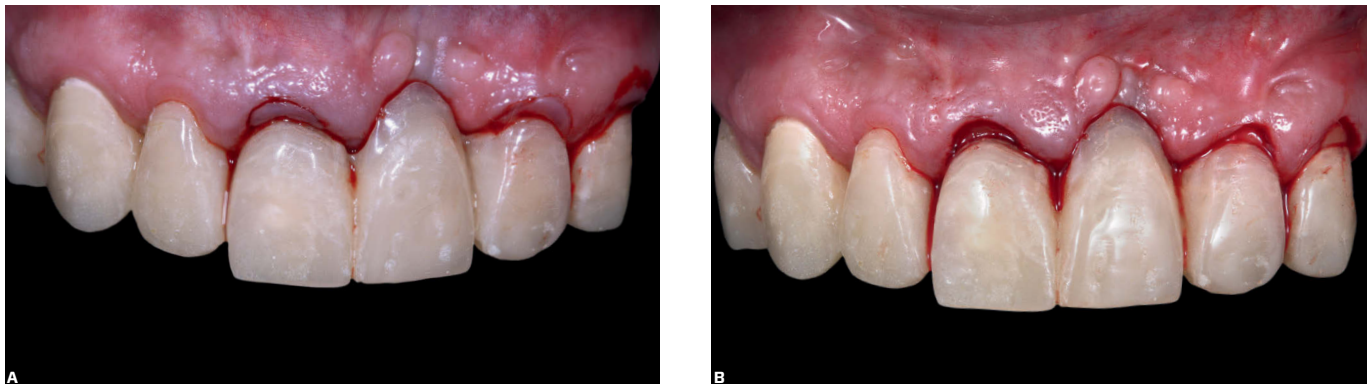


Figure 7 - Incisions for removing excess gingival tissue.

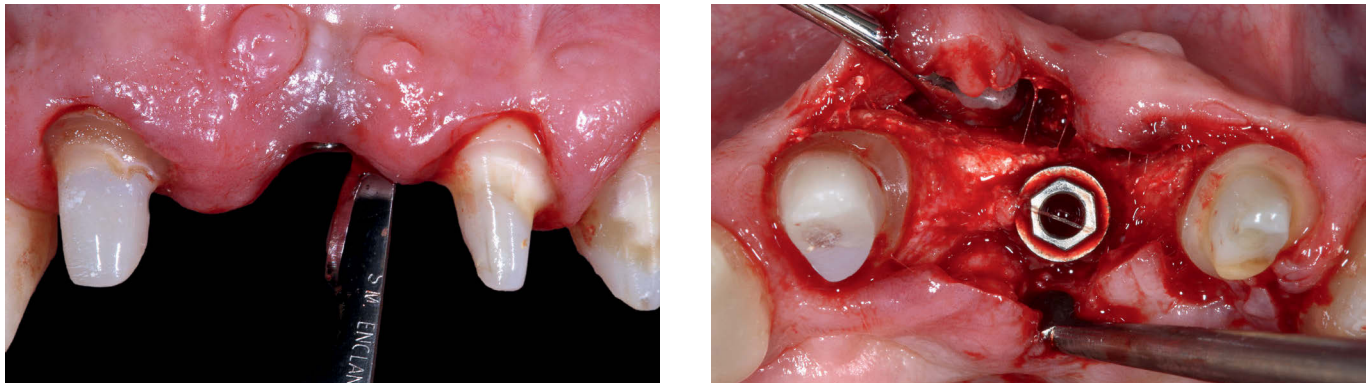


Figure 8 - Supracrestal incision slightly palatal shifted.

Figure 9 - Occlusal view after flap folding.

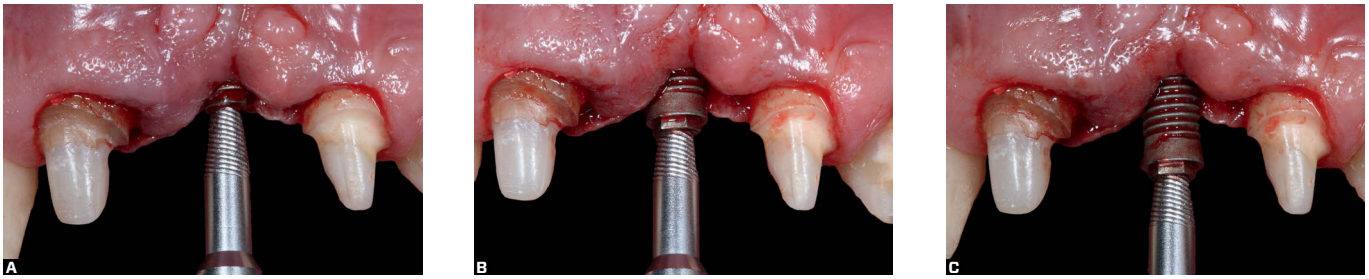


Figure 10 - Implant gradually being removed. Note the opposite direction of the tapered threads remover compared to the implant.

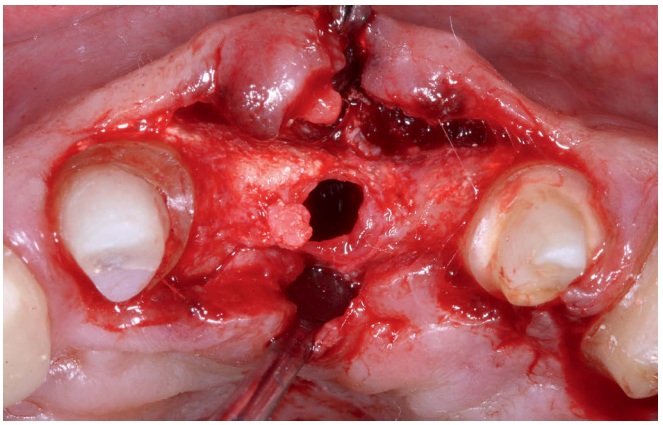


Figure 11 - Occlusal view of the alveolus after explantation.

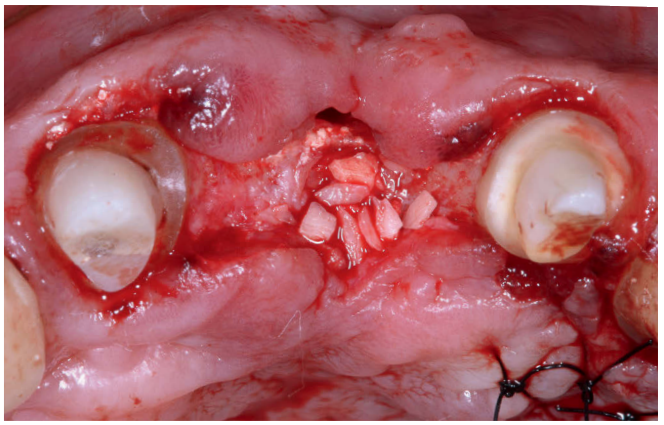


Figure 12 - Alveolus filling with biomaterial.

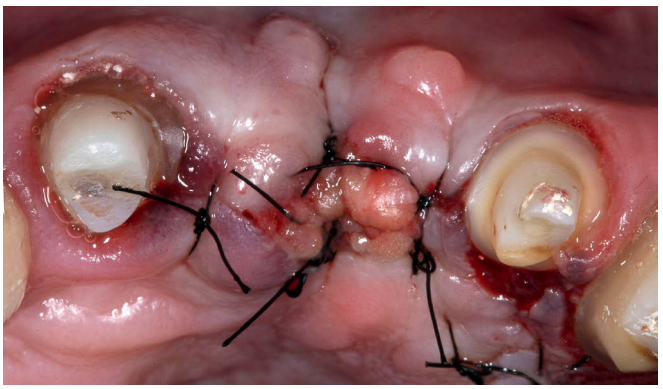


Figure 13 - Suture after covering with a connective tissue graft.

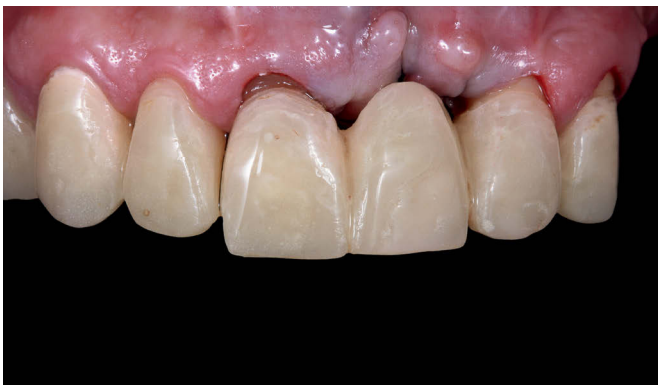


Figure 14 - Provisional crowns repositioned and recemented.

After removal of the implant (Fig 15) we inspected the integrity of the alveolus. It was filled with a slow resorption biomaterial Bio-Oss® and then a subepithelial connective tissue graft was performed, transplanted from the palate, under the flap from the buccal surface to the cervical ridge, stabilized by sutures (Fig 16 and 17). Then the crowns were relieved in the bridge, repositioned and cemented (Fig 18). A new procedure should be performed in 8 months after complete healing and remodeling of the bone tissue.

© 2012 Dental Press Implantology

Bibliographic review and discussion

There are many options to treat late failures in Implantology. Each technique have its directions, advantages and disadvantages. These are described below and related to the clinical case reported.

Treatment options with the maintenance of the implant

Using an implant prosthesis

Dental-gingival prosthesis

The offsetting of soft tissue in an implant prosthesis[8,9] is indicated in cases of advanced uncorrected tissue deficiencies, preferably in multiple implants, and patients resistant to surgical treatment options. This artifice allows a balance of form and height / width ratio, dental papilla to be at an ideal height, a correct dental axis, sealing of air during speech, smile line and optimal gain of lip support in cases of severe tissue defects. The limitations of the technique are the height of the smile, the tissue conditioning to correct emergence profile and maintenance of oral hygiene. There is the need for strict control of plaque by the patient and due to this factor was not opted for this alternative treatment in the clinical case reported. There is the need for strict control of plaque by the patient and due to this factor, this treatment option was not choice for the clinical case reported.

Connective tissue graft associated with techniques

The subepithelial connective tissue graft[10] is a surgical technique that emerged from the periodontal plastic surgery in order to recover roots on exposed areas and / or form a band of keratinized tissue where there is an absence. In the Implantology this technique may be employed before, during or after implantation, and may be performed in more than one surgical approach. The best donor region is the palatal mucosa and the technique of choice with less postoperative discomfort is the technique of linear incision with suspended sutures, which reduces the risk of bleeding and enhances the healing process. In late failure implants, this technique is recommended in situations where there are minor tissue deficiencies that were previously uncorrected and exposure of a few implant threads, provided that they are decontaminated and that the implant has proper tridimensional placement.[11,12] The tissue defects presented in our case made it impossible to use the implant, but the subepithelial tissues graft allowed greater gain in vestibular thickness for future reimplant in the region.

Temporary submerged-implant

The submerged-root is a technique that emerged because of the impossibility to use prosthetical disabled teeth.[13,14] The extraction of these teeth would lead to vestibular bone resorption and loss of tissue volume; the submerged-root technique preserves the tissue volume in that area. Temporary submerged-implant technique promotes a gain of soft tissue in the regions of implant exposure and may be associated with subepithelial connective tissue grafting techniques. It is recommended to recover in case of exposure of the platform and / or the threads of the implant, tissue deficiencies, or peri-implantitis. However the technique is contraindicated in cases where there is no decontamination of the threads. In the clinical case described, the temporary submerged-implant could be performed in order to be able to recover the implant platform with soft tissue, since the biomaterial Bio-Oss® was placed in the alveolus after explantation and this would not be exposed to the oral cavity.

Surgical relocation

This technique is indicated in cases of incorrectly positioned implants with great prosthetical limitations without the presence of peri-implantitis. It consists of removing and repositioning of the implant bone block and can be performed with drills, chisels and / or piezosonic scalpel.[15,16] This last offers lower post-surgical trauma, because it does not generate osseous heat and performs a more delicate osteotomy. The limitations of the technique are the risk of slicing the adjacent dental roots,

© 2012 Dental Press Implantology

the difficulty in fixing the block and poor access (in some cases). Because of the difficulty of the technique, it has become a less used option. This technique has not been shown in this case because there was peri-implant bone loss.

Surgical peri-implantitis regeneration therapy

Some studies indicate the possibility of a regenerative surgery, and even re-osseointegration, in implants disabled by peri-implantitis. Despite being a recent issue, the etiology of periodontal disease and peri-implant disease are similar, but the second has much more rapid progression due the absence of the periodontal ligament and the difficulty of complete decontamination of screw threads. The main objective of the technique is decontamination and the filing of the implant threads with drills and ultrasonic instruments.[18,19] Antiseptic solutions, topical antibiotics may be used, along with, in some cases, grafts and biomaterials for covering bone defects. It is indicated only in cases of well positioned long implants, with a maximum of one third of the height jeopardized of the bone loss, and / or supporting extensive prosthetic rehabilitation. Because of the large bone loss around the implant, difficulty of the technique and high cost, this alternative treatment has not been ruled out for this clinical case.

Without using an implant prosthesis

Permanent submerged-implant

The implant failure may lead the patient to frustration regarding surgical approaches and so prosthetic conventional treatments can be a solution in such cases. In regions that the adjacent teeth are present, conventional fixed prostheses or adhesive prostheses[3] are two options, with or without association of a connective tissue graft to correct defects in the volume of the pontic area. Due to the need for a surgical procedure, like clinical crown lengthening surgery in the adjacent teeth, and by the choice of the patient, this technique was not chosen.

Treatment options without implant maintenance

Implant removal

Traumatic techniques of explantation

Many times late implant failures render impossible prosthetic rehabilitation with adequate function / esthetic, and thus, the removal of dental implants becomes a required solution. However, conventional techniques of explantation are traumatics[7] because peri-implant bone tissue is unnecessarily filed. For this reason this kind of procedure becomes the last treatment choice in cases of failure.

Carbide and trephine drill (Fig 19) produce bone heating due the difficulty of cooling and induce necrosis after surgery, remove unnecessary peri-implantar bone tissue and create a risk of injury to the adjacent roots. Conventional instruments of exodontia technique, such as root elevators, tooth forceps and bone rongeurs, have a limited efficiency in the removal of dental implants. Those boorish instruments can injure the buccal peri-implantar bone wall. Recently an electrosurgical device for implant remove emerged[20] to make the approach easier. However, this procedure causes thermal necrosis and indicates high peri-implantar bone trauma. Piezosonic scalpel can be used in this technique too, but it leads to unnecessary removal of the peri-implantar bone also.

Minimally traumatic technique of explantation.

The minimally traumatic implant removal appeared to make the explantation easier.[6,21] The conventional approach can lead to a clinical case with additional reconstructive procedures, delayed healing, damage to adjacent teeth, complex operation, high costs and risk of impossibility of future reimplantation in the same area. Being a high-risk technique, it has turned into the last treatment option or even ruled out of the question.

The explantation by counterclockwise torque was used[22] to evaluate in rabbits the implant osseointegration

© 2012 Dental Press Implantology

with different surface treatments. Another study[23] evaluated *in vivo* the amount of torque required to remove orthodontic mini implants with surface treatment. They concluded the removal torque was 67.91 ± 12.47 N and varied according the implanted area.

As described in recent literature,[6] there emerged in the dental market a counterclockwise threaded conical device (Fig 20), which by imbrication with the implant's inner surface, and connected to a ratchet, can transfer the torque load from the ratchet to the implant, breaking the osseointegration and easily unscrewing the implant (Fig 21). The need for tissue reconstruction is reduced because it causes less trauma and does not need to remove periimplantar bone, which would lead to less time for a new reimplantation or even immediated reimplantation after the explantation.

Figure 15 - Trephine drills of different diameters.

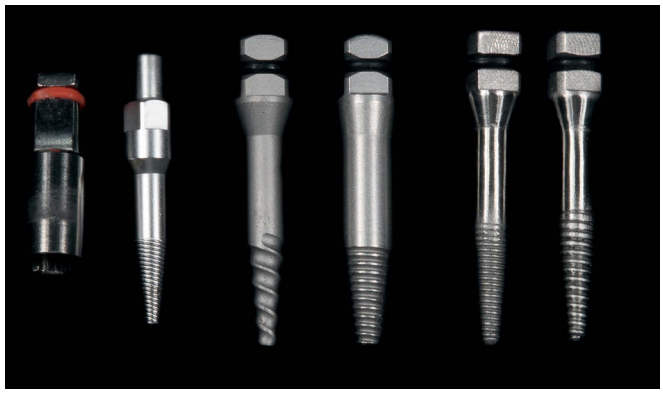


Figure 16 - Tapered removers available in the dental market of the brands: Nobel Biocare (Zurich, Switzerland), Kopp (Curitiba, Brazil) and Maximus (Contagem, Brazil), from left to right, respectively.

Figure 17 - Dental implant explanted with the conical remover.

Figure 18 - Tapered remover used in mechanical removal of screws.

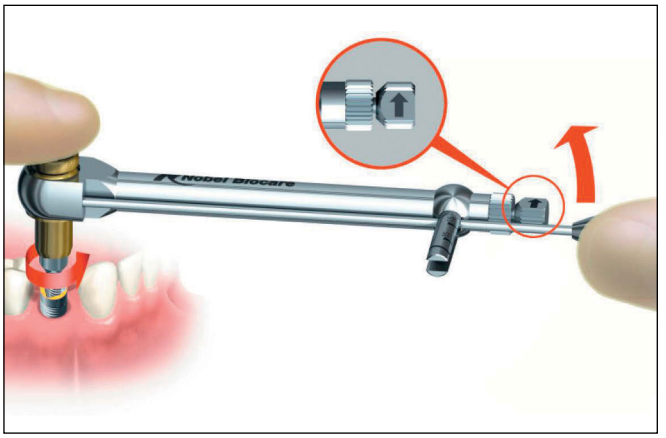


Figure 19 - Dental implant being unscrewed from the tapered ratchet remover by means of counterclockwise torque (image courtesy of Nobel Biocare Services AG).

Another article[21] reports the use of a implant remove kit with the conical tool and trephine drills to cervical osteotomy. It was observed that when used, it decreases the necessary torque required for removal, and it is in the range of 80-200N.

The tapered remover works from a mechanical principle and is widely diffused in the mechanics for the removal of broken screws (Fig 22).

The sequence suggested by the authors to use the tapered device is:

1) Widening the internal implant hole – aiming to establish better positioning of the tapering tool in the implant and avoid fracturing of the part caused by partial or improper settling.
2) Osteotomy in switching platform implant – this type of implant may have a accommodation of bone tissue in the cervical area and platform of the implant, which can enhance the stress generated in the remove and hinder it.
3) Attach the removal device in the implant – this should be done by threading the tool in a counterclockwise direction, being careful to stabilize it on the same axis of the implant.
4) Snap on the removal device with ratchet – a ratchet, in good condition, with a counterclockwise orientation must be used, so that there is no damage to internal components, as the torque can reach 200N.
5) Rotate the set in a counter-clockwise direction – the removal tool is progressively locked inside the implant until it is stabilized by the increased resistance.
6) Load the ratchet until it breaks osseointegration – this force varies according to the implanted area and the implant surface treatment. The ratchet must be stabilized with your fingers against the implant (Fig 23) because at this point a fracture risk arises.
7) Unscrewing the implant – which is easily removed.
8) Inspection of explanted area – the integrity of the alveolus bone walls are assessed, which will guide the decision to do an immediate reimplantation, an early reimplantation or a delayed reimplantation that can be performed at this time, following the bone graft.

© 2012 Dental Press Implantology

In this suggested sequence we observe that we can perform a flapless surgery. In this clinical case we chosen by flap the mucosa, since there was a previous osteotomy and needed to grafting after explantation. We could have a direct visual inspection of the peri-implant bone walls with the flap approach. After the period of bone remodeling, approximately 8 months due to the use of biomaterial,[24] a new, more apical and shifted toward the palate implant will be installed.

In clinical cases of unaltered bone walls and with adequate height and thickness, we suggest that reimplantation may be performed subsequent to the minimally traumatic explantation surgery, which would decrease even more time and costs to prosthetic rehabilitation treatment. In the clinical case described, the bone walls were thin and we chose to fill the socket after explantation with Bio-Oss® biomaterial, and at the same time performed a subepithelial connective tissue graft. The proposed to use is a xenogenic biomaterial in order to reduce the buccal bone wall resorption, as occurs in cases of sockets after exodontia. However we can not say that the behavior of sockets after explantation is equals the sockets after dental extraction, which suggests further studies on this subject.

REFERENCES

1. Esposito M, Grusovin MG, Coulthard P, Thomsen P, Worthington HV. A 5-year follow-up comparative analysis of the efficacy of various osseointegrated dental implant systems: a systematic review of randomized controlled clinical trials. Int J Oral Maxillofac Implants. 2005;20:557-68.
2. Cury PR, Sendyk WR, Sallum AW. Factors associated with early and late failure of osseointegrated implant. Braz J Oral Sci. 2003;2(6):233-8.
3. Levin L. Dealing with dental implant failures. J Appl Oral Sci. 2008;16(3):171-5.
4. Swamberg DF, Henry MD. Avoiding implant overload. Implant Soc. 1995;6:12-4.
5. Veli G, Gracis S, Capelli M. Influence of the 3_D Bone to Implant Relationship on Esthetics. Int J Periodontics Restorative Dent. 2005;25(2):113-9.
6. Joly JC, Carvalho PFM, Silva RC. Reconstrução Tecidual Estética: procedimentos plásticos e regenerativos periodontais e peri-implantares. São Paulo: Artes Médicas; 2010.
7. ten Bruggenkate CM, Sutter F, Schroeder A, Oosterbeek HS. Explantation procedure in the F-type and Bonefit ITI implant system. Int J Oral Maxillofac Surg. 1991;20(3):155-8.
8. Coachman C, Salama M, Garber D, Calamita M, Salama H, Cabral G. Prosthetic gingival reconstruction in a fixed partial restoration. Part 1: introduction to artificial gingiva as an alternative therapy. Int J Periodontics Restorative Dent. 2009;29(5):471-7.
9. Salama M, Coachman C, Garber D, Calamita M, Salama H, Cabral G. Prosthetic gingival reconstruction in the fixed partial restoration. Part 2: diagnosis and treatment planning. Int J Periodontics Restorative Dent. 2009;29(6):573-81.
10. Raetzke PB. Covering localized areas of root exposure employing the envelope technique. J Periodontol. 1985;56(7):397-402.
11. Price RB, Price DE. Esthetic restoration of a single-tooth dental implant using a subepithelial connective tissue graft: a case report with 3-year follow-up. Int J Periodontics Restorative Dent. 1999;19(1):92-101.

© 2012 Dental Press Implantology

12. Rungcharassaeng K, Kan JY. Management of unfavorable implant placement: a clinical report. J Prosthet Dent. 2000;84(3):264-8.
13. Langer B. Spontaneous in situ gingival augmentation. Int J Periodontics Restorative Dent. 1994;14(6):524-35.
14. Von Wowwern N, Winther S. Submergence of roots for alveolar ridge preservation. A failure (4-year follow-up study). Int J Oral Surg. 1981;10(4):247-50.
15. Watanabe F, Hata Y, Mataga I, Yoshie S. Retrieval and replacement of a malpositioned dental implant: a clinical report. J Prosthet Dent. 2002;88(3):255-8.
16. Stacchi C, Constantinides F, Biassoto M, di Lenarda R. Relocation of malpositioned maxillary implant with piezoeletric osteotomies: Int J Periodontics Restorative Dent. 2008;28(5):489-95.
17. Zanatta FB, Ravanello F, Antoniazzi RP, Rösing CK. Tratamento da periimplantite: uma revisão sistemática. Periodontia. 2009;19(4):111-20.
18. Romeo E, Ghisolfi M, Murgolo N, Chiapasco M, Lops D, Vogel G. Therapy of peri-implantitis with resective surgery. A 3-year clinical trial on rough screw-shaped oral implants. Part I: clinical outcome. Clin Oral Implants Res. 2005;16(1):9-18.
19. Schwarz F, Sculean A, Bieling K, Ferrari D, Rothamel D, Becker J. Two-year. Clinical results following treatment of peri-implantitis lesions using a nanocrystalline hydroxyapatite or a natural bone mineral in combination with a collagen membrane. J Clin Periodontol. 2008;35(1):80-7.
20. Massei G, Szmukler-Moncler S. Thermo-explantation. Anovel approach to remove osseointegrated implants. Eur Cells Mater. 2004;7 Suppl 2:48.
21. Anitua E, Orive G. Atraumatic implant explantation, is it possible? Description of a novel technique and a case series study. JIACD. 2010;2(7):65-71.
22. Klokkevold PR, Jhonson P, Dadgostan S, Davies JE, Caputo A, Nishimura RD. Early endosseous integration enhanced by dual acid etching of titanium: atorque removal stidy in the rabbit. Clin Oral Implants Res. 2001;12:350-7.
23. Favero LG, Pisoni A, Paganelli C. Removal torque of osseointegrated mini-implants: na in vivo evaluation. Eur J Orthod. 2007;29:443-8.
24. Araújo MG, Lindhe J. Rigge preservation with the use of Bio-Oss collagen: a 6-month study in the dog. Clin Oral Implants Res. 2009;20:433-40.

© 2012 Dental Press Implantology

implanteperio
potencializando seu talento

REFRESQUE SEU CONHECIMENTO COM ESSAS OPÇÕES IRRESISTÍVEIS.

Aprecie o sabor de estar cientificamente e tecnicamente atualizado, num ambiente especialmente planejado para agregar benefícios à sua carreira.

Os cursos do **Instituto ImplantePerio** são ministrados por profissionais conceituados e experientes que primam pela integração das especialidades na busca da excelência estética.

Invista numa infraestrutura que prioriza o seu conforto e a sua performance.

CURSOS DE IMERSÃO (HANDS-ON)

- Cirurgia Plástica Peri-implantar - 4 dias
- Recobrimento Radicular - 3 dias
- Reconstrução Óssea - 3 dias

CURSOS DE EXTENSÃO (CLÍNICOS)

- Excelência em Perio-implantodontia - 18 meses (3 dias/mês)
- Avançado em Cirurgia Plástica Periodontal - 6 meses (2 dias/mês)
- Excelência em Reabilitação Oral - 15 meses (2 dias/mês)

* Cursos em São Paulo e em outras cidades do país

Acesse a programação completa de cursos:

www.implanteperio.com.br ou **(11) 3257.4190 | 3219.0164**

Presentation of a model of periodontal clinical record

João **CARNIO***
Simone **VALENGA****
Fernanda Akemi Nakanishi **ITO*****
Marcel Rodrigo **FUGANTI******

Abstract

Introduction: The clinic form is an essential tool for the execution of any periodontal procedure. Its finality is to obtain and record as much information as possible about the patient's general and oral state of health, besides storing records of all executed procedures since initial appointment until the treatment conclusion. **Objective:** The purpose of this work is to emphasize the importance of the periodontal clinic form and propose a guidance model for professionals and institutions on the elaboration of their own clinical forms. **Methods:** Through the analysis of the data contained on clinical forms of several institutions and study of the main articles related to the subject it was created an specific model of clinical form for Periodontics.

Keywords: Clinic form. Periodontics. Periodontitis. Data analysis.

How to mention this article: Carnio J, Valenga S, Ito FAN, Fuganti MR. Presentation of a model of periodontal clinical record. Dental Press Implantol. 2012 Apr-June;6(2):92-103.

» The authors inform that they do not have no associative, commercial, intellectual property, or financial interests representing a conflict of interest in products and companies described in this article.

Contact address

João Carnio
Av. Adhemar Pereira de Barros, 131 – Jd. Bela Suiça
Zip Code: 86.050-190 – Londrina/PR – Brazil
Email: jcarnio@onda.com.br

Submitted on: 09/01/2011
Reviewed and received on: 02/24/2012

* Professor and Coordinator of Periodontics, State University of Londrina.
** MSc student of Dentistry, State University of Londrina.
*** Professor of Periodontics, State University of Londrina.
**** Intern in Periodontics, State University of Londrina.

© 2012 Dental Press Implantology

Introduction

The periodontal form, present on dental clinical records, was defined as a document in which it can be recorded and kept all information regarding the patient, from his/her systemic health condition to clinical particularities, that will guide his/her treatment needs.[1] This documentation, based on the individual response of each patient, helps to improve the diagnosis accuracy, inform the correct prognosis and elaborate an appropriate treatment plan.[2] The periodontal clinic form is one of the components of the dental record. Besides the clinical forms, it is also part of the dental record: Prescriptions, recommendations, certificates, complementary exams, radiographs, photographs, models and other documents, that must be correctly executed and stored by the professional.[3] Recording data becomes essential especially to follow the treatment development, for revaluation of each phase and to follow the case in the long term.[4] Many professionals, although perform an appropriate technical work, end up not recording correctly the information obtained before, during and after treatment, by negligence or, most of the time, because they don't have an embracing clinical form or of easy fill out. It is important to emphasize that the dental documentation, when correctly done, shows technical efficiency from the professional in his practice, besides, it can be used as evidence in eventual civil suit, criminal procedures, ethical process, and as consultation tool in cases of human identification.[5] The present study has as objective to introduce an specific periodontal clinical form, in a simple, concise and complete way that allows the correct elaboration of the patient's treatment and that facilitates restoring all relevant data in every appointment, providing a model that can guide professionals or educational institutions on the elaboration of their own clinical forms.

Material and Methods

For the elaboration of a periodontal clinic form model, it was performed a study of the main articles related to the subject and an investigation of the data contained on periodontal forms used in some graduation courses in Brazil and abroad.[6] The personal, medical and dental questioning as well as periodontal charts and procedure forms were analyzed and compared with one another. All relevant data were collected and new data were introduced for the elaboration of a new periodontal clinic form model, updated and integrated with the medical specialties. The form is constituted of:

Term of commitment

The negligence on anamnesis characterize professional mistake, and may subject to ethical and legal sanctions. Therefore, professionals must explain to their patients about the importance of having access to all clinical information for the sake of their own health and success of the dental therapy.[7] In this form model, the patient is responsible for the veracity of the information and authorize the use of the material for didactic purposes and research, becoming particularly important for the clinical forms of educational institutions or research centers (Fig 1).

Register

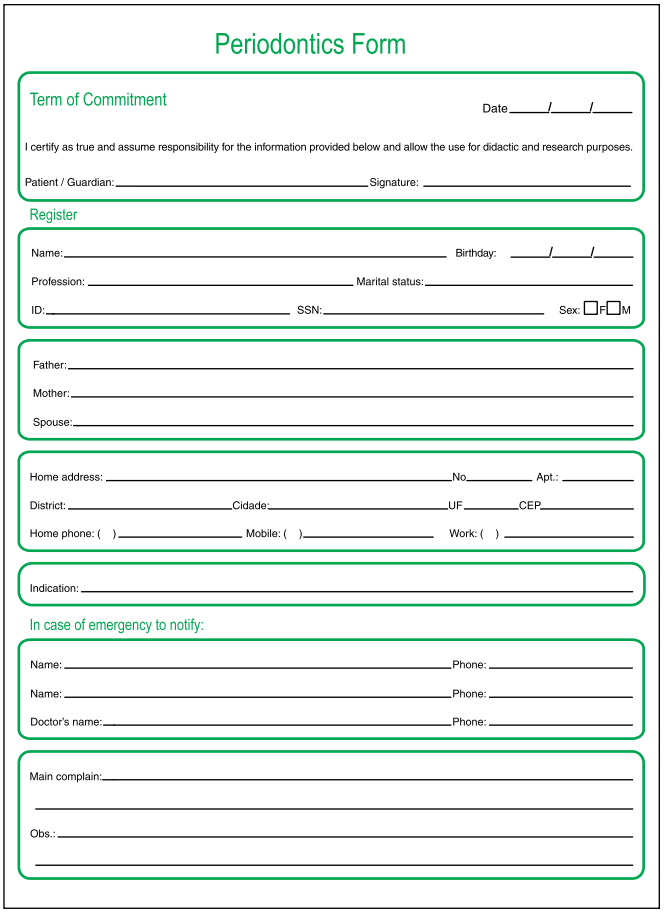
This item contains the patient's data usually found in most forms: full name, date of birth, profession, civil status, ID, SSN, gender, filiation, home address, contact phone numbers.[8] Besides, data related to the name of the spouse or close people are fundamental to secondary contact in case of complications during treatment. The name of the doctor is also necessary to allow access to further information about the state of health, prescription of medicines or availability of certain procedures (Fig 1).

Chief complaint

The chief complaint is a key component. It will determine the beginning of the intraoral exam, for it is the main objective of the appointment for the patient.[9,10]

© 2012 Dental Press Implantology

The correct comprehension of the patient's complaint facilitates the good relationship between patient and professional and his satisfaction with the treatment. Obviously, the professional must expound other findings from the intraoral exam that are, many times, more important than the chief complaint reported and orientate the patient regarding all other necessary procedures that must be prioritized so that it is possible to effectively promote oral health (Fig 1).[11] On the "Observations" item below the "Chief complaint" the professional can included other information such as: difficulty to express or communicate about the chief complaint from the patient, degree of concern about the reported event and other relevant information.


Periodontics Form

Term of Commitment

Date ____/____/____

I certify as true and assume responsibility for the information provided below and allow the use for didactic and research purposes.

Patient / Guardian: _____ Signature: _____

Register

Name: _____ Birthday: ____/____/____

Profession: _____ Marital status: _____

ID: _____ SSN: _____ Sex: ☐F ☐M

Father: _____

Mother: _____

Spouse: _____

Home address: _____ No. _____ Apt.: _____

District: _____ Cidade: _____ UF _____ CEP _____

Home phone: ( ) _____ Mobile: ( ) _____ Work: ( ) _____

Indication: _____

In case of emergency to notify:

Name: _____ Phone: _____

Name: _____ Phone: _____

Doctor's name: _____ Phone: _____

Main complain: _____

Obs.: _____

Figure 1 - Term of commitment, register and chief complain.

Medical history

The performance of the medical history investigation provides support so the surgeon dentist correlates the systemic state of the patient with his dental history, providing relevant information for the clinical diagnosis and elaboration of the treatment plan associating them to medical specialties.[12] As the periodontal disease etiology is multifactorial, diseases or systemic alterations can directly affect the host compromising his immune response, accelerating or increasing the progression and tissue destruction caused by the disease. The same way, the periodontal disease may cause some systemic alterations as cardiopathy, chronic pulmonary alteration among other things.[13-18] It is important to know the relation of the medication used by the patient, either for the possibility of interaction with others eventually prescribed or for alterations in the oral cavity and on periodontal tissues that it may cause.[17] On the presented survey there is a differentiated space for prescribed and non-prescribed medication. It is important to emphasize that the intake of medication without the prescription of a professional is a fact very commonly found and it can lead to complications and cause interference on the treatment, if not reported. Any cases of allergy must me recorded, including food, drugs or dental material sensibility. For women, it is important to record situations characterized by hormonal alteration such as puberty, menstrual cycle, pregnancy, menopause or the use of contraceptive.[18] The medical history of this form was carefully elaborated aiming to obtain as much information as possible regarding the patient's current and previous general health state, to allow a safe and integrated clinical management with his condition (Fig 2).

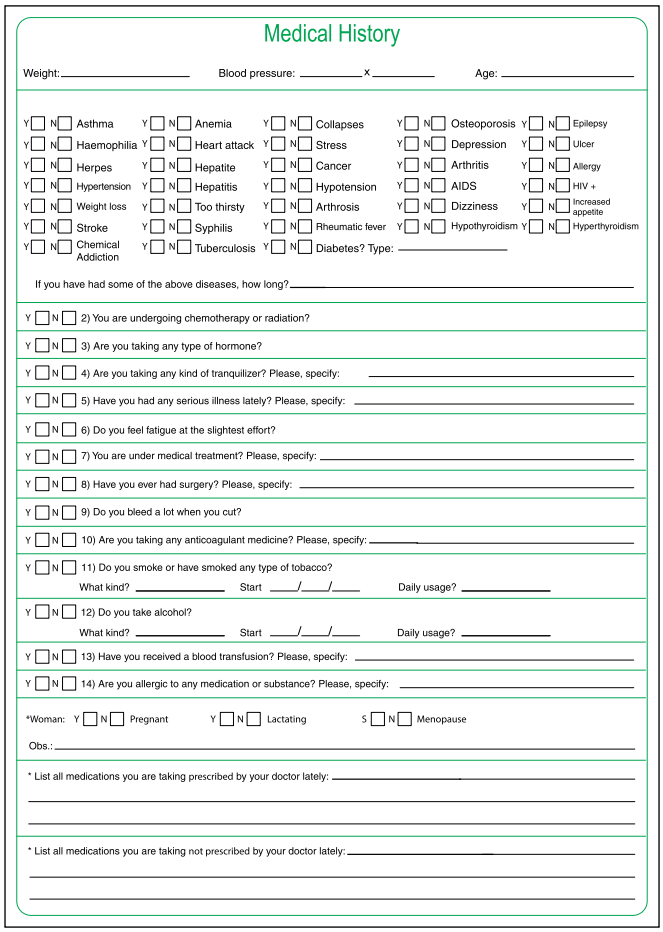
© 2012 Dental Press Implantology

Dental history

The suggested survey is composed of direct questions that aim to record all data related to habits of hygiene, parafunctional, periodontal problems such as gingival mobility and bleeding, reactions to anesthesia, complications in previous dental treatments and performance of treatments from other specialties[19,20] (Fig 3). These data are import so the surgeon dentist has an overview of the patient's oral health condition or, at least, of the perception that the patient has regarding his own oral health.

Examiner's comments

This area located right below the Dental history, allows the addition of extra data collected from the dental or medical history, besides others impressions from the professional that can assist on the diagnosis, planning and execution of the treatment, such as socioeconomic aspects, motivation, expectation of cooperation, intellectual capacity of comprehension of the disease or the treatment or other complementary information collected on the dialogue with the patient and not specified in other areas (Fig 4). This area is also used for that


Medical History

Weight: _____ Blood pressure: _____ x _____ Age: _____

Y ☐ N ☐ Asthma | Y ☐ N ☐ Anemia | Y ☐ N ☐ Collapses | Y ☐ N ☐ Osteoporosis | Y ☐ N ☐ Epilepsy
Y ☐ N ☐ Haemophilia | Y ☐ N ☐ Heart attack | Y ☐ N ☐ Stress | Y ☐ N ☐ Depression | Y ☐ N ☐ Ulcer
Y ☐ N ☐ Herpes | Y ☐ N ☐ Hepatite | Y ☐ N ☐ Cancer | Y ☐ N ☐ Arthritis | Y ☐ N ☐ Allergy
Y ☐ N ☐ Hypertension | Y ☐ N ☐ Hepatitis | Y ☐ N ☐ Hypotension | Y ☐ N ☐ AIDS | Y ☐ N ☐ HIV +
Y ☐ N ☐ Weight loss | Y ☐ N ☐ Too thirsty | Y ☐ N ☐ Arthrosis | Y ☐ N ☐ Dizziness | Y ☐ N ☐ Increased appetite
Y ☐ N ☐ Stroke | Y ☐ N ☐ Syphilis | Y ☐ N ☐ Rheumatic fever | Y ☐ N ☐ Hypothyroidism | Y ☐ N ☐ Hyperthyroidism
Y ☐ N ☐ Chemical Addiction | Y ☐ N ☐ Tuberculosis | Y ☐ N ☐ Diabetes? Type: _____

If you have had some of the above diseases, how long? _____

Y ☐ N ☐ 2) You are undergoing chemotherapy or radiation?
Y ☐ N ☐ 3) Are you taking any type of hormone?
Y ☐ N ☐ 4) Are you taking any kind of tranquillizer? Please, specify: _____
Y ☐ N ☐ 5) Have you had any serious illness lately? Please, specify: _____
Y ☐ N ☐ 6) Do you feel fatigue at the slightest effort?
Y ☐ N ☐ 7) You are under medical treatment? Please, specify: _____
Y ☐ N ☐ 8) Have you ever had surgery? Please, specify: _____
Y ☐ N ☐ 9) Do you bleed a lot when you cut?
Y ☐ N ☐ 10) Are you taking any anticoagulant medicine? Please, specify: _____
Y ☐ N ☐ 11) Do you smoke or have smoked any type of tobacco?
What kind? _____ Start ____/____/____ Daily usage? _____
Y ☐ N ☐ 12) Do you take alcohol?
What kind? _____ Start ____/____/____ Daily usage? _____
Y ☐ N ☐ 13) Have you received a blood transfusion? Please, specify: _____
Y ☐ N ☐ 14) Are you allergic to any medication or substance? Please, specify: _____

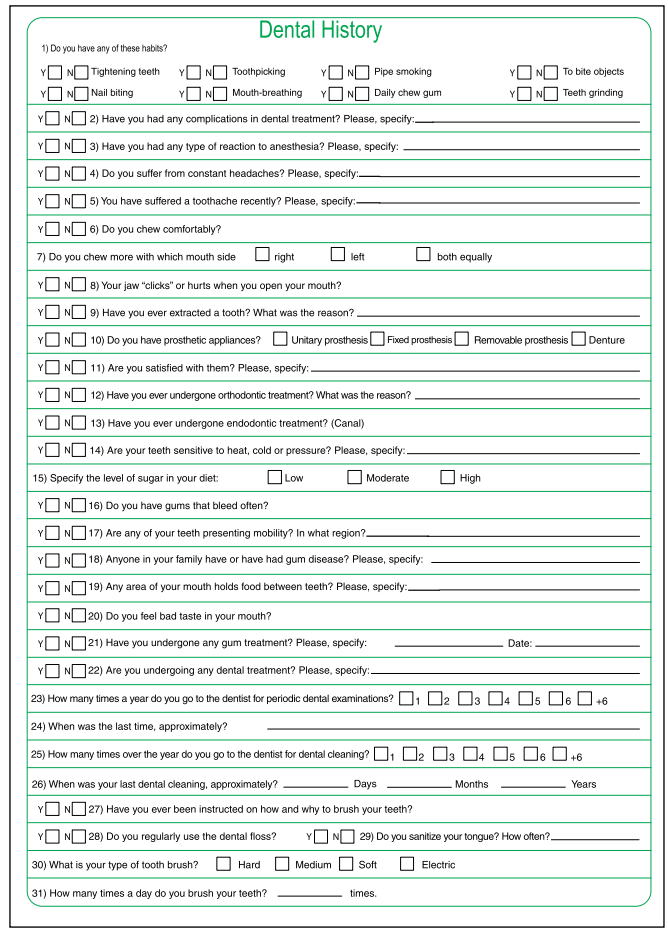
*Woman: Y ☐ N ☐ Pregnant Y ☐ N ☐ Lactating S ☐ N ☐ Menopause

Obs.: _____

* List all medications you are taking prescribed by your doctor lately: _____

* List all medications you are taking not prescribed by your doctor lately: _____

Figure 2 - Medical history.


Dental History

1) Do you have any of these habits?

Y ☐ N ☐ Tightening teeth | Y ☐ N ☐ Toothpicking | Y ☐ N ☐ Pipe smoking | Y ☐ N ☐ To bite objects
Y ☐ N ☐ Nail biting | Y ☐ N ☐ Mouth-breathing | Y ☐ N ☐ Daily chew gum | Y ☐ N ☐ Teeth grinding

Y ☐ N ☐ 2) Have you had any complications in dental treatment? Please, specify: _____
Y ☐ N ☐ 3) Have you had any type of reaction to anesthesia? Please, specify: _____
Y ☐ N ☐ 4) Do you suffer from constant headaches? Please, specify: _____
Y ☐ N ☐ 5) You have suffered a toothache recently? Please, specify: _____
Y ☐ N ☐ 6) Do you chew comfortably?
7) Do you chew more with which mouth side ☐ right ☐ left ☐ both equally
Y ☐ N ☐ 8) Your jaw "clicks" or hurts when you open your mouth?
Y ☐ N ☐ 9) Have you ever extracted a tooth? What was the reason? _____
Y ☐ N ☐ 10) Do you have prosthetic appliances? ☐ Unitary prosthesis ☐ Fixed prosthesis ☐ Removable prosthesis ☐ Denture
Y ☐ N ☐ 11) Are you satisfied with them? Please, specify: _____
Y ☐ N ☐ 12) Have you ever undergone orthodontic treatment? What was the reason? _____
Y ☐ N ☐ 13) Have you ever undergone endodontic treatment? (Canal)
Y ☐ N ☐ 14) Are your teeth sensitive to heat, cold or pressure? Please, specify: _____
15) Specify the level of sugar in your diet: ☐ Low ☐ Moderate ☐ High
Y ☐ N ☐ 16) Do you have gums that bleed often?
Y ☐ N ☐ 17) Are any of your teeth presenting mobility? In what region? _____
Y ☐ N ☐ 18) Anyone in your family have or have had gum disease? Please, specify: _____
Y ☐ N ☐ 19) Any area of your mouth holds food between teeth? Please, specify: _____
Y ☐ N ☐ 20) Do you feel bad taste in your mouth?
Y ☐ N ☐ 21) Have you undergone any gum treatment? Please, specify: _____ Date: _____
Y ☐ N ☐ 22) Are you undergoing any dental treatment? Please, specify: _____
23) How many times a year do you go to the dentist for periodic dental examinations? ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐+6
24) When was the last time, approximately? _____
25) How many times over the year do you go to the dentist for dental cleaning? ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐+6
26) When was your last dental cleaning, approximately? _____ Days _____ Months _____ Years
Y ☐ N ☐ 27) Have you ever been instructed on how and why to brush your teeth?
Y ☐ N ☐ 28) Do you regularly use the dental floss? Y ☐ N ☐ 29) Do you sanitize your tongue? How often? _____
30) What is your type of tooth brush? ☐ Hard ☐ Medium ☐ Soft ☐ Electric
31) How many times a day do you brush your teeth? _____ times.

Figure 3 - Dental history.

alterations of data from medical and dental history, reported in return visits after significant period of time, can be updated, adding them without having to fill out another form. There are specific spaces to record the updates dates.

Complementary exams

Among the complementary exams that may assist on the diagnosis, the radiographs are one of the most frequently required.[21,22] Regarding microbiological tests, they can be requested to assist on specific identification of pathogenic microorganism in the sulcus. These tests provide information that can guide the clinician on the determination of when or which antimicrobial agent could particularly provide a therapeutic benefit to the patient.[23] Laboratorial tests such as hematological analysis (glycemia, clotting time, platelet count), immunoassay and hormonal test are extremely important to assist the management of patients during the treatment of periodontal disease. The laboratorial tests can be required as result of oral findings or when aspects of the treatment can potentially affect the patient's systemic health. Many times, the laboratorial exams are necessary to confirm a systemic disease or monitor its current situation.[24] All required exams, as well as its results must be carefully recorded in this item (Fig 4). There are spaces designated for recording the dates of these exams updates.

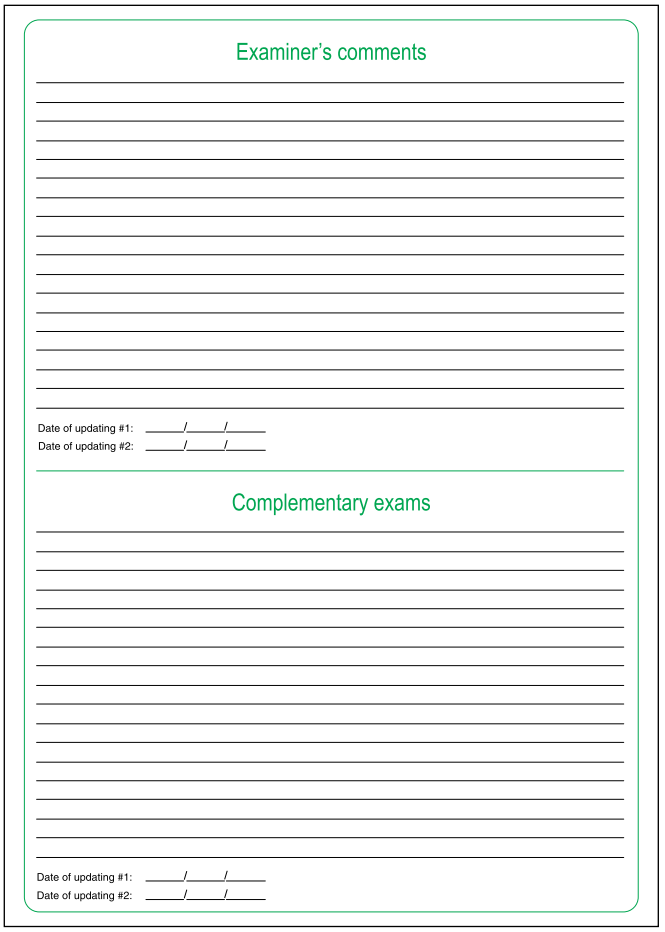


Figure 4 - Examiner's comments and additional exams.

Periodontal chart

The periodontal chart work as a guide for a direct exam and to record the patient's conditions. It is also used to evaluate the response to the treatment and for comparison to posterior visits.[25] The periodontal chart elaborated for this form (Fig 5) enable in a simple and quick way the recording of all periodontal alterations. Through the use of the signs described on the legend, the professional can mark the main clinical findings associated or predisposing to periodontal disease, such as: presence of diastema, open contact, food impaction, excess of restorations margins, degree of commitment of furcation lesions, degree of dental mobility, mesialization or distalization of the dental elements, presence of bleeding on probing, absence of papilla and presence of endodontic lesions. The boards above the dental diagram are designated to measurement of probing depth (PD), recession measure (Re) and amount of gingiva measure (Ge) on the initial appointment and after periodontal therapy. Although the absence of space related to insertion loss, fundamental item on periodontal analysis, it can be obtained through sum of

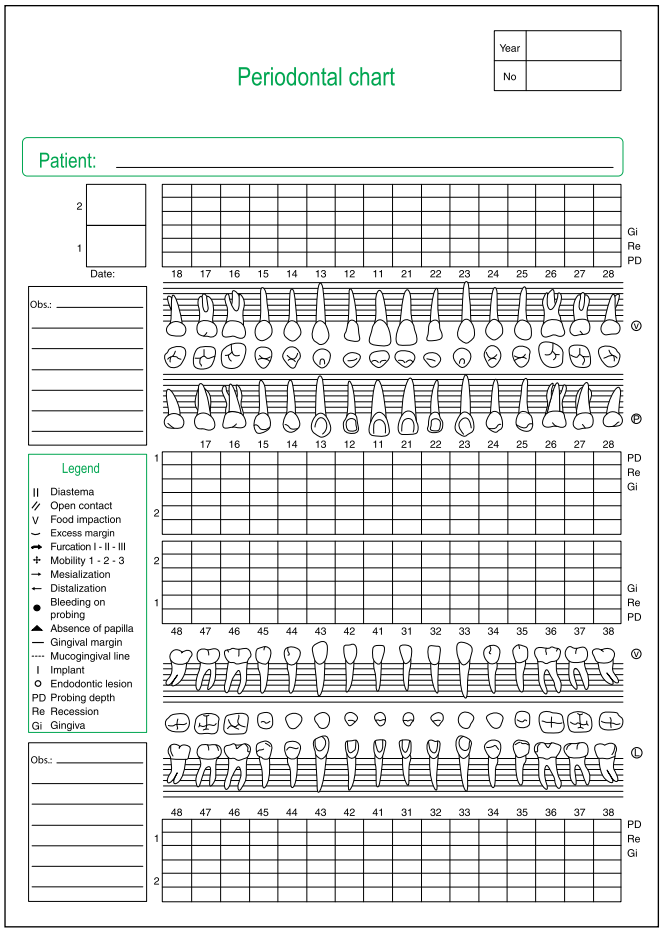


Figure 5 - Periograma.

the recession (if existent) with the probing depth. On the boards denominated "Observations" located below and above the legend, it can be added other explanations about situations not enough graphically clarified. It is emphasized the importance of recording the date of the information note to allow evaluate the evolution of executed treatment on posterior measurements.

Plaque index (O'Leary)

The plaque control record was developed to give the dentist, the sanitarian or the educator a simple method to record the presence of plaque on individual surfaces of the teeth (mesial, distal, buccal, lingual). The record allows the patient to visualize his own progress on plaque control and works as motivator.[26] The index used was the O'leary's due to greater facility to take notes and for the fact of being the one of greater acquaintance among academics.[27] In this space, below the records, it is found the formula for its attainment, facilitating its application in case of unawareness. There is space for six evaluations (Fig 6) that will be recorded on sessions determined by the professional.

Observations

This item is reserved for additional data verified by the examiner concerning the patient's hygiene. Other orientations may be recorded such as brushing technique and frequency or type of suggested toothbrush, new orientations, collaborations and other relevant information (Fig 6).[28,29,30]

Diagnosis

The correct periodontal diagnosis is an essential verification that will determine the efficiency of the treatment. In periodontal practice, the diagnosis is derivative from information obtained on the patient's medical and dental survey combined to findings of a deep oral exam. All signs and symptoms associated to the current condition must be considered before concluding the diagnosis. In some cases, additional information derivative from laboratory exams are useful on the global process of decision-making. Experienced clinicians prefer using the term differential diagnosis which is a list of possible diagnoses for that situation, organized from the most likely to the less likely. This provides the clinician other diagnostic options, in case the initial hypothesis is mistaken (Fig 7).[31]

Prognosis

The prognosis is a preview of the probable course, duration and result of a disease based on general knowledge

© 2012 Dental Press Implantology

of the pathogenesis and in presence of risk factors. It is established after the diagnosis is done and before the treatment plan is determined.[32] It will depend on several factors as disease severity and cooperation from the patient (Fig 7).[31]

Treatment plan

After the diagnosis and prognosis have been established, the treatment plan is instituted, based on collected data from previous items associated to other dental and medical specialties. The treatment plan is the project for management of the case. On periodontal therapy, many times, the treatment plan includes the following decisions: teeth to be kept or extracted, techniques of pocket therapy – surgical or non-surgical that will be used, necessity of occlusal correction, endodontic or orthodontic therapy, necessity of temporary restoration, types of final restorations that will be necessary after periodontal therapy, teeth that will be pillars for the fixed prosthesis, esthetic considerations on periodontal therapy and therapy sequence.[33] The space designated to this item is vast so it can be included several options of possible treatment to that specific case and not only the ideal treatment.[29,34] Informed about all implications and after have done the choice for certain plan, the patient must date and sign on the proper lines (Fig 8).[35]

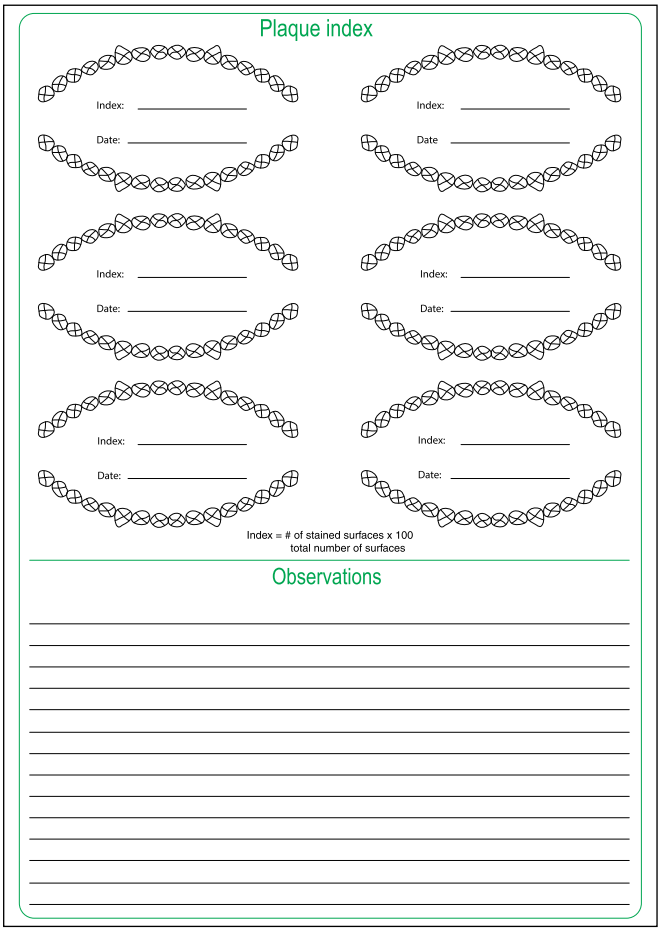


Figure 6 - Plaque index.

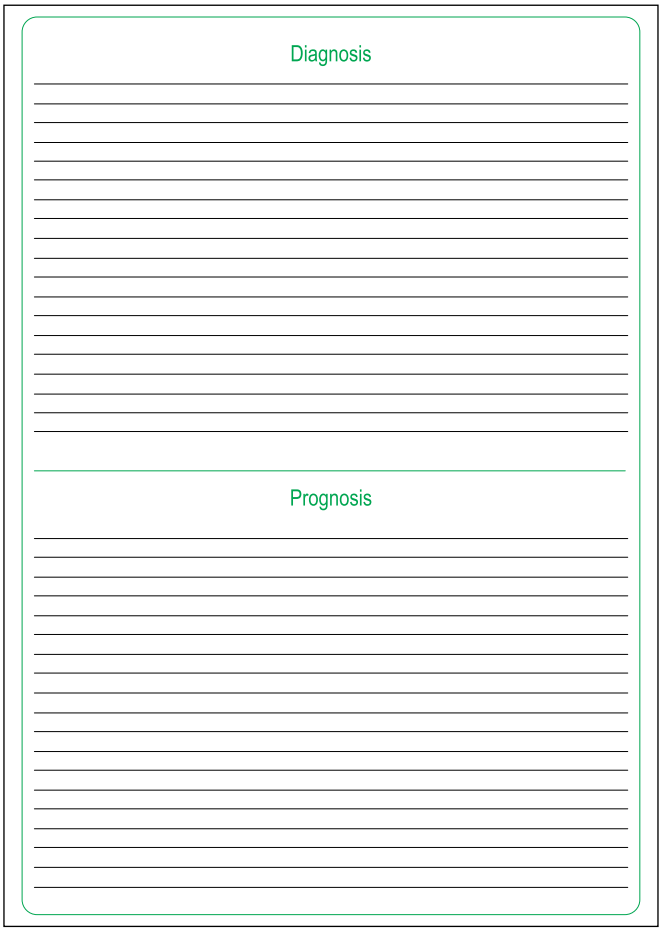


Figure 7 - Diagnosis and prognosis.

Economic plan

In case of private practice or institutions where the patients has to pay any fees, it is important to specify and record the cost of each procedure as well as the total cost of the treatment and the payment options. The patient's signature points his approval to the proposed conditions (Fig 8).

Procedures: It is indispensable on the clinical form the detailed description of performed procedures and used materials during the treatment. Besides, it also must be recorded all typed of occurrences such as: Intervention of other professionals, referral, modifications on the treatment plan and its reason, cases of delays, patient's absences and psychological behavior, hygiene condition and lack of collaboration.[36,37] These data have legal value, as a way to prevent lawsuit, for well elaborated clinical records will allow to explain the professional's situation and define is he executed the correct procedures and conduct (Fig 9).[38] It must be recorded the date and signature of the responsible professional. On the presented form, elaborated for academics purposes, there is space for signature of the student responsible for the procedure.

Figure 8 - Treatment plan.

Envelope

It gathers all data in an organized and convenient way (Fig 10). This envelope illustration has the traditional areas for filling in with the record number, patient's name, treatment initiation year and name of the students that performed the medical care (in case of educational institutions) and assembles a relevant differential on the superior left board: On it will be done, if necessary, an apparent mark aiming to quickly recognize any important situation that needs to be considered during treatment. Laterally there is space to mention the aggravations to be considered. This is extremely functional since, many times, these data, when recorded on the clinical form, can go unnoticed in subsequent visits, especially after a relevant period of time since the initial appointment.

Logo

On figures 1, 5 and 10 it can be noticed the space reserved for logo of the institution or private practice.

Results

The new model of clinical form was developed to offer to professionals and educational institutions a way of data storage that show in a succinct, yet complete, way all relevant and current information for an appropriate periodontal treatment plan (Fig 1-10).

© 2012 Dental Press Implantology

Figure 9 - Description of performed procedures.

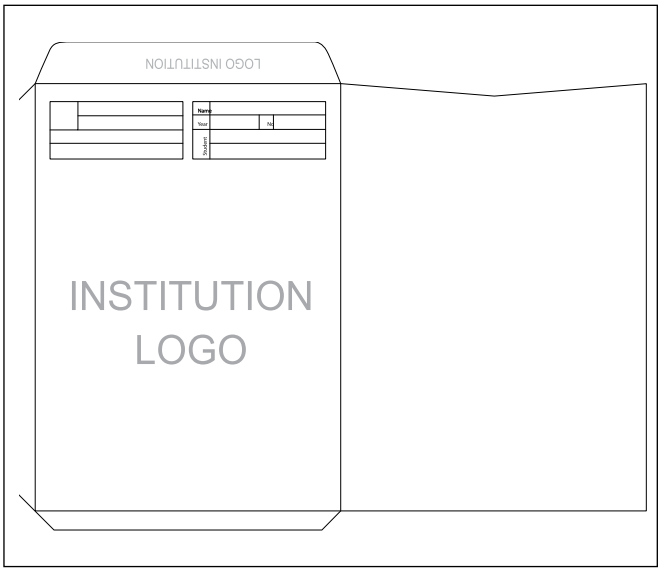


Figure 10 - Envelope.

Discussion

The definition of health, according to the World Health Organization, is not only based on the absence of disease, but on a complete state of physical, mental and social welfare.[39] It is fact that the oral health has serious implications on the human health, therefore a complete and adequate survey is necessary to obtain and record all relevant information for the beginning and progress of an efficient and safe treatment.[15] The periodontal disease, defined as an inflammation of the dental supporting tissues that leads to progressive destruction of bone tissue and periodontal ligament[40] is one of the chronic diseases of greater incidence on the world population today.[41] Even in developed countries it reaches over 85% of the adult population, affecting one or two teeth.[42,43] In Brazil, the percentage of individuals with periodontal disease is of 83% for adults between 35 and 44 years old, achieving 98.2% when considered the elderly between 65 and 74 years old.[44] Being a multifactorial disease, the methodologies used until early last decade did not have a classic standard to determine the illnesses presented by patients, making it difficult to store information due to divergences on the classification.[45-48] However, in 1999 an international meeting defined, in consensus, a new classification of periodontal diseases based mainly on the modulation between microorganism and host, being distributed in multiple categories of disease.[49] This new classification allowed clinicians and researchers to communicate more efficiently about the characteristic of the lesion acquired. This communication is through notes recorded on a periodontal clinic form that, the more

standardized[8] and easy to read, it facilitates the gathering of data allowing multicenter studies to be performed with a greater number of cases and increase the reliability of the presented results. An embracing and simple periodontal form model is of great utility specially for specialists on the beginning of their carriers when the concern with the adequate treatment plan and correct execution of techniques, associated to clinical inexperience may leave aspects prior to treatment such as medical survey and a judicious periodontal chart fill out on a second plan. A study performed in a university of São Paulo[50] verified that during graduation course most of the academics do not entirely fill out the forms for the difficulty to read and interpret or absence of adequate symbology. Another study analyzed the periodontal forms from 10 Brazilian universities and verified the lack of adequacy to didactic and clinical needs of the analyzed forms. As an example it can be mentioned that from all assessed forms, only four presented the item "Medical history", and from these, only one presented it appropriately.[8] The presented form was developed to facilitate its reading and comprehension: an apparent mark on the envelope's superior left board alerts for a supposed main problem (Fig 10). Then, there are items of full identification and medical and dental history with simple terminology (Figs 1, 2, 3). It presents, on the clinical part, a periodontal chart where the dental structures are reported with dental format and not symbols, facilitating the reading and with markings positioned right above the referred teeth (Fig 5). Besides, it offers enough space for observations, diagnosis, prognosis, detailed treatment and economic plans, where the patient's signature is required making it mutual the responsibility for the execution and honoraria of the professional when necessary (Figs 7 and 8). It estimates a space for examiner's comments and complementary exams (Fig 4) that will be recorded and become particularly important in case of switching professionals or demand of other specialties. This form comprises all parameters for the recording of data and its formulation estimate certain versatility that can be adapted to academic purposes or private practice.

Conclusion

In Periodontics, there is a great difficulty to establish a periodontal form model, due to variety of collected data that must be converted systematically in a written and comprehensive treatment plan. When it is assessed the didactic matter, this difficulty is emphasized since it is necessary a form of easy comprehension, simple and that comprises and fulfill the present requirements needed to periodontal exam. Through the analysis of several periodontal forms and study of legal requirements, it was possible to elaborate a complete periodontal form that allows the recording of procedures in a safe way that comprises all clinical data and findings that guide the periodontal treatment.

© 2012 Dental Press Implantology

REFERENCES

1. Lascala NT, Lascala NT Jr. Fichas clínicas periodontais. In: Lascala NT, Moussalli NH. Compêndio terapêutico periodontal. 3a ed. São Paulo: Artes Médicas; 1999. p. 35-41.
2. Wilson TG Jr, Magnusson I. Exame de pacientes para detecção de doenças periodontais. In: Wilson TG, Kornman KS. Fundamentos da periodontia. 1a ed. São Paulo: Quintessence; 2001. p. 195-218.
3. Costa SM, Braga SL, Abreu MHNG, Bonan PRF. Questões éticas e legais no preenchimento das fichas clínicas odontológicas. RGO: Ver Gaucha Odontol. 2009;57(2):211-6.
4. Wolf HF, Rateitschack EM, Rateitschack KH. Exame clínico diagnóstico-prognóstico. In: Wolf HF, Rateitschack EM, Rateitschack KH. Periodontia. 3a ed. Porto Alegre: Artmed; 2004. p. 165-77.
5. Benedicto EN, Lages LHR, Oliveira OF, Silva RHA, Paranhos LR. A importância da correta elaboração do prontuário odontológico. Odonto. 2010;18(36):41-50.
6. American Academy of Periodontology. Sample periodontal office forms. Chicago: AAP; 1996.
7. Silva M, Ramos D, Maruyama N. Alguns comentários sobre ética profissional odontológica. In: Silva MS, organizador. Compêndio de odontologia legal. São Paulo: Medsi; 1997. p. 53-54, 67-68.
8. Motta ACF, Lacerda SA, Komesu MC. Documentação odontológica: aspectos clínicos legais das fichas periodontais utilizadas em faculdades de odontologia brasileiras. Rev Periodontia. 2001;12(4):5-11.
9. Matthews DA, Sledge WH, Lieberman PB. Evaluation of intern performance by medical in patients. Am J Med. 1987;83(5):938-44.
10. Santos JB. Ouvir o paciente: a anamnese no diagnóstico clínico. Brasília Med. 1999;36(3-4):67-8.
11. Brunsvold MA, Nair P, Oates TW Jr. Chief complaints of patients seeking treatment for periodontitis. J Am Dent Assoc. 1999;130(3):359-64.
12. Anzai A, Takaku C, Sato CE, Ribeiro DA, Alencar FAL, Lunardi DB, et al. Prontuário odontológico na clínica odontopediátrica. J Bras Odontopediatr Odontol Bebê. 2003;6(31):250-4.
13. Assaf AV. Fatores de risco para a doença periodontal. Rev Bras Odontol. 1999;56(6):291-4.
14. Randolph WM, Ostir GV, Markides KS. Prevalence of tooth loss and dental service use in older Mexican Americans. J Am Geriatr Soc. 2001;49(5):585-9.
15. Fowler EB, Breault LG, Cuenin MF. Periodontal disease and its association with systemic disease. Mil Med. 2001;166(1):85-9.
16. Van Winkelhoff AJ, Winkel EG, Vandenbrouke-Grauls CM. Periodontitis: a hidden chronic infection. Ned Tijdschr Geneeskd. 2001;145(12):557-63.
17. Gusmão ES, Santos RL, Silveira RCJ, Souza EHA. Avaliação clínica e sistêmica em pacientes que procuram tratamento periodontal. Rev Odonto Ciênc. 2005;20(49):199-203.
18. American Academy of Periodontology. Parameters of care. J Periodontol. 2000;71(5s):847-83.
19. Gallarretaa FWM, Turssib P, Palma-Dibbc RG, Serra MC. Histórico de saúde: atenção a condições sistêmicas e suas implicações, sobretudo nos fatores de risco de cárie: [revisão]. Rev Odonto Ciênc. 2008;23(2):192-6.
20. Buischi YP, Axelsson P. Controle mecânico do biofilme dental realizado pelo paciente. In: Kriger L, editor. ABOPREV - Promoção de saúde bucal. 3a ed. São Paulo: Artes Médicas; 2003. p. 121-39.
21. Langi NP, Hill RW. Radiographs in periodontics. J Clin Periodontol. 1977;4(1):16-28.
22. Hildebolt CF, Pilgram TK, Yokoyama-Crothers N, Fletcher G, Helbig JL, Bartlett TQ, et al. Reliability of linear alveolar bone loss measurements of mandibular posterior teeth from digitized bitewing radiographs. J Clin Periodontol. 1998;25(11):850-6.
23. Loomer PM. Microbiological diagnostic testing in the treatment of periodontal diseases. Periodontol 2000. 2004;34(1):49-56.
24. Mariotti A. Laboratory testing of patients with systemic conditions in periodontal practice. Periodontol 2000. 2004; 34(1): 84-108.
25. Takei HH. Tratamento da doença periodontal. In: Newman MG, Takei HH, Klokkevold PR, Carranza FA. Periodontia clínica. Rio de Janeiro: Elsevier; 2007. p 540-60.
26. O´Leary TJ, Drake RB, Naylor JE. The plaque control record. J Periodontol. 1972;43(1):38-40.
27. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and Severity. Acta Odontol Scand. 1963;21:533-51.
28. Gomes MA, Candelária LF, Silva M. Aspectos legais da prevenção das doenças bucais em relação a documentação profissional. Rev Paul Odontol. 1997;19(1):18-28.
29. Silva M. Documentação em Odontologia e sua importância jurídica. Odontol Soc. 1999;1(1-2):1-3.
30. Silva M. Os dez mandamentos da documentação a ser realizada num consultório odontológico. Rev ABO Nac. 2000;8(1):42-4.
31. Armitage GC. Periodontal diagnoses and classification and periodontal diseases. Periodontol 2000. 2004;34(1):9-21.
32. Novak KF, Goodman SF, Takei HH. Determinação do Prognóstico. In: Newman MG, Takei HH, Klokkevold PR, Carranza FA. Periodontia clínica. Rio de Janeiro: Elsevier; 2007. p. 614-25.
33. Armitage GC. The complete periodontal examination. Periodontol 2000. 2004;34:22-3.
34. Németh G, Paula LM, Varella MA, Angeletti P. Prontuário odontológico na clínica de cursos de Odontologia. Rev ABENO. 2001;1(1):77-81.
35. Paranhos LR, Salazar M, Ramos AL, Siqueira DF. Orientações legais aos cirurgiões-dentistas. Odonto. 2007;15(30):55-62.
36. Ramos DLP. Ética odontológica: o Código de Ética Odontológica (Resolução CFO 179/91) comentado. São Paulo: Ed. Santos; 1994.
37. Eckstein EC. Dental office record keeping and its impact on anticipated litigation. Compendium. 1993;14(5):590, 593-5, 598 passim.

© 2012 Dental Press Implantology

38. Ramirez AIC. Legislacion y Odontologia. Dent Paciente. 1992;1(8):12-4.
39. Nutbeam D. Health promotion glossary. In: Pan American Health Organization, organizador. Health promotion: an anthology. Washington: Pan American Health Organization; 1996; p. 343-59.
40. American Academy of Periodontology. Glossary of periodontal terms. Chicago: American Academy of Periodontology; 2001.
41. Grollmus ZC, Chávez MC, Donat FJ. Periodontal disease associated to systemic genetic disorders. Med Oral Patol Oral Cir Bucal. 2007;12:211-5.
42. Dye BA. Global periodontal disease epidemiology. Periodontol 2000. 2012 Feb;58(1):10-25.
43. Holtfreter B, Schwahn C, Biffar R, Kocher T. Epidemiology of periodontal diseases in the study of health in Pomerania. J Clin Periodontol. 2009;36(2):114-23.
44. Brasil. Ministério da Saúde. Pesquisa Nacional de Saúde Bucal – 2010. Nota para a imprensa. Brasília, 28 de dezembro de 2010. Disponível em: http://observasaude.fundap.sp.gov.br/BibliotecaPortal/Acervo/Sa%C3%BAde%20Bucal/SB_NI_2010dez28.pdf. Acesso em: 08 out 2011.
45. Russel AL. A system of classification and scoring for prevalence surveys of periodontal disease. J Dent Res. 1956;35:350-9.
46. Ainamo J, Barmes D, Beagrie G, Cutress T, Martin J, Sardo-Infirri J. Development of the World Health Organization (WHO) community periodontal index of treatment needs (CPITN). Int Dent J. 1982;32:281-91.
47. American Academy of Periodontology. Proceedings of the World Workshop in Clinical Periodontics. Chicago: American Academy of Periodontology. 1989;I:23-4.
48. Attström R, Van Der Velden U. Consensus report (epidemiology). In: Lang NP, Karring T, editors. Proceedings of the 1st European Workshop on Periodontics, 1993. London: Quintessence; 1994. p. 120-6.
49. Armitage GC. Development of a classification system for periodontal diseases and conditions. International Workshop for a Classification of Periodontal Diseases and Conditions. Ann Periodontol. 1999;4(1):1-6.
50. Brihy M. Avaliação do preenchimento das fichas de exame clínico usadas nas Disciplinas de Odontologia comparando-as com as da Disciplina de Clínica Integrada (Ficha nova-UNIP). Rev Inst Ciênc Saúde. 1997;15(Nº Especial):27-30.

© 2012 Dental Press Implantology

Crown cementation over implant

Lucas **LIMA***

We evaluate our clinical everyday under various clinical aspects, using our ability to achieve maximum technical details and turning them into actual art capturing the moment by means of photography.

Photograph data:
» Canon EOS Rebel T1i
» Focal length: 55
» *F*: 13
» Exposure Time: 1/320'

How to cite this article: Lima L. Crown cementation over implant. Dental Press Implantol. 2012 Apr-June;6(2):104-5.

Contact address

Lucas Lima
Av. Marechal Deodoro 521, Araés
Zip Code: 78.005-505 – Cuiabá/MT – Brazil
E-mail: drlucaslima@hotmail.com

Submitted: 04/13/2012
Revised and accepted: 04/16/2012

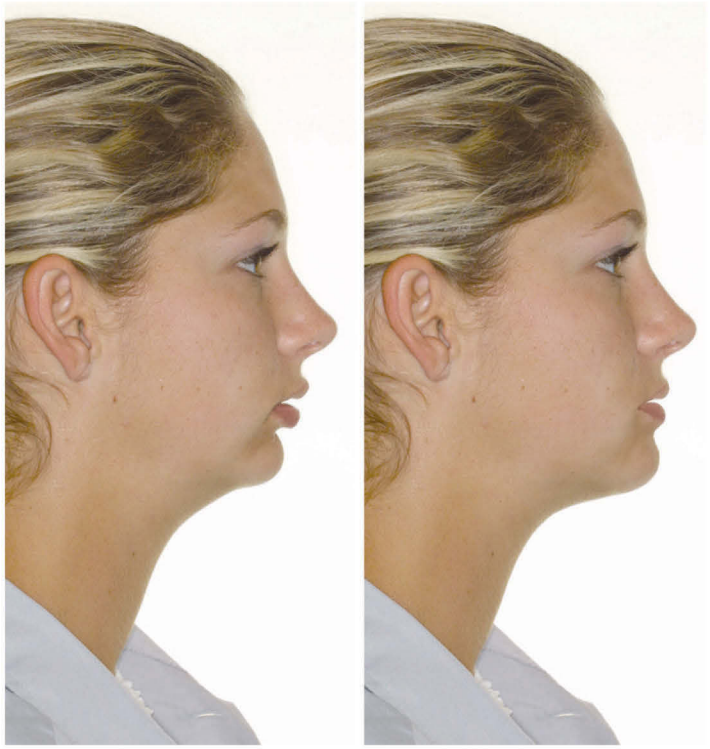
* Graduated in Dentistry, Universidade do Sagrado Coração (USC - Bauru). Specialist in Orthodontics, UNIC-Cuiabá. Specialist in Implantology, PROFIS-Bauru. Professor of specialization courses in Orthodontics, Darwin Institute of Dentistry, Cuiabá. MSc student of Implantology, São Leopoldo Mandic-Campinas.

© 2012 Dental Press Implantology

© 2012 Dental Press Implantology

Dolphin Imaging 11

ImagingPlus™ • Ceph Tracing • **Treatment Simulation** • AnywhereDolphin.com • 3D • Letter System

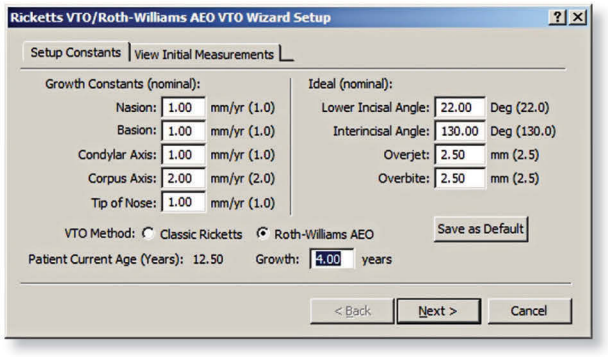


Simulação cirúrgica

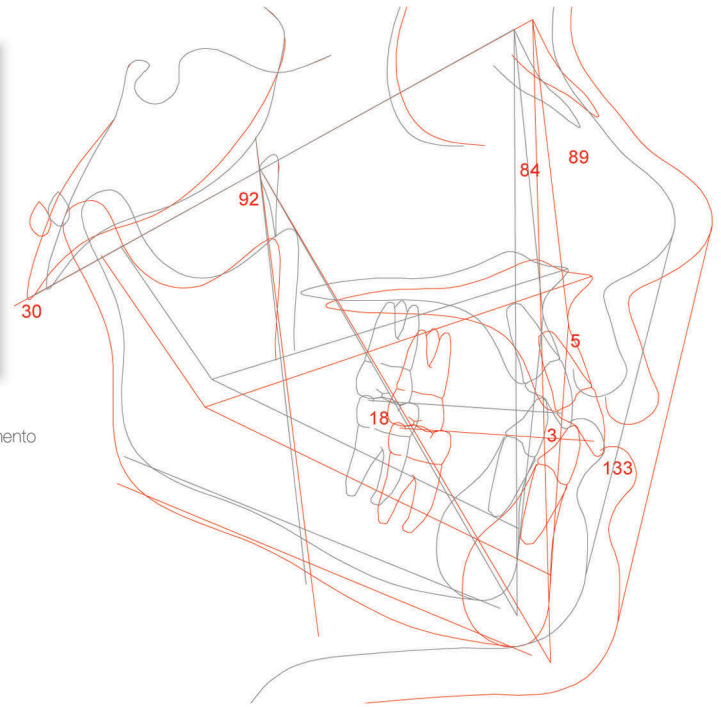
Ver e alcançar.

- Novos aplicativos!
- Nova Prescrição de VTO Roth/Ricketts
- Adotado pelo Grupo de Educação Avançada em Ortodontia (Roth/Williams)

Visualize resultados para seu preciso plano de tratamento e apresentação de caso. Os aplicativos otimizados da versão Dolphin Imaging 11.0 oferecem novas ferramentas como a prescrição de VTO Roth/Ricketts. A simples programação passo a passo reduz e facilita o trabalho necessário para realizar adequada e sistematicamente o diagnóstico e tratamento de pacientes. Para saber mais, acesse: www.dolphinimaging.com/imaging ou contate: comercial@renovatio3.com.br / fone: +11 3286.0300.



VTO AEO/Roth para paciente em crescimento



RENOVATIO
Distribuidor e Serviços Dolphin no Brasil

Microsoft GOLD CERTIFIED Partner

Dolphin Imaging & Management Solutions

20 Years of Excellence

© 2009 Dolphin Imaging & Management Solutions

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

Dario Augusto Oliveira **MIRANDA***

Effect of interimplant distance (2 and 3 mm) on the height of interimplant bone crest: a histomorphometric evaluation

Elian N, Bloom M, Dard M, Cho SC, Trushkowsky RD, Tarnow D. *Effect of interimplant distance (2 and 3 mm) on the height of interimplant bone crest: a histomorphometric evaluation.* J Periodontol. 2011 Dec;82(12):1749-56. Epub 2011 Mar 29.

Background

Implants restored according to a platform-switching concept (implant abutment interface with a reduced diameter relative to the implant platform diameter) present less crestal bone loss than implants restored with a standard protocol. When implants are placed adjacent to one another, this bone loss may combine through overlapping, thereby causing loss of the interproximal height of bone and papilla. The present study compares the effects of two interimplant distances (2 and 3 mm) on bone maintenance when bone-level implants with platform-switching are used.

Methods

This study evaluates marginal bone level preservation and soft tissue quality around a bone-level implant after 2 months of healing in minipig mandibles. The primary objective is to evaluate histologically and histomorphometrically the affect that an implant design with a horizontally displaced implant-abutment junction has on the height of the crest of bone, between adjacent implants separated by two different distances.

Results

Results show that the interproximal bone loss measured from the edge of the implant platform to the bone crest was not different for interimplant distances of 2 or 3 mm. The horizontal position of the bone relative to the microgap on platform level (horizontal component of crestal bone loss) was 0.31 ± 0.3 mm for the 2 mm interimplant distance and 0.57 ± 0.51 mm above the platform 8 weeks after implantation for the 3 mm interimplant distance.

Conclusions

This study shows that interimplant bone levels can be maintained at similar levels for 2 and 3 mm distances. The horizontally displaced implant-abutment junction provided for a more coronal position of the first point of bone-implant contact. The study reveals a smaller horizontal component at the crest of bone than has been reported for non-horizontally displaced implant-abutment junctions.

* PhD in Implantology, São Leopoldo Mandic. MSc, University of Illinois, Chicago. Professor, UEFS.

© 2012 Dental Press Implantology

A Retrospective Analysis of Implants Immediately Placed in Sites With and Without Periapical Pathology in Sixty-Four Patients

Fugazzotto PA. *A retrospective analysis of implants immediately placed in sites with and without periapical pathology in sixty-four patients.* J Periodontol. 2012;83(2):182-6. Epub 2011 May 31.

Many patients requiring implant therapy present with hopeless teeth exhibiting periapical pathology. The advisability of implant placement in such situations has not been conclusively determined. Methods: Sixty-four patients underwent therapy in their maxillary incisor region. Treatment consisted of immediate implant placement in a site demonstrating periapical pathology, and immediate implant placement in a ''pristine'' site, either during the same visit or during separate visits. The implants placed in the sites demonstrating periapical pathology were followed in function for 117 months, with a mean time in function of 64 months. The implants placed in pristine sites were followed in function for 120 months, with a mean time in function of 62 months. Results: Two implants in the central incisor positions of one patient demonstrated 2 mm of buccal recession after 46 months in function. These implants were deemed esthetic failures, despite the absence of inflammation and continued clinical implant immobility, yielding cumulative survival rates of 98.1 and 98.2 for implants placed in sites with periapical pathology and implants placed in sites without periapical pathology, respectively, according to published criteria. Conclusions: Implants immediately placed in sites demonstrating periapical pathology yielded results comparable to those immediately placed in pristine sites. The difference in survival rates was not statistically significant. J Periodontol 2012;83:182-186.

Variability observed in mechano-regulated in vivo tissue differentiation can be explained by variation in cell mechano-sensitivity

Khayyeri H, Checa S, Tägil M, Aspenberg P, Prendergast PJ. *Variability observed in mechano-regulated in vivo tissue differentiation can be explained by variation in cell mechano-sensitivity.* J Biomech. 2011 Apr 7;44(6):1051-8. Epub 2011 Mar 5.

Computational simulations of tissue differentiation have been able to capture the main aspects of tissue formation/regeneration observed in animal experiments—except for the considerable degree of variability reported. Understanding and modelling the source of this variability is crucial if computational tools are to be developed for clinical applications. The objective of this study was to test the hypothesis that differences in cell mechanosensitivity between individuals can explain the variability of tissue differentiation patterns observed experimentally. Simulations of an experiment of tissue differentiation in a mechanically loaded bone chamber were performed. Finite element analysis was used to determine the biophysical environment, and a lattice-modelling approach was used to simulate cell activity. Differences in cell mechanosensitivity among individuals were modelled as differences in cell activity rates, with the activation of cell activities regulated by the mechanical environment. Predictions of the tissue distribution in the chambers produced the two different classes of results found experimentally: (i) chambers with a layer of bone across the chamber covered by a layer of cartilage on top and (ii) chambers with almost no bone, mainly fibrous tissue and small islands of cartilage. This indicates that the differing cellular response to the mechanical environment (i.e., subject-specific mechanosensitivity) could be a reason for the different outcomes found when implants (or tissue engineered constructs) are used in a population.

© 2012 Dental Press Implantology

Predatory bacteria: A future biological antimicrobial agent?

Van Essche M, Quirynen M, Sliepen I, Loozen G, Boon N, Van Eldere J, Teughels W. *Killing of anaerobic pathogens by predatory bacteria*. Mol Oral Microbiol. 2011 Feb;26(1):52-61. Epub 2010 Nov 18.

Bdellovibrio and like organisms (Balos) can attack and kill gram-negative bacteria. The present study suggests that Balos could be potential living biological antibiotics for the prevention and treatment of periodontitis. Since almost all periodontal pathogens are gram-negative, ideally they should all be susceptible to predation of Balos. On the other hand, commensal and / or gram-positive beneficial microbiota must be resistant to predation of Balos. The potential antimicrobial activity of various Balos — also known as predatory bacteria — was studied against: 1) several major periodontal pathogens and 2) Agregatibacter actinomycetemcomitans (Aa) in combination with the non-target microorganism Actinomyces naeslundii (An) (decoy). Thus, six strains were tested in BALO Aa [Porphyromonas gingivalis (Pg), Prevotella intermedia (Pi), Fusobacterium nucleatum (Fn), Sputigena Capnocytophaga (Cs), Eikenella corrodens (Ec)], An-Aa [Porphyromonas gingivalis (Pg) , Prevotella intermedia (Pi), Fusobacterium nucleatum (Fn), Capnocytophaga sputigena (Cs), Eikenella corrodens (Ec)] and An. Bdellovibrio bacteriovorus HD100 proved to be the most versatile predator, reducing the viability of four of the six pathogens tested. Significant reductions in the viability of the pathogen reached by Balos reached 3.04 log10 Aa, 2.99 log10 for Ec, 2.70 log10 Fn, and 1.03 log10 Pi. The second part of the study revealed no differences in Bdellovibrio bacteriovorus HD100 predatory efficacy in a mixture of biofilm when different ratios of extract (Aa) against decoy (An) were tested. The overall results suggest that oral administration of BALO strains in high concentrations of inoculum has the potential to quickly decrease the numbers of a wide range of periodontal pathogens from the mixed oral microbiota. Thus, the results of this research support the ongoing research on predatory therapy for the development of an adjunct to standard periodontal therapy.

Minimally rough implant surfaces favor the repair in experimental defects of peri-implantitis

Albouy JP, Abrahamsson I, Persson LG, Berglundh T. *Implant surface characteristics influence the outcome of treatment of peri-implantitis: an experimental study in dogs.* J Clin Periodontol. 2011 Jan;38(1):58-64. Epub 2010 Nov 24.

Implant surfaces favor the repair of peri-implant experimental defects. In this article, the third of a series of this research group, it was investigated the characteristics of different oral implant surfaces and their effects on surgical treatment of peri-implantitis without antibiotics. In an in vivo study in dogs, four types of implants were used representing four different surface characteristics: type A = smooth (Biomet 3i), type B = TiOblast (Astra Tech AB), type C = SLA (Straumann AG), and type = D TiUnite (Nobel Biocare AB). Each one was placed on the left side of the mandible in six Labrador dogs. Three months after implant healing, experimental peri-implantitis was started by placing bands over a period of 12 weeks until 40 to 50% of bone loss had occurred. Four weeks later, the surgical treatment included full thickness flaps, removal of granulation tissue and mechanical cleaning of the surfaces of the implant using curettes and sterile saline solution in a gauze. No antibiotic regimen was instituted. After 12 to 18 weeks of surgery, the dogs were sacrificed and tissue blocks collected. Radiographs from

© 2012 Dental Press Implantology

the beginning, 12 weeks and 36 weeks (18 weeks after surgery) were analyzed; clinical measures were not included. The results showed that the plate control exerted during post-surgical treatment improved the clinical symptoms of inflammation in the implant types A, B and C, while in the type D, the swelling and redness in the peri-implant mucosa persisted. In addition, three D-type implants were lost during follow-up. Radiographic bone gain was observed between weeks 12 and 36 of implant type A (2.22 ± 1.49 mm), Type B (1.59 ± 1.51 mm) and type C (0.89 ± 1.50 mm). In type D, however, additional bone loss 1.83 ± 2.37 mm did not occur. The difference between implant types A and D were statistically significant. The findings of this research were: 1) the resolution of peri-implantitis without systemic or local antimicrobial therapy is possible, and 2) the outcome of the therapy is influenced by characteristics of the implant surface in favor of minimally rough surfaces. Although bone mass gain observed following surgery for treatment of peri-implantitis with implant types A, B and C appear promising, the results should be interpreted cautiously because the process of healing in dogs can be different from humans beings.

© 2012 Dental Press Implantology

— **Dental Press Implantology** publishes scientific research articles, significant reviews, clinical case reports and techniques, brief communications and other materials related to Periodontics and Implantology.

— **Dental Press Implantology** uses the Publication Management System, an online system for submission and evaluation of works. To submit new works visit the website: www.dentalpressjournals.com.br

— Other types of correspondence it may be sent to:
Dental Press International
Av. Euclides da Cunha 1718, Zona 5
Zip code: 87.015-180, Maringá/PR – Brazil
Phone: +55 (44) 3031-9818
E-mail: artigos@dentalpress.com.br

— Statements and opinions expresses by the author(s) does/do not necessarily correspond to those of editor(s) or publisher who will not assume responsibility for them. Neither editor(s) nor publisher guarantee or endorse any product or service advertised in this publication or allegation made by the respective manufacturers. Each reader must determine whether or not to act according to the information contained in this publication. Journal or sponsoring companies will not be responsible for any damage arising from the publication of erroneous information.

— Works submitted must be original and not published or submitted for other journal. Manuscripts will be reviewed by the editor and consultants, and are subject to editorial review. Authors should follow the guidelines described below.

GUIDELINES FOR SUBMISSION OF MANUSCRIPTS

— Works must be submitted in English and Portuguese.

— Despite being officially published in English, Dental Press Implantology also has a version in Portuguese. Therefore, submissions of article in Portuguese are also accepted.

— In this case, the authors should also send the version in English of the article with proper vernacular quality and content identical to the version in Portuguese, so that work may be considered approved.

FORMAT OF THE MANUSCRIPTS

— Submit items for the website:
www.dentalpressjournals.com.br
— Organize your presentation as described aside

1. Authors

— The number of authors is unlimited; however, articles with more than 4 authors shall inform the participation of each author in the execution of the work.

2. Title page

— It must contain title, abstract, keywords in Portuguese and English.
— Information on the identification of authors (e.g.: authors' full names, academic degrees, institutional affiliations and / or administrative positions) must not be included. They should be included only in specific fields in the article submission website. Thus, this information will not be available to reviewers.

3. Abstract

— Structured abstracts in Portuguese and English of 250 words or less are preferred.
— Structured abstracts must contain the following sections: INTRODUCTION, with the proposition of the study; METHODS, describing how it was conducted; RESULTS, describing the primary results; and CONCLUSIONS, reporting the conclusions of the study and the clinical implications of the results.
— Abstracts must be accompanied with 3 to 5 keywords, also in Portuguese and English, adapted in accordance to DeCS (http://decs.bvs.br/) and MeSH (www.nlm.nih.gov/mesh) guidelines.

4. Text

— Text must be organized into the following sections: Introduction, Material and Methods, Results, Discussion, Conclusions, References and Figure legends.
— Text must have a maximum of 3,500 words, including figure and table legends (excluding the data of tables), abstract and references.
— Figures must be sent in separate files (see below).
— Insert figure legends also in the text, to guide the final assembly of the article.

5. Figures

— Digital images must be in JPG or TIF format, in CMYK or grayscale, with at least 7 cm width and 300 DPI of resolution.
— Images must be sent in separate files.
— If a figure has been published previously, the legend must give full credit to the original source.
— All figures must be cited in the text.

6. Graphics and cephalometric tracings

— They must be cited in the text as figures.
— Files containing the original versions of graphics and tracings must be sent, in the programs that were used for their confection.
— Sending them only in bitmap image format is not recommended (not editable).
— Drawings submitted can be improved or redesigned for the production of the journal, at the discretion of the Editorial Board.

7. Tables

— Tables must be self-explanatory and complementary and not duplicate the text.
— They should be numbered with Arabic numerals in the order they are mentioned in the text.

© 2012 Dental Press Implantology

— Supply a brief title for each table.
— If a table has been previously published, include a footnote giving credit to the original source.
— Submit tables as a text file (e.g., Word or Excel), and not as graphic element (image not editable).

8. Ethics Committees

— Articles must make refer to the opinion of the Ethics Committee of the institution, if applicable.

9. Statements required

All manuscripts must be accompanied with the following statements to be filled at the time of submission of the article:

— Cession of Copyright
Transferring the copyright of the manuscript for Dental Press, if the work is published.
— Conflict of Interest
If there is any interest of authors to the object of work research, this must be clarified.
— Protection of Human and Animal Rights
If applicable, inform the compliance of the recommendations of the international protection bodies and the Declaration of Helsinki, respecting the ethical standards of the responsible committee on human/animal experimentation.
— Permission for using copyrighted images
Original or modified illustrations or tables of copyrighted material must be accompanied by the owners' permission to use these rights and the original author (and the legend must provide correctly credit to the source).
— Informed Consent
Patients have a right to privacy that should not be violated without informed consent. Photographs of identifiable persons must be accompanied by an authorization signed by the person or parents or guardians in the case of under age. These authorizations must be saved indefinitely by the author responsible for the article. Cover sheet should be sent stating the fact that all patients' authorizations were obtained and are in possession of the corresponding author.

10. References

— All articles cited in the text must be included in the reference list.
— All references must be cited in the text.
— To facilitate the reading, the references are cited in the text only indicating their numbering.
— References should be identified in the text by superscript Arabic numerals and numbered in the order they are cited.
— Abbreviations of journal titles must be standardized according to the "Index Medicus" and "Index to Dental Literature" publications.
— Accuracy of references is the responsibility of the authors and they must include all information needed for their identification.
— References must be listed at the end of the text meeting the Vancouver Standards (http://www.nlm.nih.gov/bsd/uniform_requirements.html).
— Use the following examples:

Articles with up to six authors

Sterrett JD, Oliver T, Robinson F, Fortson W, Knaak B, Russell CM. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. J Clin Periodontol. 1999 Mar;26(3):153-7.

Articles with more than six authors

De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M, et al. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res. 2005 Feb;84(2):118-32.

Chapter of Book

Kina S. Preparos dentários com finalidade protética. In: Kina S, Brugnera A. Invisível: restaurações estéticas cerâmicas. Maringá: Dental Press; 2007. cap. 6, p. 223-301.

Chapter of book with editor

Breedlove GK, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services; 2001.

Dissertation, thesis and completion of course work

Beltrami LER. Braquetes com sulcos retentivos na base, colados clinicamente e removidos em laboratórios por testes de tração, cisalhamento e torção [dissertação]. Bauru (SP): Universidade de São Paulo; 1990.

Electronic format

Câmara CALP. Estética em Ortodontia: Diagramas de Referências Estéticas Dentárias (DRED) e Faciais (DREF). Rev Dental Press Ortod Ortop Facial. 2006 nov-dez;11(6):130-56. [Accessed on 2008 Jun 12]. Available at: www.scielo.br/pdf/dpress/v11n6/a15v11n6.pdf.